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*Published in:*  
International Journal of Osteoarchaeology

*DOI:*  
[10.1002/oa.3128](https://doi.org/10.1002/oa.3128)

**IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.**

*Document Version*  
Publisher's PDF, also known as Version of record

*Publication date:*  
2022

[Link to publication in University of Groningen/UMCG research database](#)

*Citation for published version (APA):*

Vergidou, C., Karamitrou-Mentessidi, G., Voutsaki, S., & Nikita, E. (2022). A bioarcheological contribution to the social history of Roman Macedonia: The Pontokomi-Vrysi site in Kozani Prefecture, Greece. *International Journal of Osteoarchaeology*, 32(5), 1020-1034. <https://doi.org/10.1002/oa.3128>

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## RESEARCH ARTICLE

# A bioarcheological contribution to the social history of Roman Macedonia: The Pontokomi-Vrysi site in Kozani Prefecture, Greece

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**Funding information**

The Cyprus Institute; University of Groningen

**Abstract**

Roman Macedonia has been largely neglected by bioarcheological research. As a result, little is known about the imprint of living conditions of that time on the skeletons of its inhabitants, especially those of the lower classes. This paper presents the paleopathological study conducted on a Roman period (1st–4th c. CE) skeletal assemblage from Pontokomi-Vrysi, a site in the semi-mountainous region of Eordaea in Upper Macedonia (now in Kozani Prefecture, Greece). The aim is to investigate differences in the frequency of multiple paleopathological conditions in the buried population and to assess whether these are linked to sex- or age-related differences. The study examines cribra orbitalia (CO), porotic hyperostosis (PH), enamel hypoplasia (EH), osteoarthritis (OA), vertebral osteoarthritis (VOA), intervertebral disk disease (IDD), Schmorl's nodes (SNs), trauma (Tr), and lower limb periostitis/periostosis (PO). The results show higher frequencies of OA, IDD, PO, and Tr among males compared with those among females. These results suggest increased male physical hardship, pointing to a possible gender division of labor with the men of the community being mostly responsible for the physically demanding agricultural and animal husbandry activities. Additionally, comparisons of the CO, PH, and EH patterns in adults and nonadults support that, in general, the Pontokomi-Vrysi community was resilient enough to overcome stress. Overall, these findings make an important contribution to both the bioarcheology and social history of Roman Macedonia and stress the need for more studies that combine historical, archeological (cultural), and bioarcheological data.

**KEYWORDS**

labor division, paleopathology, Roman Greece, Roman Macedonia

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## 1 | INTRODUCTION

Bioarcheological data regarding the health status of Roman Macedonian populations within the territory of modern Greece are extremely scarce. To date, there are merely six relevant studies; Malama and Triantaphyllou (2003) examined the biological and paleopathological profile of an assemblage from Amphipolis; Papageorgopoulou et al. (2009) presented a case study of embalming from Thessaloniki; Michael and Dotsika (2017), Dotsika and Michael (2018), and Dotsika et al. (2022) performed isotopic analysis on individuals from Edessa; and, finally, Vergidou et al. (2021) addressed issues related to dental health and diet in the community of Pontokomi-Vrysi. These studies highlight the important role bioarcheology can play in an area where many aspects of its social history, especially that of the lower classes, remain unknown due to the lack of adequate historical and textual evidence. They also stress the necessity to incorporate bioarcheological data into historical/archeological research towards a more comprehensive understanding of Roman Macedonia. The current paper complements and extends the study of Vergidou et al. (2021), mentioned above, by presenting the paleopathological profile of the Pontokomi-Vrysi community. The aim is to investigate differences in the frequency of multiple paleopathological conditions among males, females, and nonadults; to assess whether these can be attributed to sex- and age-related social differences; and to advance our understanding of the life quality and health status of the inhabitants of the Roman Province of Macedonia.

## 2 | HISTORICAL AND SOCIOPOLITICAL BACKGROUND

The skeletal assemblage under study dates to the 1st–4th c. CE and was excavated at the site of Vrysi (Kozani Prefecture, Greece), once belonging to the lands of *Eordaea* in the mountainous region of Upper Macedonia, the westernmost part of *Provincia Macedonia* (Figure 1) (Karamitrou-Mentessidi, 1999). During the time period under review, Upper Macedonia was part of the fourth administrative district of the Province, possibly organized as a federation of cities, *komai* (villages), and farmsteads (Sverkos, 2013).

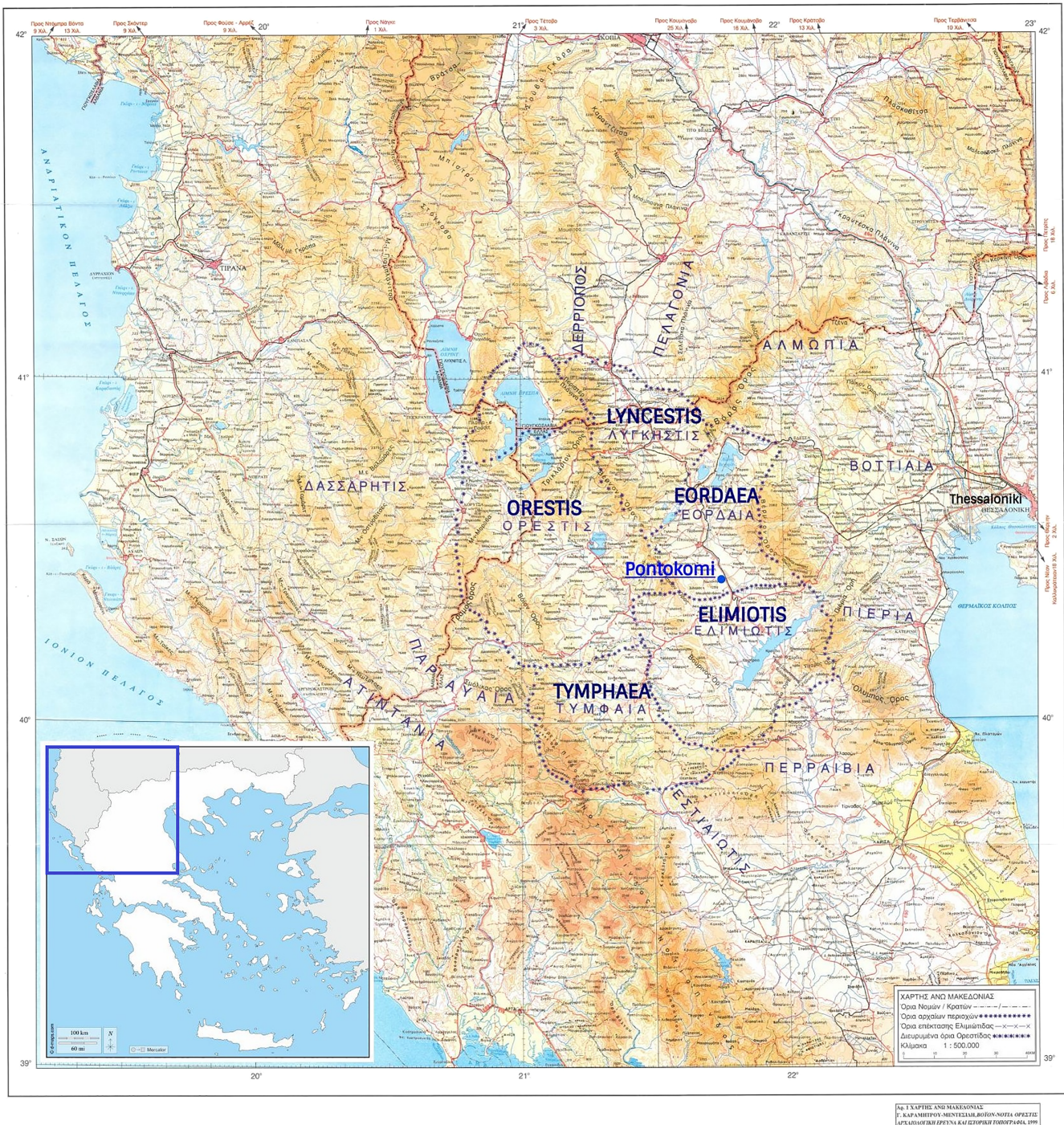
Placing, however, the Pontokomi-Vrysi community within the political and social historical context of Macedonia and the Roman Empire as a whole is not without problems as information regarding the political history of Upper Macedonia is extremely limited. The region entered the Imperial era not having fully recovered from the civil war battles of the 1st c. BCE, during which several of its towns and villages were sacked by the armies of the pretenders to the Roman *Imperium* (Sverkos, 2000). Later on, reformations by Augustus brought new life to the province, but recovery for Upper Macedonia was slow, because the construction of military roads, the maintenance of troops, the recruitment of local soldiers to the Roman army, and misadministration (Sverkos, 2000) added new economic pressures. The situation worsened during the so-called “period of the military emperors” (235–284 CE), as many battles were fought in Macedonian

territories while raids by Goths exacerbated the situation further (Vanderspoel, 2010). However, in the 4th c. CE, reforms carried out by the Tetrarchy and Constantine and relative peace brought renewed prosperity and economic recovery to the Province and restored administrative order (Vanderspoel, 2010).

Similarly to its political history, many aspects of the social history of Upper Macedonia remain unknown because of the fragmentary textual records (Sverkos, 2000). The information, in particular, on whether Upper Macedonian communities had civic status or not is scarce and contradictory (Hatzopoulos, 1996; Papazoglou, 1988). Among the *Eordaeen* communities known from epigraphic evidence, only the location of *Kellae* and *Bokeria* and perhaps that of *Arnissa* has been identified (Hammond, 1972). As a result, very little is known about the life quality of the low-status Upper Macedonians during imperial times. While some scholars argue that the region was impoverished (Hammond, 2000) and its political institutions were less advanced than in the rest of Macedonia (Rostovtzeff, 1957), others maintain the exact opposite (Hatzopoulos, 1996; Papazoglou, 1988). Moreover, the microecology of Upper Macedonia should not be overlooked; the mountainous and well-watered terrain favored both pastoral (Ntassiou & Doukas, 2019; Thomas, 2010) and agricultural activities, while the Via Egnatia facilitated interaction (Papazoglou, 1988). Recent archeological finds document contacts with the neighboring areas of Thessaly, Epirus, the rest of Macedonia, and southern Greece (Karamitrou-Mentessidi, 1999). Despite the problems in the documentation, Upper Macedonia in this period developed a special political and cultural identity (Sverkos, 2013).

## 3 | ARCHEOLOGICAL CONTEXT

Vrysi lies near the semi-mountainous modern-day village of Pontokomi at Kozani's Prefecture in Western Macedonia, Greece (Figure 1). Rescue excavations revealed the floor plan of several buildings, cisterns, and parts of the water supply system dating from late Hellenistic times (2nd–1st c. BCE) to the 2nd c. CE (Roman times), a Neolithic settlement, and two burial areas dated to the late Archaic-Classical (5th–3rd c. BCE) and the Roman period (1st–4th c. CE), respectively (Karamitrou-Mentessidi, 2001, 2002, 2004, 2009). From the burial areas, 101 graves belong to the Roman era and are the focus of the current paper. The majority of the graves belonged to primary single supine inhumations in simple, shallow and poorly furnished pit graves, cut into the natural bedrock or into the earth, often destroying the walls of earlier buildings (Karamitrou-Mentessidi, 2002). Other grave types were also found (four poorly furnished and two unfurnished tile-covered graves, one richly furnished built cist and one unfurnished rectangular cist), and a few graves contained more interments (nine graves containing two and two graves three skeletons) (Karamitrou-Mentessidi, 2002). The grave-goods included pottery vases, followed by glass and bronze vases, jewelry, agricultural tools, pins, and coins (Karamitrou-Mentessidi, 2002). Finally, it should be mentioned that none of the abovementioned buildings were in use when the Roman graves were



**FIGURE 1** Map of ancient Upper Macedonia and adjacent regions. Note the location of Pontokomi in Eordaea. Map adapted from Karamitrou-Mentessidi (1999) with the permission of Dr. G. Karamitrou-Mentessidi and the Hellenic Military Geographical Service [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

created and no other contemporaneous settlement was found associated with them, with the excavator postulating its relocation to a nearby area (Karamitrou-Mentessidi, 2002).

Placing these mortuary choices in the wider funerary tradition of Roman Macedonia is difficult because of the absence of large-scale excavations and the dearth of systematic contextual analyses of mortuary practices. It is therefore not easy to understand mortuary

variation between sub-regions, between urban and rural sites, or between sites of different size and/or socio-political status. Further complications arise by changing mortuary customs, for example, alternation between inhumation and cremation, shifts from ostentation to austerity in grave goods, or from above-ground to subterranean tombs. As a result, it is very difficult to make inferences about the social status of the burial populations. Despite these limitations, some

general observations can be made. Contemporary cemeteries with inhumations in simple, shallow, and poorly furnished graves have been found in other parts of the province of Macedonia (Kottaridou, 1997; Malama, 2002; Vrahionidou, 2017). From data known for the Roman world in general (Toynbee, 1971), we can infer that these were used primarily for the lower social strata. However, whether we are dealing with a largely undifferentiated population or a funerary ideology denying social differences is not easy to establish without a full contextual study of both mortuary and settlement evidence. However, it is hoped that a comprehensive bioarcheological analysis is a first step towards this direction.

## 4 | MATERIALS AND METHODS

The material under study comprises 108 Roman era skeletons (60 adult and 48 nonadult).

Sex for adult individuals was estimated based on morphological traits of the os coxae and skull (Buikstra & Ubelaker, 1994), aided by long bone measurements (Spradley & Jantz, 2011). Adult age-at-death was estimated from degenerative alterations of the iliac auricular surface (Buckberry & Chamberlain, 2002) and the pubic symphysis (Brooks & Suchey, 1990). Age-at-death estimation for nonadults was based on the union of the ossification centers (Schaefer et al., 2008), the length of the long bones (Maresh, 1970), and the development of the dentition (AlQahtani et al., 2010). The age groups used were fetus (before birth); infant (0–2 years); child (3–12 years); adolescent (13–20 years); young adult-YA (21–34 years); middle aged adult-MA (35–49 years); old adult-OA (50 + years); and adult-A (individuals over 18 years whose age could not be estimated due to poor preservation).

To assess completeness, a skeletal inventory was compiled. Bones were divided per anatomical region, and an adapted version of the anatomical preservation index (API) by Bello et al. (2006) was recorded, whereby API expressed the percentage of preserved bones of each anatomical region compared to the anatomical region's total number of bones. The degree of fragmentation per anatomical region was recorded as: 0 = *none to slight*; 1 = *moderate*; and 2 = *severe*. The degree of cortical surface destruction per anatomical region was evaluated by the qualitative bone index (QBI) (Bello et al., 2006) and weathering (Behrensmeyer, 1978).

Health status was evaluated based on pathological skeletal and dental lesions of diverse etiology, as detailed below.

Cribra orbitalia (CO) and porotic hyperostosis (PH) describe the manifestation of porosity and pitting at the roof of the eye sockets and the outer surface of the cranial vault, respectively (Grauer, 2021). No consensus exists regarding their etiology, but scholars agree that these lesions suggest physiological stress (Goodman, 2019). Individuals with at least one orbital roof present were included in the analysis of CO, while the outer surfaces of the parietals and occipital bone were considered for PH. For both lesions, the severity and state of healing were recorded (Nikita, 2017, and references therein).

Enamel hypoplasia (EH) describes localized lines, pits, or grooves on tooth surfaces, resulting from the imperfect mineralization of teeth

during their development (Goodman, 2019). Its etiology is multifactorial; hence, it is considered a non-specific indicator of childhood stress (Guatelli-Steinberg, 2016). EH recording included the type of defect, location, and severity (Nikita, 2017, and references therein).

Osteoarthritis (OA) is a progressive degenerative disease affecting the joint articular cartilage, which eventually breaks down causing inflammation to the synovial membrane, forcing the bone to respond in order to repair the damage (Waldron, 2021). Its etiology is multifactorial with various systemic and mechanical factors having been linked with it (Weiss & Jurmain, 2007). OA was macroscopically assessed for each element of the shoulder, elbow, wrist, hand, hip, knee, ankle, and foot. The condition was considered present when Waldron's (2009) criteria were met.

Vertebral osteoarthritis (VOA) refers to degenerative changes affecting the diarthrodial joints of the spine. Its clinical manifestation is the same as OA (Waldron, 2021). VOA is mostly caused by mechanical stress and aggravates with advanced age (Laplanche & DePalma, 2012). Degenerative alterations in the spinal amphiarthrodial joints differ from VOA on the affected tissue and joint type as well as the mechanical stress causing them (Waldron, 2009). Therefore, degenerative changes affecting the vertebral bodies will be presented under the term intervertebral disk disease (IDD). All available cervical, thoracic, lumbar, and first sacral vertebrae were examined. VOA and IDD were recorded according to their location and degree of expression (Nikita, 2017, and references therein). Each condition was considered present when Waldron's (2009) criteria were met.

Schmorl's nodes (SNs) occur when the *nucleus pulposus* protrudes into the bony tissue of adjacent vertebrae causing herniation (Schmorl & Junghans, 1971). They have been associated with several risk factors such as developmental and degenerative diseases, neoplasia, autoimmunity, and mechanical stress (e.g., Mattei & Rehman, 2014). In osteoarcheology, they are often used as indicators of physical stress (e.g., Novak & Šlaus, 2011). SNs were recorded according to their location and degree of expression (Nikita, 2017, and references therein).

Trauma (Tr) denotes any discontinuity of a skeletal element (Redfern & Roberts, 2021), though *myositis ossificans* was also included in this category. Trauma for the postcranial elements was recorded according to its location, type, severity, time of occurrence, healing stage, complications, and etiology, while cranial trauma was recorded according to the affected surface, type, severity, time of occurrence, etiology, and healing stage (Nikita, 2017, and references therein).

Periostitis/periostosis (PO) is the term used for bone lesions indicative of periosteal inflammation. While common in archeological remains, their etiology is difficult to determine (Weston, 2012). Here, the detection of periosteal lesions focused on the diaphyses of the femora, tibiae, and fibulae. PO was recorded according to lesion and bone type, severity, and type of periosteal reaction (Nikita, 2017, and references therein).

Prior to any statistical treatment, and due to the rather small sample sizes, the recorded data were converted into present/absent

scores. Chi-squared tests examined the association between sex and each pathological condition per age group, as well as bilateral asymmetry in OA expression. In cases of small sample size, the Fisher's exact test was used instead. Statistical significance was set at  $\alpha < 0.05$ . All analyses were performed in SPSS version 23.0.

## 5 | RESULTS

### 5.1 | Demographic composition

Within the sample, adult males and females were almost equally represented per age group, with only exception YA females ( $n = 13$ ), whose number was almost twice that of YA males ( $n = 7$ ) (Table 1). Adults represent the majority of the individuals studied ( $n = 60$ ) compared to nonadults ( $n = 48$ ); however, this difference is rather small. Regarding the distribution of the nonadult age groups, fetuses account for 3.7% ( $n = 4$ ), while infants and children represent respectively 18.5% ( $n = 20$ ) and 15.7% ( $n = 17$ ) of the total assemblage.

### 5.2 | Preservation

The preservation per anatomical region is given in Table S1. The adult assemblage was overall well preserved with an API average score (3.6) close to class 4 (50–74%); the degree of fragmentation average (1.2) shows a moderate state of severity; the QBI average score (4.5) is between classes 4 (50–74%) and 5 (75–99%), and the weathering average score (0.6) is very low in the Behrensmeyer (1978) five-stage scheme. Nonadults exhibited less good preservation (API = 2.7, fragmentation = 1, QBI = 3.7, weathering = 2.9) but were still well preserved. Different anatomical regions exhibited somewhat different patterns, but the overall completeness and surface preservation of the skeletons ranged from moderate to very good.

**TABLE 1** Age-at-death and sex distribution of the Pontokomi-Vrysi assemblage

Adults	YA	MA	OA	A	Total
Males	7	9	6	4	26
Females	13	8	6	4	31
?	0	2	0	1	3
Total	20	19	12	9	60
Nonadults	Fetuses	Infants	Children	Adolescents	Total
	4	20	17	7	48

Note: Key: fetus (before birth); infant (0–2 years); child (3–12 years); adolescent (13–20 years).

Abbreviations: ?, indeterminate sex; A, adult (18+ years); F, female; M, male; MA, middle aged adult (35–49 years); OA, old adult (50+ years); YA, young adult (21–34 years).

## 5.3 | Paleopathology

### 5.3.1 | CO and PH

Only 14.3% of the sample was affected by CO while 40.7% by PH (Table S2). No females showed evidence of CO, and males were more affected by PH, though not significantly so (Fisher's exact  $p > 0.05$ ). This lack of a statistically significant difference persisted when the comparison was performed per age group, with the exception of YA (Table 2). With regard to severity, most CO lesions were remodeled micropores, and most PH lesions were microporous borderline mixed or totally remodeled (Table S3).

Among nonadults, CO (73.7%) prevailed compared to PH (22.9%) (Table S4). The lesions manifested mostly in their mildest form; for CO, there was an equal distribution of active, remodeled and mixed lesions, and for PH active and mixed lesions in infants and adolescents but only remodeled lesions in children (Table S5).

### 5.3.2 | Enamel hypoplasia

EH in the adult sample was examined in an earlier study (Vergidou et al., 2021). Here, we present the results for nonadults and summarize the published adult data. Hypoplastic lesions exhibited a very high frequency among nonadults, whether estimated per individual (94.4%) or per tooth (82.9%) (Table S6). This agrees with the results for adults (Vergidou et al., 2021), where the frequency per individual was 82%, though the frequency per tooth was 47.6%. Among adults, hypoplastic defects were more common in males although the difference between sexes was statistically significant only in the OA group (Vergidou et al., 2021).

### 5.3.3 | OA, VOA, IDD, and SNs

Males overall exhibited a higher percentage of OA in all joints (Table S7). The statistically significant results are given in Table 2 where it can be seen that significant sex differences are found for pooled age groups in the right shoulder ( $\chi^2 = 3.771$ ,  $p = 0.052$ ), right wrist (Fisher's exact  $p = 0.018$ ), right hand ( $\chi^2 = 3.815$ ,  $p = 0.051$ ), and right and left hip ( $\chi^2 = 4.821$ ,  $p = 0.028$ ). When sexual dimorphism is examined per age group, significant differences are found in the right shoulder (Fisher's exact  $p = 0.015$ ), left shoulder (Fisher's exact  $p = 0.021$ ), and right hip (Fisher's exact  $p = 0.041$ ) of MA.

Almost half of the adult sample (41.5%) displayed lesions pathognomonic of VOA at least in one vertebra (Table S8). Such lesions were more common in males (males: 47.8%; females: 37.9%) and absent among YA females (YA, males 2/7; females 0/11). When examining VOA patterns per spinal segment, males showed a higher frequency in all segments except for the lumbar (cervical: males 38.9%, females 21.7%; thoracic: males 42.9%, females 23.1%; lumbar: males 29.4%, females 34.8%; sacral: males 25%, females 16.7%). Nevertheless, none of the differences between sexes reached statistical

**TABLE 2** Statistically significant results of the comparison between males and females

Condition	Affected element	Side	Age group	Frequency males	Frequency females	Chi-square/Fisher's exact	p
PH	-	-	YA	66.7%	27.3%	Fisher's exact	0.028
OA	Shoulder	Right	Pooled	81.8%	54.5%	$\chi^2 = 3.771$	0.052
OA	Shoulder	Right	MA	100%	33.3%	Fisher's exact	0.015
OA	Shoulder	Left	MA	100%	33.3%	Fisher's exact	0.021
OA	Wrist	Right	Pooled	25%	0%	Fisher's exact	0.018
OA	Hand	Right	Pooled	41.2%	13.6%	$\chi^2 = 3.815$	0.051
OA	Hip	Right	Pooled	66.7%	33.3%	$\chi^2 = 4.821$	0.028
OA	Hip	Left	Pooled	66.7%	33.3%	$\chi^2 = 4.821$	0.028
OA	Hip	Right	MA	75%	12.5%	Fisher's exact	0.041
IDD	Thoracic	-	Pooled	88.2%	58.6%	$\chi^2 = 4.440$	0.035
IDD	Sacral 1	-	Pooled	91%	50%	$\chi^2 = 4.909$	0.027
PO	Femora	Right	Pooled	90.9%	67.9%	$\chi^2 = 3.815$	0.051
Tr	craniofacial	-	Pooled	20%	0%	$\chi^2 = 6.808$	0.009

**FIGURE 2** “Parry” fracture on the left ulna of MA male, Grave 38—Skeleton A, scale = 5 cm (image with the kind permission of Dr. G. Karamitrou-Mentessidi) [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

significance. The frequency of IDD within the adult sample was high, with males being more often affected than females (males: 85%; females: 69%), a pattern that also characterized individual spinal segments (Table S9). The only statistically significant difference between sexes was in the thoracic ( $\chi^2 = 4.440$ ,  $p = 0.035$ ) and sacral segments ( $\chi^2 = 4.909$ ,  $p = 0.027$ ) (Table 2). The frequency of adults displaying SNs at least in one vertebral segment was relatively low (27.1%, Table S10). The lumbar vertebrae were most affected (28.2%), followed by the thoracics (21.7%), while S1 showed very low affliction (4.2%). Males were again more frequently affected than females but not significantly so.

### 5.3.4 | Trauma

Fourteen adult skeletons displayed at least one traumatic postcranial lesion (23.3%, Table S11). Males showed a higher percentage of Tr than females (30.8% vs. 19.4%), but this difference was not statistically significant. The postcranial elements mostly affected by trauma were the ribs (6/14 individuals, 42.9%) and the long bones (11/14 individuals, 78.6%). Of the 11 long bones affected by trauma, six were fractures showing evidence of callous formation (two MA males: metacarpal and fibula; three females: YA fibula, OA clavicle, and A humerus), among which two showed evidence of malunion (angulation). In one individual, a MA male with a fractured left fibula

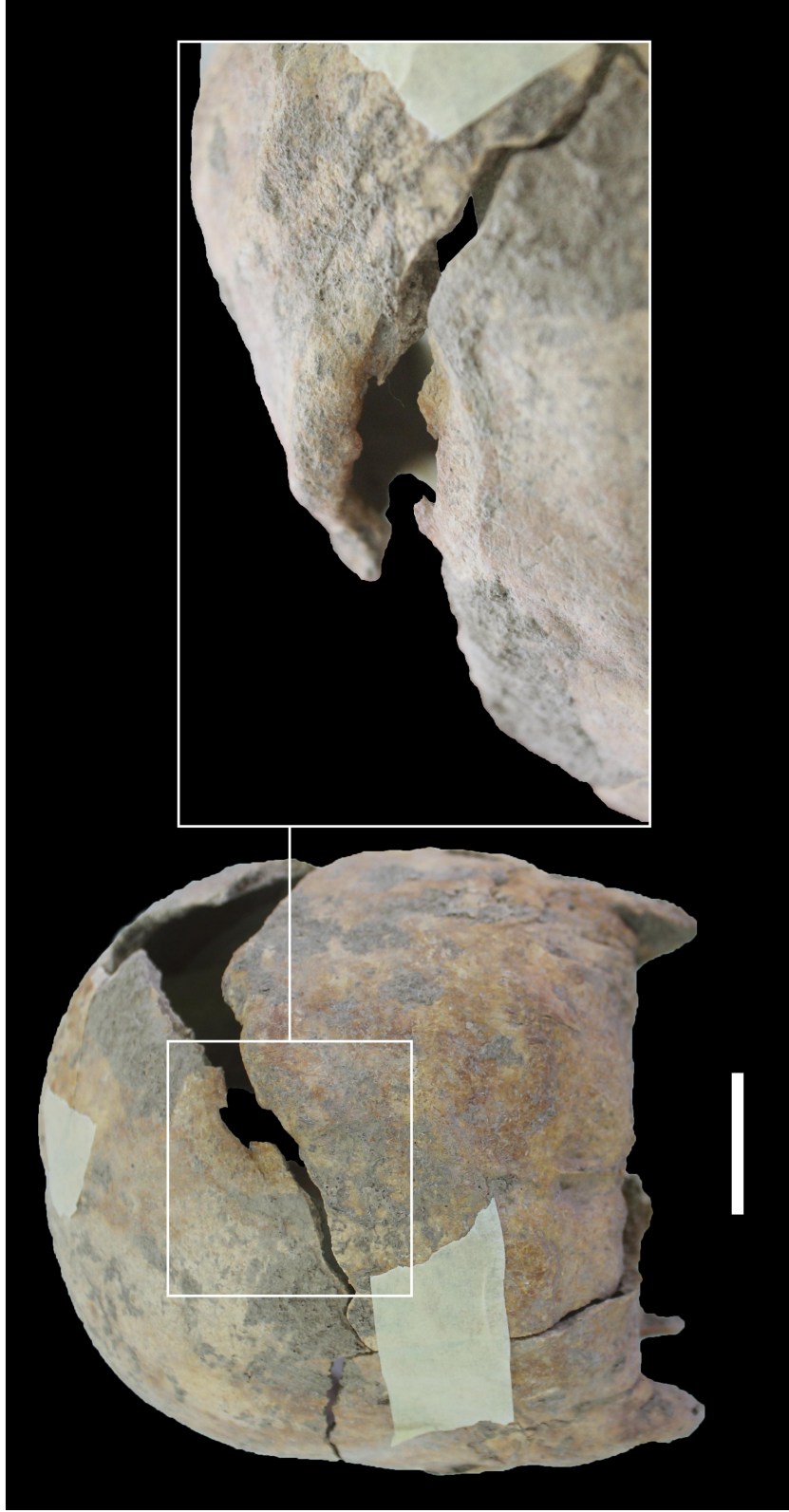
and a healed “Parry” fracture on the left ulna (Figure 2), fractures occurred in more than one element. The remaining long bone Tr were cases of *myositis ossificans traumatica* (three males: MA fibula and OA clavicle and tibia; and two females: A femur and YA tibia).

Craniofacial Tr was detected in 10% of the individuals, all males (Tables 2 and S11). All vault lesions represent depressed fractures possibly caused by a low velocity blunt object (Figure 3). Two nasal bone fractures (Figure 4) also occurred in one MA and one A male with the latter also displaying one of the aforementioned vault depressed fractures.

### 5.3.5 | Lower limb periostitis/periostosis

PO was particularly frequent with 86% of the individuals having been afflicted in at least one element (Table S12). Statistically significant differences between sexes were not identified. The tibia was the most frequently affected element (right: 91.5%; left: 91.8%; Table S13); however, it was followed by the femur (right: 77.4%; left: 75.9%; Table S13), an element that other studies have shown not to be frequently affected by PO (Figure 5). Striking is also the low frequency of PO in the fibulae of our assemblage (right: 24.4%; left: 26.2%; Table S13). The lesions were mostly healed, showing mild severity (Table S14). No significant difference was found between sexes per element, age group, and side apart from borderline significant results for pooled age groups in the right femur ( $\chi^2 = 3.815$ ,  $p = 0.051$ ) (Table 2).

PO frequencies were lower for nonadults (61.8%; Table S15) than adults (adults: 86%; Table S12). The lesions in nonadults also affected mostly the tibiae, followed by the femora and, finally, the fibulae (Table S15). Most lesions were diffuse woven and/or mixed and mild in severity, with only some of the children and adolescents showing evidence of healing (Table S16).



**FIGURE 3** Depressed (crush) fracture at the posterior middle cranial vault of OA male, Grave 82, scale = 5 cm (image with the kind permission of Dr. G. Karamitrou-Mentessidi) [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/oa.3128)]



**FIGURE 4** Fracture on the nasal bone of MA male, Grave 65, scale = 5 cm (image with the kind permission of Dr. G. Karamitrou-Mentessidi) [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



**FIGURE 5** Periostitis; top: left anterior distal 1/3 femoral shaft; middle: right lateral femoral midshaft; bottom: right middle femoral midshaft of MA? male, Grave 47, scale = 5 cm (image with the kind permission of Dr. G. Karamitrou-Mentessidi) [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

## 6 | DISCUSSION

Most of the population in classical antiquity must have belonged to low social strata relying mostly for their subsistence on agricultural manual labor (Alcock, 2012). However, archeological evidence has

shown that many Greco-Roman rural sites were characterized by elite features (Alcock, 1993). Accounting for the obscurities raised by the use of the urban–rural dichotomy (Scheidel, 2008), and since no settlement has been associated with the Pontokomi-Vrysi cemetery, the term “community” has been used here to refer to a population residing in a semi-mountainous settlement, remote from major urban centers, and comprising most probably farmers or pastoralists. This inference is strengthened by the observations on the mortuary practices which suggest a population belonging to low social strata. As we pointed out earlier, it is very difficult to place the mortuary and paleopathological data from the current study within a broader social history of Upper Macedonia. Bioarcheology can provide important information, but we need to keep in mind the conceptual uncertainties surrounding “health” and “stress” when they cannot be placed securely in the environmental and cultural context (Temple & Goodman, 2014). Despite this caveat, this study can elucidate aspects relating to the life and health status of the Pontokomi-Vrysi community and thereby enrich the social history of a largely unexplored part of the ancient Greek world.

### 6.1 | Demographic profile

Demographic patterns reveal key information on structure, growth, living standards, and other aspects of a population's life circle (Scheidel, 2008). Past demographic reconstructions, however, are challenging, primarily because archeological populations rarely represent the once living community (selective mortality) and because not all individuals were equally susceptible to diseases and the risk of

dying (hidden heterogeneity risks) (Wood et al., 1992). Among several other paleodemographic biases, the unequal nonadult to adult ratio is frequently encountered in osteoarcheology. In the Pontokomi-Vrysi sample, however, these groups are almost equally represented. This may be attributed to the carefully excavated site, the excellent bone preservation, and the uniform mortuary treatment of all age groups. It should be stressed, however, that the excavation was a rescue one and, therefore, underrepresentation biases might act upon the sample, since it is not certain if the entire burial ground has been excavated or if other contemporaneous cemeteries related to the same community existed and have not been found yet (Karamitrou-Mentessidi, 2001). Among nonadults, a high representation of infants and children is



**FIGURE 6** Tomb 48, Pontokomi-Vrysi assemblage. Inhumation of female individual with fetus just below the pelvic area shown with red arrow (image with kind permission of Dr. G. Karamitrou-Mentessidi) [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

common in Mediterranean bioarcheological contexts (Bourbou, 2013; Fox, 2012), and Pontokomi-Vrysi conforms to this pattern. Several factors can account for high death rates among younger nonadults, such as earlier weaning during which infants/children lose the immunity offered by breastfeeding (Dupras & Tocheri, 2007). The lower representation of adolescents also conforms to the mortality curve of many archeological populations (DeWitte & Stojanowski, 2015). Moreover, the high number of YA females in the sample may be linked to complications during pregnancy and childbirth and the difficulties faced by women during reproductive age. An example comes from the burial (tomb 48) of a female with fetal bones below the pelvic area (Figure 6).

Table 3 shows comparative demographic data from two Roman assemblages from Greece, used with some reservation, as the authors use different age subdivisions. We can see that the adult to nonadult ratio is so close to 1:1 only for Pontokomi-Vrysi. Corinth shows a very high frequency of nonadults compared to adults, while the inverse pattern characterizes Athens. The pattern of increased frequency of younger nonadults compared to lower numbers of adolescents is shared between Pontokomi-Vrysi and Corinth, while no comparison with Athens can be made due to the nonadult age groups generated. These results show a lack of uniformity among the sites compared. Demographic ratios are usually affected by economic performance (Scheidel, 2008). Archeological and historical evidence shows that Athens and Corinth received particular attention by the Roman rule, but the impact this had on the living standards of their populations is debated (Alcock, 1993). Nonetheless, these two urban centers display completely different age-at-death distributions. Moreover, although we would expect higher mortality rates in Pontokomi-Vrysi due to its different socioeconomic background and microecology, this is not the case, when compared to Corinth. Thus, taphonomic, methodological, sample, and excavation biases should be accounted for before attempting conclusions (Stodder, 2008).

## 6.2 | Paleopathological profile

Paleopathological studies can be subject to major biases. Among them, hidden heterogeneity to frailty, also discussed in Wood et al. (1992)

**TABLE 3** Comparative demographic data from Roman sites in Greece

Site	Fetus	Infant (0–2 years)	Child (3–12 years)	Adolescent (13–20 years)	Nonadults total	Adults (>20 years)
Pontokomi (Roman-late Roman)	3.7% (4/108)	18.5% (20/108)	15.7% (20/108)	6.5% (7/108)	44.4% (48/108)	55.5% (60/108)
Athens <sup>a</sup> (early Roman)	0–1 years: 6.7% (7/104); 1–4 years: 6.7% (7/104); 5–14 years: 11.5% (12/104)				25% (26/104)	75% (78/104)
Corinth <sup>b</sup> (Roman-late Roman)	Late fetal to 3 years: 31.8% (14/44); 4–11 years: 34% (15/44)		12–20 years: 11.4% (2/44)		70.5% (31/44)	29.5% (13/44)

Note: The first row age categories are those used in the current paper.

<sup>a</sup>Lagia (2007).

<sup>b</sup>Fox (2005).

“osteological paradox,” plays a pivotal role. This heterogeneity expresses the fact that the population represented by any skeletal assemblage was composed of individuals with different susceptibilities to disease and death, which complicates inter- and intra-assemblage comparisons. Moreover, the osteological paradox acknowledges that diseases resulting in acute death will likely not manifest on the skeleton. Ways to remedy these biases include the comparative analysis of multiple stress indicators and the contextualization of the osteoarcheological data (Temple & Goodman, 2014). Taking these suggestions into consideration, the Pontokomi-Vrysi health status was evaluated by using multiple lines of contextualized paleopathological evidence.

CO was more frequent in nonadults compared to adults, in agreement with previous studies that linked a higher frequency of CO in Roman era nonadults to episodes of childhood stress (Cucina et al., 2006). This observation, coupled with the high representation of nonadults in the sample, suggests a frail health for the most vulnerable members of the community, perhaps linked to weaning, when immunity due to breastfeeding ceased to provide a protective shield (Dupras et al., 2001). Adults with healed CO lesions likely represent children who survived and reached adulthood. Of them, males appear to have been more resilient, as no adult female in the assemblage exhibited CO. At the same time, the frequency of PH in nonadults is lower than in adults, in contrast to previous clinical and bioarcheological studies (Walker et al., 2009). It should be mentioned, however, that for almost all adult individuals, the lesions are microporous and healed. Among them, the lack of statistically significant sex differences matches many archeological settings, with growth period anemia having been linked to this pattern (Stuart-Macadam, 1985). Such a hypothesis cannot be ruled out for the Pontokomi-Vrysi community; however, given the several pathological or systemic factors at play (e.g., metabolic and/or infectious diseases), the anemia hypothesis remains uncertain. CO and PH represent bone responses to a variety of abnormalities related to blood production due to physiological stress. Therefore, the difference between adult and nonadult CO and PH frequency and severity may be related to the different hematopoietic anatomical sites for adults (spongy bone of ribs, sternum, pelvis, and spine) and nonadults (skull diploë and long bones marrow) and the efforts of their respective systems to retain their homeostasis during various health assaults (Walker et al., 2009). Overall, the prevalence of CO and PH shows that physiological stress is evident in the sample causing the death of many individuals at a young age, with several of them, however, surviving into adulthood. The high frequency of EH for all age cohorts (Vergidou et al., 2021) complements this picture.

The results for OA, VOA, IDD, and SNs suggest a greater affliction of males by degenerative changes in the spine and the right side appendicular skeleton joints. Despite the age-progressive nature of these lesions, their greater frequency in males cannot be attributed to the higher number of YA females in the assemblage, as the statistically significant patterns involve middle-aged adults, an age group where males and females are equally represented. The multifactorial etiology of these lesions should not be overlooked (e.g., Weiss & Jurmain, 2007); however, based on the microecology of the region,

this pattern may be attributed to greater physical work load, as skeletal degenerative alterations have been often associated with mechanical loading (e.g., Cheverko & Bartelink, 2017). Results on Tr suggest a higher risk of trauma among males, though not resulting in severe physical impairment. Most injuries must have been accidental or associated with agricultural activities. These findings support ancient literary evidence that attests gender-based division of labor in the Roman world and social restrictions on the involvement of women in agricultural activities (Erdkamp, 1999). However, it would be premature to assume that females engaged exclusively in less physically demanding tasks. Finally, it is possible that some of the observed injuries were the result of interpersonal violence, since inscriptional sources attest the service of Macedonian men in the Roman army (Sverkos, 2000). The particularly high frequency of PO in Pontokomi-Vrysi is striking and may indicate a community susceptible to different health assaults. However, most lesions were mild, diffuse, and healed, suggesting a population resilient enough to survive periods of extended stress (DeWitte, 2014).

Overall, our results suggest that the community of Pontokomi-Vrysi engaged in agricultural activities, which tend to cause unilateral skeletal degenerative changes and afflict mostly males (Croft et al., 1992). The site lies in an area with small fertile plains and lakes surrounded by mountains and hills, limited forest cover and extensive bare areas (Ntassiou & Doukas, 2019). This microecology would promote a mixed subsistence economy of small-scale agriculture and animal husbandry, with physically strenuous activities practiced mostly by men. A possible link between systemic factors and the microecology of the site may be proposed, with hardships associated to the harsh semi-mountainous and remote environment, often afflicted by adverse climatic conditions, causing physiological stress. It can be argued, however, that the community managed to compensate for the harsh living conditions, as many of its individuals overcame stress episodes during childhood and reached adulthood.

### 6.3 | Comparing lifestyle and health patterns across the Roman Empire

Placing the Pontokomi-Vrysi (PNKV) data within a wider Roman times setting will allow a deeper understanding and contextualization of the observed patterns. Two assemblages from outside Roman Macedonia have been identified as suitable for comparison, as they comprise more or less contemporaneous populations of similar socio-economic status, use samples similar in size, and record largely the same pathological lesions. The first assemblage comes from the 1st–3rd c. CE necropolis of the rural town of Lucus Feroniae (LF), approximately 30 km north of Rome, with archeological and osteological data pointing to a group of slaves or war veterans actively engaged in manual agricultural activities (Manzi et al., 1999; Salvadei et al., 2001; Sperduti, 1997). The second assemblage comes from the 3rd–4th c. CE necropolis of a rural settlement at Oymaağaç Höyük (OM) in northern Turkey with archeological and mortuary evidence pointing to a group of low socioeconomic status (Marklein, 2018). No

**TABLE 4** Comparative paleopathological data from Roman sites across the Mediterranean

Skeletal lesion	Sex/age group	Pontokomi-Vrysi (PNKV) (1st–4th c. CE, Greece)	Corinth (CRTH) (1st–4th c. CE, Greece) (Petry, 2020)	Lucus Feroniae (LF) (1st–3rd c. CE, Italy) (Manzi et al., 1999; Salvadei et al., 2001; Sperduti, 1997)	Oymağaç (OM) (3rd–4th c. CE, Turkey) (Marklein, 2018)
CO	Males	23.5% (4/17)	-	14.8% (4/27)	-
	Females	0% (0/17)	-	24.2% (8/33)	-
	Indeterminate	100% (1/1)	-	-	-
	Total adult	14.3% (5/35)	7% (4/57)	17.9% (12/67)	-
	Total nonadult	73.7% (14/19)	7% (2/29)	65.4% (17/26)	-
	Total assemblage	35.2% (19/54)	7% (6/86)	32.2% (30/93)	-
PH	Males	45.8% (11/24)	-	-	-
	Females	35.7% (10/28)	-	-	-
	Indeterminate	50% (1/2)	-	-	-
	Total adult	40.7% (22/54)	0% (0/57)	5% (5/100)	-
	Total nonadult	22.9% (8/35)	0% (0/29)	27.9% (9/31)	-
	Total assemblage	33.7% (30/89)	0% (0/86)	10.7% (14/131)	-
EH	Males	85.2% (23/27)	-	84% (21/25)	31.8% (7/22)
	Females	80.6% (25/31)	-	83.3% (20/24)	11.1% (2/18)
	Indeterminate	66.7% (2/3)	-	-	-
	Total adult	82% (50/61)	21% (12/57)	82% (41/50)	22.5% (9/40)
	Total nonadult	94.4% (17/18)	0% (0/29)	-	-
	Total assemblage	84.8% (67/79)	14% (12/86)	-	-
OA	Males	84.6% (22/26)	-	83.7% (41/49)	71.7% (38/53)
	Females	61.3% (19/31)	-	61.8% (34/55)	61.1% (22/36)
	Indeterminate	33.3% (1/3)	-	-	-
	Total adult	70% (42/60)	-	72.1% (75/104)	67.4% (60/89)
VOA	Males	47.8% (11/23)	-	-	-
	Females	37.9% (11/29)	-	-	-
	Indeterminate	0% (0/1)	-	-	-
	Total adult	41.5% (22/53)	-	-	-
IDD	Males	85% (17/20)	-	82.8% (24/29)	45.4% (15/33)
	Females	69% (20/29)	-	76.5% (26/34)	37% (10/27)
	Indeterminate	0/0 (0%)	-	-	-
	Total adult	74% (37/50)	-	79.4% (50/63)	41.7% (25/60)
PO	Males	91.7% (22/24)	-	-	11.6% (5/43)
	Females	80% (24/30)	-	-	7.14% (2/28)
	Indeterminate	100% (3/3)	-	-	-
	Total adult	86% (49/57)	-	-	9.9% (7/71)
TR	Males	42.3% (11/26)	-	38.5% (15/39)	40% (16/40)
	Females	19.4% (6/31)	-	37.5% (21/56)	15.2% (5/33)
	Indeterminate	33.3% (1/3)	-	-	-
	Total adult	30% (18/60)	-	37.9% (36/95)	28.8% (21/73)

comparable assemblage from Roman Greece has been located. However, a third assemblage, from the major urban colonial center of Corinth (CRTH) in Greece (Petry, 2020), is added in the comparison because of its chronological (1st–4th c. CE) and geographic proximity.

Table 4 presents the frequency of different pathological conditions in the four assemblages. At a glance, the much smaller frequency of CO, PH, and EH in urban CRTH compared to the three rural communities is evident, with sole exception the EH frequency which is very similar in CRTH (21%) and OM (22.5%). CO and PH for the rural

communities could be only compared between PNKV and LF. CO showed overall similar frequencies in the total adult (PNKV, 14.3%; LF, 17.9%), nonadult (PNKV, 73.7%; LF, 65.4%), and entire population sample (PNKV, 35.2%; LF, 32.2%). When sex differences were considered, male individuals prevailed in the PNKV sample and females in the LF one. No male–female difference between the two assemblages was significant. No comparable data are available for the frequency of PH between sexes. While nonadults in both assemblages were similarly affected by PH (PNKV, 22.9%; LF, 27.9%), PH lesions were significantly more common in PNKV adults (PNKV, 40.7%; LF, 5%,  $\chi^2 = 7.631$ ,  $p = 0.005$ ). Comparisons for EH could be made only between adults. The lesions showed the same frequency between the total population of PNKV and LF (both 82%) and a significant difference between PNKV (82%) and OM (22.5%) ( $\chi^2 = 17.553$ ,  $p < 0.001$ ). Statistically significant results were also obtained when males and females were separately compared between OM on the one hand and PNKV and LF on the other.

Data on degenerative changes and trauma are not available for CRTH. The frequency of OA was almost identical in PNKV and LF (both per sex and total adults). The frequency in OM males was slightly lower compared to PNKV, but not significantly so, while females in all three assemblages were equally affected (PNKV, 61.3%; LF, 61.8%; OM, 61.1%). VOA comparative data were not available, but IDD frequencies were similar between PNKV and LF and significantly different from OM (PNKV vs. OM males,  $\chi^2 = 8.14$ ,  $p = 0.004$ ; PNKV vs. OM females,  $\chi^2 = 5.73$ ,  $p = 0.01$ ; PNKV vs. OM total adults,  $\chi^2 = 11.59$ ,  $p = 0.0006$ ). PO could be only compared between PNKV and OM and was significantly more frequent in PNKV ( $\chi^2 = 74.415$ ,  $p < 0.001$ ). Finally, all three rural communities displayed the same Tr frequencies, but traumatic lesions were significantly more common in males compared to females in PNKV and OM, whereas LF males and females displayed almost the same Tr frequencies.

Although data were not equally available for all four assemblages, the above comparisons offer some important insights. The lower frequency of CO, PH, and EH in urban CRTH compared to the three rural communities is striking. It has been argued that living conditions in crowded cities were worse than in the countryside (Betsinger & DeWitte, 2020), but Petry (2020) attributed the improved health of Roman period Corinthians to novelties in water technology, sanitation, grain acquisition, and distribution and intensified food importation. Conversely, increased stress markers in rural communities may be linked to the asymmetrical distribution of resources of a globalized world favoring the bigger urban centers (Pitts, 2014).

Turning to the rural communities, overall, the response of PNKV to physiological stress resembles more LF than OM. Salvadei et al. (2001) attribute the high CO and PH frequencies in nonadults in LF to iron-deficiency anemic incidences during childhood. The acquired anemia hypothesis cannot be ruled out also for PNKV, but the same holds for systemic factors (e.g., malnutrition). It is hoped that forthcoming isotopic analysis will provide a clearer picture. Although a definite etiology behind the stress factors for PNKV cannot be identified, it is interesting to note (1) the overall similarity of PNKV and LF responses

to physiological stress; (2) the strenuous life for nonadults in PNKV and LF; (3) the greater resilience of PNKV compared to LF towards surviving childhood physiological stress and reaching adulthood; and (4) the possible different etiology behind the manifestation of CO and PH for PNKV with individuals afflicted by CO having less, and those afflicted by PH having more chances to survive into adulthood. The high frequency of EH in PNKV and LF complements the above observations. Although no nonadult EH frequencies are available for the OM sample, the much lower adult/nonadult ratio in OM compared to PNKV supports a greater frailty of PNKV nonadults, even though many of them survived into adulthood.

Adding to the above picture, stress due to manual labor was also detected in the three rural communities. It is well known that in antiquity most individuals belonged to the low social strata and depended for their subsistence upon manual labor, mostly agriculture (Scheidel et al., 2008). According to degenerative joint changes, the men and to a slightly lesser degree the women of all three communities, especially PNKV and LF, were involved in physically demanding tasks.

## 7 | CONCLUDING REMARKS

Our study on the people of the Pontokomi-Vrysi community examined multiple lines of paleopathological evidence, with emphasis on sex- and age-related divisions. The demographic profile shows many infant and young children deaths following the normative nonadult mortality curves observed in many agricultural archeological populations. The paleopathological data, however, show the resilience of many of its young members, who reached into adulthood despite the adverse living conditions in a small rural community in that period. Another interesting finding is the increased physical hardship for males, possibly pointing to a gender division of labor, with males being mostly responsible for the physically demanding agricultural and animal husbandry activities. Increased male physical hardship is also evident by trauma, pointing to occupational accidents. Previously published results on the dental health of the same community showed a rather undifferentiated diet between males and females (Vergidou et al., 2021). Taken together, the results of the two studies speak of a resilient community, relying for its subsistence on agriculture, with less strictly defined gender-based social roles when it comes to consumption and more differentiated when it comes to labor, possibly on the basis of physical strength and/or societal prescriptions. As already mentioned, available evidence regarding the social history of Roman Macedonia, especially in relation to lower in status populations, is scarce. Our findings, despite the rather small sample size, make an important contribution to the social history of Roman Macedonia and highlight the need for more studies that combine historical, archeological (cultural), and bioarcheological data.

## ACKNOWLEDGMENTS

This research was conducted at the Archaeological Museum of Aiani in Kozani Prefecture, Greece. The authors would like to thank the director, Dr. A. Chondrogianni-Metoki and all colleagues working at

the museum, who supported and encouraged our work. Our special thanks are extended to the staff of the conservation section of the museum for helping in the cleaning, sieving, packaging, and storage of the bones. Our warmest gratitude goes also to Ass. Prof. Elias Sverkos (Aristoteles University of Thessaloniki), Dr. Paraskevi Tritsaroli (Groningen Institute of Archaeology), and Dr. Nancy Kyriakou (Aristoteles University of Thessaloniki) for advice on the interpretation of the results, as well as to Mahmoud Mardini (STARC-The Cyprus Institute) for help with preparing and editing the figures of the manuscript. This study was financially supported by the University of Groningen and The Cyprus Institute.

## CONFLICT OF INTEREST

None.

## DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available in the supplementary material of this article. Any more detailed data is available from the corresponding author upon reasonable request.

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**How to cite this article:** Vergidou, C., Karamitrou-Mentessidi, G., Voutsaki, S., & Nikita, E. (2022). A bioarchaeological contribution to the social history of Roman Macedonia: The Pontokomi-Vrysi site in Kozani Prefecture, Greece. *International Journal of Osteoarchaeology*, 32(5), 1020–1034. <https://doi.org/10.1002/oa.3128>