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Surviving Childhood: The Relationship Between Childhood Health and Longevity in the Early Bronze Age Necropolises Mokrin and Ostojićevo (2100-1800 BC)

Abstract: The study of prehistoric societies requires a holistic approach to all segments of the population. Researchers agree that the period of growth and development is crucial for the life course, its quality, and duration. In recent decades, there has been a noticeable increase in studies focusing on the material traces of children in the archaeological record, particularly within bioarcheology. These approaches, however, are not without limitations. Focusing exclusively on children's skeletons provides valuable insights, but it also limits the analysis to those who did not survive childhood. Therefore, it is necessary to include adult individuals to gain a more complete understanding of childhood health in the past. In this paper, we show that analysing markers of survived childhood stress in skeletons of adult individuals can provide insights into many aspects of children's lives in the past while focusing on an EBA skeletal series from Mokrin and Ostojićevo.

Keywords: markers of stress, linear enamel hypoplasia, bioarchaeology of children, health in prehistory, Maros culture, Early Bronze Age

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(In)visible members of society

Before the 1970s and 1980s, the prevailing approach in archaeology relied heavily on Phillip Aries' theory (1965) that asserted the concept of childhood as an entirely modern construct. This framework resulted in near complete exclusion of children from archaeological research. However, with the second wave of feminism, researchers started carving out a place for children in the archaeological record, often aligning their studies with women's spaces. Since then, the archaeology of childhood has made great strides towards shedding light on the immense importance of including children in archaeological interpretations and narratives (Lillehammer 1989; Crawford, Hadley, Shepherd 2018; Rohnbogner 2021).

One of the biggest hurdles in the study of past childhood is the scarcity of material evidence that can be directly attributed to children. Toys are not always readily recognized: not all small objects should be interpreted as toys, nor are toys the only things children play with (Balj 2009; Rohnbogner 2021). After all, sticks, rocks and household objects are fair game even for modern children when it comes to playtime. While fingerprints (Dorland 2018; Fernandez and Chapon 2015), footprints, and tooth marks (Stefanović et al. 2019) are more direct traces of children's activities, they are relatively rare finds at archaeological sites. The most unequivocal evidence by far is found in skeletal remains. Bones and teeth of non-adults can reveal details about diet, health status, growth, breastfeeding and weaning practices, trauma, and physical activities (Buikstra and Ubelaker 1994). The health of children in particular is a highly important indicator of population health and cultural practices, as children are dependent on the care of adults (Mays et al. 2017). However, the study of sub-adult skeletal remains has a significant limitation because these remains typically represent the cohort of children who experienced the poorest health outcomes and did not survive to adulthood. One promising avenue of research that addresses this limitation involves examining the remains of adults who successfully survived childhood. By analysing bone and dental markers accumulated during early life stages, researchers can gain insights into childhood conditions and experiences of the past, enhancing the visibility of childhood in the archaeological record.

Bioarchaeology of health: Linear enamel hypoplasia

The importance of early life stress and its impact on later health outcomes has been shown in both modern (Barker and Osmond 1986; Barker 2004a; Barker 2004b) and archaeological populations (Goodman and Rose 1990; Saunders

and Keenleyside 1999; Palubeckaite et al. 2002; Masterson et al. 2017; Minozzi et al. 2020). The *developmental origin of health and disease* hypothesis (DOHaD, also referred to as Barker's hypothesis) is based on findings from a study of the relationship between low birth weight and the possibility of cardio-vascular disease in later life (Barker and Osmond 1986). Since then, many researchers have expanded this field of inquiry, applying the DOHaD hypothesis to archaeological populations with varying levels of success. The ability of dental enamel to serve as a permanent record of early life physiological stress provides researchers with a potential for research into developmental plasticity and adaptive response when coupled with data on health and longevity inferred from skeletal remains.

Teeth have many qualities that make them a compelling subject in the study of human health in the past. Dental enamel is one of the most durable materials in our bodies, making teeth more likely to survive different taphonomic processes and to be recovered to a large degree during an excavation (Hillson 2014). During formation, dental enamel is susceptible to physiological stressors, which manifests as visible disruptions in its growth patterns (Hillson 2014; Smith and Warinner 2022). Furthermore, due to the near-complete calcification of dental enamel during its final developmental phase, this tissue becomes inert and any growth disruptions recorded during formation remain permanent (Hillson, 2014; Goodman and Rose 1990). Barring tooth loss and occlusal wear, the examination of adult teeth for the presence of macroscopic or microscopic growth disruptions enables the bioarchaeologist to infer episodes of childhood physiological stress (Goodman 1989; Goodman and Rose 1990; Saunders and Keenleyside 1999; Palubeckaite et al. 2002). Most commonly used stress markers recorded on tooth enamel are linear enamel hypoplasia (LEH), which can be studied both macroscopically (Goodman and Rose 1990; Saunders and Keenleyside 1999; Masterson et al. 2017; Minozzi et al. 2020) and microscopically (King, Hillson and Humphrey 2002; King, Humphrey and Hillson 2005; Henriquez and Oxenham 2017), as well as Willson bands (Rose 1979; Rose, Armelagos and Lallo 1978; Fitzgerald and Saunders 2005).

Tooth formation tables (Massler, Schour and Poncher 1941; Hillson 2014) and enamel formation tables (Reid and Dean 2006; Holt et al. 2012), produced during the study of teeth and dental enamel development, are instrumental in determining the age at onset of the growth disruption that led to an enamel defect. These formation tables are indispensable tools that enable researchers to analyse health outcomes resulting from episodes of survived childhood stress using adult teeth.

There are many limitations to studying the health of past populations. Unlike most paleopathological markers, health cannot be observed as a dichotomy,

as 'present' or 'absent'; rather, it is a scale of gradients (DeWitte 2014; Klaus 2014). Taking into account the nature of the skeletal remains found at archaeological sites – the taphonomy, incompleteness of the series, the cumulative nature of the graveyards (Milner, Wood and Boldsen 2008), methods of excavation and conservation, and the osteological paradox (Wood et al. 1992; Soltysiak 2015) – already limited data becomes even more so. Furthermore, even if the skeletal remains are optimally preserved, risks of morbidity and mortality are complex and tied to many variables like sex, gender, age, social status, cultural practices, ecology, to name a few. Through an analysis of LEH formation on skeletons from Mokrin and Ostojićevo, this study aimed to explore if there was a relationship between an episode of stress survived in childhood (as evidenced by the LEH) and negative health outcomes later in life for individuals from these two necropoles and garner a new understanding of health and disease in the Bronze Age.

Hypotheses

This paper's hypothesis is based on the DOHaD hypothesis which states that childhood stress episodes lead to less desirable health outcomes later in life (Barker and Osmond 1986; Barker 2004a; Barker 2004b). We posit that the individuals buried at Mokrin and Ostojićevo who experienced a period of stress in childhood will have a shorter average life expectancy compared to those who were not exposed to stress during childhood. We will use LEH as a proxy for childhood stress episodes to test the following hypotheses:

1. The incidence of stress events during growth and development, as indicated by linear enamel hypoplasia, will be linked to changes in adult mortality. Individuals with LEH are expected to exhibit lower age values at death. The null hypothesis predicts that there will be no correlation between the presence of enamel defects and adult mortality.
2. The frequency of stress events during growth and development, as indicated by the number of incidences of stress events resulting in LEH, will be linked to different outcomes in adult mortality. It is expected that individuals with higher frequency of LEH will exhibit lower values of age at death. The null hypothesis predicts that there will be no correlation between the frequency of LEH and adult mortality.
3. The difference in the relationship between the occurrence and frequency of LEH and adult mortality will be dependent on sex. The null hypothesis is that there will be no sex-based difference between the examined individuals, and so there will be no distinct patterns of the occurrence and frequency of LEH and adult mortality between males and females.

Materials and methods

Maros is one of a number of cultural groups that thrived in the Carpathian Basin in the Early and Middle Bronze Age. It spans the territories of three modern-day countries – Romania, Hungary and Serbia – and its sites are usually found near the Tisza and Maros rivers and their tributaries (Bona 1975; O'Shea 1996). In literature it is mostly known for abundant and diverse grave goods: ceramic vessels, jewellery made of animal teeth, bones, seashells, bronze, copper and gold, and daggers and axes (Bona 1975; Girić 1971; O'Shea 1996). Even though both settlements and necropoles of this culture group have been excavated and analysed since the beginning of the 20th century, absolute dating has been somewhat limited. The available absolute dates indicate that the Maros culture group formed around 2500 BC and lasted until c. 1700 BC (O'Shea 1992; O'Shea et al. 2019).

Necropoles of the Maros group have been more widely excavated and analysed than its settlements. The Maros people practised skeletal burial in rectangular graves, with the deceased interred in a crouched position on their sides, arms bent at the elbows and legs at the knees while being pulled close to the body. The orientation of the grave in a large number of cases appears to be connected to biological sex and/or gender: men were usually buried on their right side, with their heads to the north and legs to the south, facing east, while for the women the opposite is true, with very little exceptions (Girić 1971; O'Shea 1996; Matić 2012). This norm is present at every necropolis of the culture and appears to extend even to children, as the aDNA analysis of a number of children's graves has shown (Žegarac et al. 2021).

The Mokrin necropolis is situated in Northern Banat in Serbia, near the city of Kikinda. Archaeologist found 312 graves during the first excavation campaign in the 1960s (Girić 1971) and an additional eight have been excavated in the ongoing campaign that started in 2020 (Pendić et al. 2021). The necropolis was the subject of many archaeological (O'Shea 1996; Wagner 2009; Ljuština, Krečković Gavrilović and Radišić 2019) and bioarchaeological analyses (Stefanović and Dimitrijević 2007; Stefanović 2008; Porčić and Stefanović 2009; Stefanović and Porčić 2013; Vitezović 2017; Blagojević 2020; Žegarac et al. 2021; Krečković Gavrilović 2023). The necropolis has been absolutely dated to the period between 2100-1800 BC (O'Shea 1992).

The Ostojićevo necropolis is situated in Northern Banat in Serbia as well, some 20 km from the Mokrin cemetery and 40 km from the Tisza-Maros confluence (Girić 1995; Milašinović 2008). It was excavated in the 1980s, but unlike Mokrin, material from this site was only analysed as part of unpublished master's (Milašinović 2008) and PhD theses (Vučićević 2015; Krečković Gavrilović

2022). Unlike Mokrin, Ostojićevo had a hiatus in the middle of its use – the earliest 77 graves from this site belonged to the Maros population, and after hiatus the site was used by a different Middle Bronze Age community (Milašinović 2008; Girić 1989). The absolute dates confirmed relative chronology – the Ostojićevo site was used by the Maros cultural group population somewhat later than Mokrin, and has been dated to 2000-1800 BC (O'Shea et al. 2019).

Even though some of the mentioned works have included children buried at Mokrin and Ostojićevo necropolises, only two studies have been done so far within the framework of the archaeology of childhood. E. Rega (2000) studied the role of gender of boys and girls buried at Mokrin in their social status, while M. Amzirkov (2020) analysed the roles and status of children through their funeral practice. Detailed analyses of children buried at both Mokrin and Ostojićevo are underway as part of the INFANO project, but as of 2024, nothing is published.

For this research paper, an analysis of skeletal remains was conducted, encompassing a total of 123 individuals, specifically 91 adult individuals found in the Mokrin necropolis and 32 Maros adult individuals excavated at the Ostojićevo necropolis. It should be noted that despite the larger number of specimens comprising the skeletal assemblages from these respective sites, specifically 320 individuals from Mokrin and 77 individuals from Ostojićevo, the overall quality of preservation was found to be suboptimal, primarily due to the high acidity of the soil. Additionally, the skeletal material from the Mokrin necropolis has been analysed and sampled on multiple occasions since the site was first excavated in the 1960s, resulting in the further fragmentation of the assemblage. For this analysis, our sample included adult individuals from both necropoles, as both had sufficiently preserved dental and postcranial skeletons. If all that remained from an individual were one long bone and the cranium (which was often the case with the Mokrin necropolis), the individual was excluded from the study.

Given the substantial sample size, which exceeded the practical limits for scanning electron microscopy (SEM) analysis in terms of time and cost constraints, a macroscopic approach was adopted for this project. A specific protocol for the documentation of enamel hypoplasia was devised, encompassing the assessment of tooth presence or absence, the identification of enamel hypoplastic defects, the quantification of the total number of defects, the measurement of the total height of the tooth crown, and the determination of the height at which these defects were observed. Observations of the teeth were conducted using two light sources: natural light and a table top lamp, strategically positioned to enhance defect visibility on the highly reflective enamel surface due to light refraction.

The age at which the linear enamel hypoplasia formed, i.e., when the episode of stress resulting in a defect occurred, was based on the crown's height and the

height at which the defects were identified. Previously published tooth crown growth schedules were employed for the estimation of age at defect formation: schedules established by D. Reid and M. Dean (2006, 343-344) were utilized for incisors, canines, and molars, while those created by S. Holt and colleagues (2012, 6) were employed for premolars. To ascertain the age at which the enamel defect occurred, each tooth crown was divided into 10 equal segments, marked as a percentage of the total crown area. The calculation relied on measurements of both the total crown height and the height at which the defect was observed, measured from the cementoenamel junction (CEJ) to the crown's apex. This approach allowed for the determination of the specific segment within the tooth crown where the defect was located, thereby facilitating the calculation of the individual's age at the time of LEH formation. The data regarding the presence of hypoplastic defects, their occurrence frequency, and the age at which the stress episode was endured were utilized for subsequent analytical procedures.

As a proxy for childhood stress episodes, two variables were used: presence/absence of linear enamel hypoplasia and frequency of enamel hypoplasia. The binary presence/absence variable is self-explanatory, and the frequency variable relies heavily on the enamel formation tables (Reid and Dean 2006; Holt et al. 2012). Each enamel defect was assigned to one of five arbitrarily denoted cycles: the first cycle includes defects that occurred on the teeth in the period of life from their earliest appearance to 2.4 years of age (according to the measurement of the tooth crown); the second cycle includes defects occurring in the period between 2.5 and 3.4 years of age; the third cycle includes defects occurring in the period between 3.5 and 4.4 years of age. The fourth cycle includes all defects that occurred between 4.5 and 5.4 years, while the fifth cycle includes defects that occurred between 5.5 and 6.4 years. For the frequency variable, the number of cycles (0-5) with an enamel defect was recorded, thus marking the number of recurring stress episodes in childhood.

Age estimation

Standard anthropological methodologies were used to assess the age at death of the individuals included in this research: wear patterns on the pubic symphysis (Todd 1920; Brooks and Suchey 1990) and auricular surfaces of the ilium (Lovejoy et al. 1985). Additionally, wear patterns on the occlusal surfaces of both the maxillary and mandibular dentition, as detailed by Lovejoy in 1985, were also considered. State of preservation excluded the usage of many of the well-established methodologies for age estimation, but multiple markers were used whenever possible to infer the final estimation of the age range. As a result, these ranges were larger than 10 years for more than two thirds of the individ-

uals, and larger than 15 years for more than half of the sample. These ranges were not ideal for testing our hypotheses. However, the primary focus in this analysis centres on the relative age at death within the population, rather than establishing absolute ages. In other words, the focus lies on identifying the oldest individuals within the population, irrespective of whether they lived up to 55 or 60. To address this limitation, an alternative analysis was employed, utilizing the entire age ranges derived from the anthropological assessments. Code was written for the R Core Team (2020) program, which facilitated the selection of one age value from the anthropological age range for each individual through a random sampling process (the code used can be found at the free link https://osf.io/3xqde/). By randomly sampling multiple times (10,000 times in this case) from the existing age ranges, the desired statistical tests were performed with simulated age values, reducing precision but increasing accuracy, since almost every possible age was utilized in the simulated values.

Dental preservation

As previously discussed, the preservation of the skeletal remains from Mokrin and Ostojićevo is suboptimal. In this study, we define preservation as the presence of at least one tooth of each type in a row of teeth, regardless of its lateralization. In other words, a mandibular or maxillary dentition is considered 100% preserved when one central incisor, one lateral incisor, one canine, one first premolar, one second premolar, and one first, second, and third molar are present, irrespective of their location within the left or right mandible or maxilla. Since the formation of tooth enamel is contingent upon tooth type rather than lateralization (Hillson 2014, 33), having at least one tooth from each pair of the same type is adequate for unhampered tracking of the tooth formation sequence.

Results

Approximately 60% of individuals in our sample had more than a half of their dentition preserved (see Table 1).

Table 1. Dental preservation of Mokrin and Ostojićevo samples

	<25%	**25-49%**	**50-74%**	**75-100%**
Mokrin	12 (13%)	27 (29.3%)	36 (39.1%)	17 (18.5%)
Ostojićevo	3 (9.4%)	8 (25%)	14 (43.8%)	7 (21.9%)
Total	15 (12.1%)	35 (28.2%)	50 (40.3%)	24 (19.4%)

The level of dentition preservation can have a significant impact on the quantity of enamel defects recorded. To ascertain whether there was a statistically

significant difference in the percentage of dental preservation between those individuals who had linear enamel hypoplasia and those who did not, an independent t-test was employed. The results demonstrated a statistically significant difference in the percentage of dental preservation (t(117)=3.451, p=.001) between individuals with linear enamel hypoplasia (N=61, M=0.604, sd=.227) and those with no enamel defects (N=58, M=0.46, sd=.217). As expected, the level of dentition preservation was better among individuals who had linear enamel hypoplasia than for those who did not.

Impact of age at death on the dental preservation

Knowing that dentition preservation significantly influences the occurrence of linear enamel hypoplasia in our sample, it was necessary to check if age at death had a similar effect on preservation. To determine this, we used rough age categories for all individuals in our sample: *adultus* (18-40), *maturus* (40-60), and *senilis* (60+). A Kruskal-Wallis H test found a statistically significant difference in dental preservation between different age groups $\chi^2(2)$: 6.912, p=0.032, with a mean rank preservation score of 66.57 for *adultus* individuals, 52.50 for the *maturus* group, and 41.44 for *senilis* individuals.

Partial correlation between age at death and presence of LEH

To test the hypothesis that those individuals who survived an episode of stress in childhood, evidenced by linear enamel hypoplasia, had shorter lifespans than those who were not exposed to similar stress, a correlation test was conducted using the simulated estimated age variable and binary presence/absence of linear enamel hypoplasia variable. Having previously ascertained that the level of dentition preservation had a statistically significant relationship with both the presence of LEH and the estimated age, we used a partial correlation coefficient. In this way, the level of preservation could be used as a control for both variables (Field 2009:186).

The use of the simulated age variable (explained above) necessitated the repetition of the correlation test utilizing the partial correlation coefficient 10,000 times. The analysis entailed the observation of the number of instances in which the results achieved statistical significance.

The results of the analysis of the total sample showed a negative correlation between age at death and the presence of LEH (Table 2). The median value of the partial correlation coefficient showed a weak negative correlation (-0.18125) between age and the presence of LEH, with the result being statistically significant (for $p<0.05$) in 51.34% of the simulations.

Table 2. Results of the partial correlation between age at death and presence of LEH

	Min	1st quartile	Median	Mean	3rd quartile	Max
R	-0.30131	-0.20355	-0.18125	-0.18143	-0.15918	-0.05051
P	0.001013	0.028409	0.051755	0.066470	0.087861	0.590279

For further analysis, the sample was divided into male and female groups, and the same partial correlation coefficient was used, controlling for the dental preservation level and using the simulated age variable. For the male subsample (see Table 3), the median value of the partial correlation coefficient showed a weak negative correlation between age at death and the presence of LEH (-0.2825), with the result being statistically significant (for $p<0.05$) in 55.58% of the simulations. For the female subsample (Table 4), the median value of the partial correlation coefficient showed a weak negative correlation (-0.2828), but the results were statistically significant (for $p<0.05$) in only 0.04% of the simulations.

Table 3. Results of the partial correlation between age at death and presence of LEH for men

	Min	1st quartile	Median	Mean	3rd quartile	Max
R	-0.4559	-0.3132	-0.2828	-0.2825	-0.2515	-0.1124
P	0.00077	0.025244	0.044342	0.05634	0.07503	0.432242

Table 4. Results of the partial correlation between age at death and presence of LEH for women

	Min	1st quartile	Median	Mean	3rd quartile	max
R	-0.2822	-0.14170	-0.10836	-0.10809	-0.074170	0.08122
P	0.03684	0.30209	0.43101	0.45628	0.59034	0.99969

Partial correlation of age at death and the frequency of LEH

To test the hypothesis that the individuals who survived more frequent episodes of stress in childhood had shorter lifespans than those who were exposed to fewer episodes of similar stress, a correlation analysis was conducted between the simulated age and frequency of LEH variables. Once again, a partial correlation coefficient was used, controlling for the dental preservation level for both variables.

The results of the analysis of the total sample showed a negative correlation between age at death and the frequency of LEH (Table 5). The median value of the partial correlation coefficient shows a very weak negative correlation (-0.1699) between age and the frequency of LEH, with the result being statistically significant (for $p<0.05$) in 34.86% of the simulations.

Table 5. Results of the partial correlation between age at death and the frequency of LEH

	Min	1st quartile	Median	Mean	3rd quartile	Max
R	-0.29043	-0.19139	-0.1699	-0.17026	-0.14938	-0.05675
P	0.001564	0.03958	0.068246	0.083496	0.1090505	0.545129

For further analysis, the sample was divided into male and female groups, and the same partial correlation coefficient was used, controlling for the dental preservation level and using the simulated age variable. For the male subsample (see Table 6), the median value of the partial correlation coefficient showed a very weak negative correlation between age at death and the presence of LEH (-0.16006), with the result being statistically significant (for p=.05) in only 0.37% of the simulations. For the female subsample (Table 7), the median value of the partial correlation coefficient showed a weak negative correlation (-0.20795), but the results were statistically significant (for $p<0.05$) in 11.64% of the simulations.

Table 6. Results of the partial correlation between age at death and the frequency of LEH for men

	Min	1st quartile	Median	Mean	3rd quartile	Max
R	-0.32571	-0.18828	-0.16006	-0.15994	-0.13139	0.004643
P	0.01968	0.18579	0.26187	0.28142	0.35809	0.9742

Table 7. Results of the partial correlation between age at death and the frequency of LEH for women

	Min	1st quartile	Median	Mean	3rd quartile	Max
R	-0.36039	-0.23999	-0.20795	-0.20684	-0.17325	-0.0435
P	0.006875	0.075595	0.127631	0.153959	0.205888	0.755001

Discussion

The main theoretical framework of this paper proposed that episodes of stress survived in the early childhood will have a significant impact on adult mortality, and the three hypotheses were posited to reflect this framework. The results showed some significant relationship between LEH and reduced age at death, as well as different sex-specific patterns related to LEH that were in line with previous research (Boldsen 2007; DeWitte 2010; Gamble, Boldsen and Hoppa 2017). Therefore, even though the negative correlation was weak in most cases, the general trend that emerged from the results of this research indicates that early childhood stress has adverse effects on mortality outcomes.

The binary variable for the presence of LEH appears to indicate an impact on adult mortality. The general trend of a weak negative correlation between the presence of LEH and the age at death was shown to be statistically significant in

a little more than half of the simulations (51,34%). Interestingly, when the sample was divided into sex-specific groups, the results revealed a weak negative correlation that was statistically significant in more than half of the simulations for the male sample (55.5%), whereas the female sample did not show a statistically significant weak negative correlation in almost any simulation (0.04%). This difference was previously established in other similar studies (Boldsen 2007; DeWitte 2010; Gamble, Boldsen and Hoppa 2017; O'Donnell and Moes 2021), which found that the presence of enamel insults (both macroscopic and microscopic) has a negative impact on mortality for men but not for women. The issue of the difference in frailty between boys/men and girls/women in both modern and past populations emphasizes the heterogeneity of factors that can impact mortality risks (Vaupel et al. 1979). Genetics, biology, environment, socioeconomic status, and cultural practices represent different buffers or stains on the health and longevity outcomes for boys/men and girls/women. In most modern populations women have a more favourable position when it comes to both morbidity and mortality. Women, on average, live longer, and they seem to be better buffered against environmental stress and have better immunocompetence (Stinson 1985). This sex-dependent difference has been the subject of many studies, with varying results. There are studies that have shown that men have significantly greater levels of morbidity and mortality than women in a wide variety of infectious diseases (Alghamdi et al. 2014; Karlberg, Chong and Lai 2004; Leong et al. 2006; Scully et al. 2020). On the other hand, some infectious diseases carry more morbidity and mortality risks for women than they do for men, especially during pregnancy (Rechtien and Altfeld 2019; Robinson and Klein 2012). The same can be said for degenerative diseases – some, like autoimmune disorders and chronic obstructive pulmonary disease – are more likely to affect women (Amur, Parekh and Mummaneni 2012; Barnes 2016; Fairweather, Frisancho-Kiss and Rose 2008), while others like cardiovascular diseases, renal diseases and cirrhosis of liver disproportionately affect men (Ng 2007; Ji et al. 2007; Silbiger and Neugarten 2003; 2008). Additionally, some X chromosome recessive diseases are more likely to impact boys/men than girls/women (Libert, Dejager and Pinheiro 2010). Aside from this genetic component, sex hormones are also linked to certain diseases and chronic conditions that negatively affect men, since oestrogens boost immunocompetence while androgens decrease it (Li et al. 2022; Ruggieri et al. 2016).

Naturally, biological sex is not the only variable at play when it comes to sex differences in morbidity and mortality: gender has just as important a role. Cultural practices that are tightly tied to gender might buffer or put greater strain on the frailty of all genders (DeWitte 2010; Wood et al. 1992). Gender roles could produce different patterns of exposure to risks of infections, parasitic burden, injury, and adverse environmental conditions, such as exposure to toxic materi-

als, zoonotic pathogens, and unsanitary conditions. Gender might lead to insufficient quantity or quality of food for some members of the community, which could in turn negatively impact the immune response and resilience, leading to higher levels of frailty. Additionally, socioeconomic status, which is often, if not always, also tied to gender, affects all aforementioned risks. Taking all of these variables into account, it becomes apparent that the heterogeneity of frailty is hard to parse even when studying modern populations, especially so for skeletal series from the distant past (DeWitte 2010; Wood et al. 1992).

The Maros community showed distinctive signs of social inequality, in line with the societal changes happening at the beginning of the Bronze Age on the European continent (O'Shea 1996). The usage of a new material (bronze), the need for the tight control of tin (one of its components), and the long-distance exchange of goods, knowledge and people during this period gave rise to new mechanisms of social complexity (Harding 2000). Previous research of grave goods from most necropoles of the Maros culture has revealed distinctive differences in social status, with certain grave goods (weapons, beaded sashes, bone needles and hair ornaments) established as markers of higher status (O'Shea 1996). Further research done on the skeletal series from the Mokrin necropolis identified differences in physical activity between different social status groups, as well as contrasting patterns for men and women (Porčić and Stefanović 2009; Stefanović and Porčić 2013). Additionally, an aDNA study of the same population suggested the existence of different models of inheriting or acquiring social status which are closely tied to sex/gender (Žegarac et al. 2021). Differences in the effect of early childhood stress on longevity between the two sexes, at this stage, could be attributed to differences in frailty caused by biology, namely generally better immunocompetence for girls/women. Fertility, a major driver of morbidity and mortality for women, could have also skewed the results. Gender differences could have played a role as well, with different buffers and risks affecting the frailty of boys/men and girls/women at Mokrin and Ostojićevo, in the same way that gender influenced different patterns of physical activity in men and women at Mokrin (Porčić and Stefanović 2009; Stefanović and Porčić 2013) and Ostojićevo (Vučićević 2015). Finally, the osteological paradox must also be taken into account: even though all individuals included in this research were adults, so we were essentially analysing "survivors" of childhood stress, the greater impact of stress on the longevity of men could have resulted from the different cultural buffering of male and female children. If better care was afforded to male children than female, males would have had a better chance of survival to adulthood, even if they were frailer. This would result in a population with even bigger differences in frailty between adult men and women, leading to a male population more prone to negative health outcomes (Wood et al. 1992; DeWitte 2010).

Interestingly, the frequency of LEH has been shown to have a lower impact on the longevity outcomes for Mokrin and Ostojićevo populations. A weak neg-

ative correlation was detected between the frequency of LEH and longevity that was statistically significant in around one-third of simulations (34.86%). For men, this weak negative correlation was not significant in almost all cases (0.37%), while for women, only 11.64% of simulations showed a statistically significant weak negative correlation. In other words, greater LEH frequency in boys did negatively impact their longevity. This result suggests that although there is a correlation between the survived episode of stress in childhood and shorter life span for men, the number of survived episodes of stress does not have an impact on lifespan. The same cultural buffers might have been afforded the boys with weaker health status, no matter how many times they went through an episode of stress. However, the small sample size must be considered, and caution should be applied.

A previously published analysis of the influence of survived childhood stress on the morbidity of the same populations based on LEH and markers of paleopathological non-specific stress identified a similar trend. While using a single marker of non-specific stress did not prove significant, the consolidated variable of frequency of non-specific stress markers showed a correlation with the frequency of LEH (Krečković Gavrilović 2023). In other words, those individuals who survived a higher number of stress episodes in childhood had a higher frequency of morbidity, as evidenced by the greater number of osteological non-specific stress markers. Once again, when the sample was divided into two groups by sex, the male sample revealed a significant correlation between the frequency of childhood stress episodes and worse morbidity outcomes, while the female sample had no such correlation. This result could also suggest the difference in the frailty and buffers afforded to boys and girls in Bronze Age Mokrin and Ostojićevo.

Conclusion

Understanding the health of past populations is a complex task for any archaeologist. The nature of the skeletal material limits the researcher in certain lines of questioning, forcing them to make inferences from unassuming (and unusual) evidence. Even though the skeletal remains of children can give us a wealth of information about their health, their presence in the archaeological record marks them as the cohort with the poorest health. In this paper, we have shown that by using non-specific stress markers as a proxy for survived childhood stress, we can explore its correlation with later health and longevity outcomes. In other words, skeletal remains of adult individuals represent a valuable source of data on childhood in the past. Using adult skeletons, we can investigate questions of both the pathologic lesions formed in childhood as well as the potential societal responses that buffered or exacerbated the frailty and pathological load of certain individuals or groups of children.

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Link to the R Core Team code used in this paper: https://osf.io/3xqde/)

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Preživeti detinjstvo: odnos između zdravlja u detinjstvu i dužine životnog veka individua sahranjenih na ranobronzanodopskim nekropolama Mokrin i Ostojićevo (2100-1800 BC)

Arheološki tragovi dece i detinjstva su u istraživanjima dugo bili zanemareni, a svoje mesto u radovima našli su tek nakon Drugog talasa feminizma, kada su priključeni istraživanjima žena u prošlosti. Arheološki materijal koji se može dovesti u vezu sa decom nije uvek lako identifikovati – nisu svi minijaturni predmeti uvek igračke. Skeletni materijal dečijih individua pruža nam najdirektniji uvid u detinjstvo u prošlosti. Kroz analize možemo dobiti uvid u ishranu, zdravstveni status i aktivnosti dece u prošlosti. Ipak, skeletni ostaci dečijih individua zapravo predstavljaju jednu vrlo specifičnu grupu dece koja su u arheološki zapis dospela uglavnom zbog izuzetno lošeg zdravstvenog statusa. Da bi upotpunili sliku o zdravlju dece u prošlosti, istraživači stoga koriste različite markere stresa na skeletima odraslih osoba koji se formiraju tokom detinjstva. Na taj način se mogu donositi zaključci i o zdravlju dece koja su detinjstvo preživela.

U ovom radu analizirane su promene na zubnoj gleđi nastale u detinjstvu, kao signal preživljenog stresa, i starost u trenutku smrti na skeletnoj populaciji odraslih individua sa ranobronzanodopskih nekropola moriške kulture Mokrin i Ostojićevo. Postavljena je hipoteza da će osobe koje su u detinjstvu preživele epizodu stresa (tj. imale zabeležen defekat zubne gleđi) imati i kraći životni vek od onih osoba koje nisu bile izložene stresu u detinjstvu. Rezultati su

pokazali da postoje naznake negativnog uticaja epizoda stresa preživljenog u detinjstvu na dužinu životnog veka kod muškaraca i ograničenog negativnog uticaja na zdravstveni status čitave populacije Mokrina i Ostojićeva. Dakle, korišćenje skeleta odraslih individua može predstavljati validan izvor podataka o zdravstvenom statusu u detinjstvu, posebno kada se on upoređuje sa kasnijim zdravstvenim ishodima i dužinom životnog veka. Markeri nespecifičnog stresa preživljenog u detinjstvu mogu pomoći u dobijanju odgovora na pitanja obrazaca društvenog odgovora na oboljenje pojedinca ili grupe, koji bi mogli pozitivno ili negativno uticati na njihovo preživljavanje.

Ključne reči: markeri stresa, linearna hipoplazija zubne gleđi, bioarheologija detinjstva, zdravlje u praistoriji, moriška kultura, rano bronzano doba

Survivre à l'enfance: relation entre la santé dans l'enfance et l'espérance de vie des individus inhumés dans les nécropoles de l'âge du bronze ancien Mokrin et Ostojićevo (2100-1800 av. J.-C.)

L'étude des sociétés préhistoriques nécessite une approche holistique de tous les segments de la population. Les chercheurs s'accordent que la période de croissance et de développement est cruciale pour le cours ultérieur de la vie, pour sa qualité et sa durée. Au cours des dernières décennies on observe une augmentation significative du nombre d'études centrées sur les traces matérielles des enfants dans les enregistrements archéologiques, en particulier dans le domaine de bioarchéologie. Pourtant, ces approches ne sont pas sans limitations. Se concentrer exclusivement sur les squelettes d'enfants offre des perspectives précieuses, mais limite également l'analyse à ceux qui n'ont pas survécu à l'enfance. Par conséquent, il est nécessaire d'inclure aussi les squelettes des individus adultes pour obtenir une compréhension plus complète de la santé des enfants dans le passé. Dans cet article nous montrons que l'analyse des marqueurs de stress subi dans l'enfance sur les squelettes des individus adultes peut offrir une perspective sur de nombreux aspects de la vie des enfants dans le passé, en nous concentrant sur la série squelettique de l'âge du bronze ancien provenant des sites Mokrin et Ostojićevo.

Mots-clés: marqueurs de stress, hypoplasie linéaire de l'émail, bioarchéologie de l'enfance, santé en préhistoire, culture de Moriš, âge du bronze ancien

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