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AN ANALYSIS OF TRAUMA FREQUENCIES IN THE HIGH AND LATE MEDIEVAL SAMPLE FROM THE PAKOŠTANE – CRKVINA SITE

This paper analysed individuals from the medieval Pakoštane – Crkvina site. Between 2006 and 2016, several excavations uncovered 160 multi-layered graves, mostly dating from the 13th to the 16th centuries. Anthropological analysis determined that at least 467 individuals were found (319 adults and 148 subadults). It was possible to analyse the remains of 70 males, 25 females and 69 subadults. However, due to the poor preservation of bones in the recovered mass graves, determining the sex and age-at-death of other individuals was not possible. Analysis of the distribution and frequency of ante- and perimortem traumas was performed on adults over the age of 15 years (n=95). Long bone traumas were observed in 13 individuals and affected a total of 19 long bones (19/780; 2.4% of the total sample). Among the 74 preserved skulls, 24 (32.4% of the total sample) exhibited one or more traumas, i.e., head trauma was observed in 21 males and 3 females. In total, 39 cranial traumas were recorded. This paper highlights the high frequencies of antemortem and perimortem traumas in the sample and provides new insights into the trauma frequencies in Dalmatia during the period of the High and Late Middle Ages.

Key words: paleopathology, antemortem trauma, perimortem trauma, intentional violence, accident-related trauma, High and Late Middle Ages, Pakoštane – Crkvina, Croatia / *Ključne riječi: paleopatologija, antemortalne traume, perimortalne traume, namjerno nasilje, traume nastale kao posljedica nesretnog slučaja, razvijeni i kasni srednji vijek, Pakoštane – Crkvina, Hrvatska*

Introduction

The municipality of Pakoštane is located in the southeast part of Zadar County, and forms the border between the Zadar and Šibenik-Knin counties. The Crkvina site is located on the western shore of Vrana Lake, i.e. at the micro-location of Košević, where the medieval church of St. Mary lies. It is known from historical sources that the medieval settlement of Zablaće was located there, which in the early Middle Ages was the seat of Zablaće county, and from the 12th century, after the appearance of the Knights Templar (between 1165 and 1169), part of the preceptorate of Vrana. In the 13th century, it formed the separate preceptorate of Zablaće.[1] An interesting fact is that the historian Ivan Kukuljević Sakcinski, when describing the Templar properties in Croatia, in addition to the information that the Zablaće preceptory was located there, also stated that there was a monastery at that location. Unfortunately, he did not provide written sources with the descriptions.[2] In 1409, this area fell under Venetian rule. The Republic of Venice ruled Zablaće until 1538, when the

1 Jelić 1898; Uglešić, Gusar 2010; Gusar, Vujević 2013; Uglešić, Gusar 2017; Balić 2017; Dobronić 2002.
2 Kukuljević Sakcinski 1886.

settlement was deserted due to constant threats from Ottoman Turks, after which its inhabitants moved to nearby Pakoštane and other surrounding settlements. Currently available historical and archaeological data indicate that the site was not in continuous use after the 16th century but may have been sporadically inhabited on short-term occasions.[3]

The church of St. Mary was initially identified by the archaeologist Father Luka Jelić (Don Luka Jelić in Croatian tradition), who stated that he had found the old Croatian church of St. Mary and a smaller chapel next to it, both of which were destroyed during Turkish conquests. He also provides the most detailed description of the settlement.[4]

Systematic archaeological research of this site was carried out from 2006 to 2016 in several successive archaeological campaigns under the project: "Medieval archaeological heritage of southern Croatia from the 5th to the 17th century", led by Ante Uglešić with numerous other expert collaborators.[5] In 2024, a new research campaign was started.[6] During these excavations, a longitudinal church with a semicircular apse in the east, two side rooms adjacent to the perimeter walls of the church, a multi-level cemetery, a bell tower and various archaeological finds were discovered and investigated. The complex has probably been used from the 9th to the end of the 15th or the beginning of the 16th century, while the movable archaeological material dates from the late antique period to the 19th century. Due to the aforementioned findings and discoveries, it is assumed that the site represents a monastery complex.[7]

So far, 160 multi-layered graves have been explored, mostly dating from the 13th to the 16th century. Anthropological analysis of the recovered bones was carried out at the Anthropological Centre of the Croatian Academy of Sciences and Arts. It was determined that at least 467 people (319 adults and 148 subadults) were found. It was possible to analyse 70 males, 25 females and 69 subadults, while for the others, due to the poor preservation of the bones in the mass graves, it was not possible to determine the sex and age. In this paper, we will exclusively analyse adults over the age of 15 as previous research has shown that trauma in children is quite rare.[8] It is important to emphasize that we put the lower age limit at 15 years because sexual dimorphism in the pelvic bone can be determined around that age.[9]

This study aims to provide detailed and extensive analysis of antemortem and perimortem traumas, with particular focus on indicators of possible violence.[10]

Archaeological context

Archaeological research by the Department of Archaeology of the University of Zadar was carried out continuously from 2006 to 2016 and resulted in the discovery of a complex consisting of a single-nave church with a semicircular apse, northern and southern additional rooms, a bell tower, a fence wall and a cemetery. Thanks to the avail-

3 Uglešić, Gusar 2017; Gusar *et al.* 2021.
4 Jelić 1898; Baraka 2009.
5 Gusar, Vujević 2013; Bedić *et al.* 2018.
6 Uglešić, oral data.
7 Uglešić, Gusar 2009; Uglešić, Gusar 2010; Uglešić, Gusar 2011; Uglešić *et al.* 2016; Uglešić, Gusar 2017; Uglešić 2019.
8 Šlaus *et al.* 2012.
9 Šlaus 2006; Šlaus 2021.
10 Several papers and abstracts have so far been published about the Pakoštane – Crkvina site, including: Bedić *et al.* (2016), *Two skulls with evidence of trepanning from Late Medieval and Modern Age sites in North Dalmatia, Croatia;* Bedić *et al.* (2018), *Traumatic injuries in the late medieval population from Pakoštane-Crkvina, Eastern Adriatic coast;* and Gusar *et al.* (2021), *Medieval grave from the Pakoštane - Crkvina site (grave 76)*. Also, Adamić Hadžić, in her PhD thesis titled *Comparative analysis of trauma on the human osteological material from Croatia from early medieval to early modern period* (2021), analysed three large composite samples from Dalmatia, one of which included a small number of skeletons analysed in this paper

able historical sources that mention the existence of a monastery at that location and a wall surrounding the entire site, it is believed that these are the remains of a monastery complex. The Church of St. Mary is a single-nave longitudinal building with a semicircular apse in the east, and it most likely belongs to the Romanesque style. Additional longitudinal rooms were found on its north and south sides. Particularly interesting is the northern room where three tombs were found, one of which has an interior decorated with Templar crosses. To the west and east of the church, architectural remains were also discovered, the purpose of which is currently unknown, but there is a possibility that they belonged to the monastery residential complex.[11]

At present, 160 graves have been recorded. The first ones, graves number one and two, were found in 2008. From then on, several graves were discovered in each campaign. In 2009, graves three and four were excavated. In the first part of the research campaign in 2010, graves from five to 15 were discovered, and in the second part of the campaign, which was extended to 2011, from 16 to 19. In 2011, graves from 20 to 76 were discovered and excavated, then in 2012 graves from 77 to 83, in 2013 from 84 to 99, in 2014 from 100 to 111, and in 2015 from 111 A to 153. Finally, in 2016, graves from 154 to 160 were excavated.[12] Based on ^{14}C analysis and the recovered grave goods the cemetery is mostly dated from the 13th to the 16th century. Graves whose grave architecture consists of slabs and covering slabs usually contain more individuals. The covering slabs are usually made of two to three rows of layered amorphous stones, and the slabs are in the form of large stone slabs, on which in some cases, inscriptions, stylized hosts, and incised decorations of crosses were found.[13]

The recovered grave goods date from the antique period up to the High and Late Middle Ages. However, most of the goods belong to the High and Late Middle Ages, and consist of jewellery, coins, parts of clothing and utilitarian objects. The jewellery items include different types of earrings (plain and twisted earrings, three-bead earrings, earrings with three beads on each side and plain hoops), silver, bronze and gold-plated rings, and glass and amber beads. Furthermore, parts of textiles were recovered, as well as buckles which most commonly were circular and in a "D" shape. Among the most interesting finds were medals, crosses, bone beads of rosaries, three gold coins of the Byzantine emperor Romanus III Argira, bagatin from Zadar with the image of St. Simon from the 15th century, as well as the bull of Pope Hadrian IV. (1154-1159), which is the oldest papal bull found in Croatia.[14]

Materials and methods

Analysis of the osteological material was carried out at the laboratory of the Anthropological Centre, in the Croatian Academy of Sciences and Arts, in Zagreb. For each skeleton, a detailed analysis of all the bones and joints was made. Also, the sex and the age-at-death of the analysed skeletons was estimated.

The sex of the skeletons was based on morphological differences between males and females, both on the cranial,[15] and the postcranial skeleton.[16]

11 Gusar, Vujević 2013.
12 Personal communication with A.U.
13 Uglešić, Gusar 2010; 2017.
14 Uglešić, Gusar 2010; 2011; 2017; Gusar, Vujević 2013.
15 Krogman, Işcan 1986.
16 Kimura 1982; Phenice 1969; Sutherland, Suchey 1991; Weaver 1980; Buikstra, Ubelaker 1994.

Age-at-death was determined based on the obliteration of the cranial and maxillary sutures,[17]changes present on the pubic symphysis[18] and the auricular surfaces of the pelvis.[19]

Only individuals with completely unambiguous determinations of sex were included in the analysis. Adults were grouped into one of the following age categories: 15-30, 31-45 and 45+.

The skeletons were analysed macroscopically for the presence of injuries. The injuries have been divided into "accidental injuries" and those inflicted by intentional violence. An accidental injury is caused by an unfortunate event, while an injury caused by violence is deliberate.[20] The analysis of antemortem trauma was carried out on the skull and long bones of the skeleton. The location, dimensions, and shape of the wounds, alongside with possible complications resulting from the wounds, were recorded for each skeletal element that had an injury present. The presence of injuries was determined by checking for angular deformities, bone calluses, bilateral bone asymmetry and depressions on the cranium. Bone injuries can be antemortem, perimortem and postmortem. They can be identified, and differ from each other by the characteristics of fracture margins.[21] Antemortem injuries are wounds that the individual survived during his lifetime and are defined by the presence of healing around the wound. On the other hand, perimortem wounds occur at or near the time of death of the analysed individual. They are usually identified by fracture margins that are typical of freshly broken bones and the absence of healing around the wound.[22] Further characteristics of perimortem injuries are internal bevelling,[23] defined or sharp edges,[24] flat or polished surfaces with macroscopically visible striations[25] and bone fragments remaining attached to one another.[26] As for postmortem injury to bone, they occur long after an individual had died and are typically lighter in colour than the bone surrounding the wound. Postmortal damage to the bone is caused by factors such as ground pressure, animal gnawing, digging equipment, etc.[27]

The presence of fractures in long bones was recorded on the clavicles, humeri, radii, ulnae, femora, tibiae and fibulae. Due to the varying degrees of skeletal preservation, fracture frequencies were calculated by cranium, skeleton, and long bone. Moreover, trauma frequencies by skeleton were calculated from the number of skeletons which exhibit fractures, divided by the total number of skeletons, regardless of the degree of preservation of the skeletal material.

The bones were analysed for the presence of three types of traumas: sharp force trauma, blunt force trauma and penetrating injuries. To identify sharp force trauma, one has to look for the presence of linear lesions with well-defined sharp edges, which have polished, smooth and flat cut surfaces. Such lesions show a V-shaped cross-section, alongside microscopical or macroscopical parallel striations, which are perpendicular to the kerf floor.[28] As for blunt force trauma, it is often caused by a low-velocity impact spread over a large surface. Such an impact is often caused by a blunt instrument or by falling.[29] It is characterized by the following: fractures radiating from the impact site, concentric fractures exhibiting

17 Mann, Jantz 1988; Meindl, Lovejoy 1985.
18 Brooks, Suchey 1990.
19 Buckberry, Chamberlain 2002; Lovejoy *et al.* 1985.
20 Walker 2001.
21 Merbs 1989; Sauer 1998.
22 Šlaus *et al*. 2010.
23 Fachini *et al*. 2007.
24 Wheatley 2008.
25 Wakely 1997.
26 Sauer 1998.
27 Šlaus *et al.* 2010.
28 Šlaus *et al*. 2012.
29 Galloway *et al.* 1999.

an internal bevel and plastic deformation. Penetrating wounds are recognised by external and internal bevelling.[30] Fractures resulting from intentional violence commonly include head injuries, such as depressed skull fractures, fractures of the nasal bones, zygomatic bones, one or both maxillae and the mandible.[31] While these fractures are often linked to interpersonal violence, they do not necessarily provide definitive proof of it.[32] Because of that, particular attention is given to those traumas in the study. Additionally, not every depressed skull fracture has a violent origin – injuries on the left side of the face, left anterior parietal and frontal bone are most commonly associated with violence. Injuries to the left side are associated with violence, as attackers approaching from the front are most often right-handed and strike the victim's left side of the face.[33] An interesting type of traumatic injury is a *parry*, or nightstick fracture. Such an injury occurs at the distal or middle part of the ulna, and occurs when the victim of an attack raises his arm in self-defence to protect his face and head. If the force of the attack is strong enough, the bone breaks, leading to the formation of a bone callus. However, a fracture of the ulna can also be the result of falling from a great height or at a great speed. It is therefore important to treat a potential fracture of the ulna as a result of violence only if there are one or more traumatic injuries present on the skeleton, ideally on the head or the face, due to them being the primary loci of attack.[34]

Data gathered in this study were statistically analysed using the $\chi 2$ test using Yates correction when applicable. Furthermore, statistical significance was defined by probability levels of $p \leq 0.05$.

Results

As previously mentioned, the sample consists of 95 adult skeletons, 70 male (73.7%) and 25 female (26.3%), which gives a male : female ratio of 1.00 : 0.36 (**Tab.1**), or in other words, males are represented 2.8 times more than females.

Table 1. Sex and age distribution / *Tablica 1. Distribucija po spolu i dobi*

Age	Males	Females
15–30	16	7
31–45	22	15
45+	32	3
Total	70	25

Long bone traumas were observed in 13 individuals (11 males and two females), and the total number of traumas is 20. Seven skeletons exhibited only one long bone fracture (7/13 or 53.8% of the total sample), five skeletons exhibited two fractures (5/13 or 38.5% of the total sample), and one skeleton has three fractures (1/13 or 7.7% of the total sample). Off the 20 observed long bone traumas, 17 are antemortem (85%), while 3 are perimortem (15%). One example of antemortem trauma on long bones was observed in grave 151 (fig. 1), while an example of perimortem trauma on long bones was observed in grave 132 (fig. 2). Table 2 shows frequency of long bones with traumas (re-

30 Berryman, Symes 1998.
31 Avrus 1999; Judd 2002b; Galloway 1999a; Lovell 1997; Walker 1998; Adamić Hadžić 2021.
32 Adamić Hadžić 2021; Šlaus 2006.
33 Šlaus 2006; 2021; Owens 2007; Djurić *et al.* 2006; Bolyston 2000.
34 Šlaus 2021; Judd 2002; 2008.

gardless of the number of them). The percentage of long bones exhibiting at least one trauma in the sample is 2.4% (19/780) (**Tab. 2**). Traumas are most commonly found on the tibias (5/121 or 4.1%), followed by the ulnae (4/102 or 3.9%), radii (4/104 or 3.8%), fibulae (3/111 or 2.7%), clavicles (2/ 100 or 2%) and finally on the humerus (1/118 or 0.8%). No trauma is present on the femurs. It can be concluded from Table 2 that there are almost no differences between traumas on the left and right sides of the body. The total percentage of traumas on the left side of the body is 2.4%, and on the right side of the body is 2.5%.

The results show that there are no statistically significant differences in the frequency of long bone traumas between males and females (3.0% vs 1.0%; $\chi 2 = 1.703$, $P = 0.191$). The biggest difference between sexes was noticed on the tibiae, however it is also not statistically significant (5/91 or 5.5% in males vs 0/30 or 0% in females; $\chi 2 = 0.612$, $P = 0.434$).

Table 2. Long bone trauma frequencies by bone element / *Tablica 2. Tablica 2. Raspored učestalosti trauma dugih kostiju*

	Left side			**Right side**		
	N	**n**	**%**	**N**	**n**	**%**
Clavicle						
Males	38	2	5.3	37	0	0.0
Females	12	0	0.0	13	0	0.0
Humerus						
Males	40	0	0.0	44	1	2.3
Females	16	0	0.0	18	0	0.0
Radius						
Males	38	2	5.3	37	2	0.0
Females	14	0	0.0	15	0	0.0
Ulna						
Males	37	1	2.7	37	2	5.4
Females	14	1	7.1	14	0	0.0
Femur						
Males	45	0	0.0	46	0	0.0
Females	16	0	0.0	17	0	0.0
Tibia						
Males	45	1	2.2	46	4	8.7
Females	15	0	0.0	15	0	0.0
Fibula						
Males	40	1	0.0	46	1	2.2
Females	11	1	9.1	14	0	0.0
Males	283	7	2.5	293	10	3.0
Females	98	2	2.0	106	0	0.0
Total	381	9	2.4	399	10	2.5

N = number of examined long bones; n = number of long bones exhibiting a fracture; % = percentage of long bones exhibiting a fracture / *N = broj analiziranih dugih kostiju; n = broj dugih kostiju s frakturom; % = postotak dugih kostiju s frakturom*

Fig. 1. Grave 151. Anterior view of an antemortal fracture on the forearm (photo: Vlasta Vyroubal) / *Sl. 1. Grob 151. Anteriorni pogled na antemortalnu frakturu na podlaktici (fotografija: Vlasta Vyroubal)*

Of the 74 preserved skulls, 24 (32.4%) were found to have one or more traumas, i.e., 21 males (21/24 or 87.5% of the total number of skulls with traumas) and 3 females (3/24 or 12.5% of the total number of skulls with traumas). The total number of skull traumas is 39. Sixteen people had one skull trauma (16/24 or 66.7% of the total number of skulls with traumas), three people had two (3/24 or 12.5% of the total number of skulls with traumas), three people had three (3/24 or 12.5%) and two had four traumas (2/24 or 8.3% of the total number of skulls with traumas). Traumas were most frequently observed on the frontal bone (14/74 or 18.9% of the total number of frontal bones), followed by the facial area (6/74 or 8.1% of the total number of recovered zygomatics, maxillae and mandibles) and the left parietal bone (6/78 or 7.7% of the total number of recovered left parietals). The least affected bone was the right parietal bone (5/75 or 6.7% of the total number of recovered right parietals) (**Tab. 3**). Traumas are not present on the left and right temporal, as well as on the occipital bone. Of the recorded 39 traumas, 28 are antemortem (71.8%), while 11 are perimortem (28.2%). An example of perimortem head trauma was observed in grave 105 A (burial B, fig. 3a and 3b).

The biggest difference in the number of head traumas between males and females was observed in the frontal bone, but, again, this difference is not statistically significant (12/54 or 22.2% vs 2/20 or 10 %; $\chi 2 = 0.736$, $P = 0.390$). Another difference between males and females was observed on the cranial area (21/54 or 38.9% vs 3/20 or 15%). This difference is also not statistically significant ($\chi 2 = 2.789$, $P = 0.094$).

Fig. 2. Grave 132. Perimortal cut on the left fibula. It is applied vertically, in a slightly upward movement, and is 10 mm long (photo: Vlasta Vyroubal) / Sl. 2. Perimortalna posjekotina na lijevoj lisnoj kosti. Nanesena je okomito, blago odozdo prema gore, a duljina joj je 10 mm (fotografija: Vlasta Vyroubal)

Table 3. Craniofacial trauma frequencies by cranial element / *Tablica 3. Raspored učestalosti trauma glave*

	FR		LP		RP		LT		RT		OCC		FA		TO
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N
Males	12	22.2	6	14.0	5	9.3	0	0.0	0	0.0	0	0.0	4	7.4	27
Females	2	10.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	2	10.0	4
Total	14	19.0	6	8.0	5	6.7	0	0.0	0	0.0	0	0.0	6	8.1	31

N = number of recorded craniofacial fractures by cranial element; % = percentage of total number of recorded craniofacial fractures; FR = frontal bone; LP = left parietal bone; RP = right parietal bone; LT = left temporal bone; RT = right temporal bone; OCC = occipital bone; FA = facial region; TO = total / *N = broj zabilježenih trauma glave po kranijalnom elementu; % = postotak ukupno zabilježenih trauma glave; FR = čeona kost; LP = lijeva tjemena kost; RP = desna tjemena kost; LT = lijeva sljepoočna kost; RT = desna sljepoočna kost; OCC = zatiljna kost; FA = područje lica; TO = ukupno*

Fig. 3a. Grave 105 A (burial B). Stabbing penetrating perimortem trauma on the right side of the frontal bone (photo: Vlasta Vyroubal) / Sl. 3a. Grob 105 A (ukop B). Ubodna penetrirajuća perimortalna trauma na desnoj strani frontalne kosti (fotografija: Vlasta Vyroubal)

Fig. 3b. Grave 105 A (burial B). Endocranial view of the stabbing penetrating perimortem trauma on the right side of the frontal bone (photo: Vlasta Vyroubal) / Sl. 3b. Endokranijalni pogled na ubodnu penetrirajuću traumu na desnoj strani frontalne kosti (fotografija: Vlasta Vyroubal)

The aim of this study is to reconstruct the extent of violence in the Pakoštane community. To achieve this, we separately analysed antemortem and perimortem traumas that indicate intentional violence. In this context, we examined depression fractures on the left side of the frontal bone, fractures of both nasal bones, orbits, fractures of one or both maxillae, zygomatic bones, antemortem trauma fractures on ulnae (so-called *parry* fractures), all antemortem and perimortem injuries caused by sharp-edged weapons, blunt weapons or projectiles (**Tab. 4**).

Table 4. Co-occurrence of skeletal indicators of intentional violence / *Tablica 4. Indikatori namjernog nasilja na osteološkim ostacima*

Grave number/sex/age	**Craniofacial**	**Perimortem**	**Sharp force**
75, male, 20-30		X	
76A, burial A, male, 17-19		X	
76A, burial B, male, 55+	X		
79, male, 50-55			X
95, skull B, male, 45-55		X	
95, skull C, male, 45+	X		
96, male, 35-45			
97, burial A, male, 20-25	X		
99, male, 25-30	X		
100, extra head, male, 35-45			X
105A, burial A, male, 30-35	X		
105A, burial B, male, 45-55		X	
107, burial B, male, 45+			X
107B, male, 45-55	X		
118, male, 50-60	X		
118, female, 35-45	X		
119, female, 25-30	X		
125, female, 30-35			
129, male, 15-17	X		
132, male, 45-50		X	
155, dislocated skull 3, male, 30-40	X		
H8/H9, male, 45+		X	
KVG8, female, 30-40		X	

AM = antemortem trauma; PM = perimortem trauma; SF = sharp force trauma; BF = blunt force trauma / *AM = antemortalna trauma; PM = perimortalna trauma; SF = trauma nastala udarcem oštrobridnim predmetom; BF = trauma nastala udarcem tupotvrdim predmetom*

Indicators of intentional violence were recorded in 21 individuals (18 males and three females). Facial and frontal region injuries were noticed in 11 individuals (11/23 or 47.8%), perimortem injuries in seven (7/23 or 30.4%) and sharp injuries in three individuals (3/23 or 13.04%). More than one antemortem or perimortem injury was found on several skeletons, which is an additional argument for the existence of intentional violence: grave 95 – skull B (exhibits two perimortem cuts), grave 95 – skull C (two antemortem traumas), grave 105 A – burial A (has five antemortem traumas), grave 105 A – burial B (two antemortem and three perimortem traumas), grave 107 B (three antemortem traumas), grave 118 (three antemortem skull traumas), grave 155 (has four antemortem traumas), skeleton from archaeological horizon H8/9 (exhibits four perimortem injuries) and skeleton from KV G8 (two perimortem injuries).

Traumas related to intentional violence were observed in 25.7% males (18/70 of all males in the analysed sample) and in 12% females (3/25 of all females in the sample), however the difference between sexes is not statistically significant ($\chi 2 = 2.0121$, $P = 0.156$). Furthermore, perimortem injuries were observed in 8.6% (6/70) of males and in 4% of females (1/25), but this difference is also not statistically significant ($\chi 2 = 0.093$, $P = 0.760$).

A total of 41.4% of males (29/70) and 20% of females (5/25) were diagnosed with one or more antemortem/perimortem traumas, but this difference is not statistically significant ($\chi 2 = 2.946$, $P = 0.093$). However, it is important to note that the number of traumas observed in all analysed skeletons (35.8% or 34/95) is very high, which points to a dangerous and difficult period for the inhabitants of Pakoštane and its surrounding area during the High and Late Middle Ages.

Discussion and conclusion

The number of recovered and analysed males in the sample is 2.8 times higher than the number of females (1 : 0.36). It is possible that this disproportion can be connected to the fact that Pakoštane – Crkvina was in all likelihood a male monastery. Given the assumption that this site may have been a male monastery, it is possible that this disparity arises from the nature of such a monastery. It has been observed in numerous other monastery sites. In monasteries associated with male orders, burials of men are predominantly found, while in monasteries with female orders, burials of women are more common. For example, in the male Benedictine monastery in Rudina 73 individuals were recovered 72.6% out of which were males.[35] On the other hand, in the female Benedictine monastery of St. Teodora, in the city of Pula, as many as 80% of the recovered individuals were found to be female.[36] There is also a possibility that the females found in this sample, as well as samples with similar characteristics (Rudina – male Benedictine monastery, Streza – male Pauline monastery), were donators to the monastery, or part of an auxiliary workforce.[37] Such a disparity may also be a consequence of the sample size.

From the results of our analysis, it is evident that the number of traumas in the analysed osteological sample indicates that the population of the high and late medieval Pakoštane settlement lived in turbulent and dangerous times. The frequency of individuals exhibiting any type of trauma is relatively high, i.e. 35.8% (34/95).

Antemortem fractures of long bones and the cranium were observed in 29 males and four females (a total of 45 antemortem injuries), while perimortem fractures were found in six males and one female (a total of 14 perimortem injuries). In other words, 34.7% (33/95) of the individuals exhibit antemortem traumas, and 7.4% (7/95) exhibit perimortem traumas.

35 Novak 2013.
36 Rajić Šikanjić, Premužić 2023.
37 Novak 2013.

In chronological terms, the Pakoštane skeletal sample can be compared with a composite sample from the medieval continental sites of Kliškovac and Crkvari. The primary difference between Pakoštane and these two sites is that Pakoštane is located in Dalmatia, while the two other sites are in Slavonia, in the continental part of Croatia. All three sites are dated to the high and late medieval period and share a similar male-to-female ratio. In the composite sample from Kliškovac and Crkvari, antemortem traumas were noticed in 14 individuals (eight females and six males), while perimortem traumas were observed in six individuals (four females and two males). This corresponds to 18.9% (14/74) of individuals exhibiting antemortem traumas, and 8.1% (6/74) exhibiting perimortem injuries.[38] This comparison shows that the frequency of individuals exhibiting antemortem traumas is significantly higher in the Pakoštane sample ($\chi 2 = 5.184$, $P = 0.023$).

In the composite sample from Continental Croatia 81.3% (13/16) of all postcranial bones with trauma belong to the upper extremities, while 18.7% (3/16) belong to the lower extremities.[39] In the Pakoštane sample this distribution is approximately equal between the extremities – 57.9% (11/19) in the upper extremities and 42.1% (8/19) in the lower extremities. The greatest difference in the number of postcranial traumas between the composite sample and the Pakoštane sample was observed in the humeral bones. The percentage of such traumas in the composite sample is 6.59% (6/91), while in the Pakoštane sample, it is 0.85% (1/118). This difference is significantly higher in the composite sample ($p = 0.027$, $\chi^2 = 4.869$). Out of six humeral injuries identified in the composite sample, five are perimortem, while one is antemortem.[40] In contrast, all humeral injuries in the Pakoštane sample are antemortem. This suggests that the composite sample reflects violence on the upper limbs, whereas the injuries in Pakoštane likely resulted from accidental incidents.[41] By analysing the injuries observed in these samples, several conclusions can be drawn, which will be further discussed in the study. Antemortem traumas on the clavicle, humerus, radius, hip (in the area of the femoral neck), tibia and fibula, are most often connected with accidents. It is considered that trauma to the clavicles most often occurs as a result of falling from a great height, falling while riding or working with large domestic animals.[42] Also, one of the best examples of accident-related trauma seen in archaeological populations is the fracture of the distal part of the radius, commonly known as a Colles' fracture. This type of fracture occurs during a fall when an individual, in an attempt to break the fall, extends his arms forward and lands on his palm.[43] The observed fractures of the diaphysis of the ulnae (four in the Pakoštane sample and two in the composite sample) do not conform to Judd's definition of a *parry* fracture. Therefore, it is very likely that all these injuries resulted from accidents.[44] Fractures of the proximal and distal articular surfaces of the tibia and fibula are also often connected with accident-related traumas.[45] Considering that the highest percentage of antemortem traumas in the sample from Pakoštane was observed on the tibiae (4.1%), it is important to further discuss the possible causes of these injuries. They are commonly considered to be the result of falls from a higher elevation or severe dislocations.[46] These fractures can be oblique or spi-

38 Šlaus, Novak 2006.
39 Šlaus, Novak 2006.
40 Šlaus, Novak 2006.
41 Šlaus 2006; 2021; Šlaus, Novak 2006.
42 Judd, Roberts 1999; Bigliani *et al.* 1991.
43 Alvrus 1999; Šlaus 2006; 2021.
44 Šlaus 2021; Judd 2002; 2008.
45 Šlaus 2006; 2021; Ortner 2003; Judd 2002; 2008; Adamić Hadžić 2021.
46 Muir, Kanwar 1993, Adamić Hadžić 2022.

ral, or fractures involving the proximal and distal epiphyses.[47] Oblique fractures of the tibia are typically associated with falling from heights.[48] Spiral fractures occur when the foot remains stable while the body twists over it.[49] Fractures of the tibial epiphyses, both proximal and distal, generally result from repetitive loading[50] or from falls from a height.[51] Thus, in the Pakoštane sample, accident-related traumas were observed on the clavicles (two), humerus (one), radii (four, two of which were Colles' fractures), ulnae (four), tibiae (three) and fibula (one); while in the composite sample on the clavicles (two), humerus (one), radii (two), ulnae (two), femur (one), and tibiae (two).[52]

Although there are no statistically significant differences in the frequency of long bone fractures between males and females in the Pakoštane sample (17/576 or 3% vs 2/204 or 1%), it is evident that males exhibit more traumas. An interesting point to consider is the one proposed by Djurić *et al*. (2006), who suggest that, historically, males were more prone to injuries than females due to their involvement in activities such as hunting, agriculture, horseback riding, and interpersonal violence.[53] Novak and Šlaus (2012), in their study on Dugopolje, conclude that the higher number of long bone fractures observed in the male sample can partly be attributed to the strict division of labour in the Adriatic hinterland during the high and late medieval periods. In this context, men were responsible for physically demanding work, while women focused on domestic tasks.[54] Therefore, given the rugged terrain of the hinterland, it is plausible that many of the fractures found in males in Dugopolje and Pakoštane were the result of such conditions.

Craniofacial traumas have also been documented in the Pakoštane sample. Specifically, 14 frontal bones, six left parietal bones, five right parietal bones, and six facial bones exhibit signs of trauma. The frequency of head and facial trauma is relatively high, as 24 out of the 74 (32.4%) preserved skulls exhibit signs of traumas (21 males and three females). In addition, the Kliškovac and Crkvari sample also exhibits a relatively high frequency of cranial trauma (16.7%), with six (five males and one female) out of 36 well-preserved skulls showing some form of trauma.[55] No statistically significant differences were found between these injuries in the samples ($p = 0.023$, $\chi^2 = 5.184$). Such a high percentage of craniofacial trauma suggests intentional interpersonal violence, as supported by numerous authors (Alvrus 1999; Walker 1989; 1997; Tyson 1977).[56]

The presence of perimortem traumas in the Pakoštane sample further supports the theory of frequent interpersonal violence. Seven individuals show signs of perimortem traumas (7/95 or 7.4%). In six out of these seven cases (85.7%), such traumas were observed on the cranium. Interestingly, similar distributions of perimortem traumas had been observed at European sites related to large battles such as Aljubarrota in Portugal,[57] Uppsala in Sweden,[58] and Towton in England.[59] Similar to Pakoštane, the distribution of perimortem traumas at these sites is primarily concentrated on the cranium and face (over 60% of all such injuries). All of the cranial perimortem traumas in the Pakoštane

47 Šlaus *et al.* 2012; Russel *et al.* 1997.
48 Russel *et al.* 2012; Šlaus *et al.* 2012.
49 Trafton 2003, Šlaus *et al.* 2012.
50 Abel 2004, Šlaus *et al.* 2012.
51 Barlett *et al.* 1997; Šlaus *et al.* 2012.
52 Šlaus, Novak 2006.
53 Djurić *et al.* 2006.
54 Novak, Šlaus 2012.
55 Šlaus, Novak 2006.
56 Alvrus 1999; Walker 1989; 1997; Tyson 1977; Šlaus, Novak 2006.
57 Cunha, Silva 1997; Šlaus *et al.* 2010.
58 Bennike 1998; Šlaus *et al.* 2010.
59 Novak 2000; Šlaus *et al.* 2010.

sample are located on the frontal bone, suggesting face-to-face combat. It is important to highlight that a higher number of males exhibit perimortem traumas (6/7 or 85.7%), which corresponds to this type of conflict. However, due to the small sample size, as well as disproportion in male : female ratio, there is no statistically significant difference in the number of males and females affected by perimortem traumas.

These results strongly suggest that the inhabitants of Pakoštane were exposed to sudden and violent raids. These raids may have been carried out by Venetians, who wished to control Dalmatia, Mongols, who made attacks in the 13th century, and Ottoman Turks in the 15th century.[60] Historically speaking, not much has been written about the Pakoštane settlement in the high and late medieval period, during the Ottoman threat (15th – 17th century). The demographic fluctuations and migrations of the populations of Dalmatia, specifically those in the Zadar and Vrana territory were caused by the fall of Bosnia, which was conquered by the Ottoman Turks in 1463.[61] After many attacks, in the year 1538, the Ottomans conquered Vrana.[62]

Finally, there is another potential reason for the high frequency of traumas in the sample from Pakoštane. As previously noted, Pakoštane is a monastery that originally belonged to the Knights Templar, and then to the Hospitallers. Among other things, the task of these orders was to care for sick pilgrims and soldiers, so it is possible that there was also a hospital or hospice in the monastery that provided shelter to sick and wounded soldiers.[63] At this point in time, this is, however, just a theory with no additional evidence that would support it.

In conclusion, numerous antemortem and perimortem traumas observed at the Pakoštane – Crkvina site may suggest that the period of the High and Late Middle Ages was challenging for the inhabitants of Pakoštane. Some of the traumas can be linked to injuries resulting from strenuous physical labour and the resulting accidents, while others are undoubtedly the result of violence. This paper provides new insights about life during that period. However, because the small sample of the analysed osteological material, generalizations should be avoided until new osteological material is discovered and analysed.

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60 Bedić *et al.* 2018.
61 Juran 2022.
62 Novosel 2016.
63 Bedić *et al.* 23.

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SAŽETAK

Analiza učestalosti trauma u uzorku iz razvijenog i kasnog srednjeg vijeka s lokaliteta Pakoštane - Crkvina

U radu su analizirani osteološki ostaci s lokaliteta Pakoštane – Crkvina. Dosad je u brojnim kampanjama od 2006. do 2016. godine istraženo 160 višeslojnih grobova koji uglavnom datiraju od 13. do 16. stoljeća. Antropološkom analizom utvrđeno je da je u grobovima pronađeno najmanje 467 osoba (319 odraslih i 148 djece). Bilo je moguće izdvojiti i analizirati 70 muškaraca, 25 žena i 69 djece, dok kod ostalih zbog loše uščuvanosti kostiju u masovnim grobnicama nije bilo moguće utvrditi spol i dob. Analiza učestalosti i distribucije trauma vršena je isključivo na odraslim osobama starijim od 15 godina (n=95). Dakle, uzorak se sastoji od 95 odraslih kostura, odnosno 70 muških (73.7 %) i 25 ženskih (26.3 %), što u omjeru iznosi 1 : 0,36. Analizirano je 780 dugih kostiju, a traume su uočene kod 13 osoba na ukupno 19 dugih kostiju, što čini 2,4 % (19/780). Od pronađene 74 očuvane lubanje kod 24 se naišlo na jednu ili više trauma (32,4 %), a riječ je o 21 muškarcu i tri žene. Ukupan broj trauma glave iznosi 39. Antemortalne traume dugih kostiju i glave uočene su kod 29 muškaraca i četiri žene (ukupno 45 antemortalnih trauma), a perimortalne traume dugih kostiju i glave kod šest muškaraca i jedne žene (ukupno 14 perimortalnih trauma). Rad ukazuje na velik broj antemortalnih i perimortalnih trauma na uzorku iz Pakoštana, te donosi nove spoznaje o učestalosti trauma u Dalmaciji u periodu razvijenog i kasnog srednjeg vijeka.