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Violence, Survival, and Infection: A Paleopathological Case Study from the Roman Necropolis of *Marinelle Vecchie* (2nd–3rd Century CE)

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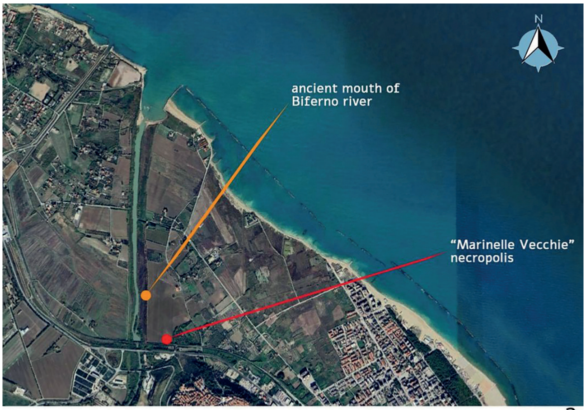
Abstract

This study presents the paleopathological analysis of human remains from the Roman necropolis of *Marinelle Vecchie* (Molise, Italy), dated to the 2nd–3rd centuries CE. Among the examined burials, the individual from tomb T8 shows multiple healed fractures of the forearm, hand, and leg, along with a proximal tibiofibular synostosis, suggestive of survival after high-energy trauma possibly related to interpersonal violence. In addition, destructive lytic lesions on thoracic vertebrae D7 and D8 raise a differential diagnosis between early-stage spinal tuberculosis and brucellar spondylitis, both endemic in the Mediterranean basin during the Classical and Imperial periods.

Keywords: Central Italy - Paleopathology - Trauma - Tibiofibular synostosis - Infectious diseases

Introduction

According to the concept of *pathocenosis*, defined by Mirko Grmek in 1969[1], emerging diseases can be identified in five different historical situations, one of which occurs when a pathology existed only in a limited number of cases and was recognized only after a qualitative and/or quantitative change in its manifestations[2]. Within this framework, it becomes meaningful to investigate even a few cases, sometimes a single one, that attest to the presence in the past of a condition that later spread widely[3]. This archaeological site, identified in 2007/2008, is located in Campomarino (Molise, Italy) on the right bank of the Biferno river[4] (Fig. 1a), where served as an optimal docking area for small boats, as suggested by the findings of the remains of an ancient port already mentioned in medieval documents[5,6,7] and connected to the nearby Roman *municipium* of *Larinum*[8]. The site's usage spans from the 4th century BCE to the 7th century CE. Associated with the port area is a necropolis (Fig. 1b): within a 6x13 meter area, a total of 18 burials were discovered and seven of these have been excavated and can



a

b

Fig. 1a: Site of *Marinelle Vecchie* in Campomarino (Molise, Italy); Fig. 1b: Aerial photograph of *the Marinelle Vecchie* Necropolis.

be dating between the 2nd and 3rd centuries CE[9]. The tomb types are quite heterogeneous, are located at different levels, and their orientations (N-S; NW-SE) are comparable to similar burials found in the same regional territory, in the municipalities of Pozzilli and Macchia di Isernia[10].

Among them are massetto tombs (T3A and T4), quadrangular in shape and built with stones and reused materials bonded with yellowish mortar; the ceramic building materials, mostly consisting of *tegulae mammatae*, *pilae*, and *tubuli*, were probably taken from a large abandoned villa in the area. Other burials are cappuccina tombs, either with the classic pitched roof of angled tiles beneath which the deceased was laid (T8), or with a double arrangement consisting of a pitched tile roof above and an additional lower covering of horizontally placed tiles, beneath which the deceased was placed in the grave pit (T2, T3B). T9 does not conform to the cappuccina type: it contained only a single horizontal tile covering, with a reused *tegula mammata* placed in the center.

In T3A and T3B, 40 nails were recovered, suggesting the presence of a wooden coffin for each of the two burials. The rich funerary assemblage, including ceramic artefacts, glass objects, coins, and lamps[11], associated with the two graves, indicates that the individuals likely belonged to a relatively high social class. Tomb T3B also contains a bronze pendant, a small gold plate (37x28 mm), a fragment of an iron axe, and a single-handled cooking pot. The pendant is made of small circles filled with glass paste and enamel, probably an amulet against the evil eye[12]. On the gold plate there is an inscription in Greek interpreted as an invocation to angelic entities for the protection of a child[13]. The fragment of axe probably represents a symbol of threat to anyone who might ever desecrate the tomb[14]. The pot[15] contains a coin of *Severus Alexander*, interpreted as a coin for Charon. The set of these funerary objects reflects the cultural influences of various peoples of the Mediterranean area with whom there were various exchanges that had as their fulcrum this landing on the Adriatic Sea.

From a medical point of view, it may be interesting to present the results of the paleopathological study carried out on the small number of skeletons brought to light to date from *Marinelle Vecchie*, pending the completion of the works and further future archaeological investigations. This is because, at present, there is no adequate paleopathological literature available for that geographical area, so even a study on a numerically limited sample can provide original data on the state of health and living conditions of the ancient populations of the region.

Material and methods

The anthropological and paleopathological investigations were conducted on the osteological remains recovered from six burials (T2, T3A, T3B, T4, T8, T9), as the skeletal remains of the subadult individual found in T1 are incomplete and in an extremely compromised state of preservation[16].

Sex and age-at-death diagnoses were performed according to the standards suggested by Buikstra and Ubelaker[17,18]. Sex determination was based on the morphology of the os coxae or hip bone[19,20,21] and the skull[22]. Age-at-death was estimated based on morphological changes of the pubic symphysis[23] and the auricular surface of the ilium[24], the degree of cranial suture synostosis[25], and the degree of occlusal surface wear of the teeth[26]. The stature values were calculated based on the anthropometric measurements of the long bones using the formulas of Trotter and Gleser[27].

Indicators of occupational stress were assessed through the observation of enthesopathic changes (EC), arthropathies, and osteoarthritis (OA) lesions affecting different joints, accessory facets, or bone metaplasia of the tendon or ligament[28]. ECs were observed in various skeletal regions, and the methodology developed by Hawkey and Merbs[29] was adopted, which identifies three categories of markers: robustness (R), stress lesions (S), and ossifications and exostoses (Os). Each of these categories was classified according to a degree of expression ranging from 0, indicating the absence of the marker, to 3, representing a strong expression. Robustness markers and stress lesions represent a continuum; therefore, the scale used to classify them varies from 0 to 6. For the evaluation of arthritic phenomena, which include indicators such as marginal lipping[30,31], osteophytosis, porosity, vertebral body compression, osteochondritis up to eburnation[32], the presence and degrees of expression of the manifestations were recorded[33]: from 0 (absent) to 3 (very evident).

In addition to the macroscopic examination, numerous findings were subjected to digital radiographic examinations to diagnose both bone pathologies and systemic pathologies that leave stigmata on the bones[34].

Results

Each burial contained a single individual in primary deposition. For individuals T2 and T3B, no appreciable paleopathological indicators were observed; the anthropological analysis did not, in fact, reveal any diagnostic evidence attributable to significant pathological processes or notable biological stress.

In the individual buried in T8 (Fig. 3a) severe periodontitis was identified in the mandible, resulting in significant recession of the alveolar margin and exposure of the tooth roots[35]. *Antemortem* tooth loss was observed at 41 and 31, along with two destructive carious lesions involving the crown and mesial cervical area of teeth 46 and 36.

Individual	Sex	Age (years)	Height (cm)	Dental pathologies*	Pathological lesions	MOS/Anatomical district	Anatomical site / Insertion	Category	Degree
T2	F	35-50 (MA)	163		N.A.	N.A.	N.A.	N.A.	N.A.
T3A	N.A.**	16-22 (Ao)	N.A.	AMTL 15, 36; apical cyst 33; periodontopathy (Fig. 2a)	Periostitis lower limbs; enamel hypoplasia	N.A.	N.A.	N.A.	N.A.
T3B	M	35-50 (MA)	N.A.		N.A.	N.A.	N.A.	N.A.	N.A.

Individual	Sex	Age (years)	Height (cm)	Dental pathologies*	Pathological lesions	MOS/Anatomical district	Anatomical site / Insertion	Category	Degree
T4	M	35-50 (MA)	164	Abnormal positioning 22; absence 12; AMTL 26, 47; caries 37 (mesial) (Fig. 2b)	N.A.	Right Scapula	Glenoid surface	OA	1
						Left Scapula	Infraglenoid tubercle	R	3
							Small teres insertion	R	2
							Subglenoid tuberosity	Os	2
						Right/Left Clavicle	Deltoid insertion	R	3
							Acromial extremities	OA	2
						Right Clavicle	Rhomboid fossa	Os	2
						Right Humerus	Deltoid tuberosity	R	2
							Bicipital groove	S	4
							Lesser tubercle	R	2
						Right Radius	Bicipital tuberosity	R	3
						Right Ulna	Brachialis insertion	R	2
							Brachialis exostosis	S	4
						Hand	Digital joints	OA	1
T8	M	20-35 (YA)	170	AMTL 41, 31; caries 46 and 36 (mesial); periodontopathy	Fracture distal third left radius and ulna; fracture 2nd left metacarpal and proximal 2nd phalanx; proximal left tibiofibular synostosis; osteolytic lesion D7, D8	Right/Left Clavicle	Rhomboid fossa	Os	2
						Right Scapula	Infraglenoid tubercle	S	4
							Coracoid process (pectoralis minor)	Os	1
						Left Scapula	Infraglenoid tubercle	S	4
T9	M	20-35 (YA)	170	AMTL 46, 47, 48	Spondyloarthrosis	Os Coxae	Iliac crest	Os	2
						Right/Left Femur	Adductor magnus	R	3
							Gastrocnemius (medial supracondylar line)	R	3
							Femoro-gluteal crest	R	3
							Poirier facets	S	–
						Left Tibia	Soleus insertion	R	2
							Oblique line	Os	2
						Right Fibula	Soleus insertion	R	3
						Left Patella	Superior margin	S	4
							Anterior surface (patellar spur)	Os	2

Tab. 1. Summary of anthropological and paleopathological data from the necropolis of *Marinelle Vecchie*. Ao = adolescent; YA = young adult; MA = middle old adult; F = female; M = male; NA = not assessable. AMTL = Antemortem tooth loss; OA = Osteoarthritis; MOS = Musculoskeletal stress markers; R = Robustness; S = Stress lesion; Os = Ossification/exostosis.
*Dental nomenclature by the FDI (World Dental Federation) notation designated by the International Organization for Standardization (also FDI notation or ISO 3950 notation).
**Sex determination for the individual in T3A was inconclusive due to missing or fragmented skeletal regions needed for estimation.

The osteoarticular pathologies include a well-healed fracture in the distal third of the left radius and ulna. The left ulna appears deformed and slightly curved, with the diaphysis showing an irregular, porous, and thickened surface, features that are typical of prolonged reactive osteogenic activity. These characteristics suggest a post-fracture healing process, with the formation of mature callus. Although less affected, the ra-

a

b

Fig. 2a: Lytic erosion at the root apex of tooth no. 33 in the individual buried in T3A; Fig. 2b: Mandible of individual T4 showing dental pathologies: antemortem tooth loss of 47 and carious lesion on the mesial surface of tooth 37.

dius also shows noticeable asymmetry compared to the contralateral side, with a possible axial misalignment, a feature compatible with a poorly healed fracture or with a functional compensation due to the injury to the ulna (Fig. 3b).

In the left hand, the second metacarpal appears visibly deformed, with a pronounced curvature of the diaphyseal axis and irregular cortical thickening, while the proximal phalanx also shows an abnormal orientation relative to the joint axis and morphological alterations of the articular surfaces (Fig. 3c). These features are consistent with a traumatic event affecting the metacarpophalangeal joint, most likely a displaced fracture of the metacarpal and/or the proximal phalanx, which healed improperly.

Fig. 3a: Photograph of T8; Fig. 3b: Healed fracture in the distal third of the left radius and ulna; Fig. 3c: Alteration of the second metacarpal bone of likely traumatic origin.

The lack of anatomical alignment and the presence of reactive bone tissue indicate a spontaneous healing process without reduction or immobilization, resulting in the formation of a malunited callus.

The same traumatic event may be associated with evidence of a proximal left tibio-fibular synostosis, most likely resulting from trauma that led to calcification of the interosseous membrane (Fig. 4). The proximal portion of the fibula appears fused to the tibia by means of a massive bony outgrowth, which has completely obliterated the natural interosseous space. The surface of the synostosis is irregular and porous, displaying characteristics typical of reactive bone formation secondary to a chronic

inflammatory process or a healed trauma. A direct bony continuity between the two elements is observed, with no visible interposition of fibrous or cartilaginous tissue, confirming the presence of a complete osseous synostosis (Fig. 4a-b).
A particularly notable finding is a destructive osteolytic lesion affecting the anterior spongy bone of the superior body of two thoracic vertebrae (D7 and D8). This lesion weakened the affected vertebral bodies, causing a slight collapse of the superior plateau (Fig. 5b-c-d). Radiographic examination of D7 in the axial projection revealed an oval-shaped cavity in the anterior left quadrant with well-defined margins (Fig. 5e). In the lateral projection, the collapse of the superior plateau and the disappearance of the bony endplates are clearly visible.

a **b**

Fig. 4a: Evidence of a proximal left tibiofibular synostosis in the individual buried in T8; Fig. 4b: Digital radiographic analysis shows heterotopic ossification of the interosseous membrane of the left leg.

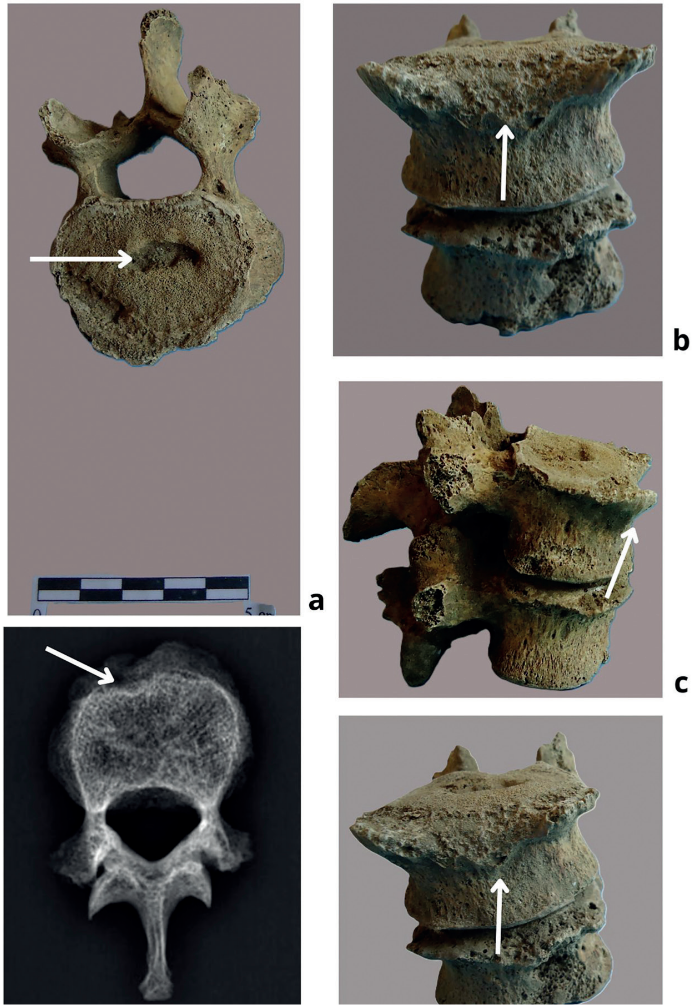


Fig. 5a: Schmorl's node on the vertebral body; Fig. 5b, c, d: Destructive osteolytic lesion involving the anterior spongy bone of the superior body of two thoracic vertebrae; Fig. 5e: Digital radiographic analysis which shows erosion in the upper-anterior portion of the vertebral body.

Some vertebral bodies exhibit oval cavities known as Schmorl's nodes, caused by the protrusion of part of the nucleus pulposus within the intervertebral disc[36]. This herniation exerts pressure on the body of the adjacent vertebra, leading to an osteolytic response[37,38](Fig. 5a).

Discussion

Among the pathologies identified on the skeletal remains of the individual buried in tomb T8, various traumatic lesions affecting the left side of the body, including the hand, forearm, and leg, are noteworthy. The fracture of the left ulna and left radius, fractures of the metacarpal and phalanx of the second finger of the left hand, as well as fractures of the tibia and fibula suggest the possibility of a single high-energy traumatic event responsible for the multiple injuries. Subsequent bone healing appears to have occurred spontaneously, without appreciable medical intervention or at least without effective treatment, as indicated by the skeletal evidence and, in particular, the proximal tibiofibular synostosis resulting from calcification of the interosseous membrane (Fig. 4a-b).

Macroscopic analysis of the cortical surfaces of the left radius and ulna revealed a diaphyseal fracture with an advanced stage of healing. The traces of bone remodeling are fully consistent with an *antemortem* trauma, followed by a survival period sufficient to allow activation and consolidation of the normal reparative processes. The location of the lesions, confined to the distal diaphyseal tract and without involvement of the olecranon or the proximal articular region, rules out a direct trauma to the elbow. The configuration and anatomical distribution of the fractures instead suggest a concentrated impact to the forearm, attributable to a direct traumatic mechanism. This dynamic may correspond to what is described in the literature as a parry fracture, generally considered the result of a reflex defensive gesture to shield the face from a frontal blow, during which the upper limb is raised laterally to absorb the impact[39,40,41,42,43]. This type of lesion has often been interpreted in paleopathological contexts as a potential indicator of interpersonal violence, although caution is required in the differential diagnosis, since accidental dynamics may also produce similar fractures[44]. Such cases include falls from a significant height, which differ from those caused by minor accidental events, such as tripping, which more commonly result in isolated fractures[45]. In the present case, the simultaneous fracture of the radius and ulna, an event that implies a high-energy impact, strengthens the hypothesis of an intentional trauma rather than the outcome of an accidental fall. The individual's survival for a period sufficient to allow marked bone remodeling may also suggest the existence of community support or, at the very least, a reduction in daily activities that facilitated the healing process.

Alongside the diaphyseal lesion of the forearm, a fracture of the second left metacarpal was identified. This injury can be related to the condition commonly referred to in clinical settings as a boxer's fracture, that is, the typical fracture caused by the impact of a clenched fist against a rigid surface[46]. Although this type of fracture is more frequently documented in the fourth and fifth metacarpals, both clinical and paleopathological literature occasionally extend the definition to the second and third metacarpals, making this interpretation plausible in the present case[47]. The consolidation process occurred without orthopedic reduction or functional immobilization, consistent with a context lacking structured medical practices, where spontaneous healing took place under biomechanically disadvantageous conditions.

At the level of the left lower limb, a rather rare condition was observed: complete fusion between the tibia and fibula proximally, mediated by extensive new bone formation that obliterates the physiological interosseous space. The surface of the synostosis exhibits macroscopic features consistent with a reactive process, irregular texture, marked porosity, and deposition of thickened lamellar bone tissue, suggesting a secondary origin due to trauma and/or chronic inflammation. Proximal tibiofibular synostosis may have congenital, idiopathic, or acquired etiologies (post-traumatic, iatrogenic, or post-inflammatory)[48]. In this case, the absence of other skeletal signs of dysplastic, malformative, or hereditary conditions (such as multiple exostoses), together with its unilateral localization, allows a congenital cause to be excluded[49]. The most plausible interpretation remains an acquired, post-traumatic origin, most likely following a fracture of the proximal fibular end and/or repeated microtrauma associated with a tibial fracture. The healing process would have involved the interosseous membrane, leading to its progressive calcification and culminating in complete bony fusion. This mechanism is described in sports medicine and orthopedic traumatology, particularly in individuals exposed to prolonged asymmetric loading or direct trauma to the knee or leg[50]. Such a condition would have resulted in significant functional limitations, especially in the mobility of the proximal tibiofibular joint, as well as in foot rotation and lateral knee stability. The loss of mobility between tibia and fibula can alter the distribution of biomechanical load during locomotion, impairing gait, posture, and stability, with consequent compensatory adaptations involving the contralateral limb or the vertebral column.

In light of the morphological evidence, the pattern observed in T8 falls within the spectrum of possible traumatic manifestations associated with aggressive dynamics, placing interpersonal violence among the most plausible etiological hypotheses. The concomitant fractures of the forearm and metacarpal on the same side reinforce the interpretation of a single traumatic event, most likely characterized by a direct and forceful impact. Within this context, the lesion of the left leg may either fit into the same traumatic framework or represent the outcome of a separate episode, likewise reflecting severe and/or repeated trauma.

It should be emphasized that it is not always possible to determine with precision the exact moment when a fracture occurred, and that skeletal trauma tends to accumulate over the course of an individual's life. The presence of multiple fractures in a single skeleton may therefore reflect a succession of distinct traumatic episodes[51,52]. In certain contexts, the recurrence of such events, so-called traumatic recidivism, has been interpreted as an indicator of constant and habitual exposure to risky conditions, or as a signal of changes in the hazards encountered during different stages of life[53,54,55].

Beyond the consequences of the traumatic injuries, the individual from T8 also presents vertebral lesions on D7 and D8, consisting of focal lytic destruction in the anterosuperior portion of the vertebral bodies, with irregular margins and a porous surface (Fig. 5b). Although these alterations suggest a chronic infectious process, they are not sufficiently pronounced to support a definitive diagnosis. Notably, there is no evidence of vertebral collapse, body fusion, or severe angular kyphosis, features typically associated with Pott's disease[56]. However, skeletal tuberculosis can present with a wide morphological variability, and many cases identified paleopathologically fall into subclinical or partially developed forms, in which skeletal signs are limited to marginal erosions or superficial lytic lesions[57].

In this respect, the lesions observed in T8 partially correspond to the minimal diagnostic criteria proposed by Holloway et alii[58,59] and subsequently applied by Toyne et alii[60], according to which vertebral tuberculosis may be suggested when at least two of the following indicators are present: (1) involvement of thoracic and/or lumbar vertebrae; (2) destructive lesions of the anterior portion of the vertebral body with little or no involvement of the posterior elements; (3) affection of 2–4 adjacent vertebrae; and (4) presence of kyphosis or scoliosis in articulation.

In the case of T8, criteria (1), (2), and (3) are met, while no spinal deformity is present. This alignment with several of the established diagnostic parameters makes tuberculosis a plausible hypothesis, even if the evidence remains insufficient for a conclusive attribution.

On the other hand, a highly plausible alternative diagnosis is brucellosis, particularly in its spondylitic form. Brucellar spondylitis often manifests as focal lytic erosions in the anterosuperior portion of the vertebral bodies, frequently accompanied by marginal sclerotic reaction, the so-called "Pedro Pons sign", which is considered pathognomonic in modern clinical cases. In addition, brucellosis can also affect thoracic vertebrae, although it shows a predilection for the lumbar region[61]. It tends to mimic milder forms of vertebral tuberculosis and generally presents with less destructive manifestations compared to tuberculosis[62,63,64,65]. In such cases, the inflammatory process is usually more localized, often accompanied by a variable degree of periosteal reaction. Brucellar spondylitis may appear as a single lesion or in a multifocal pattern, with features resembling those of tuberculosis, making the distinction between the two conditions challenging in the absence of biomolecular investigations[66].

From an epidemiological perspective, both tuberculosis and brucellosis were already endemic in the Mediterranean basin during the Classical period.

Tuberculosis is nowadays considered a disease of the lower classes, predominantly spread among the lower socioeconomic strata of large cities. Its prevalence increases with rapid urbanization and the consequent worsening of individuals' living conditions[67]. Between the 5th and 4th centuries BCE, Hippocrates, in the first book of his work *Epidemics*, described phthisis, highlighting symptoms such as acute fever, sweating, abdominal discomfort and hemoptysis, and recognizing it as one of the main causes of death at the time[68]. This demonstrates his knowledge of tuberculosis disease and its prevalence in densely populated centers, often with poor hygienic and sanitary conditions, which favored contagion. Although only about 10 to 20% of tuberculosis infections affect the bone[69], at least six cases of tuberculosis have been documented in Roman necropolises dating to the imperial age[70,71].

If tuberculosis can be regarded as a paradigm of chronic diseases intrinsically linked to urban living conditions and high population density, brucellosis, by contrast, reflects a different epidemiological model, rooted in close interaction with domestic animals and agro-pastoral practices. Unsurprisingly, this infection ranks among the earliest documented diseases: the first cases attributable with high probability to brucellosis have been identified in skeletal remains from the Middle Bronze Age at archaeological sites in Jordan[72] and Bahrain[73].

Extending the chronological horizon of the disease, evidence consistent with vertebral brucellosis has also been identified in the partial skeleton of Australopithecus africanus Stw 431, discovered at Sterkfontein, South Africa, and dated to approximately 2.3–2.5 million years ago[74]. This finding indicates that the pathogen, or closely related forms, may have affected not only modern humans but also our hominin ancestors, thereby placing brucellosis among the potentially oldest infectious diseases within the genus *Homo*[75].

Over historical periods, the frequency of brucellosis appears to have increased in Europe, with a clear peak during the Roman and Medieval eras, probably in relation to the progressive expansion and consolidation of sheep farming practices. One of the most significant cases in this regard is represented by the analysis of the skeletal population of Herculaneum, buried during the eruption of Vesuvius in 79 CE. The study revealed that approximately 17.4% of the adult individuals displayed alterations compatible with brucellar spondylitis, evidence pointing to a high level of endemicity of the disease within Roman society[76]. This interpretation is further reinforced by the identification of bacterial residues in samples of carbonized cheese recovered from the same site, which, together with historical sources, strongly supports the association between the consumption of contaminated sheep dairy products and the spread of the infection[77].

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