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RESEARCH ARTICLE

The mass burials from the western necropolis of the Greek colony of Himera (Sicily) related to the battles of 480 and 409 BCE

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Abstract

Throughout the ancient Greek, world mass burials are rare. Of the 10,000 excavated burials in the western necropolis of the Greek colony of Himera (649–409), only 16 contained more than one individual; seven of these can in all possibility be traced back to the two battles fought by Himera against the Carthaginians in 480 and 409 BCE. Written sources (Diod. 11.20ff.) state that the Himerans, accompanied by numerous Greek allies, defeated the Carthaginian forces in the first conflict whereas the loss of Greek allied support in the second battle resulted in the city's defeat and subsequent destruction.

The anthropological and taphonomical studies of the human remains aim at testing the archaeological hypothesis that individuals interred in the seven mass graves can be related to the two battles.

Skeleton density (skeletons per square metre), position, orientation, and conservation levels of the individuals in the mass burials were analysed and compared with a larger sample of 1,000 single burials from the same necropolis along with mass graves in other forensic and archaeological contexts. Sex, age at death, presence of skeletal stress indicators, and perimortal traumas were recorded using standard anthropological methods. In the case of poorly preserved remains, sex was estimated using site-specific discriminant functions.

Although representing catastrophic samples, the results from the seven mass burials all lead to the assumption that the graves can be associated with the interment of warriors fallen in battle. Moreover, burial differences have permitted to distinguish the mass burials dating to 480 BCE from those attributed to 409 BCE.

KEYWORDS
battle, Greek colonization, Himera, mass graves, Sicily, weapons

1 | INTRODUCTION

Established by Greek Chalcidian and Dorian peoples from the Sicilian colonies of Zancle (Messina), Syracuse, and the island of Euboea, Himera was founded on Sicily's northern shore near the mouth of the Himera River. The dates of the city's founding (648 BCE) and destruction (409 BCE) are provided by Diodorus Siculus.

Excavation activities have brought to light different areas of the colony, allowing better understanding of its organization and development. The town occupied a surface of approximately 120 ha and was

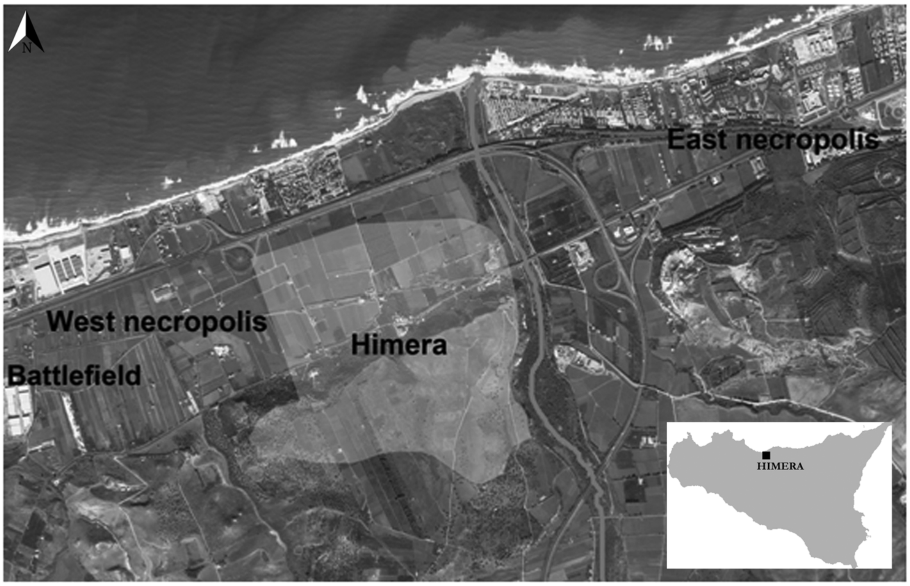

FIGURE 1 Topography of Himera

structured on two different levels: the lower city located on the coastal plain and the acropolis on the hills above (Vassallo, 2005).

Three partially excavated necropolises have been identified at Himera, situated outside the city walls and along the main thoroughfares connecting the colony to the surrounding territory, namely: the eastern (Necropoli of Pestavecchia; 3,600 burials) and western necropolis (Necropoli of Buonfornello; 9,547 burials) on the coastal plain and the southern necropolis (Necropoli of Cozzo Scacciapidocchi; 15 burials) beside the hinterland route (Fabbri, Schettino, & Vassallo, 2006; Vassallo, 2017; Vassallo, 2018; Vassallo & Valentino, 2012) (Figure 1).

Over 13,000 graves have been currently investigated, the majority featuring single burials. The practice of inhumation is significantly attested (88% in the W Necropolis; and 90% in the E Necropolis) whereas cremation rites (12% in the W Necropolis; and 10% in the E Necropolis) present much lower percentages.

Two major battles that were to affect Sicily's history were fought in 480 and 409 BCE below Himera's walls. In the first conflict, a coalition of Himerans, Acragantines, and Syracusans succeeded in defeating the Carthaginian forces; a second Carthaginian expedition resulted in the city's conquest and destruction with the ensuing massacre of its population.

The skeletal remains studied in this contribution can be traced back to the soldiers that fell in these encounters, offering an exceptionally rare testimony of common war burials in the Classical Greek Age (Vassallo, 2018).

2 | MATERIALS, REFERENCE SAMPLE, AND METHODS

Excavation activities conducted in the western necropolis of the Greek colony of Himera (HIM-W) at Buonfornello recorded 9,547 burials. Burial types include plain ditches, *cappuccina* tile graves, in situ and secondary cremations, as well as pot burials. Regardless of burial type, single burials constitute the vast majority of the sample, conforming to what is commonly attested in Greek funerary customs. Only in a very limited number of burials (n = 16) multiple bodies had been interred. These burials can be considered as multiple burials, defined by Duday (2005, 2008) as two or more individuals deposed in a single funerary structure within a very short time span (possibly at the same moment; Table 1). Unique funerary structures were ascertained in only two cases (W2373A-W2373B and W3220A-W3220B) and take on the form of *cappuccina*-style burials.

The other 14 cases were plain ditches believed to be mass graves on the grounds that the skeletons were in direct contact with one another, deposed in what appeared as a limited time span as suggested by the absence of disturbances caused by the deposition of a body near the other (i.e., the bones of all the bodies were still in articulation). The discovery of weapon fragments piercing the bones of a number of individuals in seven of these mass graves, along with perimortem sharp force traumas, has led to hypothesize that these could be identified as soldiers killed in combat.

These seven burials have been labelled as *Fossa Comune* ("common burial" in Italian)—henceforth FC—and originally numbered FC1 to 9 due to the difficulty in ascertaining burial limits. However, it was later realized that FC1 and 2 constitute a single interment, as do FC8 and 9. Thus, although we number FC1–9, these actually represent only seven mass burials (FC1 + 2, FC3, FC4, FC5, FC6, FC7, and FC8 + 9); the number of skeletons found in the FC ranges from 2 to 69.

According to stratigraphic and archaeological evidences, it has been put forward (Vassallo, 2010, 2017) that these mass burials may be connected to the battles fought in 480 and 409 BCE (Diod. 11, 20 ss), and although the burial of individuals in mass graves is only one of the means through which survivors can choose to deal with large numbers of bodies (Duday, 2008), most of the people that died during these battles were likely to have been buried in single graves.

TABLE 1 The multiple burials found in the western necropolis of Himera and the individuals recorded

Burial label	Trench main axis orientation	Skeletons (n)	Skeleton orientation	Skeleton position	Individual labels
FC1 + 2	N–S	18	E–W	Supine	HIM-W 276, 336, 396, 403, 423, 482, 458, 428, 429, 461, 462, 463, 464, 494, 503, 576, 577, 737
FC3	N–S	22	E–W	Supine	HIM-W 650, 653, 696, 697, 698, 699, 701, 702, 703, 704, 705, 706, 807, 808, 809, 810, 811, 812, 813, 814, 815, 833
FC4	N–S	15	E–W	Supine	HIM-W 1604, 1770, 1771, 1772, 1773, 1774, 1775, 1776, 1777, 1778, 1779, 1780, 1781, 1782, 1783
FC5	N–S	4	E–W	Supine	HIM-W 2587, 2588, 2589, 2590
FC6	N–S	3	E–W	Supine	HIM-W 2737, 2738, 2739
FC7	N–S	2	E–W	Supine	HIM-W 2764, 2825
FC8 + 9	E–W	69	17 N–S, 31 S–N, 12 E–W, 4 NE–SW, 1 SE–NW, 4 nd	67 supine, 2 prone	HIM-W 4341, 4342, 4375, 4376, 4378, 4379, 4380, 4381, 4382, 4383, 4384, 4651, 4652, 4653, 4654, 4655, 4656, 4657, 4658, 4660, 4661, 4662, 4663, 4664, 4665, 4666, 4667, 4668, 4669, 4670, 4671, 4672, 4673, 4674, 4675, 4676, 4677, 4678, 4679, 4680, 4681, 4682, 4683, 4684, 4685, 4686, 4687, 4688, 4689, 4690, 4691, 4692, 4693, 4694, 4695, 4696, 4697, 4698, 4699, 4700, 4701, 4702, 4703, 4704, 4705, 4706, 4707, 4708, 4709.
W2373A–W2373B	E–W	2	E–W	Supine	HIM-W 2373A-2373B
W3109–3110	E–W	2	E–W	Supine	HIM-W 3109, 3110
W3121–4130	E–W	2	E–W	Supine	HIM-W 3121, 4130
W3220A–3220B	E–W	2	E–W	Supine	HIM-W 3220A, 3220B
W3616–W3617	E–W	2	E–W	Supine	HIM-W 3616, 3617
W3944–W3945	E–W	2	E–W	Supine	HIM-W 3944-3945
W4113–W4114	E–W	2	E–W	Supine	HIM-W 4113, 4114
W4270–W4271	E–W	2	E–W	Supine	HIM-W 4270, 4271
W6054–W6055	E–W	2	E–W	Supine	HIM-W 6054, 6055

However, regardless of their relation with the aforementioned battles, skeletons in the FC can be considered as catastrophic samples, seeing that they represent the uncommon case of a large number of individuals dying in a very short time span (see also Kyle, Reitsema, Tyler, Vassallo, & Fabbri, 2018). The remaining nine multiple graves were double burials, three of these featuring either a female adult and child (W2373A-W2373B and W3220A-3220B) or two children (W3616-W3617), their composition allowing to exclude them from a military sample.

This paper will deal primarily with FC1–9, discussing the archaeological and bioarchaeological evidence that links these mass burials to the events that took place in 480 and 409 BCE.

A total of 133 skeletons were found in the seven FC; sex determination was primarily based on pelvic morphology (i.e., the pubic visual method; Phenice, 1969), greater sciatic notch shape (Walker, 2005), presence of preauricular sulcus (Houghton, 1974), absence of a piriform tubercle, and f-f-f combination (i.e., specific female shape; Bruzek, 2002). Of the 133 individuals, these were observed in 20 whereas skull-based sex determination (Ferembach, Schwidetzky, & Stloukal, 1977) was possible on a further 10 more individuals. As to the remaining 60, sex was determined using site-specific discriminant functions (Lonoce et al., 2018); the 43 remaining individuals were unsexed due to poor state of conservation (Table S1). As to age determination, the most appropriate methods—taking into account the state of preservation—are the morphology of the auricular surface of the ilium (Lovejoy, Meindl, Pryzbeck, & Mensforth, 1985), the apposition of secondary dentine to the canine (Cameriere, Cunha, Sassaroli, Nuzzolese, & Ferrante, 2009), and the degree of fusion of the long bone epiphyses (Ferembach et al., 1977).

When none of these methods could be employed, general bone dimension, degree of dental wear, and epiphyses fusion were considered in order to produce a generic adult definition (Table S2). Among the stress indicators, linear enamel hypoplasia, *cribra cranii*, and periostitis (Table S3) were taken into account. Lines of enamel hypoplasia (LEH) have been recorded on 73 individuals that still preserved at least one permanent canine (Goodman & Armelagos, 1985; Hillson, 1996). The presence of *cribra cranii* has been recorded on 27 individuals featuring at least 25% of the cranial vault (Mensforth, Lovejoy, & Armelagos, 1978; Stuart-Macadam, 1987; Stuart-Macadam & Kent, 1992). The presence of periostitis has been recorded on 99 individuals with at least one fourth of the femur, tibia, and fibula shaft (Ortner, 2003). Stress marker results can be found in the supporting information.

Perimortal traumas were analysed according to Sauer (1998) and Ubelaker and Montaperto (2014). The single burial reference sample from the same necropolis comprises a total of 963 individuals, analysed following the same methodologies illustrated above.

3 | THE MASS BURIAL SKELETAL SAMPLE

The vast majority of mass burials (FC1–7) were excavated in a part of the necropolis that had already seen intensive use prior to their establishment (Figure 2). The opening of trenches for the mass graves compromised older burials, thus providing a *terminus post quem* for their relative dating. A *terminus ante quem* was offered instead by more recent burials settled directly above or in some cases damaging the mass grave site. On the contrary, mass burial FC8 + 9, located on the eastern limit of the necropolis and nearer to the western city walls than other FC, was not disturbed by successive burial activities (Figure 3). All the FC are either situated in the area of the battlefield or in its vicinity, as evidenced by the recording of numerous arrowheads from the necropolis deposit levels (Vassallo, 2010).

3.1 | Absolute dating

It was not possible to obtain an absolute dating for the mass burials from Himera as the chronology of the city (648–409 BCE) lies in the so-called Hallstatt Plateau of the radiocarbon dates calibration curve

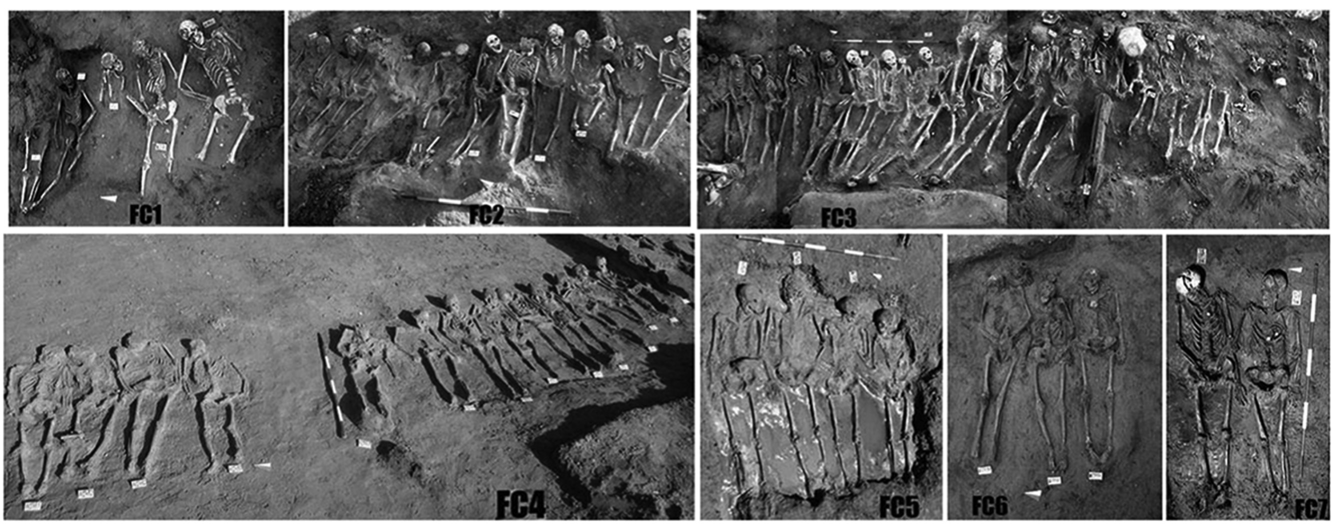

FIGURE 2 FC1–7: the mass graves associated with the battle of 480 BCE

FIGURE 3 FC9: a part of the mass grave associated with the battle of 409 BCE

(800–400 BCE) and therefore does not produce reliable data, as is the case for many other archaeological sites (Becker & Kromer, 1993; Van Strydonck et al., 2017).

3.2 | Taphonomy

In common as well as in single burials, skull fragmentation was documented in about 70% of the cases, revealing a good state of preservation in only 20% of the sample (Table S6); the state of preservation in the two samples does not show statistical variations (test χ^2, $p = .2268$).

As to the postcranial (Table S7), no skeletons were either fully or partially preserved, and only 9.8% (13 out of 133) in the mass burials and 7.9% in the single burials are in a damaged condition (Grade 2; evaluation established according to the degree of conservation presented in Table S5). The state of preservation of remains in both single and mass burials are similar (test χ^2, $p = .7255$).

3.3 | Orientation

FC1–7 were large trenches characterized by a N–S alignment: the bodies oriented with their heads to the east and feet to the west as the majority of single burials (Fabbri, Lonoce, & Viva, 2012) in the western (67.1%) and eastern (Pestavecchia; 85.8%) necropolis of Himera (Fabbri et al., 2006).

FC8 + 9 had an E–W alignment: the bodies laid out in different positions. The most frequent skeleton orientation was N–S ($n = 17$; 24.6%) and S–N ($n = 31$; 44.9%), followed by E–W ($n = 12$; 17.4%), NE–SW ($n = 4$; 5.8%), and SE–NW ($n = 1$; 1.4%); in four cases (5.8%), the bones were so fragmentary that it was not possible to determine skeleton orientation. North–south and S–N orientations are instead quite rare; only 7 (3.1%) single burials from a sample of 226 graves were in fact recorded at Pestavecchia (Fabbri et al., 2006) and 4 (1.6%) out of 243 plain burials from the western necropolis (Fabbri et al., 2012).

3.4 | Number and density

In FC1–7, where skeletons presented an E–W orientation, it was possible to distinguish between FC containing fewer individuals ($n < 5$)—FC5, 6, and 7—and FC with higher numbers ($n > 10$), respectively, FC1 + 2, 3, and 4. Nevertheless, in both subsamples, the skeletons were regularly spaced with minimum elbow superposition; therefore, skeleton density (number of skeletons per square metre) was close to 1 in mass burials FC1–7 (mean 1.08, range 0.94–1.32; Table 2). FC8 + 9 alone yielded more skeletons ($n = 69$) than FC1–7 combined ($n = 64$) and would have in all likelihood featured more if the FC had not been damaged by severe flooding during excavation activities; skeleton orientation in FC8 + 9 was highly variable, and

TABLE 2 Number and density of individuals in the mass burials from the necropolis W of Himera

Mass burial	Number of skeletons	Burial surface (m^2)	Density (skeletons per square metre
FC1 + 2	18	13.6	1.32
FC3	22	20.0	1.10
FC4	15	16.0	0.94
FC5	4	4.0	1.00
FC6	3	2.7	1.11
FC7	2	2.0	1.00
FC8	11	2.5	4.40
FC9	58	14.0	4.14
FC8 + FC9 actual	69	16.5	4.18
FC8 + FC9 estimated	88	21.0	4.18

the significant individual overlap resulted in a density of 4.18 skeletons per square metre.

3.5 | Position and decubitus

Skeletons in FC1–7 were supine (i.e., dorsal decubitus), sharing a common position with little variation: upper limbs extended or slightly flexed on the abdomen with the lower limbs fully extended. This is by far the most frequent position recorded in single burials (91.2%,).

In mass graves with numerous individuals (FC1–4; *n* > 10), body deposition started from the northern end of the trench, testified by the upper left limb of one skeleton often partially overlapping the upper right limb of the skeleton laying to its left, the skull frequently resting on the right shoulder, and the trunk and lower limbs formed an angle at pelvis level. Moreover, the right humerus was often partially abducted. This particular position has led to hypothesize that the bodies had been dragged into the burial from south to north.

As to the division between FC5–7 and FC1–4, archaeological evidence points to the fact that they were all dug at the same time and for the same reasons (Vassallo, 2010). Although the burials were contemporary, more care is observed in the deposition of bodies in FC5–7, that is, no traces of dragging and the presence of grave goods in FC5 and FC6.

In FC8 + 9, several levels of skeletons were documented. As observed in FC1–7, in FC8 + 9, body deposition started from one end of the trench, that is, the eastern one, and proceeded westward, setting them dorsally side by side, often slightly overlapping, with the head placed to the south on the opposite side of the trench. A second layer of bodies was laid over the first in the same orientation, with their skulls on the chests of the individuals below. A third layer of bodies, in the same position, but with opposite orientation (head to the north), was then set on top, with their feet on the shoulders of the individuals in the first layer. A subsequent layer of bodies, perpendicular to the ones in the first three layers and with their heads oriented to the east, was set on the northern and southern sides of the ditch, near the heads or feet of the underlying bodies. Lastly, a number of bodies covering the others were set obliquely, with a SE–NW or NE–SW orientation; two of these bodies (W4658 and W4661) were laid in prone position (Video S1).

Individuals from mass burials FC1–7 appear to be ordered and deposited in a regular pattern following the customary funerary ritual recorded in thousands of cases in the necropolis of Himera. The trenches were large enough to have allowed for a more accessible laying out of the bodies, which could also be very few (2–4) with minimal overlap. The density is of about 1 skeleton per square metre, more or less the space required to deposit a corpse. FC1–7 were excavated in the centre of the designated area and regularly spaced, the necropolis seeing a continuous use after the establishment of FC1–7. On the contrary, FC8 + 9 is isolated from the other mass burials and single graves, with no burial activity taking place after its excavation. Skeleton orientation in FC8 + 9 is variable, although the most represented samples (N–S and S–N) are rarely found in the rest of the necropolis. The trench was dug to contain as many bodies as possible, placing them in successive layers, using also the trench outer limits. Body overlap and density, more than 4 skeletons per square metre, are markedly higher than in FC1–7.

In the following paragraphs, we will split the mass burial samples into three subsamples (when *n* > 10) containing

1. “Ordered” mass burials with more than 10 individuals (FC1–4).
2. “Ordered” mass burials with less than five individuals (FC5–7).
3. “Disordered” mass burial FC8 + 9.

3.6 | Sex determination

In FC1–7, sex determination was ascertained in 20 individuals using pelvic morphology, in 24 individuals using site-specific discriminant functions (Lonoce et al., 2018), and in 6 individuals using skull features. Thirty-six individuals from FC8 + 9 were sexed using the same discriminant functions and four using cranial features (Table 3).

We were able to diagnose sex in 90 out of 133 individuals, with a sex diagnosis of 89 males and 1 female.

3.7 | Age determination

All of the individuals in the mass burials were adults. When a quantitative determination was possible, mean age at death was of 31.6 years (minimum = 18.0 and maximum = 61.5; Table 4). Mean

TABLE 4 Age at death

FC	*n*	Individuals with age determination	Mean age (years)	Range
1–4	55	43	29.6	19.5–47.5
5–7	9	8	45.0	32.0–61.5
8–9	69	4	26.6	18.0–42.0
Total	133	55	31.6	18.0–61.5

TABLE 3 Sex determination

	Hip bone			Skull			Discriminant functions			Total		
FC	*n*	M	F	*n*	M	F	*n*	M	F	*n*	M	F
1–7	20	20	0	6	6	0	24	23	1	50	49	1
8 + 9	0	-	-	4	4	0	36	36	0	40	40	0

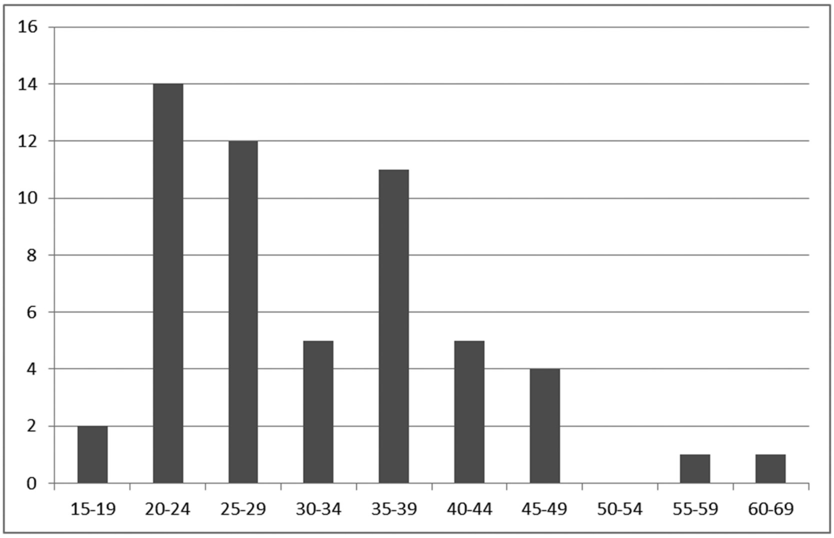

FIGURE 4 Age at death in individuals from the mass graves

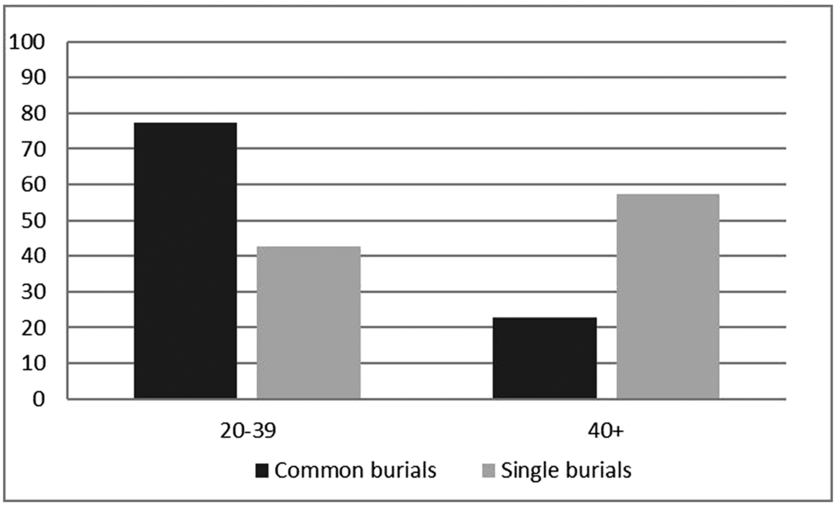

FIGURE 5 Age at death in mass and single burials

age in "ordered" mass burials FC5–7 containing less than five skeletons is of 45.0 (minimum = 32.0 and maximum = 61.5), higher than what is observed in "ordered" mass burials with more than 10 individuals (29.6; minimum = 19.5 and maximum = 47.1). Mean age in "disordered" burials FC8 + 9 is 26.6 (minimum = 18.0 and maximum = 42.0). Mean age in FC5–7 is statistically different from the mean age in FC1–4 (test t = –5.02; p = .000) and in FC8 + 9 (t = 2.908; p = .0156), whereas FC1–4 and FC8 + 9 are not significantly different (t = 0.747; p = .4580).

The skeletal sample from the mass burials stretches across all adulthood, from 18.0 to 61.5 years, although the histogram (Figure 4) shows that young adults (15–39 years old) form 83.1% of the sample. Considering that grave goods have been found in two out of four of the "ordered" burials with less than five individuals—FC5 and FC6—we can suppose that these burials were reserved for prominent older age individuals who died in battle, whereas FC1 + 2, 3, and 4 were mainly reserved for younger soldiers.

Comparing age at death in the mass burials (n = 53) with age at death in a similar (n = 61) random sample from single burials (Figure 5), it is possible to observe that in the former individuals between 20 and 39 years represent 77.3% of the sample whereas in the latter, they form only 42.6%. The difference between these

TABLE 5 Types of trauma

Individual labels	Traumas
W2764	Bone scar and a spear point pierced in the trunk
W576	Multiple sharp force traumas
W336	Spear point in the trunk
W1773, W4689	Single trauma produced by arrow
W2825	Double trauma produced by arrow
W429, W482, W494, W2587, W4697	Single sharp-force trauma
W429, W482, W494, W576, W2587, W4697	Only bony traces of trauma
W336, W1773, W2825, W4689	Associated weapon points without bone injury

samples in the number of young adults is statistically significant (χ^2 = 14.12; *p* = .00).

3.8 | Perimortem trauma

Bone fractures and blunt-/sharp-force traumas showing no trace of bone regeneration are evidence of perimortem traumas (Sauer, 1998; Ubelaker & Montaperto, 2014). Cases where the point of a metal weapon was found in contact with or at a very short distance (<2 cm) from any of the bones, therefore allowing to assume that the weapon had pierced the body, were scored as perimortem traumas. The possibility of observing perimortem traumas depends on the level of bone conservation. Taking into account that the samples from mass and single burials are in similar state of conservation (Tables S6 and S7), we can expect that any differences observed in the prevalence of traumas between the two samples are meaningful (Table 5).

Traces of perimortem traumas were observed in 11 of 133 individuals (8.27%) from mass burials, with a total of 16 individual traumatic incidents seeing that multiple perimortem traumas were recorded in four of these (Table S8).

In a sample of 936 individuals from single burials, evidences of perimortem traumas were recorded in only 15 cases (five individuals showing multiple perimortem traumas). The prevalence of perimortem traumas in single burials was of 1.55%, nearly one sixth of the prevalence observed in the mass burials (*Z* test = 4,7685; *p* = .00). Regarding multiple perimortem traumas, similar percentages are recorded in both mass and single burials (respectively, 36.4% and 33.3%; Table S9). As to trauma distribution, the two samples show a similar trend (test χ^2, *p* = .6041) with a higher frequency of trunk and skull traumas (Table S10).

The prevalence of perimortem injuries in mass burials (8.27%) may seem low, acknowledging that all of the individuals died at war. The prevalence is surely underestimated seeing the skeletal state of preservation and because uncertain cases were not considered. Moreover, only a low percentage of injuries leaves traces on bones (Milner, 2005).

4 | DISCUSSION

Absolute dating of the seven mass burials (labelled FC1 + 2, 3, 4, 5, 6, 7, and 8 + 9) excavated in the western necropolis of the Greek colony of Himera (648–409 BCE) cannot be obtained as C14 dates are unreliable in the so-called Hallstatt Plateau (800–400 BCE). Nevertheless, stratigraphic and archaeological indicators can be used to establish a relative chronology. FC1 + 2, 3, 4, 5, 6, and 7 were located in an area of the necropolis that saw intensive use both before and after FC1–7 were established, providing both a *terminus post* and *ante quem* chronological reference. On the other hand, FC8 + 9 was in a part of the necropolis that saw intensive use prior to its excavation, remaining undisturbed until recent times. Mass burials are infrequent in Greek necropolises (only 16 out of approximately 10,000 at HIM-W), both in colony sites and in continental Greece. In three well-investigated necropolises of the Greek colonies of Metaponto, Kamarina, and Mégara Hyblaea, common graves were not documented (Duday & Gras, 2018; Henneberg & Henneberg, 1988; Sulosky Weaver, 2015). Mass burials are often referred to as *polyandrion* (literally, many men) and are related to catastrophic events such as wars or civil riots. *Polyandreia* have been documented in several Greek sites such as Marathon (Stais, 1893), Olynthus (Robinson, 1942), Athens (Young, 1942; Clairmont, 1981; Baziotopoulou-Valavani, 2002; and the recently discovered mass grave at Phaleron [http://phaleron.digital-ascsa.org/]), Thespiae (Schilardi, 1977), Pydna (Triantaphyllou & Bessios, 2005), and Paros (Agelarakis, 2017).

Historical sources (Diod. 11.20ff.) state that the two battles (480 and 409 BCE) took place just outside Himera's western fortifications, corresponding to the area where the HIM-W necropolis is located. On the basis of historical sources as well as stratigraphic and archaeological evidence, mass burials FC1 + 2, 3, 4, 5, 6, and 7 have been associated with the first Battle of Himera fought in 480 BCE, whereas FC8 + 9 has been linked to the second battle of 409 BCE.

If the FC from Himera are to be considered as *polyandreia*, all of the skeletons found in the FC should be sexed as male, within the accuracy limits of sex determination methods used according to sample's state of preservation. The percentage of male individuals is 100% using the pelvis, 100% using cranial features, and 98.5% using discriminant functions. Moreover, the sporadic presence of women or subadults has been observed in other mass burials considered as *polyandreia* (Robinson, 1942). We can thus conclude that FC1–9 were *polyandreia*.

As to the position of the skeletons, it is clear that FC1 + 2, 3, 4, 5, 6, and 7 differ from FC8 + 9. In the former (FC1–7), the bodies had been carefully oriented, set, and spread out following the rules observed in the vast majority of single burials found in the same necropolis: E–W orientation and supine position, with a density of about 1 skeleton per square metre. On the contrary, in FC8 + 9 skeleton, orientation is variable, with the most frequently recorded position (NS and SN) rarely observed in single burials (1.6%). Supine burial position is predominant but not exclusive. Skeleton density is much higher—about 4 skeletons per square metre—giving the impression that the ditch was filled with as many bodies as possible. FC8 + 9 appears as fundamentally different from the normal funerary ritual documented at Himera, and it seems clear that the intention was to dispose of a large number of corpses with minimum effort. Komar (2008) observed that the ordered/disordered appearance of burials containing many corpses is not accidental. Trenches dug by relatives, friends, or comrades of the dead will look very different from those dug by enemies or under enemy control. In concise terms, following Komar (2008), order = self and disorder = other. Robinson (1942) puts forward similar arguments in his interpretation of the three mass burials from Olynthus, which are very similar to FC1–7 and probably of a similar period (second half of the fifth century BCE). Of the mass burials found at Himera, FC1 + 2, 3, 4, 5, 6, and 7 are ordered whereas FC8 + 9 is disordered. This is in accordance with the hypothesis that the former (FC1–7) are most likely associated with the battle of

480 BCE and the latter (FC8 + 9) with the one fought in 409 BCE. Following their victory in 480 BCE, the Greeks had the time and will to honour their dead with formal collective burials recalling their usual funerary customs. However, after the defeat of 409 BCE, they were probably forced by the Carthaginian army to quickly dispose of as many corpses as possible.

Concerning age at death, the skeletal sample from the mass burials covers the whole of adulthood, from 18.0 to 61.5 years. Nevertheless, young adults (15–39 years old) form the majority of the sample (83.1%). There is a clear and statistically significant difference in mean age at death between individuals buried in "ordered" mass burials and fewer individuals ($n < 5$) with a mean age of 45.0 years compared with the mean age in "ordered" mass burials with many individuals ($n > 10$) with a mean age of 29.6 years. The persons from mass burials are on average younger than individuals from the general population, as would be expected of soldiers who died in battle. Strontium isotope ratios show that individuals from single burials are different from those of FC1–7 (480 BCE) and similar to those of FC8 + 9 (409 BCE; Kazmi, Reitsema, Reinberger, Kyle, & Vassallo, 2017; Reinberger, Kyle, Fabbri, Vassallo, & Reitsema, 2017; Stamer et al., 2017). This also reflects what is stated in ancient sources: in FC1–7, the soldiers are from different parts of the Greek world and allies of the Himerans; in 409 BCE, the Himerans were alone in the confrontation with the Carthaginians. For this reason, individuals in FC8 + 9 are similar to those recorded in the rest of the necropolis. These data allow us also to exclude that Carthaginian soldiers were in FC8 + 9.

A significantly higher prevalence of perimortem traumas was observed in the mass burials (8.3%) compared with the general population (1.5%). This reinforces the hypothesis that FC are related to warfare, as we would expect perimortem traumas to be frequent in war victims (Boylston et al., 1997; Fiorato, Boylston, & Knüsel, 2000; Margerison & Knüsel, 2002; Stroud & Kemp, 1993). The recorded bone traumas (on the basis of the pattern and location of the injuries) in the mass graves can be related to weapons such as swords, spears, and arrows, the latter two actually found in clear association with five skeletons. Swords, spears, and arrows are typically used during intergroup violence (Asbury, 2012) and are the most commonly found weapons on battlefields before the invention of firearms (Ferguson, 1997). The discovery in one case (W2764) of a spear point pierced in the trunk of the skeleton (Figure S6) is of particular interest. This type of injury was likely a common consequence of fighting between hoplites (Delbruck, 1990), as this type of wound has often been depicted on Greek vases (Figure S12).

Regardless of whether the mass burials from Himera are indeed related to the battles fought in 480 and 409 BCE, they certainly represent a catastrophic sample and most likely two different samples, that is, a large number of persons who died together or during a very short time span. Catastrophic samples are thought to present demographic and epidemiological features that are more similar to living population than "attritional" mortality samples, although some papers fail to confirm this hypothesis (DeWitte & Wood, 2008; Kyle et al., 2018; Margerison & Knüsel, 2002; Milner, Anderson, & Smith, 1991). The sample from Himera is unique in the fact that both the "catastrophic" and the "attritional" samples are drawn from the same necropolis, whereas other works compare samples from different sites (DeWitte & Wood, 2008; Margerison & Knüsel, 2002). The "catastrophic" sample from Himera is indeed demographically different from the "attritional" sample, with younger (20–39 years), mostly male individuals in the "catastrophic" sample and older (40+ years) individuals as well as a more equal male to female ratio in the "attritional" sample. Sex ratio differences observed between single and mass burials can be easily accounted for seeing that an army is usually composed of males. This implies that our "catastrophic" sample represents a unique segment of society and cannot be regarded as similar to the existing/living population. On the contrary, as to age at death, we may assume that sample composition from mass burials is closer to the living population, where young adults were certainly more numerous than older ones.

Further observations were made by comparing catastrophic with attritional samples on the basis of stress indicators. The most interesting data relate to LEH incidence, significantly more frequent in single (37.1%) than in mass (21.9%) burials (Z test = −2,079; p = .04). LEH incidence is very low in "ordered" mass graves (FC1–7; 7.5%) and very high in "disordered" ones (FC8 + 9; 60.0%). The high percentage of people with LEH in FC8 + 9 (associated with the battle of 409 BCE) might suggest that life conditions for the Himerans had sensibly worsened in its last decades, possibly due to the continual state of hostility in the region (see supporting information).

5 | CONCLUSION

Taphonomic and anthropological analyses conducted on the skeletons recorded in the mass graves of Himera and the comparative work carried out on a large sample from the same necropolis have permitted to associate the mass graves with two important warfare events that involved the Greek colony. Each analysed element confirmed that the individuals buried in the mass graves were soldiers fallen in battle: male sex, age at death below the average of male individuals in the necropolis sample, increased presence of weapons in contact with the skeleton, and perimortem traumas. The isotopic analyses show that these were soldiers from the Greek world—in FC8 + 9, these were exclusively Himerans—thus excluding the hypothesis as to the presence of Carthaginian soldiers. Furthermore, the topographical location of the mass graves, the taphonomic analysis of the individuals, and the density of inhumed skeletons made it possible to distinguish the mass graves resulting from the battles fought in 480 and 409 BCE.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

Conceived and designed the work: P. F. F., S. Viva, and N. L. *Taphonomic analysis*: P. F. F. and S. Viva. *Anthropological analysis*: P. F. F. and N. L. *Analysed the data*: P. F. F., S. Viva, and N. L. *Perimortal traumas analysis*: P. F. F. and G. V. *Canine X-ray images*: R. C. *Contributed to the writing of the manuscript*: P. F. F., S. Viva, N. L., G. V., and S. Vassallo.

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