Mario Novak, Željka Bedić,
Dženi Los, Zrinka Premužić

DOI: 10.21857/y7v64t0wxy
Original scientific paper
Received: 3.V.2021.
Accepted: 24.VI.2021.

# BIOARCHAEOLOGICAL ANALYSIS OF THE 15TH–17TH CENTURY POPULATION FROM ZRIN, CONTINENTAL CROATIA

The fortress of Zrin is one of the most important and well-known fortifications from the Late Medieval/Early Modern periods in Croatia. However, we have very scant information on the mortality, health, diet, and lifestyle of the people inhabiting the village of Zrin during this period. Recent archaeological excavations conducted around the church of the Discovery of the Holy Cross in Zrin provided an excellent opportunity to learn more about various aspects of the life and death of these people through the analysis of skeletal and dental remains. Archaeological context and direct radiocarbon dates place the recovered burials between the 15th and 17th centuries CE. The analysis of 32 skeletons revealed the presence of eight subadults and 24 adults. Palaeodontological and isotopic data indicate a mixed protein-carbohydrate diet with heavy emphasis on C4-type plants such as millet. The presence of various skeletal indicators of intense physical activity strongly suggests hard labour while performing every-day chores in and around the house. Physiological stress, especially during childhood, was widespread and frequent – it was probably the consequence of the synergistic effect of inadequate diet, metabolic and infectious diseases. Most of the observed injuries were a result of accidents associated with rural lifestyle rather than intentional violence. The studied assemblage is small and fragmented, and therefore, all results and hypotheses based on these results have to be taken with caution.

Key words: skeletal remains; Late Medieval Period; Early Modern Period; continental Croatia; demography; average height; diet; isotopic studies; physiological stress; injuries / *Ključne riječi: koštani ostaci; kasni srednji vijek; rani novi vijek; kontinentalna Hrvatska; demografija; prosječna visina; prehrana; izotopska istraživanja; fiziološki stres, ozljede*

## Introduction

Zrin is a settlement located in Sisak-Moslavina County on the southern slopes of the central part of the Zrinska gora (**Map 1**). The whole area is dominated by the Zrin fortress that is situated on a hilltop above the village of Zrin. Furthermore, it is located on an important road that has been connecting Una river valley with river Kupa across Zrinska gora from the prehistoric period to the present day. Based on the preserved architectural forms, it is assumed that the fortress was built as early as the end of the 12th and the beginning of the 13th century CE[1]. The oldest mention of Zrin fortress dates to 1295 and is found in a document issued by viceroy Stjepan Babonić[2]. The fortress was owned by the Babonići counts until 1328 when it was sold to Toth-Lovričan family. However, in 1347 king Louis of Anjou donated Zrin to an aristocratic family of Šubić (who consequently took the name

1 Kekez, Regan 2020.
2 Kekez, Regan 2020.

Šubić Zrinski) in exchange for the fortress of Ostrovica[3]. Šubić Zrinski family significantly enlarged the fortress and it became their main seat of power until it was occupied by the Ottoman Turks led by Ferhad Pasha Sokolović in 1577. It stayed under the Ottoman occupation until the summer of 1689 when the Croatian forces led by Ivan Drašković defeated the Ottomans and liberated the fortress[4]. After the Great Turkish War (1683–1689) and the liberation of this part of Croatia, the location of the fortress was no longer strategically important which gradually affected its maintenance. The fortress of Zrin was completely abandoned after the fire at the beginning of the 19th century. The fortress was bombed and additionally destroyed during the Second World War[5].

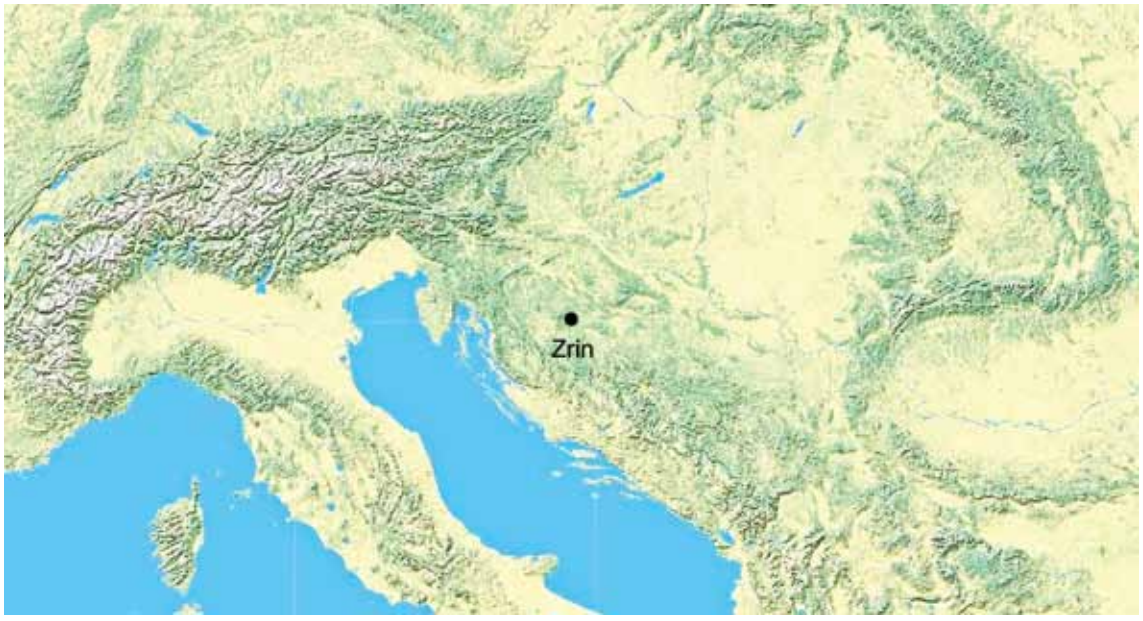
As can be seen from the information presented above, ample historic written records are speaking about the history of the fortress. However, we have almost no information about the people inhabiting the village of Zrin, i.e. the members of the lower social classes who lived in the settlement and not in the fortress itself. Fortunately, recent archaeological excavations conducted around the church of the Discovery of the Holy Cross in Zrin revealed a certain number of burials dated to the Late Medieval/Early Modern periods thus providing an excellent opportunity to learn more about various aspects of life and death of these people.

On the other hand, numerous bioarchaeological studies of the Late Medieval/Early Modern populations from continental Croatia have been published so far. Population-based analyses dealing with general bioarchaeological data were published for Nova Rača[6], Torčec[7], Ivankovo[8], Ilok[9], Zagreb – Opatovina[10], Tomaš[11], Kamengrad[12], and Đakovo (phase II)[13]. Furthermore, the studies discussing more specific topics such as the intentional violence[14], dental health[15], various vertebral pathologies[16], subadult stress[17], and deviant burials[18] were also published together with those describing certain pathological disorders like tuberculosis[19], syphilis[20], hydrocephalus[21], and cerebral palsy[22]. And finally, three papers dealt with monastic skeletal assemblages from this time period[23].

The main aim of this paper is to provide a detailed picture of the biological characteristics of the people inhabiting the village of Zrin between the 15th and 17th centuries CE based on a comprehensive bioarchaeological analysis of their skeletal and dental remains. New, previously unknown, information on the demography, health, diet, and

3 Pleše, Sekulić 2014.
4 Kekez, Regan 2020.
5 Pleše, Sekulić 2014.
6 Šlaus 2000; Jakovljević, Šlaus 2003.
7 Šlaus *et al.* 2003; Novak, Krznar 2010.
8 Krznar, Hajdu 2020.
9 Novak *et al.* 2017; Rimpf, Novak 2020.
10 Šlaus *et al.* 2007.
11 Šlaus 2002.
12 Šlaus 2002.
13 Šlaus 2002.
14 Šlaus 1994; Šlaus, Novak 2006; Krznar *et al.* 2010; Šlaus *et al.* 2010; Bedić *et al.* 2019a.
15 Šlaus *et al.* 1997, 2018; Novak *et al.* 2010.
16 Novak, Šlaus 2011.
17 Novak *et al.* 2009.
18 Krznar, Bedić 2016.
19 Krznar, Novak, 2013; Bedić *et al.* 2015.
20 Šlaus, Novak 2007; Lauc *et al.* 2015.
21 Bedić *et al.* 2019b.
22 Novak *et al.* 2014.
23 Novak 2013; Vyroubal *et al.* 2016; Janeš, Bedić 2020.

lifestyle of this population will be presented and compared with similar data from other Croatian contemporaneous sites. Carbon and nitrogen isotopic data for four individuals who were also directly radiocarbon dated will be additionally presented and discussed.




Map 1. Map showing the geographic location of Zrin (base map credit: USGS National Map Viewer, http://viewer.nationalmap.gov/viewer/) / *Karta 1. Karta koja prikazuje zemljopisni položaj Zrina (preuzeto s: USGS National Map Viewer, http://viewer.nationalmap.gov/viewer)*

## Archaeological context

Archaeological rescue excavations carried out during the spring and summer of 2018 by "Kaducej" company were conducted on the slope of the hill where the remains of the church of the Discovery of the Holy Cross in Zrin are located. This excavation, comprising the area of approximately 122 m², is a continuation of the excavations carried out by the City Museum of Sisak during which three development phases of the church were established. The discovery of burials during the latest excavation that can be associated with the existing church provides a clearer picture of the Zrin parish church as well as the whole settlement and its inhabitants.

Stratigraphic excavation of the layers up to the relative depth of 1–1.3 m revealed three different phases of the site. The stratigraphy of the excavated surface consists of different layers that have the properties of backfills due to the presence of large quantities of dislocated human skeletal remains in their composition (especially layer SU 30, representing dislocated backfill in a secondary use). At the top of the surfaces of the layers that are interpretive in the archaeological sense numerous burials with visible fillings and human remains were found. The recovered human remains are extremely poorly preserved, probably due to the chemical properties of the soil. All recorded skeletons were laid on their backs with the hands laid on the torsos, oriented west-east with their heads to the west (**Figs 1–2**). There were no material artefacts recovered from the graves apart from some iron nails and wedges that represent the remains of wooden coffins. Furthermore, several multiple burials have been observed within the same burial

pit where the skeletons were positioned side by side or one above the other. Because some burials were positioned under the western profile of the excavation surface it seems that the cemetery extends towards the west, i.e. towards the plateau of the hill that was included in the recent excavation. Based on stratigraphy, it seemed that dislocated human remains found within the backfill layers were chronologically different from those found within the undisturbed burials.

However, four human bone samples from different contexts provided uniform absolute dates: the sample from burial 17 (Beta-511492) is dated between 1458 and 1635 cal CE (95.4% probability, 350 +/- 30 BP); the sample from the backfill SU 6 (Beta-511493) is dated between 1426 and 1618 cal CE (95.4% probability, 420 +/- 30 BP), while two samples recovered by the police during the construction of the church foundations (Beta-511494 and Beta-511495) are dated between 1440 and 1630 cal CE (95.4% probability, 390 +/- 30 BP), and between 1446 and 1634 cal CE (95.4% probability, 370 +/- 30 BP) respectively. Therefore, these four direct radiocarbon dates place the use of the cemetery to the Late Medieval/Early Modern periods (between the 15th and 17th centuries CE), i.e. approximately to the period when the area around Zrin was threatened by the Ottomans, but also during the Ottoman rule over the region.

Some archaeological finds such as fragments of ceramic and glass vessels as well as metal finds were recovered from the strata located directly below the topsoil layer. Given their characteristics, these can be dated from the Early Modern Period up to the present times.


Fig. 1. The skeleton from G 14 *in situ* (photo by B. Rožanković) / *Sl. 1. Kostur iz groba 14* in situ *(snimio B. Rožanković)*

Fig. 2. The skeleton from G 15 *in situ* (photo by B. Rožanković) / *Sl. 2. Kostur iz groba 15* in situ *(snimio B. Rožanković)*

## Bioarchaeological methods

The skeletal remains were analysed at the Centre for Applied Bioanthropology of the Institute for Anthropological Research in Zagreb, Croatia. Studied human remains from Zrin originate from undisturbed burials, but some are from non-burial contexts (backfills, in a secondary position). Here we will present the results of conventional bioarchaeological analysis only for those skeletons which were recovered from *in situ* burials, and not from secondary positions such as backfills. The sex and the age-at-death of the analysed individuals were established using methods described by Buikstra and Ubelaker[24], and Klales[25]. All subadults were divided into three age groups according to the recommendations proposed by Powers[26], with some modifications in the youngest age category. These categories are: infants/younger children (birth to 5 years), older children (6 to 11 years) and adolescents (12 to 17 years). Adults were assigned to one of the three age categories: young adults (18 to 35 years), middle adults (36 to 50 years) and old adults (over 50 years). The stature estimation was calculated for adult individuals by using formulae proposed by Trotter[27] (based on the maximum femur length).

All individuals were analysed for the possible presence of various pathological changes usually seen in archaeological samples. These include: ante-mortem tooth loss

24 Buikstra, Ubelaker 1994.
25 Klales 2020.
26 Powers 2008.
27 Trotter 1970.

(AMTL)[28], caries[29], calculus[30], degenerative osteoarthritis[31], Schmorl's nodes[32], benign cortical defects at muscle attachment sites[33], *cribra orbitalia*[34], sub-periosteal new bone formation[35], and injuries (trauma). All observed conditions were documented according to criteria described by Ortner[36], and Aufderheide and Rodríguez-Martín[37].

The samples were taken from four individuals for radiocarbon dating who also provided carbon and nitrogen stable isotopes data that are important for the reconstruction of the diet of these individuals[38]. These analyses have been conducted at Beta Analytic laboratory, USA.

## Results

Most of the studied skeletons are characterised by poor preservation and pronounced fragmentation with medium cortical damage due to post-mortem erosion and weathering. Unfortunately, this had a significant negative impact on the final results of the analysis.

The total number of skeletons retrieved from burials is 32 (**Tab. 1**). Of these, eight (25%) belong to children (two infants/younger children, two older children, and four

28 Ante-mortem tooth loss (AMTL) is a good indicator of health in archaeological populations. There are various factors that contribute to AMTL, such as changes in dietary consistency, diseases as a result of nutritional deficiency, trauma, and cultural or ritual removal of teeth (Lukacs 2007). AMTL could also occur as a result of different alveolar diseases, most commonly the inflammation of gums (gingivitis) (Ortner 2003).

29 Caries is a disease that is most recognizable by the hole in a tooth that is a result of the progressive decalcification of enamel or dentine (White, Folkens 2005) caused by the bacteria and solutes of the oral fluids (Aufderheide, Rodriguez-Martin 1998).

30 A detailed macroscopic examination of the teeth deposits distinguished true dental calculus from post-mortem deposits such as sand or soil. Analysis of dental calculus in past populations may provide useful information regarding their dietary habits and nutrition, although the exact meaning of the development of calculus is not yet fully understood (Delgado-Darias *et al.* 2006). However, most authors agree that the occurrence of dental calculus is mostly associated with diet (Lillie 1996; Lieverse 1999).

31 Osteoarthritis is one of the most common types of arthritis, also known as degenerative joint disease (White, Folkens 2005). Osteoarthritis is characterized by the destruction of the articular cartilage in a joint and vertebral discs, accompanied by bony lipping (osteophytes) and spur formation adjacent to the joint (White, Folkens 2005). Degenerative osteoarthritis is generally viewed as a result of advanced age, but also repetitive mechanical loading and movement (Knüsel *et al.* 1997; van der Merwe *et al.* 2006).

32 Schmorl's node is a herniation of the intervertebral disc penetrating into the vertebral body; it can appear on any vertebra but tends to concentrate in the lower thoracic and lumbar regions (Ortner 2003). It mostly appears as an indentation around the midline of the vertebral plate.

33 Benign cortical defects usually manifest as narrow elongated depressions with smooth cortical edges and irregular bottom located at sites for muscles attachments (Silverman *et al.* 1993). The aetiology of these defects can be associated with strenuous activity of the pectoral girdle (Mann, Murphy 1990). Severe skeletal changes involving the pectoral girdle and upper limbs, especially *pectoralis major* muscles and costo-clavicular ligaments, have been observed in numerous skeletal collections where they were associated with activities involving watercraft propulsion such as long-term and intensive use of paddles and/or oars.

34 *Cribra orbitalia* is an indicator of subadult stress. It manifests in a form of lesions on the orbital roof, generally in the form of bilateral pitting of the orbital part of the frontal bone (Mittler, van Gerven 1994; White, Folkens 2005). The lesion usually develops in fullest during infancy (not at birth) (Aufderheide, Rodriguez-Martin 1998) and is most commonly associated with anaemia and malnutrition in childhood (Mensforth *et al.* 1978; Walker *et al.* 2009).

35 Sub-periosteal new bone formation is a non-specific change in the bone which is visible on the periosteum – a membrane that covers the outer surface of bones except in areas of articulation (White, Folkens 2005). Any irritation of the periosteum may result in new bone formation on the underlying bone, and this may be caused by not only infection or inflammation but also by other factors such as trauma; it can be acute or chronic (White, Folkens 2005).

36 Ortner 2003.

37 Aufderheide, Rodríguez-Martín 1998.

38 For more information on this subject see DeNiro 1985; van Klinken 1999.

| Grave | Sex/age | Pathology (yes/no) |
|---|---|---|
| 1 | Unknown, 14–16y | No |
| 3 | Unknown, 6–10y | No |
| 4 | Female, +50y | Yes |
| 5 | Unknown, 1–5y | Yes |
| 6 | Unknown, 1.5–2y | Yes |
| 7 | Male, +50y | Yes |
| 9 | Unknown, 15–17y | Yes |
| 10 A | Male, 38–48y | Yes |
| 10 B | Female, 20–25y | No |
| 11 | Male +50y | Yes |
| 12 | Male, 35–45y | Yes |
| 14 A | Unknown, 7–9y | Yes |
| 14 B | Female, 20–25y | No |
| 15 | Male, +50y | Yes |
| 16 | Male, 34–45y | Yes |
| 18 | Male, 35–45y | Yes |
| 19 | Male, 35–42y | Yes |
| 21 | Unknown, adult | Yes |
| 22 | Female, 28–35y | Yes |
| 23 | Unknown, adult | No |
| 24 | Unknown, adult | No |
| 25 | Female, 25–35y | Yes |
| 26 | Unknown, 11–12y | No |
| 27 | Male, 40–50y | Yes |
| 28 | Probably female, 18–25y | Yes |
| 29 | Female, 40–50y | Yes |
| 30 | Male, 35–45y | Yes |
| 31 | Unknown, 15–17 | Yes |
| 32 | Female, 18–25y | No |
| 33 | Female, 35–45y | Yes |
| 34 | Unknown, adult | No |
| 35 | Male, 35–50y | Yes |

Tab. 1. Sex/age distribution and pathological features by grave / *Tab. 1. Raspodjela po spolu i dobi te patološke promjene po pojedinom grobu*

adolescents) and 24 (75%) to adults (11 males, nine females and four adults whose sex could not be established). In males, eight individuals belong to the "middle adults" age group and three individuals to the "old adults" age group; in females, six individuals belong to the "young adults" age group, two to "middle adults", and one individual belongs to "old adults". The average-age-at-death for adult individuals from Zrin is 39.4 years.

It was possible to estimate the stature of ten adult individuals: four females and six males. The average height of females is 161.6 cm (ranging between 156.6 and 170.9 cm), and of males 170.5 cm (ranging between 160.9 and 184.7 cm).

As far as pathological changes are concerned, slightly over two-thirds (23/32) of all analysed skeletons exhibit some kind of pathological lesion. Dento-alveolar lesions are the most prevalent pathologies recorded in Zrin: ante-mortem tooth loss was observed in eight adult individuals and 12.9% (36/278) of alveoli belonging to adults, caries was observed in eight adult individuals and 16.1% (26/161) of teeth belonging to adults, while dental calculus was observed in nine adult individuals or 66.5% (107/161) of teeth belonging to adults. Vertebral osteoarthritis is the second most prevalent pathology recorded in Zrin – it was observed in nine adult individuals and 26.4% (51/193) of all adult vertebrae: it is most prevalent on the lumbar vertebrae (33.3% or 17/51), followed by the cervical vertebrae (25% or 12/48) and finally by the thoracic vertebrae (23.4% or 22/94). Schmorl's nodes were recorded in eight adult individuals and 20% (29/145) of thoracic and lumbar adult vertebrae: these were more frequent in the thoracic (23.4% or 22/94) than in the lumbar vertebrae (13.7% or 7/51). Benign cortical defects at muscle attachment sites were observed in two individuals with benign cortical defects present at the site for *pectoralis major* and *teres major* muscles of both humeri (**Fig. 3**). Sub-periosteal new bone formation of non-specific origin was observed in five individuals (subadults and adults) with the tibiae and the fibulae as the most affected elements; all recorded cases were healed and remodelled at the time of death. *Cribra orbitalia* was recorded in two skeletons (one adult and one child); both cases were healed and remodelled at the time of death. And lastly, three adult

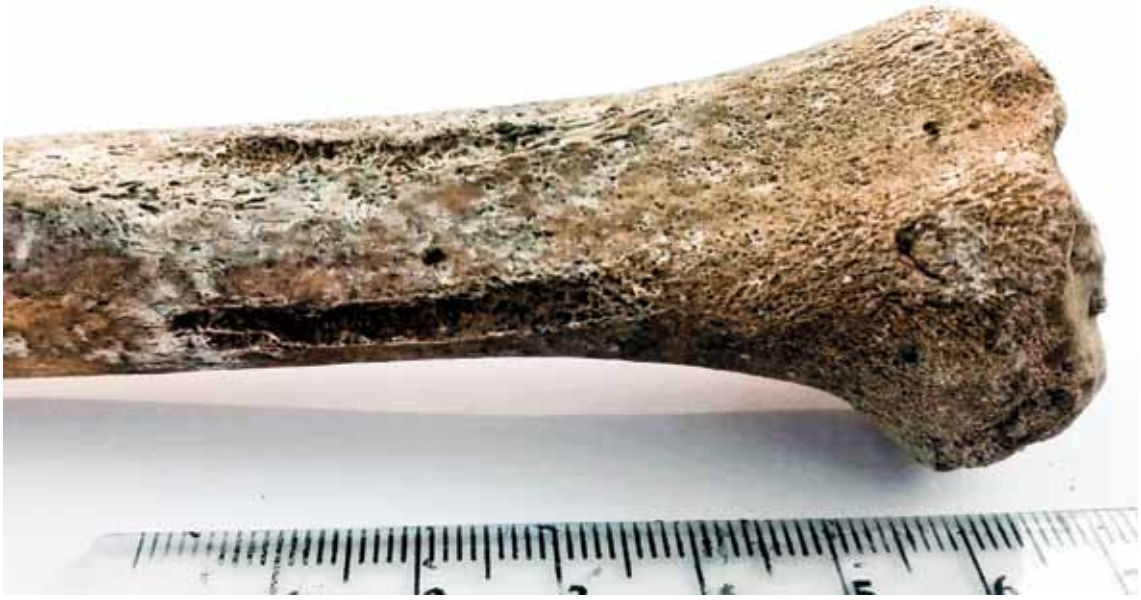


Fig. 3. Benign cortical defect at site for *pectoralis major* and *teres major* muscles of the right humerus, G 9 (photo by M. Novak) / *Sl. 3. Benigni kortikalni defekt na hvatištu mišića* pectoralis major i teres major *desne nadlaktične kosti, grob 9 (snimio M. Novak)*

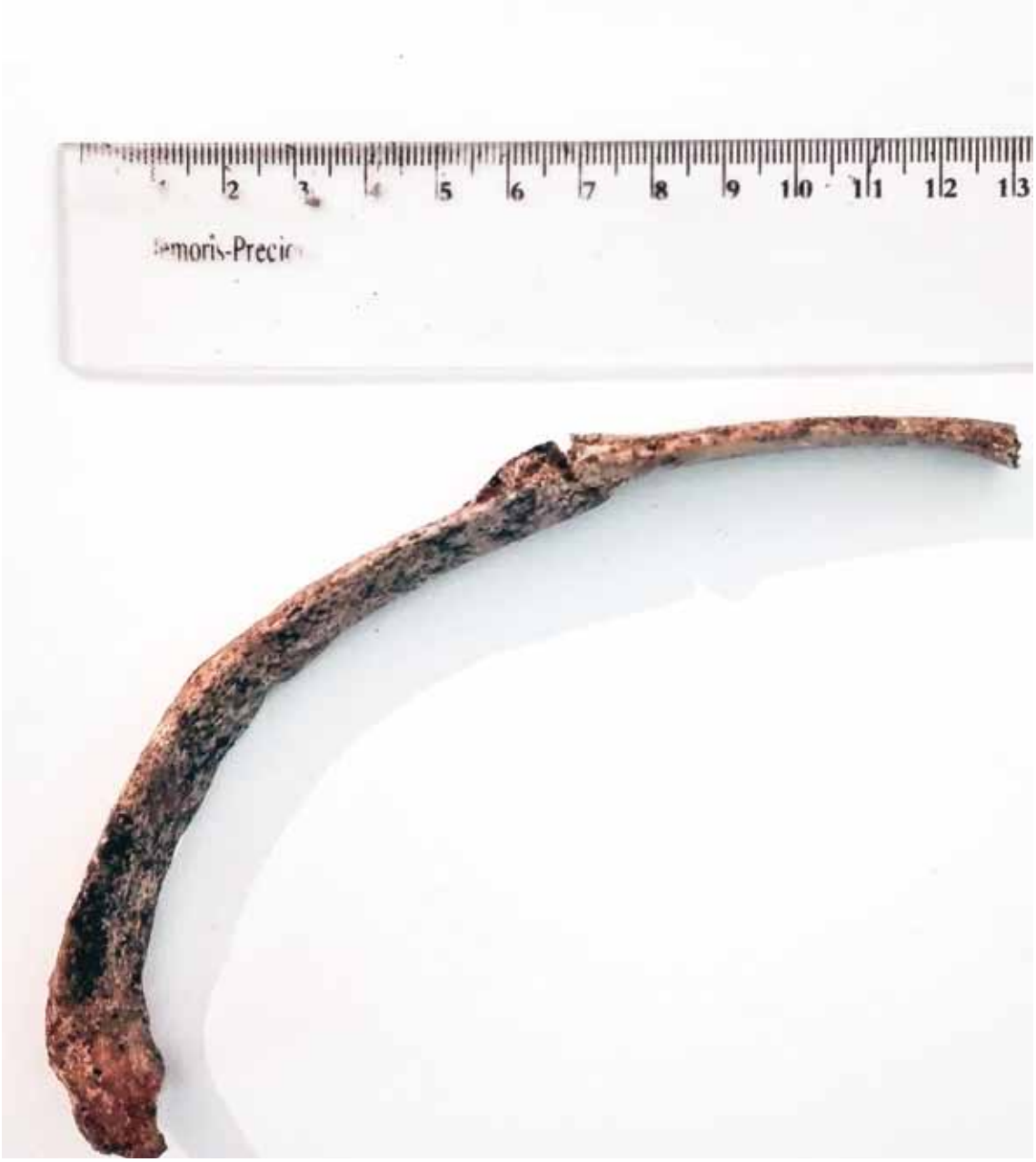


Fig. 4. Ante-mortem injury of the 7th right rib with pseudoarthrosis, G 11 (photo by M. Novak) / *Sl. 4. Zaživotna ozljeda sedmog desnog rebra s pseudoartrozom, grob 11 (snimio M. Novak)*

individuals exhibit signs of skeletal trauma: (i) older male (G 11) shows evidence of ante-mortem injury of the 7th right rib with pseudoarthrosis (false joint; **Fig. 4**); (ii) the skeleton of an older male (G 15) exhibits multiple ante-mortem rib fractures (6th and 7th right, 10th left with pseudoarthrosis) and T11 vertebral compression body fracture (**Fig. 5**); and (iii) middle-aged male (G 16) shows evidence of ante-mortem condylar fracture of the head of the proximal phalanx of the right hand.

In terms of isotopic data, the average value of four human samples from Zrin for $\delta^{13}C$ is -15.8‰ (ranging between -17.7 and -14.3‰), and for $\delta^{15}N$ the average value is 9.0‰ (ranging between 8.6 and 9.4‰).

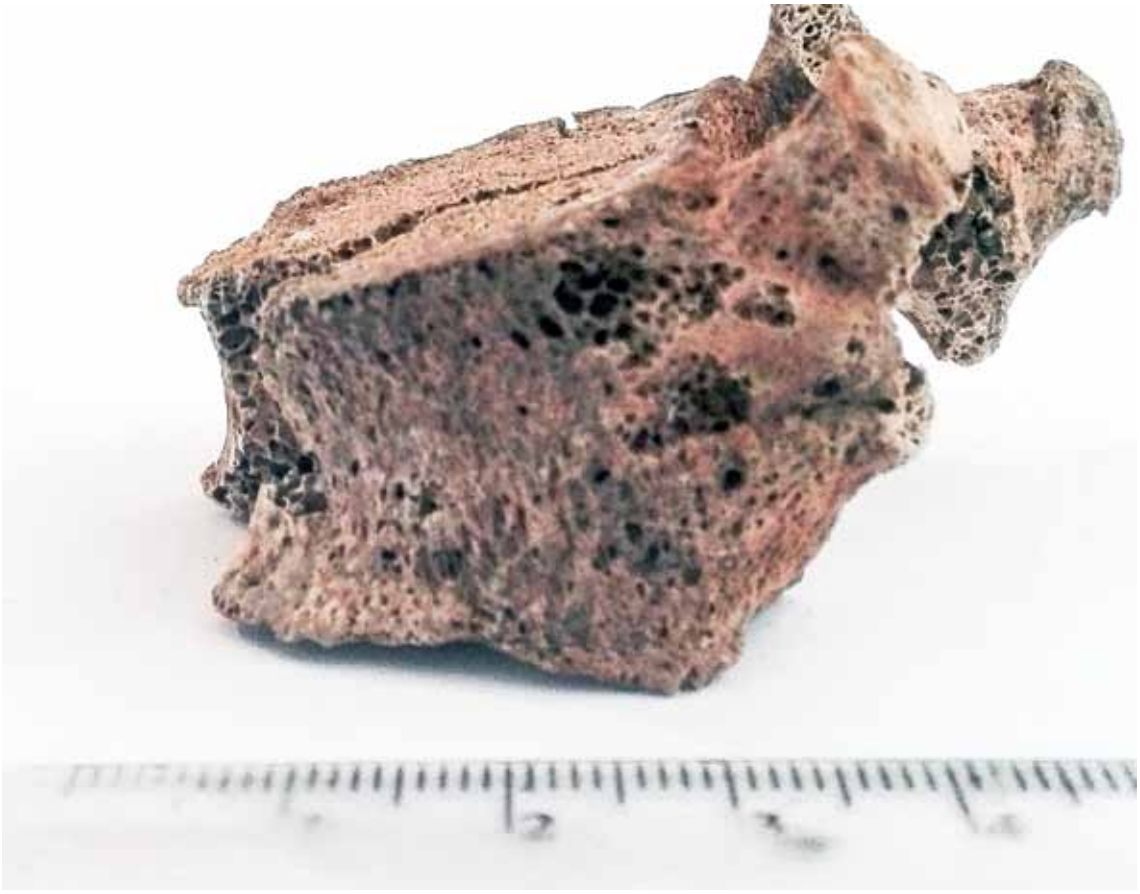


Fig. 5. Ante-mortem T11 vertebral body compression fracture, G 15 (photo by M. Novak) / *Sl. 5. Zaživotna kompresijska fraktura tijela 11. prsnog kralješka, grob 15 (snimio M. Novak)*

## Discussion

First, we have to mention that the analysed skeletal assemblage from Zrin is relatively small and that most of the skeletons are fragmented/partially preserved. Furthermore, these skeletons were recovered during the rescue excavation of only a small part of the site and not from the excavation covering the cemetery in its entirety. As such, this assemblage most probably does not reflect the true demographic and epidemiological distribution of the population living in Zrin between the 15th and 17th centuries CE. However, the data presented in this paper are the only available biological information about these people so far, and should be of significant help in our attempt to reconstruct numerous details on their demography, health, diet, and lifestyle.

The sex and age distribution analysis of the Zrin skeletal assemblage reveals that people of both sexes and all age groups were buried at the cemetery around the church of the Discovery of the Holy Cross. However, two details stand out: (i) very few (only two) individuals can be placed into the youngest age group, and (ii) distinctive difference in age distribution between the sexes, i.e. most females belong to the "young adults" age group while most males belong to the "middle adults" age group. Regarding the underrepresentation of the youngest individuals in the analysed assemblage, this may be explained by the small excavated plot that did not contain the remains of neonates/

infants. In other words, it is quite possible that the recent excavations in Zrin completely missed the part of the cemetery where the unbaptized (youngest) children were buried as postulated by the Church rules[39]. A similar situation was already recorded in several Medieval/Early Modern Period skeletal series from Croatia[40]. The pronounced sex difference in mortality, i.e. higher female mortality in younger age groups (between the age of 15 and 30 years) has been observed in numerous archaeological populations[41]. This coincides with a period when females give most births, especially in the past, so some authors associate this occurrence with complications due to pregnancy and birth. Of course, the pronounced female mortality in younger age groups cannot be explained only by the previously mentioned factors because the female mortality in archaeological populations may be also affected by infectious diseases, quality of diet, and so on. Most probably, a combination of these factors resulted in a much higher female mortality in younger age groups in Zrin.

The average height of the Zrin individuals fits well into the similar data available from other Croatian contemporaneous sites. The average height of females from Zrin is 161.6 cm which is almost identical to that of females from the Early Medieval site of Svećurje – Žestinj (161.1 cm)[42] and somewhat higher for the females from Early Medieval Šarengrad (155.5 cm)[43]. The height of Zrin males is 170.5 cm and as such stands between the values recorded in Šarengrad (167.1 cm)[44], Tribalj (172.8 cm)[45] and Svećurje (175 cm)[46].

The high prevalence of dento-alveolar lesions in Zrin such as caries, alveolar diseases and dental calculus suggests poor oral health of the majority of the adults from this assemblage. Similar values were recorded in many Medieval/Early Modern Period sites from continental Croatia[47]. Such dento-alveolar lesion frequencies in a population are also indicative of a certain type of diet because numerous palaeodontological studies suggest that there is a correlation between high frequency of caries (and calculus) and the type of diet involving frequent consumption of carbohydrates, i.e., the lifestyle based on agriculture and growing crops[48]. Therefore, it is safe to assume that the diet of most inhabitants of Zrin during this period was based on grains with only occasional consumption of animal protein. The diet of past populations can be reconstructed in more detail by using carbon and nitrogen stable isotopes from bone collagen. In this case we obtained isotopic data for four individuals from Zrin. These data clearly indicate that these four individuals form a compact whole in terms of diet, implying a mixed, protein-carbohydrate diet with an accentuated C4-type plant intake, millet being the most obvious suspect. These assumptions are furthermore supported by historic records such as *urbarium* of the Pauline monastery in Streza, dated to the 15th century, which describes the amount and structure of levies peasants had to provide for their feudal lords[49]. The *urbarium* lists in detail the types of food consumed by the members of lower social classes during this period in continental

39 For more details see Tkalčec 2016.
40 Krznar, Hajdu 2020; Novak, Hajdu, in press.
41 For example Acsádi, Nemeskéri 1970; Owsley, Bass 1979; Arriaza *et al.* 1988; Šlaus 2000.
42 Anterić, Bašić 2015.
43 Carić *et al.* 2019.
44 Carić *et al.* 2019.
45 Novak, Hajdu, in press.
46 Anterić, Bašić 2015.
47 Šlaus *et al.* 1997; Novak *et al.* 2010, 2017; Krznar, Hajdu 2020.
48 Lieverse 1999; Šlaus *et al.* 2011.
49 Kolar Dimitrijević 2003.

Croatia. According to this document, millet was the most important crop and was the base of every-day diet because it was easy to grow, it has a short vegetation period, and can be sown in dry and sandy ground. Wheat was considered the most important grain for making bread, while buckwheat and sorghum were important in the every-day diet as well; rye and barley were also cultivated in large amounts. On the other hand, pork, poultry, and fish were the most common sources of protein for Croatian peasants of the time[50].

The presence of various indicators of intense physical activity such as osteoarthritis, Schmorl's nodes and benign cortical defects at muscle attachment sites found in numerous adult skeletons from Zrin strongly suggests hard labour while performing everyday chores[51]. Intense physical labor that most of the analyzed adults from Zrin were exposed to affected mostly the spine and the upper arms and might have involved a whole series of activities such as work in and around the house, work in the field and with cattle, and possibly even the practice of *kulluk* (strictly enforced obligation for public labor imposed by the Ottomans)[52]. The prevalence and patterning of the pathologies associated with chronic mechanical stress that were observed in Zrin are, again, very similar to the values recorded in other contemporaneous sites from continental Croatia such as Nova Rača[53], Ivankovo[54], Ilok[55], and so on.

Several cases of skeletal indicators of subadult stress and infectious diseases (*cribra orbitalia* and sub-periosteal new bone formation) indicate the frequent occurrence of physiological stress in individuals from the studied population. Again, similar results were noticed in other contemporaneous sites from this area[56]. These episodes of physiological stress were probably the consequence of the synergistic effect of different biological and sociocultural factors, such as inadequate diet, infectious diseases, anaemia, and some other, yet undetermined, factors. However, one has to bear in mind that due to poor skeletal preservation the actual prevalence of recorded pathologies was probably much higher and that some pathologies were even completely lost due to post-mortem damage of skeletal remains.

Skeletal injuries were recorded in three adult males from Zrin. All observed fractures occurred ante-mortem indicating that they were not directly associated with the cause and manner of death of the analysed individuals. The observed injuries are mostly located in the region of the torso (ribs and vertebrae). Vertebral compression fracture could have been sustained as a result of a hyperflexion injury caused by vertical force such as jump from a height[57], but also as a result of osteoporosis[58]. Rib fractures are one of the most common types of injuries found in archaeological populations – they occur as a result of habitual or work-related activities[59], but can also occur as a result of direct trauma such as blows or a fall/impact on a hard object[60]. And finally, phalanx fractures of

50 Adamček 1980.
51 For more details see Novak, Šlaus 2011.
52 E.g. Holjevac, Moačanin 2007.
53 Šlaus 2000.
54 Krznar, Hajdu 2020.
55 Novak *et al.* 2017.
56 Novak *et al.* 2009.
57 Cooper *et al.* 1993.
58 Roberts, Manchester 2007.
59 Lovell 1997.
60 Adams Crawford 1987.

the hand like the one seen in Zrin are some of the most common fractures[61], and they are most usually associated with every-day activities such as sports[62]. There is a complete lack of skeletal evidence in the analysed assemblage that would point to intentional violence; it seems that the observed injuries were a result of accidents associated with rural lifestyle rather than violent episodes. However, the skeletal sample in question is quite small and fragmented and at the moment we cannot make any firm conclusions.

## Conclusion

As previously mentioned, up until now we had almost no biological information about the people inhabiting the village of Zrin (and the whole region) between the 15th and 17th centuries. The data presented here is the first glimpse into mortality, health, diet, and lifestyle of these people based on the analysis of their skeletal and dental remains. Furthermore, we presented the first isotopic data for Late Medieval/Early Modern periods individuals from the region which allowed a much better insight into their diet. Demographic and pathological characteristics of the inhabitants of Zrin are similar to those recorded at other contemporaneous sites from continental Croatia suggesting that there were no significant differences in the quality of life between various rural sites from this time period. And finally, we have to emphasise that the studied assemblage is quite small and fragmented, so consequently, all obtained results as well as hypotheses based on these results have to be taken with caution until a larger skeletal sample becomes available for study.

## Acknowledgements

The authors wish to thank Josip Burmaz from "Kaducej" d.o.o.

61 Hove 1993.
62 Yoong *et al*. 2010.

## LITERATURE / *LITERATURA*


| | |
|---|---|
| Acsádi, Nemeskéri 1970 | G. Acsádi, J. Nemeskéri, *History of human life span and mortality*, Akadémiai Kiadó, Budapest, 1970. |
| Adamček 1980 | J. Adamček, *Agrarni odnosi u Hrvatskoj od sredine 15. do kraja 17. stoljeća*, Sveučilišna naklada Liber, Zagreb, 1980. |
| Adams Crawford 1987 | J. Adams Crawford, *Outline of fractures*, Longman, Edinburgh, 1987. |
| Anterić, Bašić 2015 | I. Anterić, Ž. Bašić, Paleodemografska i paleopatološka analiza srednjovjekovnog groblja Svećurje – Žestinj, *ShP* 42, 2015, 213–229. |
| Arriaza *et al.* 1988 | B. Arriaza, M. Allison, E. Gerstze, Maternal mortality in Pre-Columbian Indians of Arica, Chile, *AJPhA* 77, 1988, 35–41. |
| Aufderheide, Rodríguez-Martín 1998 | A. C. Aufderheide, C. Rodríguez-Martín, *The Cambridge encyclopedia of human paleopathology*, Cambridge University Press, Cambridge, 1998. |
| Bedić *et al.* 2015 | Ž. Bedić, V. Vyroubal, T. Tkalčec, M. Šlaus, A case of childhood tuberculosis from Modern Period burial from Crkvari, Northern Croatia, *Podravina* 14, 2015, 64–72. |
| Bedić *et al.* 2019a | Ž. Bedić, A. Janeš, M. Šlaus, Anthropological analysis of trauma frequencies and distribution in the skeletal series from the Benedictine monastery of St Margaret in Bijela, Croatia, *CAntr* 43, 2019, 141–146. |
| Bedić *et al.* 2019b | Ž. Bedić, A. Azinović Bebek, M. Čavka, M. Šlaus, A case of hydrocephalus in a child from early modern period Žumberak, Croatia, *International Journal of Paleopathology* 26, 2019, 1–7. |
| Buikstra, Ubelaker 1994 | J. E. Buikstra, D. H. Ubelaker, *Standards for data collection from human skeletal remains*, Arkansas Archaeological Survey, Fayetteville, 1994. |
| Carić *et al.* 2019 | M. Carić, B. Zagorc, D. Ložnjak Dizdar, A. Rapan Papeša, A. Rimpf, M. Čavka, I. Janković, M. Novak, Bioarchaeology of the Late Avar population from Šarengrad – Klopare: preliminary results, *PIAZ* 36, 2019, 161–180. |
| Cooper *et al.* 1993 | C. Cooper, T. O'Neill, A. Silman, Epidemiology of vertebral fractures. European Vertebral Osteoporosis Study Group, *Bone* 14, 1993, 89–97. |
| Delgado-Darias *et al.* 2006 | T. Delgado-Darias, J. Velasco-Vázquez, M. Arnay-de-la-Rosa, E. Martín-Rodríguez, E. González-Reimers, Calculus, periodontal disease and tooth decay among the prehispanic population from Gran Canaria, *Journal of Archaeological Science* 33, 2006, 663–670. |
| DeNiro 1985 | M. J. DeNiro, Postmortem preservation and alteration of *in vivo* bone collagen isotope ratios in relation to palaeodietary reconstruction, *Nature* 317, 1985, 806–809. |
| Goodman, Rose 1991 | A. H. Goodman, J. C. Rose, Dental enamel hypoplasias as indicators of nutritional status, in: M. A. Kelley, C. S. Larsen (Eds), *Advances in dental anthropology*, Wiley – Liss, New York, 1991, 279–294. |

Hawkey, Merbs 1995 — D. E. Hawkey, C. F. Merbs, Activity-induced musculoskeletal stress markers (MSM) and subsistence strategy changes among ancient Hudson Bay Eskimo, *International Journal of Osteoarchaeology* 5, 1995, 324–338.

Hillson 1996 — S. Hillson, *Dental anthropology*, Cambridge University Press, Cambridge, 1996.

Holjevac, Moačanin 2007 — Ž. Holjevac, N. Moačanin, *Hrvatsko-slavonska vojna krajina i Hrvati pod vlašću Osmanskog Carstva u ranome novom vijeku*, Leykam international, Zagreb, 2007.

Hove 1993 — L. M. Hove, Fractures of the hand. Distribution and relative incidence, *Scandinavian Journal of Plastic and Reconstructive Surgery and Hand Surgery* 27, 1993, 317–319.

Jakovljević, Šlaus 2003 — G. Jakovljević, M. Šlaus, Rača i župna crkva Uznesenja Blažene Djevice Marije u Novoj Rači u svjetlu povijesnih i arheološko-antropoloških istraživanja, in: B. Čečuk (Ed.), *Arheološka istraživanja u Bjelovarsko-bilogorskoj županiji i pogrebni ritusi na teritoriju Hrvatske*, *IzdHAD* 21, 2003, 121–144.

Janeš, Bedić 2020 — A. Janeš, Ž. Bedić, Death in the convent: Burials in a Benedictine monastery, in: S. Krznar, T. Sekelj Ivančan, J. Belaj, T. Tkalčec (Eds), *Life and death in mediaeval and early modern times. Proceedings of the 5th International Scientific Conference of Mediaeval Archaeology of the Institute of Archaeology Zagreb, 6th and 7th June 2018*, Institut za arheologiju, Zagreb, 2020, 189–201.

Kekez, Regan 2020 — Hrvoje Kekez, Krešimir Regan, *Zrin: srednjovjekovno sijelo knezova Babonića i Zrinskih – tvrdi grad, urbana aglomeracija i posjed*, Srednja Europa, Zagreb, 2020.

Klales 2020 — A. R. Klales, *Sex estimation of the human skeleton. History, methods, and emerging techniques*, Academic Press, London, 2020.

Knüsel *et al.* 1997 — C. J. Knüsel, S. Gögel, D. Lucy, Comparative degenerative joint disease of the vertebral column in the medieval monastic cemetery of the Gilbertine Priory of St. Andrew, Fishergate, York, England, *AJPhA* 103, 1997, 481–495.

Kolar Dimitrijević 2003 — Mira Kolar Dimitrijević, Urbar pavlinskog samostana u Strezi 1477. godine, *Podravina* 2, 2003, 103–123.

Krznar *et al.* 2010 — S. Krznar, J. Belaj, Ž. Bedić, Prilog poznavanju nasilja u kasnosrednjovjekovnom Ivancu (grobovi 202 i 204) / A contribution to the knowledge of violence in the Late Middle Ages in Ivanec (graves 202 and 204), *PIAZ* 27, 2010, 225–240.

Krznar, Novak 2013 — S. Krznar, M. Novak, A case of skeletal tuberculosis from St. John the Baptist site in Ivankovo near Vinkovci, *PIAZ* 30, 2013, 93–106.

Krznar, Bedić 2016 — S. Krznar, Ž. Bedić, Neuobičajeni ritus pokopavanja u srednjem i novom vijeku na prostoru sjeverne Hrvatske, in: S. Krznar, T. Sekelj Ivančan, T. Tkalčec, J. Belaj (Eds), *Groblja i pogrebni običaji u srednjem i ranom novom vijeku na prostoru sjeverne Hrvatske*, Institut za arheologiju, Zagreb, 2016, 203–220.

Krznar, Hajdu 2020 — Siniša Krznar, Tamas Hajdu, Kasnosrednjovjekovna i ranonovovjekovna populacija iz Ivankova, istočna Hrvatska: rezultati (bio)arheološke analize, *PIAZ* 37, 2020, 165–194.

Lauc *et al.* 2015 — T. Lauc, C. Fornai, Z. Premužić, M. Vodanović, G. W. Weber, B. Mašić, P. Rajić Šikanjić, Dental stigmata and enamel thickness in a probable case of congenital syphilis from XVI century Croatia, *Archives of Oral Biology* 60, 2015, 1554–1564.

Lillie 1996 — M. C. Lillie, Mesolithic and Neolithic populations of Ukraine: indications of diet from dental pathology, *Current Anthropology* 37, 1996, 35–42.

Lieverse 1999 — A. Lieverse, Diet and the aetiology of dental calculus, *International Journal of Osteoarchaeology* 9, 1999, 219–232.

Lovell 1997 — N. C. Lovell, Trauma analysis in paleopathology, *Yearbook of Physical Anthropology* 40, 1997, 139–170.

Lukacs 2007 — J. R. Lukacs, Dental trauma and antemortem tooth loss in prehistoric Canary Islanders: prevalence and contributing factors, *International Journal of Osteoarchaeology* 17, 2007, 153– 173.

Mann, Murphy 1990 — W. R. Mann, P. S. Murphy, *Regional atlas of bone disease*, C. C. Thomas, Springfield, 1990.

Mensforth *et al.* 1978 — R. P. Mensforth, C. O. Lovejoy, J. W. Lallo, G. J. Armelagos, The role of constitutional factors, diet, and infectious disease in the etiology of porotic hyperostosis and periosteal reactions in prehistoric infants and children, *Medical Anthropology* 2, 1978, 1–59.

Mittler, van Gerven 1994 — D. M. Mittler, D. P. van Gerven, Developmental, diachronic, and demographic analysis of cribra orbitalia in the medieval Christian populations of Kulubnarti, *AJPhA* 93, 1994, 287–297.

Novak *et al.* 2009 — M. Novak, M. Šlaus, M. Pasarić, Subadult stress in the medieval and early modern populations of continental Croatia, *PIAZ* 26, 2009, 247–270.

Novak, Krznar 2010 — M. Novak, S. Krznar, Prilozi poznavanju uvjeta i kvalitete života u ranonovovjekovnom podravskom selu na primjeru Torčeca kraj Koprivnice, *Podravina* 9, 2010, 59–88.

Novak *et al.* 2010 — M. Novak, M. Šlaus, V. Vyroubal, Ž. Bedić, Dental pathologies in rural mediaeval populations from continental Croatia, *Anthropologiai Közlemények* 51, 2010, 11–21.

Novak, Šlaus 2011 — M. Novak, M. Šlaus, Vertebral pathologies in two early Modern period (16th-19th century) populations from Croatia, *AJPhA* 145, 2011, 270–281.

Novak 2013 — Mario Novak, Antropološka analiza ljudskih koštanih ostataka s nalazišta Rudina – benediktinski samostan Sv. Mihovila, *Radovi Zavoda za znanstveni i umjetnički rad HAZU u Požegi* 2, 2013, 115–136.

Novak *et al.* 2014 — Mario Novak, Mislav Čavka, Mario Šlaus, Two cases of neurogenic paralysis in medieval skeletal samples from Croatia, *International Journal of Paleopathology* 7, 2014, 25–32.

Novak *et al.* 2017 — M. Novak, A. Rimpf, Ž. Bedić, S. Krznar, I. Janković, Reconstructing medieval lifestyles: an example of Ilok, eastern Croatia, *Acta Musei Tiberopolitani* 2, 2017, 171–180.

Novak, Hajdu, in press — M. Novak, T. Hajdu, Život i smrt u zaleđu Kvarnerskog zaljeva tijekom srednjeg vijeka: bioarheološka analiza ljudskih koštanih ostataka iz Triblja, iskopavanja 2015. godine, *Acta Histriae* (in press).

Ortner 2003 — D. J. Ortner, *Identification of pathological conditions in human skeletal remains*, Academic Press, London, 2003.

Owsley, Bass 1979 — D. W. Owsley, W. M. Bass, A demographic analysis of skeletons from the Larson site (39WW2), Walworth County, South Dakota: vital statistics, *AJPhA* 51, 1979, 145–154.

Pleše, Sekulić 2014 — T. Pleše, P. Sekulić, Stari gradovi i utvrde Moslavačke i Zrinske gore: problemi istraživanja, konzerviranja i prezentiranja, *ShP* 41, 2014, 243–251.

Powers 2008 — N. Powers, *Human osteology method statement*, Museum of London, London, 2008.

Rimpf, Novak 2020 — A. Rimpf, M. Novak, Evliya Çelebi and the town cemetery of Ilok, in: S. Krznar, T. Sekelj Ivančan, J. Belaj, T. Tkalčec (Eds), *Life and death in mediaeval and early modern times. Proceedings of the 5th International Scientific Conference of Mediaeval Archaeology of the Institute of Archaeology Zagreb, 6th and 7th June 2018*, Institut za arheologiju, Zagreb, 2020, 239–260.

Roberts, Manchester 2007 — C. A. Roberts, K. Manchester, *The archaeology of disease*, Cornell University Press, Ithaca, 2007.

Silverman *et al.* 1993 — F. N. Silverman, B. D. Coley, J. P. Kuhn, *Caffey's pediatric X-ray diagnosis*, Mosby, St. Louis, 1993.

Šlaus 1994 — M. Šlaus, Osteological evidence for peri-mortem trauma and occupational stress in two medieval skeletons from Croatia, *CAntr* 18, 1994, 165–175.

Šlaus *et al.* 1997 — M. Šlaus, A. Pećina-Hrnčević, G. Jakovljević, Dental disease in the late Medieval population from Nova Rača, Croatia, *CAntr* 21, 1997, 561–572.

Šlaus 2000 — M. Šlaus, Biocultural analysis of sex differences in mortality profiles and stress levels in the late Medieval population from Nova Rača, Croatia, *AJPhA* 111, 2000, 193–209.

Šlaus 2002 — M. Šlaus, *The bioarchaeology of continental Croatia: An analysis of human skeletal remains from the prehistoric to post-medieval periods*, BAR international series, 1021, Archaeopress, Oxford, 2002.

Šlaus *et al.* 2003 — M. Šlaus, M. Novak, S. Krznar, Paleodemografska i paleopatološka analiza ljudskog osteološkog materijala s nalazišta Torčec – Cirkvišče kraj Koprivnice, *Podravina* 2, 2003, 37–48.

Šlaus, Novak 2006 — M. Šlaus, M. Novak, Analiza trauma u srednjovjekovnim uzorcima iz Kliškovca i Crkvara / An analysis of traumas in medieval samples from Kliškovac and Crkvari, *PIAZ* 23, 2006, 213–228.

Šlaus, Novak 2007 — M. Šlaus, M. Novak, Slučaj veneričnog sifilisa u novovjekovnom horizontu grobova kraj crkve Svetog Lovre u Crkvarima / A case of venereal syphilis in the Modern Age horizon of graves near the church of St. Lawrence in Crkvari, *PIAZ* 24, 2007, 503–510.

Šlaus *et al.* 2007 — M. Šlaus, M. Novak, Ž. Bedić, V. Vyroubal, Antropološka analiza kasnosrednjovjekovnog groblja kraj crkve Sv. Franje na Opatovini u Zagrebu, *ARR* 15, 2007, 211–247.

Šlaus *et al.* 2010 — M. Šlaus, M. Novak, V. Vyroubal, Ž. Bedić, The harsh life on the 15th century Croatia – Ottoman Empire military border: Analyzing and identifying the reasons for the massacre in Čepin, *AJPhA* 141, 2010, 358–372.

Šlaus *et al.* 2011 — M. Šlaus, Ž. Bedić, P. Rajić Šikanjić, M. Vodanović, A. Domić Kunić, Dental health at the transition from the Late Antique to the early Medieval period on Croatia's eastern Adriatic coast, *International Journal of Osteoarchaeology* 21, 2011, 577–590.

Šlaus *et al.* 2018 — M. Šlaus, Ž. Bedić, A. Bačić, J. Bradić, M. Vodanović, H. Brkić, Endemic warfare and dental health in historic period archaeological series from Croatia, *International Journal of Osteoarchaeology* 28, 2018, 65–74.

Trotter 1970 — M. L. Trotter, Estimation of stature from intact limb bones, in: T. D. Stewart (Ed.), *Personal identification in mass disasters*, Smithsonian Institution, National Museum of Natural History, Washington DC, 1970, 71–83.

van der Merwe *et al.* 2006 — A. E. van der Merwe, M. Y. Işcan, E. N. L'Abbè, The pattern of vertebral osteophyte development in a South African population, *International Journal of Osteoarchaeology* 16, 2006, 459–464.

van Klinken 1999 — G. J. van Klinken, Bone collagen quality indicators for palaeodietary and radiocarbon measurements, *Journal of Archaeological Science* 26, 1999, 687–695.

Vyroubal *et al.* 2016 — V. Vyroubal, T. Pleše, M. Novak, Rezultati antropološke analize osteološkog materijala pronađenog u crkvi pavlinskog samostana Svih svetih u Strezi – prijedlog povijesno-arhivske kontekstualizacije i interpretacije, in: S. Krznar, T. Sekelj Ivančan, T. Tkalčec, J. Belaj (Eds), *Groblja i pogrebni običaji u srednjem i ranom novom vijeku na prostoru sjeverne Hrvatske*, Institut za arheologiju, Zagreb, 2016, 87–106.

White, Folkens 2005 — T. D. White, P. A. Folkens, *The human bone manual*, Academic Press, London, 2005.

Walker *et al.* 2009 — P. L. Walker, R. R. Bathurst, R. Richman, T. Gjerdrum, V. A. Andrushko, The causes of porotic hyperostosis and cribra orbitalia: a reappraisal of the iron-deficiency anemia hypothesis, *AJPhA* 139, 2009, 109–125.

Yoong *et al.* 2010 — P. Yoong, R. W. Goodwin, A. Chojnowski, Phalangeal fractures of the hand, *Clinical Radiology* 65, 2010, 773–780.

## SAŽETAK

**Bioarheološka analiza stanovništva Zrina, kontinentalna Hrvatska, iz 15.–17. stoljeća**

Utvrda Zrin jedan je od najznačajnijih i najpoznatijih fortifikacijskih objekata iz razdoblja kasnog srednjeg i ranog novog vijeka na području Hrvatske. Unatoč tomu, do danas je poznato vrlo malo detalja o demografiji, općem zdravlju, prehrani i svakodnevnom životu ljudi koji su nastanjivali selo Zrin tijekom ovog perioda. No, nedavna arheološka istraživanja provedena uokolo crkve Našašća sv. Križa u Zrinu pružila su odličnu priliku za nova saznanja o različitim aspektima života i smrti ovih ljudi, kroz analizu njihovih koštanih i zubnih ostataka.

Arheološki kontekst i radiokarbonska datacija smještaju otkrivene grobove u razdoblje između 15. i 17. stoljeća. Analiza 32 kostura otkrila je da su u ovom uzorku prisutni ostaci osmero djece i 24 odrasle osobe. Paleodontološki i izotopni podaci sugeriraju miješanu prehranu s velikim udjelom C4 biljaka kao što je proso. Prisutnost različitih pokazatelja intenzivne fizičke aktivnosti sugerira da je uvelike bio zastupljen teški fizički rad tijekom obavljanja svakodnevnih poslova u kući i polju. Fiziološki stres, posebice onaj koji se pojavljuje tijekom djetinjstva, bio je čest i raširen – najvjerojatnije kao posljedica sinergističkog djelovanja neadekvatne prehrane, zaraznih bolesti i anemije. Većina zabilježenih ozljeda rezultat su nesreća povezanih s ruralnim načinom života, a ne namjernog nasilja. Analizirani uzorak relativno je malen i fragmentiran te je stoga sve rezultate i hipoteze temeljene na tim rezultatima potrebno uzeti s dozom opreza.