Journal of Archaeological Science: Reports 51 (2023) 104142

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

journal homepage: www.elsevier.com/locate/jasrep

Mobility and connection among the Early Bronze Age Syrian elite

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A B S T R A C T

The archaeological site of Umm el-Marra (in the Jabbul plain, western Syria), is a large, fortified urban center. Excavations have uncovered ten tomb structures built during the Early Bronze Age (ca. 2600–2150 BCE) that possibly contain royalty as evidenced by lavish grave goods and paleopathological evidence suggesting sociocultural buffering from the harsh social and physical environments of agricultural urban centers in the Bronze Age Near East. Inside adjacent brick installations are animal (primarily equid) skeletons interpreted as interments, possibly sacrifices in some instances, as part of ceremonies honoring the entombed. The burial site was eventually re-used as evidenced by a monumental platform above the tombs, interpreted as use for ritual activities of ancestor veneration.

This study analyzed $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values from enamel of 13 individuals interred in these tombs, along with enamel and bone samples from animals found in and around the tomb structures. Six of 13 (43 %) individuals analyzed in these tombs are identified as non-locals. Although contemporaneous data in the northern Levant is scarce, we see much higher evidence of human movement at Umm el-Marra compared to others. Only elites are included in this study, but their relative mobility might imply that the ancient city established its position as a secondary center along major trade routes through intermarriage and connectivity. The concept of 'social memory' is evident, as the lives and deaths of these elites are integrated into this site where ancestor veneration is evidenced in centuries following interment.

1. Introduction

Elite tombs at Umm el-Marra are focal centers on the Jabbul Plain in northern Syria, centered in the settlement that would have visibly dominated this landscape (Schwartz 2012b). Venerated in the centuries following their death, the elites interred in these tombs became a collective representation of the settlement. These permanent monuments on the Jabbul Plain dominated both the physical and political landscapes (Schwartz 2016; Schwartz 2023; Schwartz 2013). During the Early Bronze Age (EBA, ca. 3000–2000 BCE) and Middle Bronze Age (MBA, ca. 2000–1550 BCE) this city was a smaller polity on the crossroads of major powers such as Ebla and Mari but maintained local dominance as a secondary settlement and ritual center (Schwartz et al. 2012).

How did the rulers of this settlement create and maintain power in life? Were these elites all local to this secondary settlement, or did migration aid in securing power and wealth? In this paper, $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ from human tooth enamel are analyzed from the elites buried at Umm el-Marra in western Syria during the EBA. Isotopic methodologies allow the investigation of interconnectivity and movement in the ancient Near East (Gregoricka et al. 2020; Ingman et al. 2021; Perry et al. 2017; Stantis et al. 2020). $\delta^{15}N$ and $\delta^{13}C$ are utilized as evidence of paleodiet. In some instances where traditional 'paleomobility' isotopes were unsuccessful in identifying non-locals due to homogeneity of isotopic compositions in the physical environments, dietary differences have been used to investigate geographic origins where available foods and/or food preferences demarcated regions of study (Cheung et al., 2017; Stantis et al., 2016).

1.1. The site

Umm el-Marra (36.134, 37.694) is the largest site on the Jabbul Plain in the Bronze Age at a size of roughly 20–25 ha (Fig. 1). This settlement bears evidence of occupation from the mid-third millennium through

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https://doi.org/10.1016/j.jasrep.2023.104142
Received 21 February 2023; Received in revised form 18 July 2023; Accepted 23 July 2023
Available online 7 August 2023

the late second millennium BCE before temporary abandonment, followed by small-scale re-occupations in the later Persian, Hellenistic, and Roman periods (Curvers et al. 1997a; Schwartz et al. 2012). Located in northwest Syria between Aleppo, Ebla, and the Euphrates Valley, this urban center may have been a gateway city along a trade route (Schwartz et al. 2003; Schwartz et al. 2012). Given its size, Umm el-Marra is interpreted to be a secondary urban center—larger than the surrounding villages on the plains which are less than 10 ha in size, but smaller than the larger cities of Ebla and Aleppo.

Because of its position and size, it has been posited that Umm el-Marra might be the ancient city of Tuba, capital of a small kingdom in the EBA and MBA, mentioned in texts from Ebla as a subservient administrative node to the larger kingdom (Matthiae 1979). Regardless of its ancient name or political connections, Umm el-Marra would have been a fortified regional center visible in the surrounding landscape during the height of its power (Dolce 2014).

1.2. The elite tombs

Joint excavations between Johns Hopkins (USA) and University of Amsterdam (Netherlands) have revealed an elite mortuary complex in the Acropolis Center, with ten tombs built during the EBA. With their

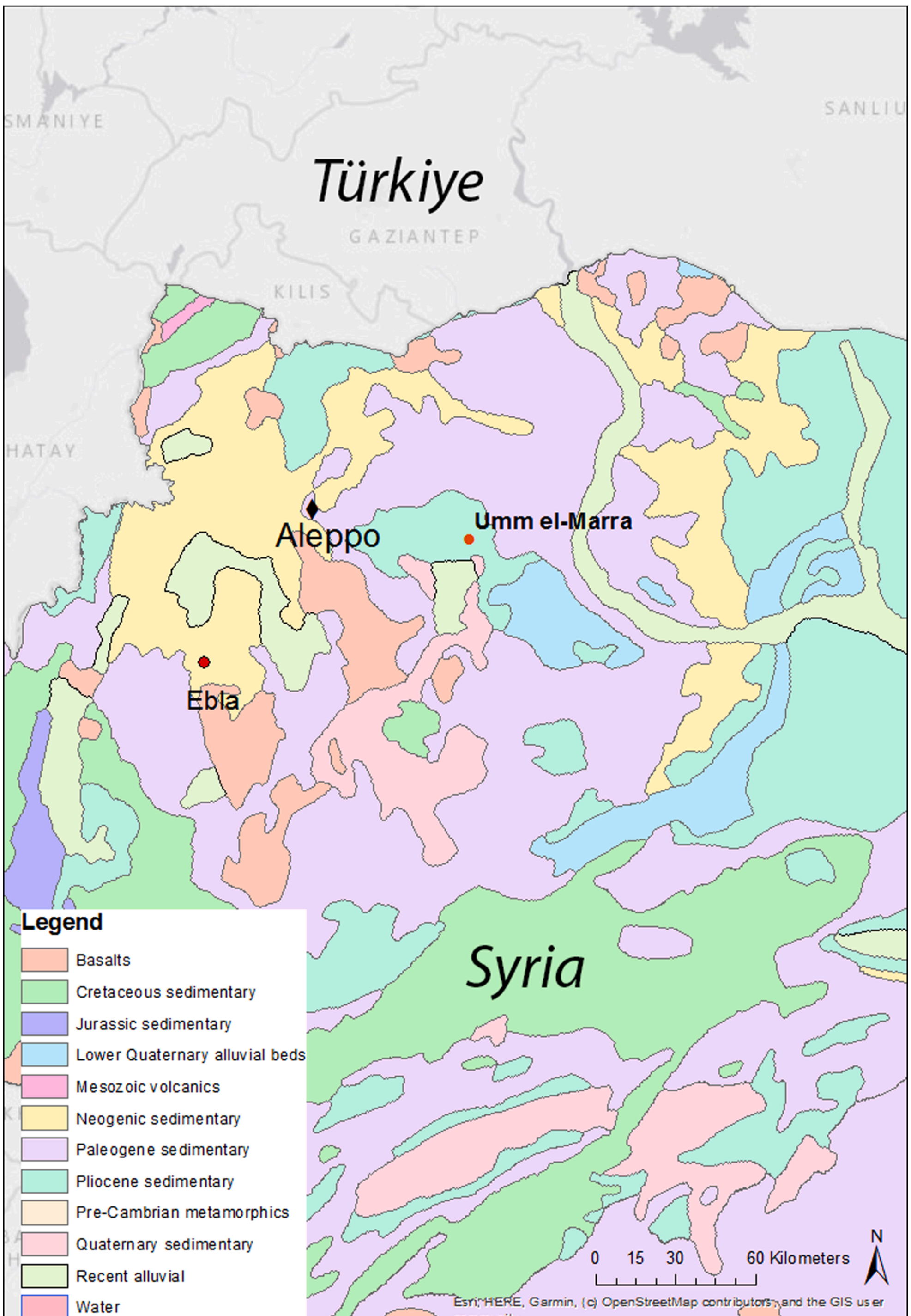

Fig. 1. Geological map of northwestern Syria. Geological data extrapolated from Ponikarov et al. 1986.

placement in the city center and the rich funerary goods found within the tombs and the lack of other adult humans buried within the wider settlement, it is thought that these tombs contain the royalty of the Bronze Age settlement. Beginning in the EBIII (ca. 2600–2450 BCE), these limestone and mudbrick tombs seem to have not just been resting places for the elites of the city, but also a cultic center for ancestor veneration (Schwartz 2013).

Schwartz (2013) suggests the focalization of the mortuary complex at the center of the city would have played a role in bringing the 'elite dead' to the forefront of the lives of the inhabitants of the city. This would have legitimized the legacy and authority of the elite through ancestor veneration rituals and their connections with the dead, solidifying the social hierarchy (Schwartz 2012b; Schwartz 2013; Schwartz et al. 2003). This is a trait common in new and unsteady political systems used to maintain control (Schwartz et al., 2003) and is observed in other parts of the ancient Near East (Boutin and Porter 2019).

The veneration of the dead is not uncommon in the ancient Near East. During the Bronze Age, a ritual sometimes referred to as *kispum* in Mesopotamian writing has been described (MacDougal 2017). During *kispum*, food and drink were prepared, offered, and sometimes partially consumed by the living as a form of meal-sharing in a ritualized setting in front of tombs (Bayliss 1973; Creamer 2020; Kharobi and Buccellati 2017; Zwitser 2017; Van der Toorn 2014). While *kispum* rituals were often practiced for honoring those more directly related to the practitioner (e.g., honoring their parents), a ruler might be venerated for generations as a sort of ancestor of the entire settlement (Bayliss 1973). In the centuries following the creation of the tombs at Umm el-Marra, ancestor veneration and appeasement continued as evidenced by offerings of animals in installations outside of tombs. Infants have also been found in these areas, although child sacrifice is not a testable hypothesis in these instances and the placement of infants who died of natural causes close to the resting place of these honored dead seems just as, if not more, likely (Schwartz 2012a). In Neo-Babylonian (1000–539 BCE) Kish, the placement of infant burials near a temple has similarly been debated as infanticide/sacrifice or the burial of infants lost to natural causes in a sacred space (Torres-Rouff and Pestle 2012).

Tombs 5, 6, and 8 appear to be the earliest tombs in the acropolis (Table 1), built of mudbrick and stone. More tombs were built during the EB IVA/ Umm el-Marra period V (ca. 2450–2300 BCE), along with associated installations surrounding the tombs containing human infants and sacrificed equids before tomb construction ends in the acropolis around the EB IVB/Umm el-Marra period IV (ca. 2300–2150) (Schwartz and Miller 2007; Weber 2008). Morphological and metric data has suggested that these equids might be hybrids of donkey and onager (*Equus hemionus*), highly valued animals with sacred affiliations known as *kunga* (Weber 2008; Weber 2012). A recent genetic study has confirmed that these equids are hybrids (Bennett et al. 2022).

Tomb 6 is the largest of all the tombs (10 × 6 m) and postulated to be the first because of its size and its dominant location in the center of the tomb installations (Schwartz 2016). An adult male was buried in this tomb alone with gold and silver toggle pins, bronze weaponry, and beads of lapis lazuli, gold, and carnelian (Schwartz et al. 2006). Weapon burials, also referred to as warrior burials, first appeared in Mesopotamia and northern Syria in EBI-II, spreading to the Levantine coast by EBIII-IV (Cohen 2012).

Tomb 1 is worth highlighting in this study. A wealthy tomb dating to the Early Bronze IVB (ca. 2300), Tomb 1 contained five adults excavated across three layers. In addition, two infants tucked near the two women on the top layer were also excavated. This tomb is notable for its undisturbed wealth of grave goods (Fig. 2), relatively good skeletal preservation, and being one of the only multiple inhumation tombs where all adults had some bone and/or teeth exported and available for destructive analysis.

Table 1
The six Umm el-Marra tombs examined in this study and their estimated dates of use.

Tombs	General Period	Umm el-Marra Period	Date Range (BCE)
5, 6, and 8	EB III	VI	2600–2450
4	Mid-late EB IVA	V	ca. 2350
1	Early EB IVB	IV	ca. 2300
7	EB IVB	IV	2300–2150

1.3. Isotope analyses

Isotope analyses are powerful tools in archaeological sciences (Stantis and Kendall 2022), and previous Near Eastern bioarchaeological studies have investigated human diet and migration using this suite of tools (e.g., Al-Bashaireh et al. 2010; Al-Shorman 2004; Al-Shorman and El-Khouri 2011; Kharobi et al. 2021; Perry et al. 2017).

1.3.1. Strontium ($^{87}Sr/^{86}Sr$)

Strontium isotope ($^{87}Sr/^{86}Sr$) analysis provides insight into residential mobility and origin on the individual level, allowing extrapolations into large-scale socio-political dynamics (Gregoricka, 2021; Stantis and Schutkowski, 2019). Interpretation of $^{87}Sr/^{86}Sr$ analysis relies on the concept that no appreciable biofractionation occurs across the ecosystem, and so an individual's body tissues will reflect the $^{87}Sr/^{86}Sr$ values of the underlying geology in which they lived when these tissues were forming (Bataille et al. 2020; Lewis et al. 2017).

In parts of the world with more isotopic research coverage, biospheric baselines or 'isoscapes' have been created through the collation of modern and archaeological plant and animal samples (Lewis et al. 2017). In Syria, only a very general botanical collection has been conducted in the attempt to characterize bioavailable strontium values (Henderson et al. 2009) along with some soil $^{87}Sr/^{86}Sr$ values from some archaeological sites in the northeastern region (Sołtysiak 2019).

1.3.2. Oxygen ($\delta^{18}O$)

Oxygen stable isotope analysis ($\delta^{18}O$) is commonly used for investigating individual movement (Chenery et al. 2010; Prowse et al. 2007). Oxygen stable isotope values are most influenced by drinking water (Bryant and Froelich 1995; Longinelli 1984), and the difference in proportions between ^{18}O and ^{16}O atoms is determined by the climate (e.g., mean temperature, altitude) where this water is sourced (Daux et al. 2008). Like $^{87}Sr/^{86}Sr$ analysis, $\delta^{18}O$ analysis gives information about paleomobility, but instead of reflecting the underlying geology, oxygen represents climate, latitude, altitude, and other factors (Pederzani and Britton 2018).

1.3.3. Carbon, Nitrogen, and sulfur ($\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$)

Carbon, nitrogen, and sulfur stable isotopes are often used to investigate diet in the past, placing humans and other animals within the local foodweb (Fuller et al., 2020; Schutkowski and Ogden, 2011; Stantis et al., 2021). Carbon stable isotopes in human body tissues can be analyzed from both the organic and mineral portions of bones and teeth: $\delta^{13}C_{collagen}$, analyzed in tandem with $\delta^{15}N$ and $\delta^{34}S$ from collagen, and $\delta^{13}C_{carbonate}$ analyzed together with $\delta^{18}O_{carbonate}$. Low sample availability (see Section 2.1) and poor collagen preservation generated a small collagen-derived dataset that precluded statistical analysis and confident interpretation within this site. If future studies across multiple sites or revisitations to Umm el-Marra are possible in the future, then further interpretation using the collagen data collected here may be useful. For now, collagen analytical methods and output is available in Appendix A, but these results are not discussed further in this main text.

1.4. The environment

Western Syria is geologically complex, dominated by sedimentary deposits ranging from the Cretaceous, Paleogene, and Neogene along with some erupted Pliocene basaltic outcrops (Brew 2001; Ponikarov

Fig. 2. Some of the ceramics recovered from Tomb 1. Kitten for scale. Photo by Glenn Schwartz.

et al. 1986). The site of Umm el-Marra is on Cretaceous sedimentary soil, while Lake Jabbul to the south, a rich wetlands environment used for fishing, hunting, and livestock grazing is composed of more recent alluvial sediments from the Quaternary period. Much of the wider Jabbul plain surrounding Umm el-Marra is composed of Paleogene- and Neogene- era limestones. The settlement would have made use of this plain for dry farming and pastoralism (Curvers et al. 1997b; Schwartz and Miller 2007). Modern agricultural research suggests that fertilization with lime can affect interpretation of strontium isotopic data (Thomsen and Andreasen 2019). Whether lime was used in the past to correct soil acidity in this region is unknown but, considering the modern geology, lime was likely unnecessary.

A strontium baseline for Umm el-Marra is created in this paper by analyzing bone and teeth from animals excavated from the site. Ovicaprines and cattle are utilized to build this baseline. While equids were available for analysis, the long-distance trade of these highly valued animals (Dolce 2014; Weber 2009; Weber 2008) implies that these equids might not be representative of local isotopic values.

People at Umm el-Marra would have obtained their drinking water from two sources, wells as well as a wadi that flowed along the east side of the site, originating in the hills to the north and emptying into Lake Jabbul. Some archaeologically-derived freshwater mollusk $\delta^{18}O$ data are available from northeastern Syria (Çakirlar and Şeşen 2013), but there is no comparative contemporaneous oxygen data near Umm el-Marra. Instead, modern oxygen precipitation values are used as initial reference for expected values. Expected $\delta^{18}O$ values for precipitation for the area are estimated to be -6.5 ‰ $\pm$ 0.3 (Bowen 2018).

2. Materials and methods

2.1. Sample selection and preparation

Age and sex were estimated by the site osteologists (Batey, 2011) using standard methods (Buikstra and Ubelaker 1994). A select number of samples, human and animal, were exported in 2006 to conduct pilot studies of preservation for destructive analyses. With the civil unrest from 2011 in Syria, no further visitations to the on-site storerooms have been possible for further sample selection. This created some limitations regarding which individuals could be sampled. Thirteen people from six of the ten tombs had skeletal material available to be analyzed.

To create the $^{87}Sr/^{86}Sr$ biospheric baseline to represent the movement range of Umm el-Marra humans, ovicaprine and cattle teeth (n = 4) and ovicaprine bone (n = 3) were collected. As bone more readily equilibrates with its burial environment (Hoppe et al. 2003), bone is expected to reflect the narrower $^{87}Sr/^{86}Sr$ range of the site rather than the living range of the animal. This is not an ideal method, as there is no established model for the rate at which equilibration occurs, but when sampling strategies are limited, it provides a starting point for understanding local biospheric $^{87}Sr/^{86}Sr$ ratios. For teeth, two enamel samples were taken from each animal, to represent earlier and later points in the animal's life. These samples were initially analyzed as part of a master's thesis (Compton 2020). The sample beginning with the initial C is *Bos* (cattle) and S designates ovicaprine (sheep/goat). Samples S1 and S2 are from the same ovicaprine mandible found in Trench 1250/3902, a left deciduous p4 and a permanent P4; these should represent different points in the animal's lifetime with the deciduous tooth erupting around birth to six weeks and the permanent tooth erupting between 21 and 24 months (Silver 1969). For samples C and S3 from the cow and second ovicaprine, enamel samples were taken from the crown cusp and the enamel–root junction (ERJ) to examine movement over the animals' lifetimes. Note that while the ovicaprine bone and teeth are numbered 1–3 for each sample type, there is no suggestion that the bone and teeth belong to the same animal as they come from different parts of the site; Ovicaprine 1/2 tooth enamel (samples S1 and S2) and Ovicaprine Bone 3 are possibly an exception as they are from the same trench (see Supplementary Information for specific locations).

Second permanent molars or permanent premolars (first or second) were selected for this study as these teeth, whether mandibular or maxillary, complete crown formation between five and eight years of age (AlQahtani et al. 2010) and so are likely representative of childhood post-weaning. Teeth with cavitated carious lesions were avoided to minimize variation from pathological changes to the enamel (Plomp et al. 2020).

2.2. Analysis of $\delta^{13}C_{carb}$, $\delta^{18}O$, and $^{87}Sr/^{86}Sr$

Analytical methods are the same as those described in Stantis et al., 2020 and Stantis et al., 2021. Initial sample preparation was conducted by author CS in the Department of Archaeology and Anthropology's Dorset House laboratory at Bournemouth University (United Kingdom). For tooth enamel, the surface was gently abraded to remove surface contamination, and then separated from the underlying dentine using a dental cutting instrument with a rotary saw attachment. Any dentine still attached was gently abraded. For ovicaprine bone, the surface was cleaned with aluminum oxide powder air abrasion to remove the surface. The samples were powdered in an agate mortar and pestle and then pretreated with 0.1 M buffered acetic acid at room temperature for no longer than four hours. The powders were then rinsed 3x with ultrapure water and then dried in a 50° oven overnight.

Carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope ratios were measured in the Department of Earth Sciences at Durham University (United Kingdom) in the carbonate (CO_3) component of tooth enamel following the procedures of Bentley et al. (2007). For each tooth, approximately 2 mg of powdered sample was reacted with 99 % *ortho*-phosphoric acid for 2 h at 70 °C. CO_2 was then separated from helium in the resultant gas mix using a Thermo Fisher Scientific Gasbench II passed into a Thermo Fisher Scientific MAT 253 gas source mass spectrometer for isotopic analysis. Both $\delta^{13}C$ and $\delta^{18}O$ values are presented in per mill (‰); $\delta^{13}C$ is presented relative to VPDB and $\delta^{18}O$ is presented relative to VSMOW. Replicate analysis of samples yielded a precision with a mean difference of 0.24 ‰ for $\delta^{13}C$ and 0.22 ‰ for $\delta^{18}O$. In each run the international reference carbonate materials NBS 19 ($n = 3$), IAEA-CO-1 ($n = 3$), and LSVEC ($n = 3$) were analyzed along with two internal standards: a carbonate DCS01 ($n = 7$) and a composite equid tooth enamel Dobbins ($n = 2$). International standards yielded reproducibility better than 0.12 ‰ (2 SD) for $\delta^{13}C$ and 0.20 ‰ (2 SD) for $\delta^{18}O$. All values have been normalized to the accepted values of +2.49 ‰ VPDB and −46.6 ‰ VPDB for $\delta^{13}C$, and −2.40 ‰ VPDB and −26.70 ‰ VPDB for $\delta^{18}O$, for IAEA-CO-1 and LSVEC, respectively. To compare $\delta^{18}O_{carb}$ values to local water, the carbonate values were converted to drinking water ($\delta^{18}O_{dw}$) using Daux et al.'s Equation 6 (Daux et al. 2008).

Strontium isotope ratios were measured using a ThermoFinnigan Multi-collector ICP Mass Spectrometer (MC-ICP-MS) in the Department of Earth Sciences at Durham University (United Kingdom). Reproducibility of the standard NBS987 during sample analysis was 0.710244 ± 0.000013 (2 SD, $n = 28$). All NBS987 values have been normalized to the accepted value of 0.710240 (Johnson et al. 1990; Terakado et al. 1988). Statistical analysis and data visualization were conducted using R software (R Core Team 2000). Data management follows the IsoArcH structure for managing isotopic data (Plomp et al. 2022; Salesse et al. 2018), and the data are available in the IsoArcH data repository (https://doi.org/10.48530/isoarch.2023.004).

Table 3
Statistical summary for isotopic values from Umm el-Marra human samples.

	$^{87}Sr/^{86}Sr$		$\delta^{18}O$ (‰, VSMOW)		
	Median	**± 1IQR**	**Median**	**± 1IQR**	**N**
Total	0.70802	0.00004	26.81	0.61	13
Females	0.70803	0.00008	26.60	0.67	6
Males	0.70802	0.00002	27.00	0.64	6

3. Results

Human data, including sex and age estimation and element samples are in Table 2. Summarized descriptive statistics for human isotope results are on Table 3. Animal $^{87}Sr/^{86}Sr$ values are presented on Table 4.

3.1. Animal $^{87}Sr/^{86}Sr$ values

The ovicaprine bone, as predicted, has a more restricted range of values compared to the animal enamel, 0.708015–0.708026 compared to enamel value range 0.708022–0.708048 (Fig. 3). There is bimodal distribution evident: the bone samples and two of the "later" enamel samples (from the CEJ and thus representing a point later in the animals' lives compared to the crown samples) display values in a lower range and the three "earlier" enamel samples from the top of the crown and one of the enamel samples representing later time have higher values around 0.70805. The cattle and Ovicaprine 1/2 both display a pattern of higher values in the enamel sample from the top of the crown, with the ERJ sample displaying values near/within the bone values. This may be reflective of these two animals being born farther out on the Jabbul Plain and then moved closer to the town settlement. Both of Ovicaprine 3's enamel samples display higher values like the other two animal's earlier values, suggesting this animal did not move between isotopically distinct regions in its lifetime.

The plant $^{87}Sr/^{86}Sr$ values from Henderson et al. (2009) might represent nearby biospheric ranges. $^{87}Sr/^{86}Sr$ values from Jabbul Plain and Aleppo region plant samples are displayed along with the Umm el-Marra animal ranges in Fig. 4. The plants collected near Lake Jabbul display a slightly larger range of values (0.70802–0.708085) encompassing most of the Umm el-Marra animal range as well as some higher values. The plants collected in the Aleppo metropolitan area to the west display an even wider range, 0.707872–0.708160. For this study, the median ± 1.5 IQR of all animal samples is used as a local baseline given the non-normal distribution, and any human samples outside of this

Table 2
Human $^{87}Sr/^{86}Sr$, $\delta^{18}O$, and $\delta^{13}C_{carbonate}$ data, as well as estimated age and sex.

Individual	Estimated Sex	Estimated Age Category	$^{87}Sr/^{86}Sr$	$\delta^{18}O_{carbonate}$ (‰, VSMOW)	$\delta^{13}C_{carbonate}$ (‰, VPDB)	Tooth sampled (FDI notation)	Project ID
Tomb 1 Skeleton A	Female	Young Adult	0.7081087	25.93	−12.78	37	312
Tomb 1 Skeleton B	Male	Young Adult	0.7080438	26.82	−12.43	37	313
Tomb 1 Skeleton C	Male	Young Adult	0.7080555	27.19	−12.63	47	314
Tomb 1 Skeleton D	Female	Adolescent	0.7079724	26.52	−11.93	37	315
Tomb 1 Skeleton E	Female?	Middle Adult	0.7080069	26.24	−12.15	35	316
Tomb 4 Skeleton B	Female	Old Adult	0.708032	26.67	−12.03	47	318
Tomb 4 Skeleton E	Female?	Young Adult	0.7081616	27.09	−13.29	37	321
Tomb 4 Skeleton F	Female	Middle Adult	0.7080226	28.38	−12.74	37	322
Tomb 5	Male	Middle Adult	0.7080055	26.58	−12.66	37	323
Tomb 6	Male	Middle Adult	0.7080131	27.54	−12.45	37	324
Tomb 7 Skeleton B	Indeterminate	Adult	0.707971	26.73	−12.94	37	325
Tomb 8 Skeleton A	Male	Middle Adult	0.708023	26.81	−12.03	34	327
Tomb 8 Skeleton B	Male	Young Adult	0.708021	28.6	−13.19	17	328

Table 4
$^{87}Sr/^{86}Sr$ values from Umm el-Marra animal samples.

Sample Designation	Animal Species	$^{87}Sr/^{86}Sr$	$^{87}Sr/^{86}Sr$ SE	Element Sampled
C Crown	*Bos*	0.708047	0.000008	Right Lower Premolar 2
C ERJ	*Bos*	0.708027	0.000010	Right Lower Premolar 2
S1 Crown	Ovicaprine	0.708048	0.000008	Left lower deciduous Premolar 4
S2 Crown	Ovicaprine	0.708022	0.000007	Left Lower Premolar 4
S3 Crown	Ovicaprine	0.708045	0.000006	Left Lower Molar 2
S3 ERJ	Ovicaprine	0.708045	0.000008	Left Lower Molar 2
Ovicaprine Bone 1	Ovicaprine	0.708026	0.000007	Cervical Vertebra
Ovicaprine Bone 2	Ovicaprine	0.708020	0.000007	Lumbar Vertebra
Ovicaprine Bone 3	Ovicaprine	0.708015	0.000009	Mandible

range are considered to have non-local $^{87}Sr/^{86}Sr$ ratios.

3.2. Human $^{87}Sr/^{86}Sr$ and $\delta^{18}O$

Human $^{87}Sr/^{86}Sr$ values ranged from 0.70797—0.70816, with four individuals outside of the local biospheric values calculated using animal samples: Tomb 1 Skeleton A, Tomb 1 Skeleton D, Tomb 4 Skeleton E, and Tomb 7 Skeleton B. $\delta^{18}O$ values, converted to drinking water, ranged from −4.83 — −2.24 (VSMOW). As for identifying locality using $\delta^{18}O$, with no contemporaneous $\delta^{18}O$ baseline, individuals outside of 1.5IQR from the median were considered outliers; two individuals display outlying $\delta^{18}O$ values using this method, Tomb 4 Skeleton F and Tomb 8 Skeleton B. When enamel carbonate values are converting to drinking water using equations from Daux et al. (2008), the mean value of those individuals who are not $\delta^{18}O$ outliers is -6.1 ± 0.7, close to the modern calculated precipitation values of −6.5 ‰ ± 0.3 (Bowen 2018). Fig. 5 displays the $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{dw}$ of Umm el-Marra individuals. For discussion of locality, we use the population $\delta^{18}O$ values rather than modern precipitation estimates as a broader range and thus more conservative estimation of locality, placing seven of the 13 individuals as locals (the grey shaded box in Fig. 5). Non-locals are present throughout the use of this acropolis as a burial site (Fig. 6), although representation is low for the EB IVB period of the site.

4. Discussion

Regarding the animal bone and enamel as proxies, bone $^{87}Sr/^{86}Sr$ ratios might have equilibrated with the local burial environment due to leaching and crystallization (Budd et al. 2000). As such, even animals that spent their life outside the local region might display bone $^{87}Sr/^{86}Sr$ ratios reflecting their burial environment rather than their living biospheric range. The $^{87}Sr/^{86}Sr$ ratios from ovicaprine bone display a highly restricted range of values, 0.708015–0.708026, possibly more reflective of the local burial environment on the tell rather than animals' living values. With endogenous strontium currently indiscernible from exogenous sources in calcified tissues, the degree of diagenesis is incalculable.

Nevertheless, the bone values can be used as representatives of the bioavailable $^{87}Sr/^{86}Sr$ at the settlement. If interpreted this way, the slightly higher $^{87}Sr/^{86}Sr$ values observed in all animal enamel samples representing the earlier part of the animals' lives likely reflect the pastoral land outside the settlement. The enamel samples from the ERJs of Cattle and Ovicaprine 1/2, representing later times in their lives compared to the crown samples, displayed values within the bone range, suggesting these animals were brought from the pastures further away to an area close to the settlement before slaughter. Ovicaprine 3, with both enamel samples in the group near 0.70805, may have been slaughtered

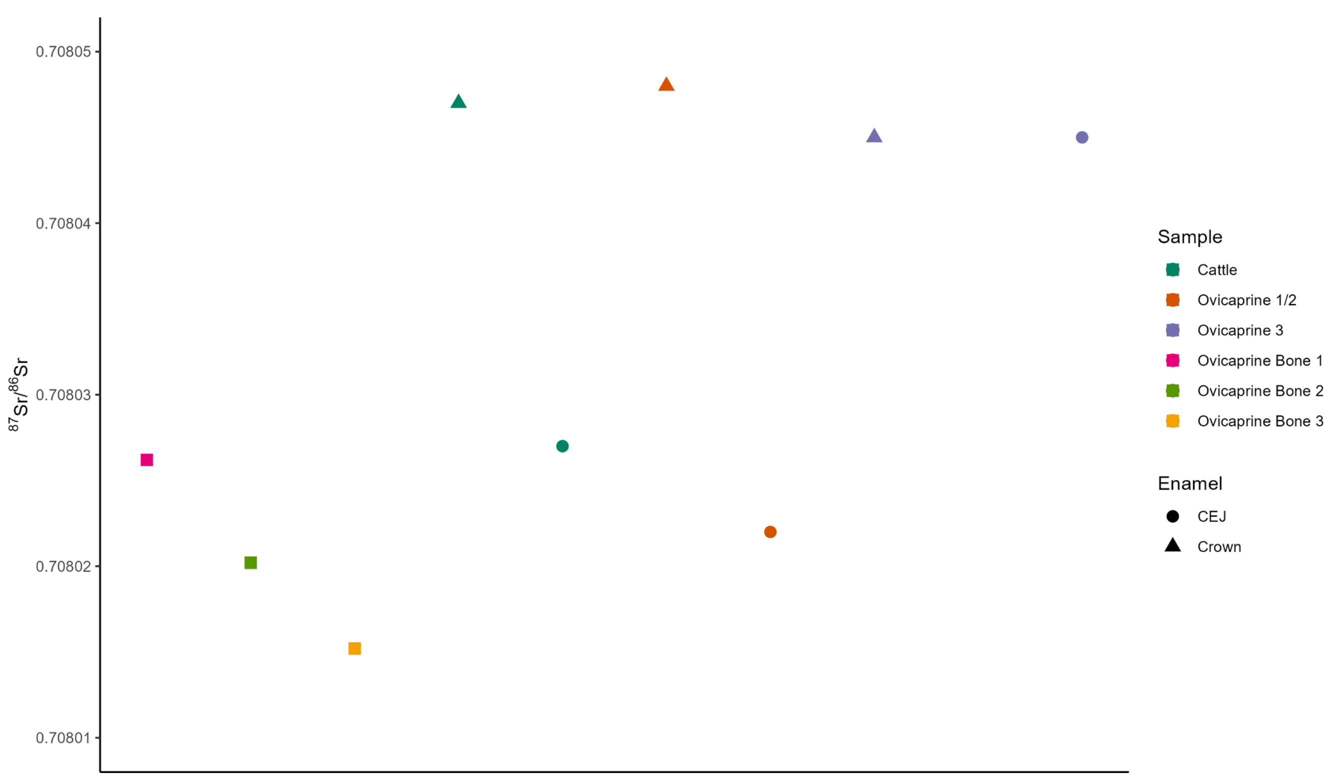

Fig. 3. $^{87}Sr/^{86}Sr$ values of all animal samples from Umm el-Marra.

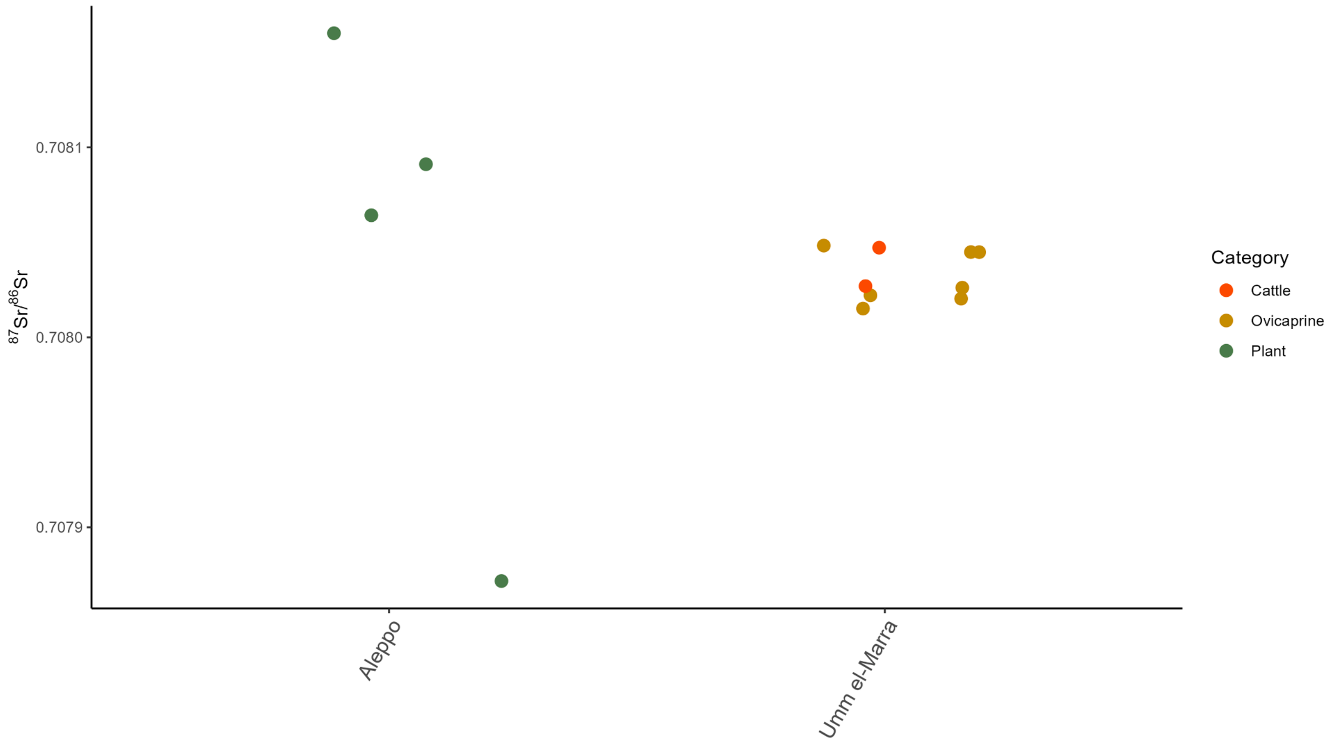

Fig. 4. $^{87}Sr/^{86}Sr$ values of plants collected from Aleppo and Jabbul areas by Henderson et al. 2009, along with animal bone and enamel studies from this study.

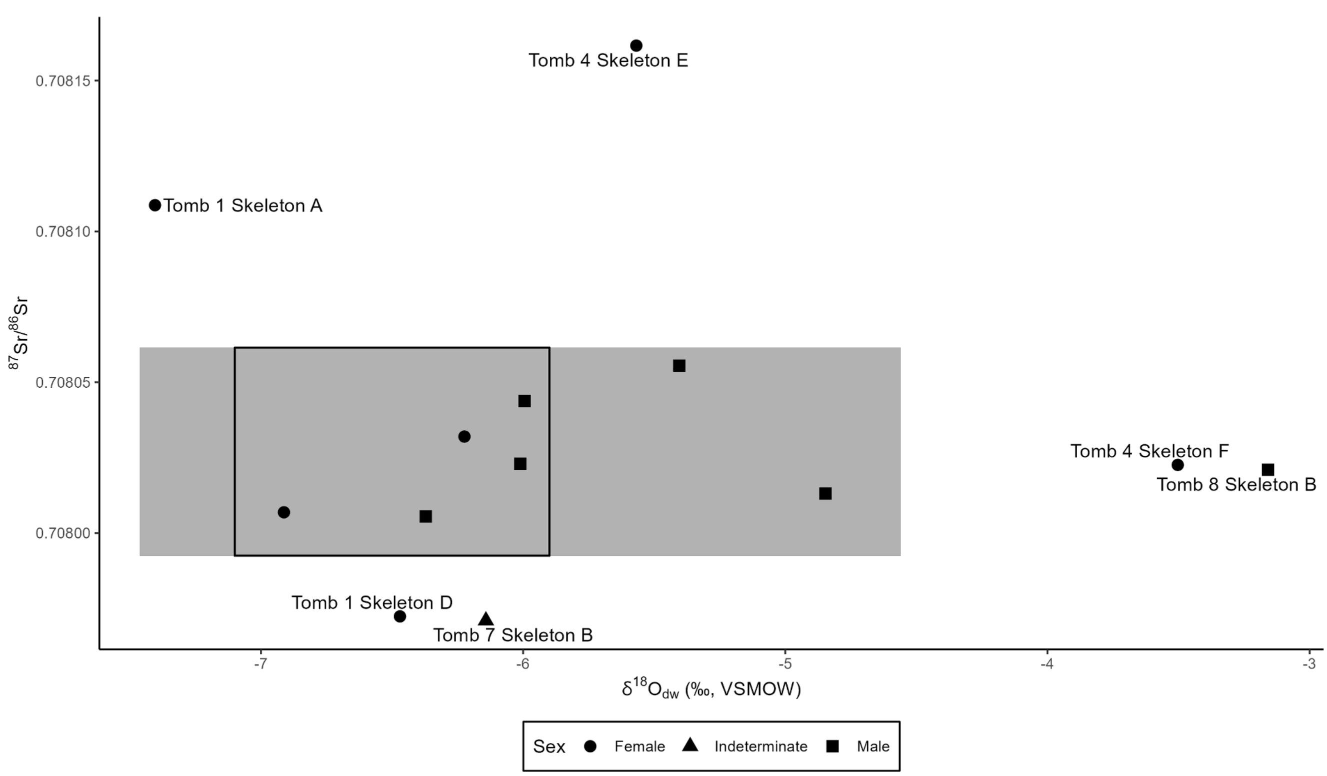

Fig. 5. $^{87}Sr/^{86}Sr$ and $\delta^{18}O_{dw}$ of Umm el-Marra individuals. The shaded box bounds the biospheric $^{87}Sr/^{86}Sr$ Sr values, and population median ± 1.5 IQR for $\delta^{18}O$ (converted to drinking water). The black lines demarcate mean ± 2SD for the area's modern precipitation $\delta^{18}O$ values.

near the pasture it was raised in and then the flesh transported to town for trade/consumption. An alternative interpretation is that the enamel sample representing the later part of life is not representative of the time closest to the end of Ovicaprine 3′s life, and it was also brought to pens near the settlement in a scenario similar to Cattle and Ovicaprine 1/2.

Greater sample size of comparative animal material would have been preferred, as would have local plant samples for determining biospheric range as per Wong et al. (2021). However, exportation of this material from Syria was done with the expectation that re-visiting the site and storage house would be possible in the following season; thus far, no re-

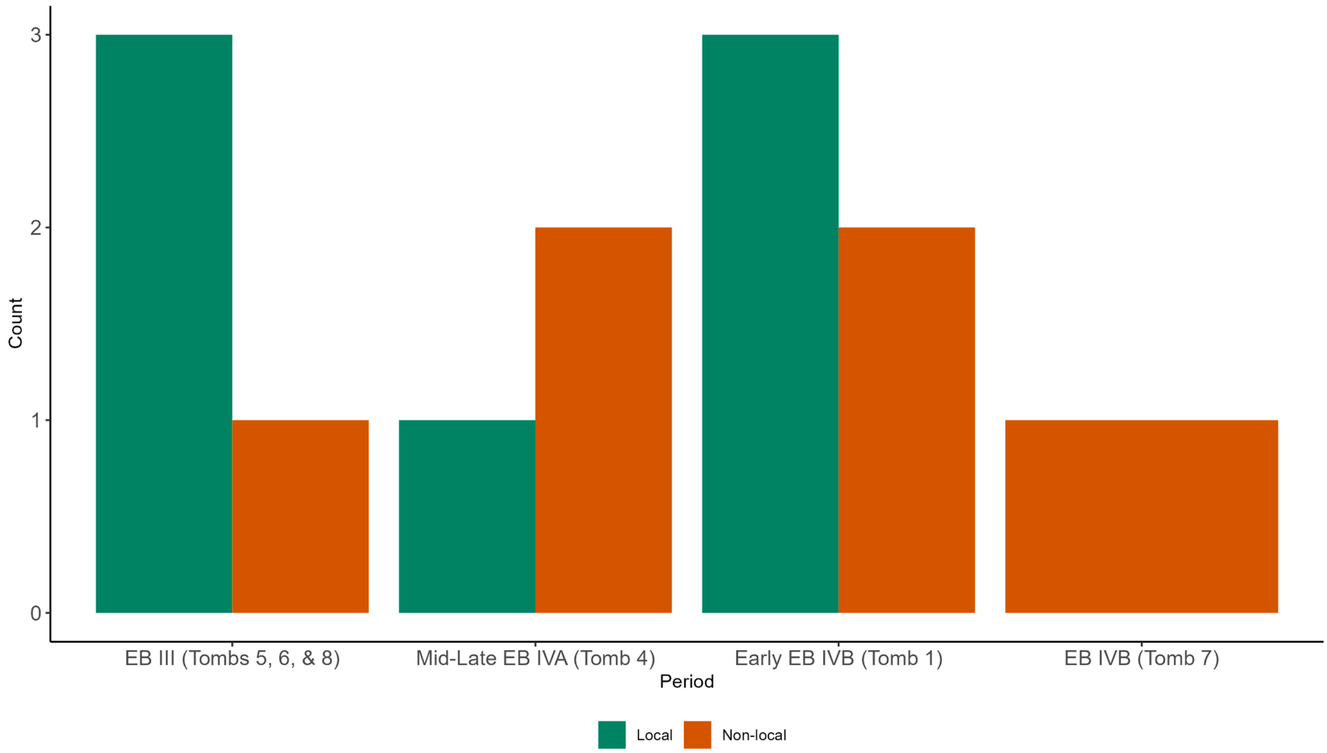

Fig. 6. Locality by time period for Umm el-Marra individuals.

visitation by excavators has been possible. Future expansion and refinement of a bioavailable baseline strontium isotope map for Syria may change our understanding of who is local and non-local at Umm el-Marra, and possibly provide some clue as to the origin of the non-locals. For now, the local baseline as created using *Bos* and ovicaprine bone and teeth highlighted four possible non-locals at Umm el-Marra, with another two identified as having outlying $\delta^{18}O$ values.

The individual in Tomb 6, the largest and possibly oldest tomb, had been cautiously identified as an elite founder of this kingdom (Schwartz et al. 2006); this individual has local isotope values. The relatively early dating, combined with the structural features of the tomb and local isotope values, suggest that Umm el-Marra may have built its nascent strength on the Jabbul Plain locally, while later cultural and political entanglements sustained its growth. A total of six of the sampled 13 humans interred in the tombs displayed isotope values suggestive of childhood residence outside of the local region. Individual tombs contained both local and non-local individuals. It must be acknowledged that some of those individuals who display local values may be in fact non-locals from similar isoscapes to Umm el-Marra; see Torrence et al. (1992) for a brief discussion of this phenomenon.

Of the six non-locals, four individuals (Individuals A and D from Tomb 1, Individuals E and F from Tomb 4) have been estimated female and date to circa 2350 to 2300 BCE. In Tomb 1, for example, the two young adult females with rich burial accoutrements (e.g., gold and silver jewelry, a lapis lazuli amulet, and small goblet possibly containing kohl) are both non-locals, while the two adult males and the less richly appointed female in the lowest level of Tomb 1 are all locals (the infants buried near the young adult women were not available to be sampled). The two non-local women have isotope values suggestive of not having the same residential origin. Tomb 4, though disturbed before excavation with bones and items scattered across the lower level when excavated (Schwartz et al. 2006), similarly displayed some luxury goods such as an ivory comb, ostrich eggshell inlay segments possibly from wooden furniture, gold items, a small basalt table, gold and silver toggle pins, and two large hollow spirals similar to those found at other Early Bronze Age tombs (Schwartz et al. 2006, p 613).

It has been postulated that the wealth and higher quantity of funerary items of Tomb 1 and 4 females are a reflection of familial power and status, a pattern identified also from the rich dowries of Eblaite princesses (Archi, 2002; Schwartz et al., 2006). Though sample size is too small to confidently postulate the dominant marriage pattern for elites during this time period, the 4:1 ratio of females to males does support patrilocality as a dominant marriage pattern for elites. Beyond that, the nearly even ratio of local: non-local emphasizes the interconnectivity of this region, at least for the elites. Marriages as connections between political forces are observed in cuneiform records (Archi and Biga 2003). These connections may have granted opportunity for these individuals and their families to consolidate and accumulate more wealth and social influence. It should be noted that there are many reasons for migration; while the burial of locals and non-locals alike suggests some union of individuals into family units, marriage might not have been the impetus for moving to Umm el-Marra; other factors within a push–pull framework (Gage et al. 2012; Mohamed and Abdul-Talib 2020) might have been the primary factors for immigration to the Jabbul Plain. Locals and non-locals alike were the ‘elite dead’ of Umm el-Marra and may have contributed to the development of this settlement through economic and political connections. Unfortunately, isotopic analysis only provides evidence of who moved, not why they moved nor the direct consequences of migration for the individuals or the community.

The conspicuous consumption in the form of valuable funerary objects, combined with the acts of memorialization and veneration later in time, showcase these people and their tombs as focal points of political and spiritual authority at Umm el-Marra. Veneration of those buried in these elite tombs cemented the relations of the living to the dead; the physical and spiritual centering of these ancestors in the settlement served to connect Umm el-Marra past and present, recentering the rights and obligations of the population towards the settlement’s needs. This determination of who exactly is an ‘ancestor’ for a community, and ancestors as a focal point for political structuring and re-structuring that follows centuries after interment, have been observed in ancient Greece (Antonaccio, 1995), Neolithic Britain (Thomas 1999), and Late

Horizon/early Colonial Peru (Dalton et al. 2022). The wealth indicated by the grave goods and tomb construction followed by offerings centuries later suggest that these individuals were valued members of Umm el-Marra by their contemporaries who buried them as well as the community several generations later.

4.1. Comparisons to the broader region

The Jabbul plants collected by Henderson et al. (2009) displayed ranges encompassing most of the Umm el-Marra animal $^{87}Sr/^{86}Sr$ range as well as higher values. The Aleppo metropolitan area, situated over Paleogenic and Neogenic sedimentary formations as well as Pliocene basalts, shows a wider range than any Jabbul samples. The Neogenic sedimentary and basalt formations in Aleppo are the same formations found around Ebla, and so these ranges may be representative. However, the small sample sizes available in Henderson et al. (2009) must be noted before over-reliance on interpretation using these data. Henderson et al. also notably did not provide coordinates for where they collected samples, only general locations. With Syria's complex geology and the current dearth of comparative data, determining origin of non-locals using isotopic analysis is unfeasible. There is also no current isoscape of $^{87}Sr/^{86}Sr$ values for Syria, a major gap in paleomobility research knowledge.

There are very few comparative assemblages to consider relative movement. In Syria, three studies have examined $^{87}Sr/^{86}Sr$ values in archaeologically-derived human remains (Santana et al. 2021; Sołtysiak 2019; Sołtysiak 2020). In nearby regions, burial assemblages from a site in southern Türkiye (Ingman et al. 2021), as well as a Middle Bronze Age assemblage from coastal Lebanon (Stantis et al., 2021) have been analyzed for $^{87}Sr/^{86}Sr$ and $\delta^{18}O$. To date, the closest comparative site with human isotopic data is the site of Tell Atchana (Alalakh), roughly 115 km away as the crow flies (Ingman et al. 2021). Tell Atchana has a cemetery assemblage spanning the Middle and Late Bronze Age (ca. 2000–1200 BCE) and, unlike Umm el-Marra, many burials both inside and outside the settlement have been excavated. At Tell Atchana, of the 53 individuals analyzed for $^{87}Sr/^{86}Sr$ values, five (9.4 %) were identified as growing up outside the local valley; these five non-locals from all came from outside the city and were generally very plain burials with no or little grave goods. With Tell Atchana's large assemblage across several burial types, Tell Atchana's assemblage may be more representative of average residential movement during the time periods it represents.

5. Conclusion

Expansion of the biospheric data when sampling and exportation are more feasible in Syria would improve interpretation of movement in this region. Nonetheless, we can see some evidence of pasturing in the animals, as evidenced by differences in $^{87}Sr/^{86}Sr$ values between enamel samples. Regarding human isotopic values, our small dataset highlights the identity of those interred in the elite mortuary complex at Umm el-Marra, created by the mix of local and non-local individuals and evidence of contact with neighboring regions. This may be evidence of intermarriage for political and economic ties between Umm el-Marra (as a major Early Bronze Age center of the Jabbul Plain) and other Syrian powerhouses in the EBA. These entanglements of identity for the Umm el-Marra elite may have aided in the creation of this settlement's role as a trade center on the plains.

Future work could include revisiting the Umm el-Marra storeroom to isotopically analyze the rest of the tombs' occupants. With a larger dataset, a more detailed mortuary analysis could be engaged with the isotopic data to explore who in the Early Bronze Age would was deemed worthy of being made an ancestor for the whole of the settlement, incorporating new osteological methodologies and theoretical frameworks to explore these elites' lives, deaths, and afterlives as venerated ancestors (Mant and Poeta 2022; Schrader and Torres-Rouff 2020). In addition, further isotopic analysis of the equids buried outside these elite tombs, believed to be sacred animals fit for royalty (Weber, 2008; Weber, 2009), could give insight into the trade networks of equids as high-status goods as well as insights into the lived experiences of these animals.

CRediT authorship contribution statement

Chris Stantis: Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Georgina S. Compton:** Methodology, Writing – review & editing. **Arwa Kharobi:** Investigation, Writing – review & editing. **Nina Maaranen:** Investigation, Writing – review & editing. **Geoff M. Nowell:** Methodology, Investigation, Resources. **Colin Macpherson:** Methodology, Investigation, Resources, Writing – review & editing. **Ernest K. Batey:** Methodology, Investigation, Writing – review & editing. **Glenn M. Schwartz:** Conceptualization, Resources, Writing – review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data is attached as Supplementary Material

Acknowledgements

We are grateful to the Directorate-General of Antiquities and Museums, Syria, for its support of the Umm el-Marra project. The Early Bronze Age excavations at Umm el-Marra were funded by the National Science Foundation (grants BCS-0137513 and BCS-0545610), the National Geographic Society, the Metropolitan Museum of Art, the Arthur and Isadora Dellheim Foundation, and the Johns Hopkins University. Funding to carry out this research was provided by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (grant agreement No 668640). Dr Julia Best (Cardiff University) happily helped unpack the animal bones shipment like it was an early Christmas at Bournemouth; thanks to her for helping confirm some of the genera identified.

Appendix A. Supplementary materials

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jasrep.2023.104142.

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