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BIOARCHAEOLOGICAL EVIDENCE FOR THE HEALTH STATUS OF A LATE BRONZE AND EARLY IRON AGES BARDZRYAL POPULATION (ARMENIA)

ABSTRACT: Osteological data from Late Bronze a nad Early Iron Ages skeletal series provide insight into health, disease, and stress levels in Bardzryal site (Armenia, Lori Region). The sample was recovered during excavations in 2009 and 2018. Fifty-five skeletons from burial ground Bardzryal were analyzed macroscopically and X-ray for pathological conditions such as traumatic injuries, trepanation, infectious disease, and dental pathology. This study has shown that average age at death was relatively high. Life expectancy at birth for the Bardzryal population is 36.3 years. Traumatic injuries appear to have been common (23.7 %). Six individuals show evidence of strenuous physical activity. Recent discoveries in Lori province have revealed that this area represents one of the most active centers of cultural transformation in the medical field. The Bardzryal individuals (2 cases) represent an important example of successful surgery in the Late Bronze and Early Iron Ages. Cases of benign neoplasm's observed in group (3 individuals) should be viewed as non-life-threatening disorders. Bardzryal site showed a high frequency of auditory exostosis (54.6%). Four men from this cemetery are of special interest owing to the presence of lesions associated with a chronic ear infection. Tuberculosis (33.3%), brain abscess (36.4%), chronic osteomyelitis (1 individual) also were present in the Bardzryal population. The dental pathology conditions of this population were numerous. Agriculture introduced people to carbohydrates, or sugars, which affect the teeth and cause dental caries (29.04%). The staple diet of ancient population from Lori Region (Shnogh River) consisted of wine, bread, vegetables, and fruits.

KEY WORDS: Armenia – Late Bronze and Early Iron Ages – Bardzryal – Trauma – Trepanation –Tumors – Metabolic disease – Infectious disease – Dental pathologies

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INTRODUCTION

The Armenian Highland was in early history a crossroads, linking the East and West. Overland trade routes existed between the Near East through the Armenian Highlands and the Caucasus and on to the Balkans, and through the Caucasus and the Balkans to the north Black Sea coast and back. Since the Early Bronze Age the ethnic history of the region developed under the interaction of various groups, among which the Indo-European tribes played an important role (Khudaverdyan 2011a). At the Late Bronze Age Armenian necropolises among the usual graves with human skeletons there were burials of horses and a chariot (Devejyan 2022, Kuftin 1941). According to the archaeological record (Kyshnareva 1990), the Bronze Age was a time of population growth. Trade networks expanded and social systems grew in complexity. Increasing migration and trade between state-level societies in Eurasia led to a higher incidence of infectious diseases (Khudaverdyan 2011).

Paleopathological research contributes directly to our understanding of cultural lifeways, biological history, and the interaction between culture and biology in prehistoric populations (Larsen 1997, Ortner 2003). Stress is a result of environment, cultural buffers, and host resistance. This stress may be inferred by the study of skeletal lesions or growth disruption of the skeleton (Goodman *et al.* 1980). Furthermore, increased levels of stress may act as an agent of cultural change (Goodman *et al.* 1984). Individual case studies can be instructive for understanding biological variability, but the population approach is critical for examining patterns of lifestyle, disease, behavior, and other aspects that impact the human condition (Larsen 1997: 3, Khudaverdyan 2009).

Paleodemography

Paleodemography, the study of past populations' vital characteristics, is an important aspect of bioarchaeological research (Acsádi, Nemeskéri 1970). Skewed sex ratios may reveal cultural patterns such as exogamy, warfare-related deaths, and political interventions into domestic life.

Bioarchaeological trauma studies

Evidence of traumatic injury to the skeleton is often cited as one of the most prevalent paleopathological lesions encountered in archaeological samples (Lovell 1997, 2008, Ortner 2003). These lesions have the potential to reveal much information regarding conditions of life in the past, including the types of risks that people may have been exposed to and the ways in which they interacted with their physical and social environments (Ortner 2003, Brickley, Smith 2006, Lovell 2008).

Trepanation

The prehistoric practice of trepanation, the surgical removal of part of the cranium, and has been recognized in many, if not most, primitive societies (Finger, Fernando 2001, Martin 2003, Khudaverdyan 2016, Khudaverdyan *et al.* 2018). Trepanation has been documented in prehistoric and historic settings around the world - from Neolithic Europe and the Melanesian Islands to the Near East and parts of Africa (Lisowski 1967, Campillo 1984, Weber, Wahl 2006).

Physiological stress

Physiological stress is pervasive in humans, and it has potentially devastating results for individuals and the populations of which they are members. Stress resulting from impoverished environmental circumstances is a central issue in the study of health and well-being of past populations. In teeth, growth disruption is indicated by various attributes, such as delayed development (Smith 1991), reduced size (Dempsey *et al.* 1996), elevated fluctuating asymmetry (Kieser 1990, Khudaverdyan 2014), and presence of enamel defects (Goodman, Rose 1991, Simpson 1999).

Fluctuating asymmetry is considered to reflect the magnitude of developmental disturbances or, as C. H. Waddington (1957) termed, developmental noise. The effects of developmental noise or environmental stresses on dental asymmetry have been established using animal experiments with stressors such as noise, cold, and heat (Bader 1965, Siegel, Smookler 1973, Siegel, Doyle 1975, Siegel *et al.* 1977). Human studies, however, have measured the effects of stress using ethnicity, age, and degree of modernization as proxies for stress. J. A. Kieser and H. T. Groenevald (1988) proposed that it was not only the 'nature and severity of stress' but the 'ability of the individual to buffer against stress,' which may be useful in explaining results where either nil or surprisingly significant associations between ethnicity and asymmetry (De Melo *et al.* 1975, Black 1980, Kieser *et al.* 1986, Kieser, Groenevald 1988, Khudaverdyan 2014a) have been found.

Hypoplasia is found at the stage of dental development between infancy and 7 years. Although this pattern may be related to the stresses of weaning, the discordance between observed age-of-stress and records available in

historic-era populations indicates that other factors can be involved (Blakey *et al.* 1994, Saunders, Keenleyside 1999). In particular, growth disruptions may result from malnutrition or from diseases that deplete the body of resources necessary for normal development (Goodman, Rose 1991, Hillson 1996).

Cribra orbitalia and porotic hyperostosis are largely representative of anemia that occurs during the early juvenile years (Stuart-Macadam 1985, 1992). The combination of and interaction between poor nutrition and infection is the most common cause of physiological stress and poor health (King, Ulijaszek 1999).

Infectious Diseases

The most common infectious diseases that can be traceable on bones are mastoiditis, osteomyelitis, and periostitis. Other infectious diseases that can affect the skeleton are those such as tuberculosis and leprosy. C. S. Larsen (1997) documented a synergy between infectious diseases and malnutrition.

The term ***osteomyelitis*** describes an infection of the bone and the bone marrow (Larsen 1997, Aufderheide, Rodriguez-Martin 1998). D. J. Ortner (2003) points out that other infectious agents, such as viruses, fungi, and multicelled parasites can also affect the bone marrow. The skeletal changes consist of bone destruction along with new bone formation (involucrum) and necrotic bone (sequestrum) (Aufderheide, Rodriguez-Martin 1998).

Tuberculosis is a chronic infectious disease caused by one of the microorganisms of the group Mycobacterium. Typical for tuberculosis is both bone formation and bone destruction (Roberts, Buikstra 2003). C.A. Roberts and J.E. Buikstra (2003) mention that the vertebrae, the ribs, and the sternum are most frequently affected by tuberculosis.

Brain abscesses account for approximately 8% of all intracranial space-occupying lesions; they are most frequent in men aged 30 to 50 years and are associated with a mortality rate of up to 53% (Brook 2017, Vargas Rodríguez *et al.* 2019).

Mastoiditis is a severe middle ear infection that is the result of otitis media (Flohr, Schultz 2009). Chronic or subacute mastoiditis possibly evolves into a long-lasting middle ear disease with chronic purulent drainage and hearing loss (Anderson, Adam 2009). Mastoiditis manifests in fever, suppuration, and painful swelling around the region of the mastoid process of the temporal bone (Abelló, Quer 1992: 63).

Periostitis is an inflammation of the periosteum and is caused by bacteria that enter the bone either due to a traumatic incident or due to infection (Larsen 1997, Ortner 2003). The surface of the bone may be irregular and appear elevated due to different degrees of thickness, nodulation, and pitting secondary to hypervascularity (Aufderheide, Rodriguez-Martin 1998).

Supernumerary teeth

An aberrant tooth can be found in sites outside of the oral cavity and can be a supernumerary, deciduous, or permanent tooth (Rajab, Hamdan 2002). The maxillary sinus and palate are the most frequently affected sites. In some cases there has been a history of facial trauma or osteomyelitis of the maxilla, causing displacement of one or more teeth into the nasal cavity (King, Lee 1987). Heredity may also play a role in the occurrence of this anomaly. A. S. Medeiros *et al.* (2000) found a prevalence of 0.48% intranasal teeth in children with complete cleft lip and palate. Other causes include as trauma, or cystic lesions leading to tooth displacement, genetic factors, persistent deciduous teeth, and supernumerary teeth (Gupta, Shah 2001). Complications of nasal teeth include rhinitis caseosa with septal perforation, aspergillosis, and oronasal fistula (El-Sayed 1995).

Neoplastic Disorders

A neoplasm (literally 'new growth') is defined as "a mass of localized tissue growth whose cellular proliferations is no longer subject to the effects of normal growth-regulating mechanisms" (Aufderheide, Rodriguez-Martin 1998: 371). Some neoplasms form a small mass of tissue that neither destroys cells nor migrates to other parts of the body. These are known as benign neoplasms. These slow-forming lesions are usually found on the outside table of bone, and very often affect the skull (Aufderheide, Rodriguez-Martin 1998: 375). Another form of neoplasm is external auditory exostoses. G. E. Kennedy (1986) has reported that auditory exostoses are most common between 30° and 45° north or south latitude. Other hypothesized causes of auditory exostoses include chronic infection or inflammation, genetics, and mastication stress (see Aufderheide, Rodriguez-Martin 1998: 255).

Activity Patterns

A number of key studies have demonstrated the importance of muscle scars called enthesiopathies located at specific muscle attachment sites for inferring activity and behavioral adaptation (Churchill, Morris 1998, Heathcote *et al.* 1996, Khudaverdyan 2018). Enthesiopathies represent the skeletal response to

muscle activity – the larger the scar, the more developed (and more highly used) the muscle or group of muscles represented. The upper trapezius (more medial fascicle: TOT) is essential in shoulder rotation and elevation as well as arm abduction (Hamill, Knutzen 1995). It helps support the scapula and clavicle when heavy weights are held by the hands, with arms down at the side (Heathcote *et al.* 2012). The oblique capitis superior muscle (m. obliquus capitis superior) (PR) is a small muscle in the upper back part of the neck. It is one of the suboccipital muscles and part of the suboccipital triangle. It works to extend and rotate the head and is also considered a postural muscle that helps to maintain neck and head posture (Bowden, Bowden 2005).

Taphonomic Processes

Many processes can alter the appearance of bone and related organic materials after death (Morlan 1984, Shipman 1981). Factors in the transport and dispersal of skeletal elements include animals, gravity, or water and fluvial processes (Marshall 1989). The properties of the bones influence their reaction to these processes. Animal-related processes include trampling, entrance fall, gnawing, and digestion. Physical factors include rockfall, water transport, sandblasting, weathering, burial, diagenetic movement, volcanic shockwave, acid attack by roots, cryoturbation, release and breakup by bottom fast ice, and mineralization by groundwater (Marshall 1989). All of these can act independently or in unison to produce alteration of bones.

MATERIALS AND METHODS

Many bioarcheological reports concerning the skeletal samples from the Lori region of the Republic of Armenia bemoan the poor state of preservation of the remains (Khudaverdyan, Hobosyan 2017, Khudaverdyan *et al.* 2021). The burials from Bardzryal are no exception (*Figure 1*). Preservation of the remains may have been poor, but that should not detract from their importance. While poor preservation is a factor that interferes with standard osteological analysis, one should not assume that obtaining quality data is impossible. The lack of complete remains can be challenging in terms of recording data, but the individuals at Bardzryal can yield specific data. An assessment of health and the adaptive success of the population requires a very careful examination of the fragmentary skeletal elements. As a result their state of preservation and condition assessments may be less accurate. Nevertheless, these assessments should provide a greater insight than no assessment.

Excavations at Lori region began in 2009 by S. Hobosyan and lasted until 2018 in progress. Archaeological excavations were done near the villages of Shnogh and Teghut, Lori District of the Republic of Armenia. Only burials dated to the Late Bronze Age and Early Iron Age are included in this analysis. The excavations of Bardzryal cemetery produced a minimum number (MNI) of 55 skeletons: 30 males and 10 females, 12 individuals is not defined sexual identity. Three children (1–6 years) and one adolescent were the only subadults present in the sample (Table 1). All analyzed individuals were buried in a flexed position, in graves in the shape of a stone coffin. All of the burials appear to have been primary interments, typical of the Late Bronze and Early Iron Ages (c. 15^{th}–14^{th}BC), and oriented in an east-west direction. The necropolis exhibits a range of mortuary practices as displayed through the form of burial (flexed and semi-flexed burials). Most of the skeletons were accompanied by large numbers of pottery vessels, bangles, and beads, semi-precious stones.

Diaphyseal length data from M. M. Maresh (1970) is used to estimate the age at death of subadults over the age of two months. In addition to long bone length, the maximum dimensions of the ilium and the basioccipital are recorded to enable age estimation (Buikstra, Ubelaker 1994: 45–46, Scheuer, Mac Laughlin-Black 1994, Scheuer, Black 2000). Dental eruption data from G. Gustafson and G. Koch (1974) is also utilized. The C. F. A. Moorees, E. A. Fanning and E. E. JR. Hunt (1963a, 1963b) noted for all teeth where the stage of crown or root completeness was visible: loose teeth or those which can easily be removed from the socket to allow observation. Epiphyseal fusion data (Connell, Rauxloh 2003, with reference to Scheuer, Black 2000) are consulted. The state of fusion in all observable epiphyses is visually quantified as fused, fusing or unfused as defined in J. E. Buikstra and E. Ubelaker (1994: 41). Adult ages are estimated from a combination of pubic symphysis degeneration (Brooks, Suchey 1990, Buikstra, Ubelaker 1994: 24–32), auricular surface degeneration (Lovejoy *et al.* 1985), sternal rib morphology (Iscan *et al.* 1984, Iscan *et al.* 1985) and dental attrition data (Brothwell 1981: 72). Sex is estimated for adult individuals only. The methods employed are based on a macroscopic assessment of selected features of the skull (including the mandible) and the pelvis.

All traumatic lesions are examined macroscopically and radiographically. Where possible, both anteroposterior

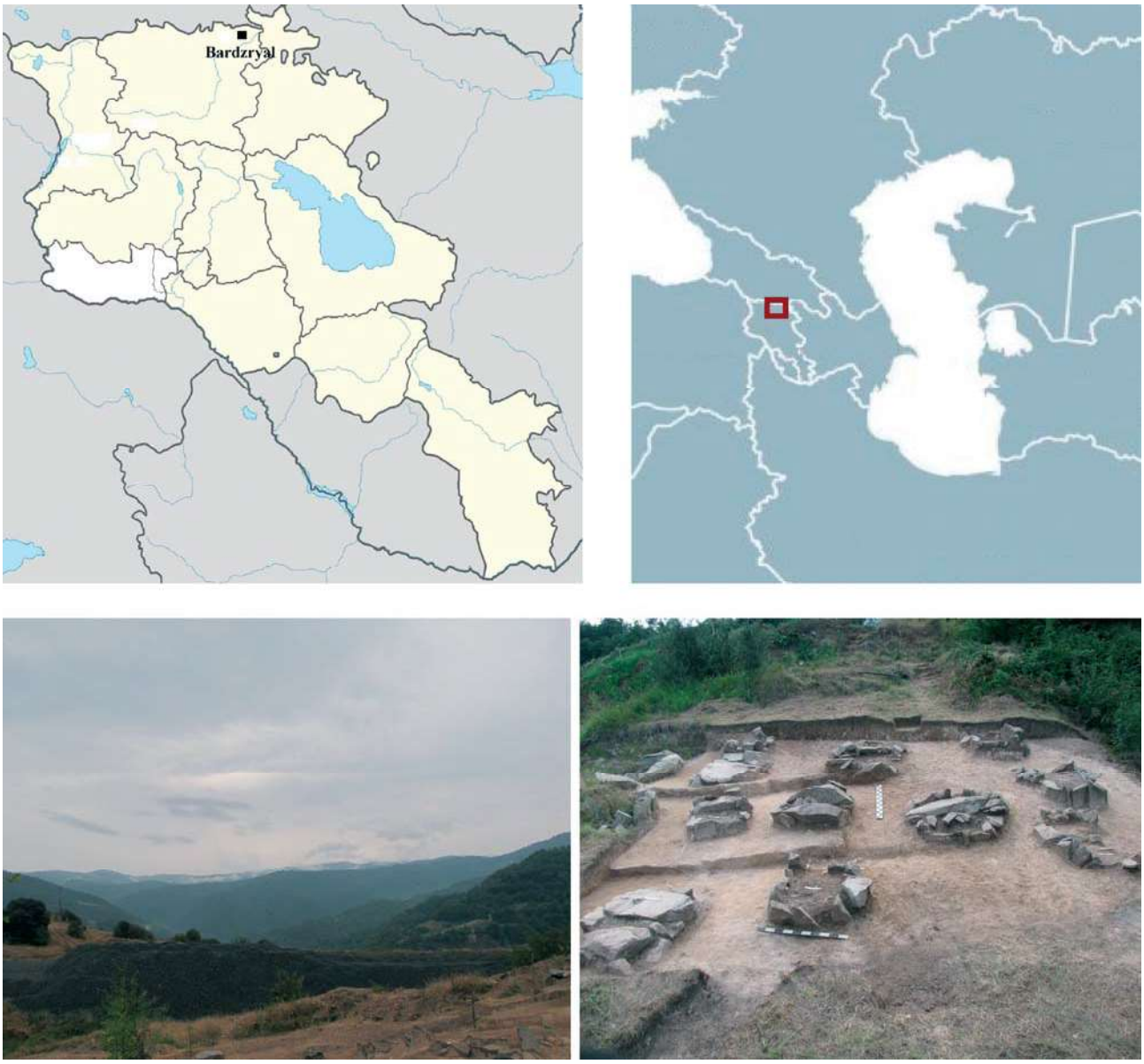

FIGURE 1: Armenia, location map of the Bardzryal cemetery (photo cemetery S. Hobosyan).

and mediolateral radiographs are taken. Recording follows J. E. Buikstra and E. Ubelaker (1994: 119–120). The location and distribution are recorded together in relation to any other pathological change identified on the skeleton. The neoplastic disease is classified as a primary or secondary bone tumor or secondary (non-metastatic) bony response to a primary soft tissue tumor (Anderson 2000: 204–205). Initial diagnostic investigations are carried out with the aid of D. J. Ortner (2003: 503–544) and D. Resnick (2002: 3745–4351).

Dental caries is recorded at individual tooth level noting the position and severity of the largest carious lesion visible (Buikstra, Ubelaker 1994: 55). Calculusis noted where mineralized plaque can be seen adhering to the tooth surface (Hillson 1996: 255). Calculus is recorded on an individual tooth. The severity is recorded as slight, medium, or considerable deposition following D. R. Brothwell (1981: 155). Diagnosis of hypoplastic defects refers to S. Hillson (1996: 167) for description of linear and pit-shaped interruption in the enamel

formation. Enamel hypoplasia is recorded on individual tooth levels. Periapical lesions are recorded at the parent tooth position according to the location of the largest sinus drainage (external, internal, or maxillary sinus). Periostitis is diagnosed where the bony changes overlie the original surface of the bone cortex, though in later stages this may appear as a generalized expansion of the shaft. There are no cloacae or other indications of infection in the medullary cavity (Ortner 2003: 209–210). For analysis of fluctuating asymmetry, buccolingual (BL) and mesiodistal (MD) crown diameters were taken of emerged upper and lower permanent teeth in 37 individuals comprised of 7 females, 27 males, and 3 of undeterminable sex. Any tooth pairs where the presence of caries, lesions, fractures, buildup of calculus, or heavy wear that would affect the dimensions were excluded. Only complete right and left pairs were considered for the study. The MD diameter of the tooth was defined as the maximum width of the tooth crown in the mesiodistal plane (Sciulli 1979). The BL diameter of a tooth was taken as the widest diameter of the tooth measured perpendicular to the mesiodistal plane (Sciulli 1979).

Osteomyelitis is diagnosed by the presence of gross expansion or destruction of the skeletal element. Tuberculosis is diagnosed macroscopically according to the morphology of the lesions and their distribution throughout the skeleton, using the diagnostic criteria presented by A.C. Aufderheide, C. Rodríguez-Martín (1998), D. J. Ortner (2003) and D. Resnick (2002).

Bones were radiographed at "Armenia" Republican Medical Center.

RESULTS

Basic paleodemographic data

Using the basic variables of age and sex, paleodemographic studies produce essential data on age-specific mortality, life expectancy, and age-specific probability of death, among other statistics; these statistics can help distinguish a relatively healthy population from one undergoing stress and premature death (Buikstra, Mielke 1985, Drusini et al. 2001). The material consists of 55 individual human skeletons. *Table 1* shows a breakdown according to age and sex of the burials from excavations. Four of the 55 individuals (all of which were adults) whose exact age could not be determined. There is an apparent underrepresentation of infants in the site's remains, one which might feasibly create an inaccurate picture of life expectancy for this age segment of the population. There are more male than female (30: 10) individuals. This difference in sex is statistically significant ($p < 0.01$) when tested by the chi-square statistic. The unbalanced sex ratios at a site may be the result of factors that have nothing to do with differential treatment of the sexes after death. Poor skeletal preservation, especially at Bardzryal, may have skewed paleodemographic assessments. One vexing paleo demographic problem that is found in the entire Bardzryal sample is the paucity of subadults (birth to 20 years of age). Three children (1–6 years) and one adolescent were the only subadults present in the sample (*Table 1*).

It is hypothesized that the underrepresentation of infants and children is due to a variety of factors including preservation issues and differential placement of infant burials elsewhere. The deliberate separation of infants and young children from the group seems somewhat common in other provinces of Armenia (Khudaverdyan 2009). This dearth of young individuals is mirrored at other sites in the region (see Khudaverdyan 2012, Khudaverdyan, Hobosyan 2017,

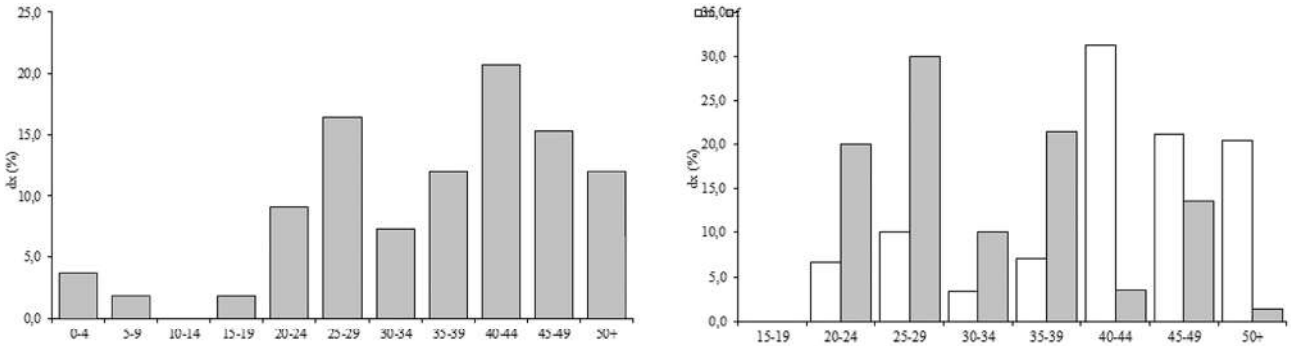

FIGURE 2: Mortality rates by sex and age in Bardzryal population (left graph). Panel a shows the distribution of female (gray columns) and male (white columns) individuals (right graph).

TABLE 1: Age and sex distribution for 55 individuals from 2008–2018 excavations at Bardzryal cemetery, Armenia.

AGE GROUP	MALE	FEMALE	SEX?	TOTAL (SEXES COMBINED)
Infant (0–1)			1	1
Child Early (2–6)			2	2
Child Late (7–11)			–	–
Adolescent (12–16)			1	1
Young Adult (17–31)	6	6	6	18
Middle-Aged Adult (32–46)	14	2	3	19
Old Adult (47–56)	9	1		10
Subtotal	**29**	**9**	**13**	**51**
Adult (exact age unknown)	1	1	2	4
Total	**30**	**10**	**15**	**55**

Khudaverdyan et al. 2021). Only 18.2% of the individuals in group were assessed as old adults. Life expectancy at birth (e_{ox}) for the Bardzryal population is 36.3 years. Estimated life expectancies are high for both males (42.1 years) and females (32.7 years). These mortality rates should be viewed cautiously.

Trauma

Archaeologists document violence (especially warfare) by various lines of evidence, including fortifications, defensible site locations, settlement pattern, weaponry, and iconographic and symbolic representations that depict people, places, and activities relating to conflict (Redmond 1994, Steponaitis 1991). Skeletal evidence for trauma provides a direct source of evidence regarding injury in the past and can be extremely valuable in giving an indication of the types of perimortem injuries experienced by individuals and the weapons they used, especially when evaluated in combination with other sources of evidence such as documented historical accounts. The prevalence of skull lesions in the Bardzryal sample is highest, where it is found only in males (23.7 %). In 7 cases the injuries displayed manifestations of healing, and no such manifestations in one case. Peri-mortem injuries were observed in 2 individuals: on the frontal bone (Burial 1), and on the mandible, just above the mental eminence (Burial 22). These males died shortly after being injured, from general sepsis, caused by an active necrosis stimulated by the infection of the cranial cavity. Two individuals that died at the fourth decade of life (Burials 12 and 57) displayed various lesions in the right supraorbital area, caused by a weapon with a sharp, probably cutting, edge. In 5 cases (Burials 12, 34, 57, 60, 67) blunt-force traumas on the vault were observed. Two of these skulls (Burials 34 and 67) exhibit healed injuries on the frontal bone, either in the center of the bone or with a deviation to the left. These traumas were caused by an attacker standing face-to-face with his victim. Traumatic lesions on the left parietal were found in 2 individuals (Burials 57 and 60), and on the right parietal in one individual (Burial 12). The latter also displayed signs of trauma in the occipital region. These injuries were caused from behind by right-handers.

Trepanation

Trepanation has garnered intense interest, because it represents an early form of cranial surgery practiced well before the advent of modern medicine. Patients often survived the initial surgery and several subsequent surgeries (despite a lack of anesthesia and antibiotics), as shown by individuals with multiple, well-healed trepanations (in particular, Burial 97).

A quadrangular trepanation was defined on the cranium of a 20–29-year-old individual from the Bardzryal necropolis (Burial 9). The part of a right parietal bone was removed, using a metal saw (or perhaps, some kind of a chisel) and a hammer (*Figure 3*). That was a deliberate and antemortem operation on the young person with the aim of removing part of the flat bones of the skull as a treatment of a serious craniocerebral injury. The square bone fragment was removed from the skull and had the following measurements: 12 mm × 10 mm × 12.8 mm × 5.5 mm at the external part and 13 mm × 8.5 mm × 14 mm × 6 mm at the internal part. The surface of the border is

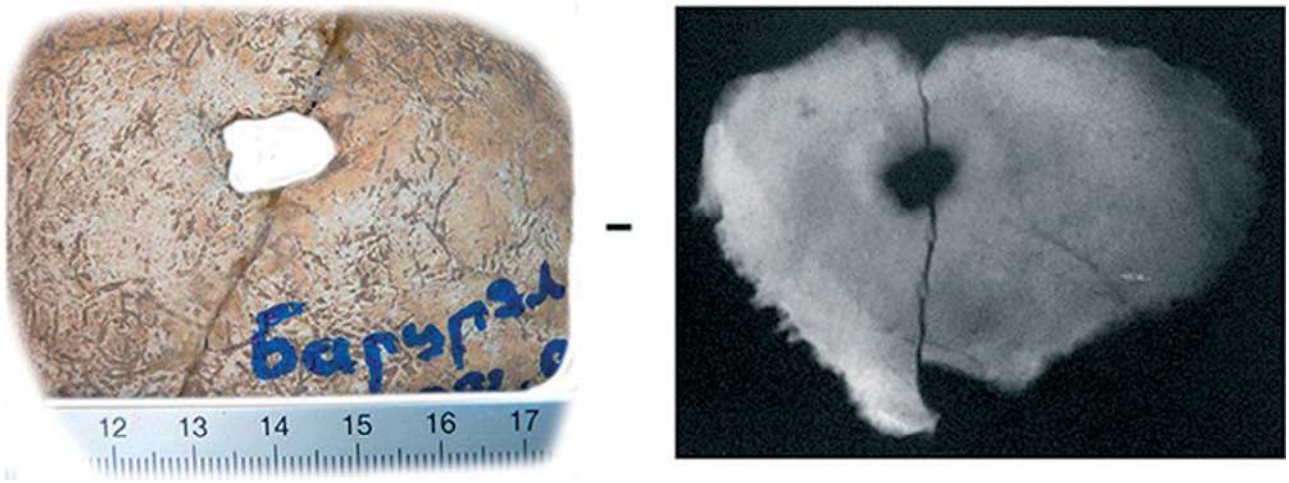

FIGURE 3: Trepanation with sawing: a skull of a 20–29-year-old individual from Bardzryal, Burial no.9 (left picture). X-ray of the same skull (right picture; Khudaverdyan 2016).

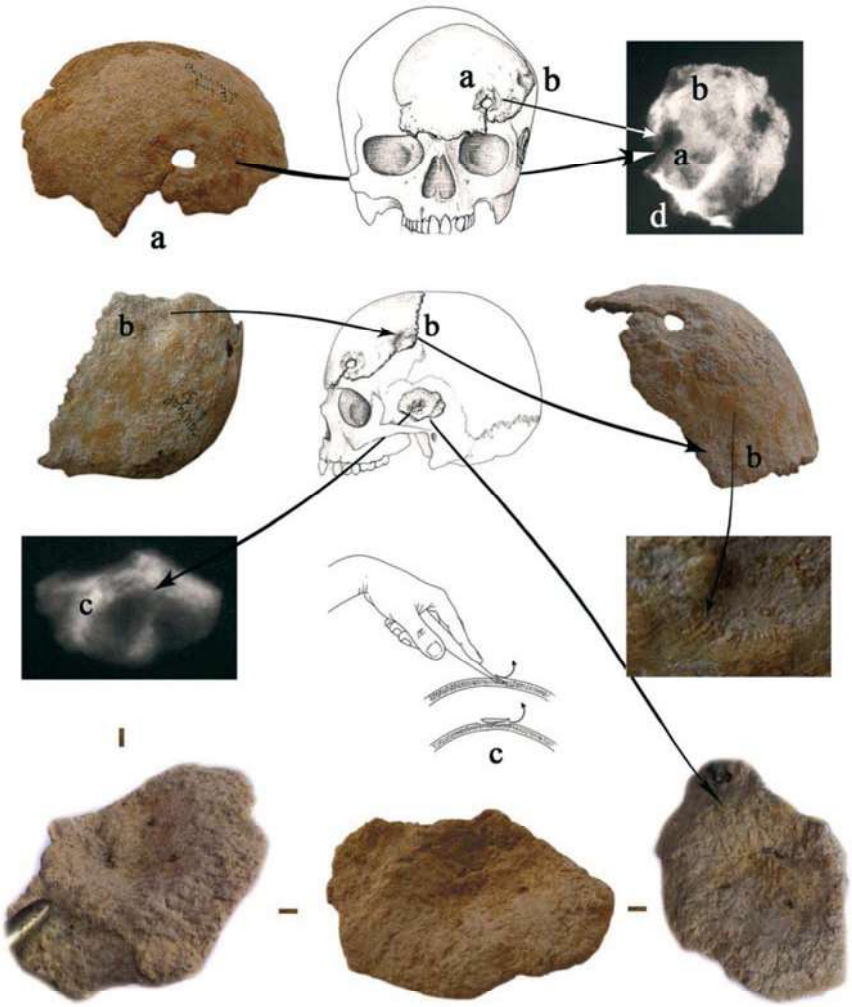

FIGURE 4: Frontal (a) and temporal (b) bones of a young female with healed trepanations (individual from Bardzryal, Burial 97), and schema of how the operation is to be carried out (c). (Khudaverdyan *et al.* 2018).

irregular, and rough and contains small pits of an osteitic nature, while the diploe has been completely obliterated by later deposition of bone as a result of healing. It was probably a surgical clearing for the removal of splinters of bone from an injury to the head caused by fight, hunting, or agricultural activity.

A rare and impressive case of multiple trepanations of the skull from Burial 97 was spotted (*Figure 4*). The age at death of this individual is between 20 and 24 years old. Sex was determined as female based on cranial morphology. Trepanation is located on the left part of the frontal bone and measures 35 × 27 mm. Its contour is not quite regular. There is a slight circular depression surrounding the defect (area 60 mm long and 45 mm wide), which may represent the extent of the original lesion. The depression is surrounded by a distinct, slightly raised margin, and the size and form of the lesion suggest that the trepanation was carried out by scraping. On visual examination, marked features consist of the oblique orientation of the hole walls, the defect edges remodeled into one compact bone layer, and the resulting loss of visible diploë structures. The edges of the trepanation hole, similar as the mentioned cut surface, exhibit clear traces of healing. Considerable osseous regeneration is also testified by the fusion of the outer and inner bone layers at the defect margins and the disappearance of the diploë structure. There is also a probability that the trephined area underwent a posttraumatic infection as some porosity possibly related to inflammatory vascularisation is clearly visible in the outer surface. A 19 × 17 mm oval depression is observed on the left part of the frontal bone near the sagittal suture (*Figure 4b*).

The surface of the depression is uneven. The presence of cut marks is generally evidenced by the occurrence of short, fine marks or scraping marks over the surface of the bone. The left temporal bone presents an osseous, ellipsoidal, infundibular defect, with a striated surface ending in a deep vortex adjacent to an exostotic formation. The size of the lesion is a transverse diameter 21.5(?) mm and anterior-posterior diameter 31(?) mm, the surface is 3-3.5 mm deep. The center of the depression is rough. The smoothed, albeit slightly uneven, edges with beveling indicate the regrowth of bone, as apparent from examination of both the peripheral part of the depression and that close to the center, characterized by reactive new bone formation and substantial bone remodeling. The radiography reveals a zone of progressive attenuation and the hyperostotic ring, which would indicate the individual's prolonged postoperative survival. The external surface of the skull shows flat, porous, and also thick new bone formations in several areas. In addition, both the external and the internal surfaces of the coronoid processes of the mandible display flat porous lesions that extend posteriorly into the mandibular notch and then to the base of the mandibular foramen.

The cranium showed an abnormal thickening of the left frontal bone (*Figures 5b-e*) where the inner cranial plate bulged into the cranial vault, expanding the diploë space, whereas the outer plate remained unaffected. X-ray showed a thickening of the inner table of the frontal bone (*Figure 5d*). There is also a small, 16 × 8 mm in diameter, oval, bone nodule at the occipital bone, by the middle of the lambdoidal suture. The internal surface of the skull as well as the vault showed multiple lytic lesions destroying the internal table (*Figure 5f*).

There are also severe erosive bilateral lesions on fragments to the scapulae, clavicles, humeral, radius, and ulnae, with lytic destructions. In a plain radiograph of the occipital bone, we identified a round homogenous mass with a smooth border. A second smaller circular bone mass is placed close to the first bone nodule (*Figure 4g*). X ray films revealed a uniform shadow of a small mass with a smooth border on the occipital bone. Our macroscopic and radiographic investigations revealed a fracture of the frontal bone on the right side (*Figure 4h*). Plain radiology (*Figure 4h*) revealed the lack of both substantial fracture healing and bone callus formation.

The skeletal changes evident in this individual are suggestive of a chronic infectious disease. There are severe erosive lesions on fragments to the scapulae, clavicles, humeral, radius, and ulnae, with lytic destructions. It is uncertain whether the changes observed in the skull are directly related to the infectious changes in the postcranial skeleton, though this seems highly likely. A possible alternative explanation is that they represent secondary changes (possibly even secondary infection?) brought about by the weakened state of the individual.

Possible differential diagnoses for the female from Bardzryal include Paget's disease and acromegaly, but in both cases, the endocranium and ectocranium are affected by hypertrophic changes (Perou 1964). Paget's disease is characterized by a partial or complete loss of the diploë (Hershkovitz *et al.* 1999), the changes associated with acromegaly include enlargement of the frontal sinuses and mandible (Hershkovitz *et al.* 1999): thus, both diseases were excluded. Also, chronic Rasmussen encephalitis (chronic, progressive inflammation of the brain of uncertain etiology) and

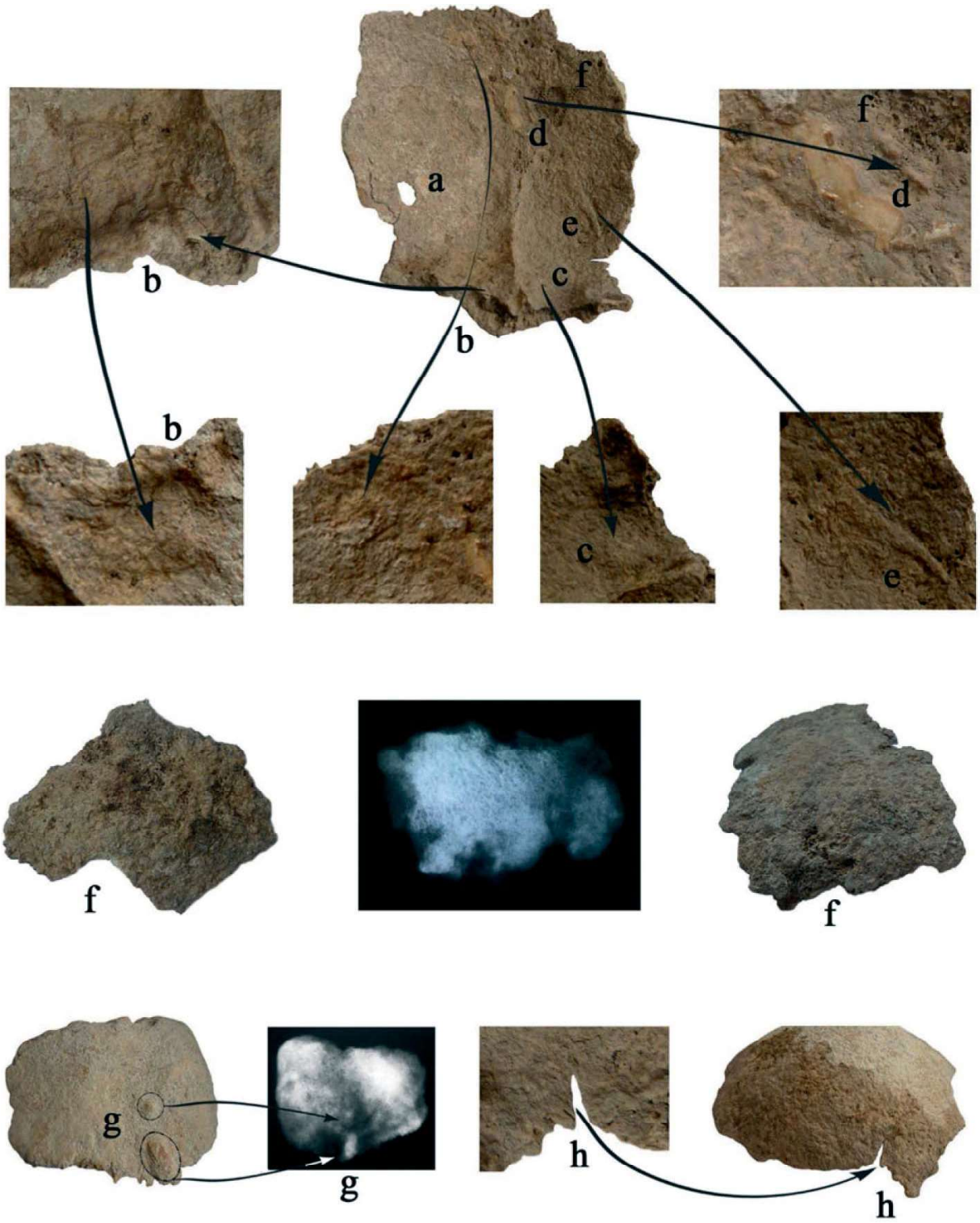

FIGURE 5: Dyke–Davidoff–Masson syndrome (characterized by isolated, elevated bony island), porotic hyperostosis, osteomas (individual from Bardzryal, Burial 97). A – frontal bone with trepanations, b, c, e – elevated bony island, f – porotic hyperostosis, g – osteomas, h – postmortem fracture of the skull (Khudaverdyan *et al.* 2018).

Sturge-Weber syndrome were excluded. However, Rasmussen encephalitis does not show calvarial changes, and Sturge-Weber syndrome additionally shows enhancing pial angiomas and cortical calcifications (Narain *et al.* 2008, Sharma *et al.* 2006). Possible differential diagnoses for the female from Bardzryal also include hyperostosis frontalis interna and Dyke-Davidoff-Masson syndrome. Hyperostosis frontalis interna is an idiopathic pathological condition characterized by bilateral thickening and accretion of bone on the inner table of the frontal bone (She, Szakacs 2004). The macroscopic appearance of hyperostosis frontalis interna may vary from discrete nodules to more continuous bony overgrowth (Hershkovitz *et al.* 1999). It is considered as an independent condition, distinct from hyperostosis cranialis interna, hyperostosis cranialis diffusa and other conditions, such as Paget's disease and acromegaly, which can cause cranial thickening (Hershkovitz *et al.* 1999, She, Szakacs 2004). Further conditions, such as neuropsychiatric disorders and persistent headaches, which can be related to hyperostosis frontalis interna, were added (Morel 1929, Moore 1955). The co-occurrence of these symptoms and pathological conditions led to the name Morgagni-Stewart-Morel-Moore syndrome (Antón 1997).

The Dyke-Davidoff-Masson syndrome was first described in 1933 (Dyke *et al.* 1933). V. Slon *et al.* (2012) reported a case of a historical patient that is a 6,000 year old skeleton of an adult male with Dyke-Davidoff-Masson syndrome. Classically, patients present a varying extent of facial asymmetry or paresis, sensory disturbances, hemiatrophy of body, focal or generalized uncontrolled seizures, contralateral hemiplegia, mental retardation, impaired cognition, learning and speech impairment, and psychiatric problems (Behera *et al.* 2012, Shrestha 2013, Tasdemir *et al.* 2002). The syndrome may be either congenital or acquired (e.g., following trauma, infection, or a vascular disorder; Atalar *et al.* 2007). The clinical features of Dyke-Davidoff-Masson syndrome in the skull include calvarial thickening, due to hypertrophy of the inner table of the frontal bone; enlargement of the paranasal sinuses and mastoid air cells; hypoplasia of the frontal and/or middle cranial fossa; loss of convolutional markings in the inner table; and elevation of the petrous ridge and of the greater wing of the sphenoid (Slon *et al.* 2012, Stoevesandt *et al.* 2009, Ünal *et al.* 2004). These changes are thought to be the result of compensation for the unilateral loss of cerebral volume (Aguiar *et al.* 1998). The age of onset of symptoms largely depends on the time of the brain injury, and specific changes may not appear until after the first decade of life (Atalar *et al.* 2007, Shrestha 2013). This syndrome is more common among males and affects the left hemisphere in 73.5-73.7% of patients (Atalar *et al.* 2007, Ünal *et al.* 2004). In the case of Bardzryal, morphological characteristics suggest of Dyke-Davidoff-Masson syndrome (*Figure 5*). We believe that trepanation was used specifically to treat the syndrome.

Individuals with teeth in the nasal cavity

The skeleton in Burial N 104-2 was fragmented and incomplete. Fractures and cracks that led to fragmentation were produced post-mortem. The bone inventory of the analyzed skeleton can be seen in *Figure 6*.

Analysis suggests that this is a young male, based on morphological characteristics of the skull and pelvis, approximately 20 to 29 years old based on dental wear, stage of fusion of the cranial sutures, and auricular surface morphology scoring system. It was possible to observe the crown of the maxillary central incisor inside the right nostril. The presence of supernumerary or ectopic teeth is not an uncommon fact; however, the presence of teeth in the nasal cavity is a rare phenomenon, regardless of etiology (Hfd *et al.* 2009). Multiple supernumerary teeth are defined as the existence of any excessive number of teeth in relation to the normal dental formula (i.e., 20 in deciduous dentition and 32 in permanent dentition). It is common to primary as well as permanent dentition and can occur in the maxilla or mandible. A.H. Brook (1974) reported that supernumerary teeth were present in 0.8% of primary dentitions and 2.1% of permanent dentitions. Tooth eruption in the nose may cause recurrent or chronic sinusitis, nasal or cheek pain, speech problems, nasal obstruction, recurrent epistaxis, headache, nasal discharge, localized ulceration, foul smell, external deviation of the nose, or nasal septal abscess (Medeiros *et al.* 2000). It was an incisor like a tooth with 15 mm (±2) length and was white colored (*Figure 6*). The extra tooth had an amorphous view, in the form of a cone and completed its crown-root development (*Figure 6*).

The X-ray revealed that another tooth was next to the first (*Figure 7*). It was an incisor-like tooth with 7 mm (± 2) length. The teeth lay cross in the jaw. One crown was located on the floor of the nasal cavity (meatus nasi inferior), and the other was inside (*Figure 7*). Because of supernumerary teeth, lateral displacements of the alveolar (tooth) socket of the medial incisors are observed (*Figure 7*). His intraoral dentition was normal (*Figure 7*). He had a fully erupted dentition. No maxillofacial trauma was elicited.

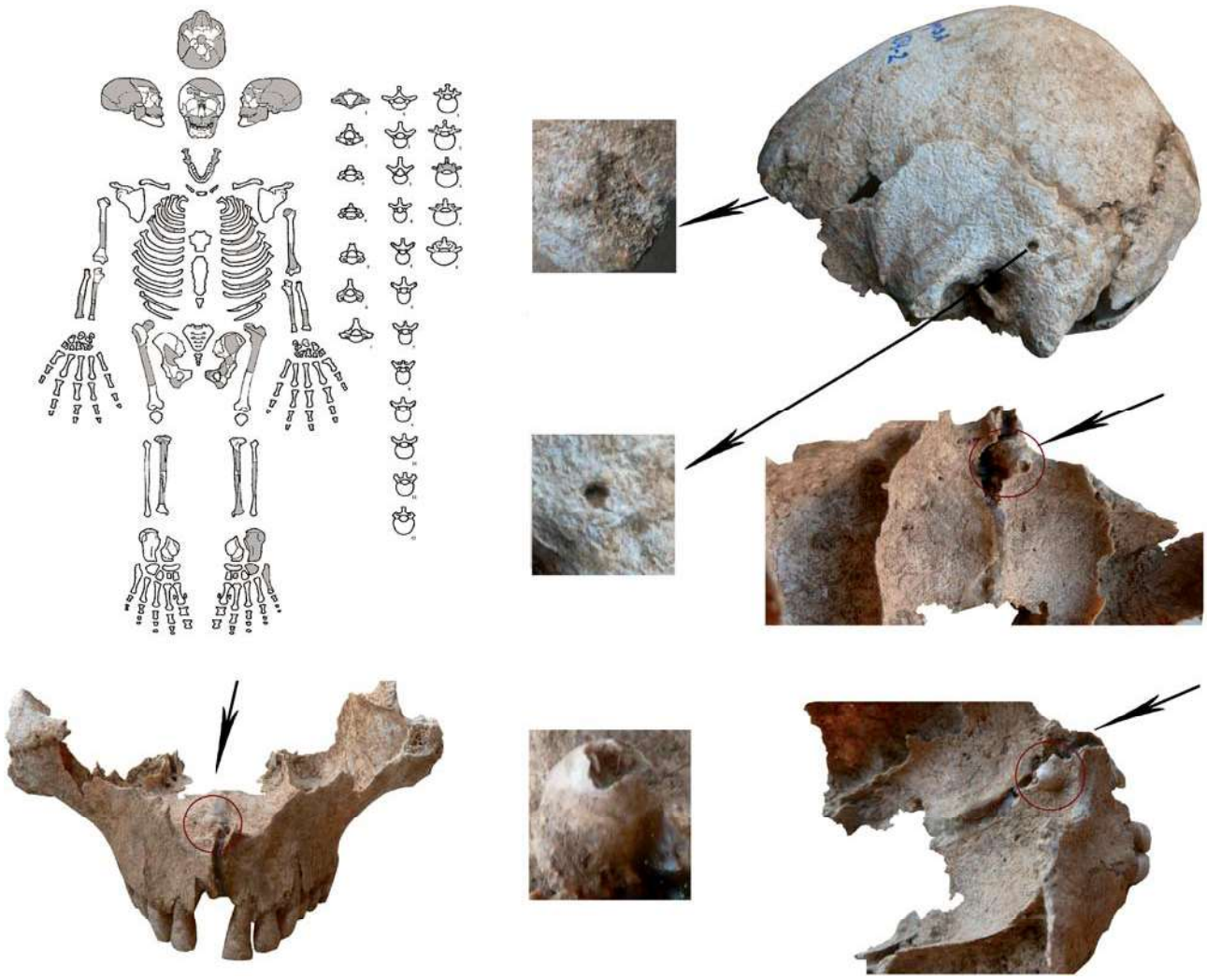

FIGURE 6: Available skeletal elements from Burial 104-2 of the Bardzryal cemetery, location of the nasal tooth in the maxilla, foci of inflammation on the skull.

On the surface of the skull, there were foci of inflammation. The right temporal bone presented a rounded hole with a maximum diameter of 4 mm, located superior to the mastoid process (*Figure 6*). The edges of this perforation were smooth and rounded, whilst the interior wall of the perforation presented a slight osteoblastic response and pitting. In the middle ear, however, there is bone destruction involving most of the retrotympanum. The hole could be an abscess caused by the infection. We found a midline cleft palate and dental calculus. Dental calculus was observed on both the anterior dentition and the posterior dentition.

Neoplastic Disorders

Six individuals from Bardzryal (54.6%, n=11) showed external ear manifestations of bony growths. Morphological and paleopathological assessment implicating differential diagnosis of these bony growths identified them as external ear exostoses. The lesions are spheroid or oval in shape, differentiate in size, and typically affect only adolescents and adults (Velasco-Vazquez *et al.* 2000). The exact etiology of the disorder is unknown (DiBartolomeo 1979, Kennedy 1986, Manzi *et al.* 1991). However, it has been linked to repeated exposure to cold water (DiBartolomeo 1979,

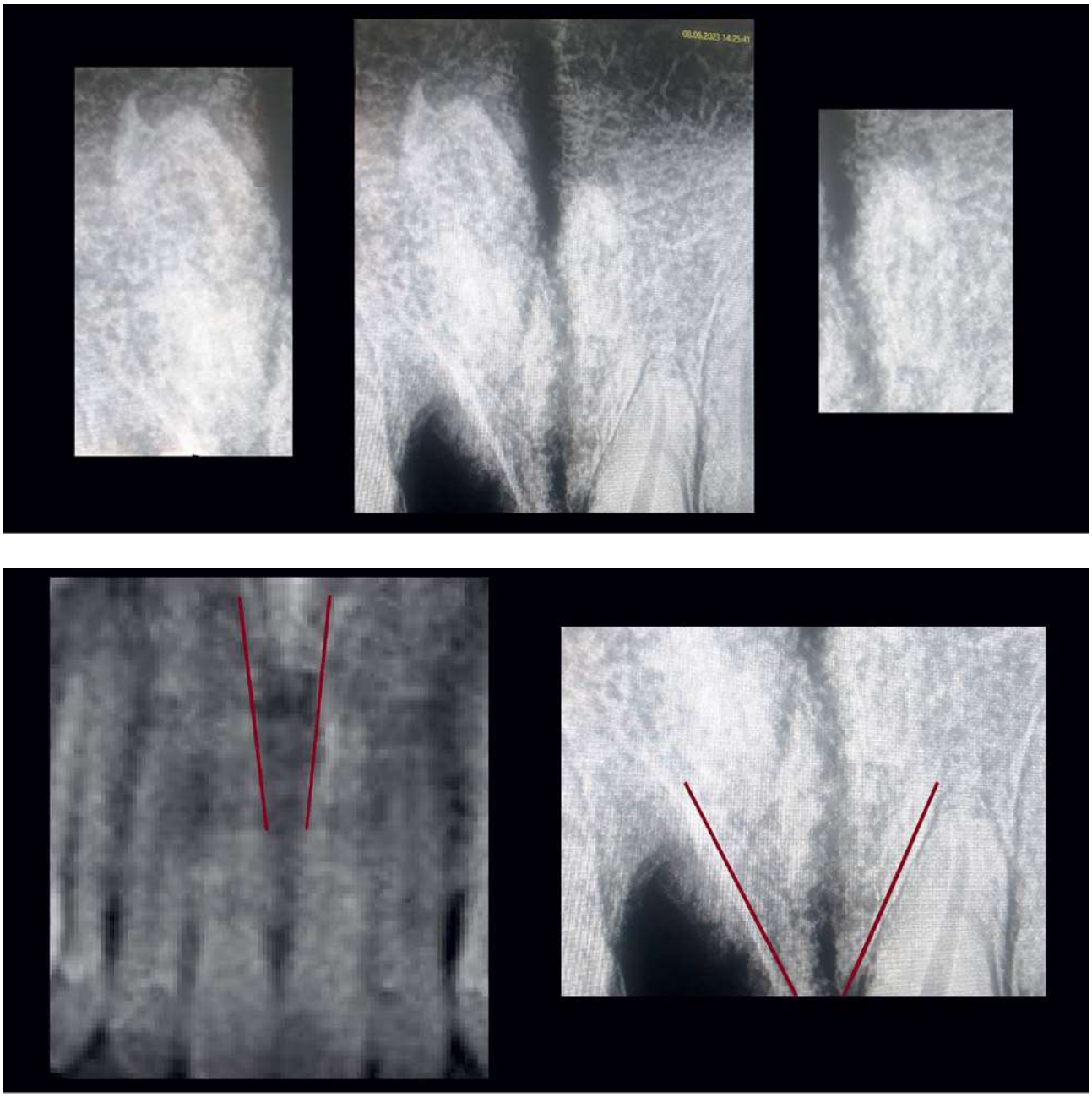

FIGURE 7: Radiographic investigations, lateral displacements of the alveolar (tooth) socket of the medial incisors are observed, normal alveolar (tooth) socket of the medial incisors.

Kennedy 1986, Manzi *et al.* 1991, Velasco-Vazquez *et al.* 2000).

Benign neoplasms include osteomas, a small bony growth that peaks in frequency during the fourth and fifth decades of life. They often appear as a small bump or "button" on the outer surface of a bone. Three individuals have osteomas present. In *Figure 8b*, an exuberant lesion on the right humerus of the individual from Burial 104-2 corresponding to a benign tumor (diameter 12.8 × 10mm) can be seen.

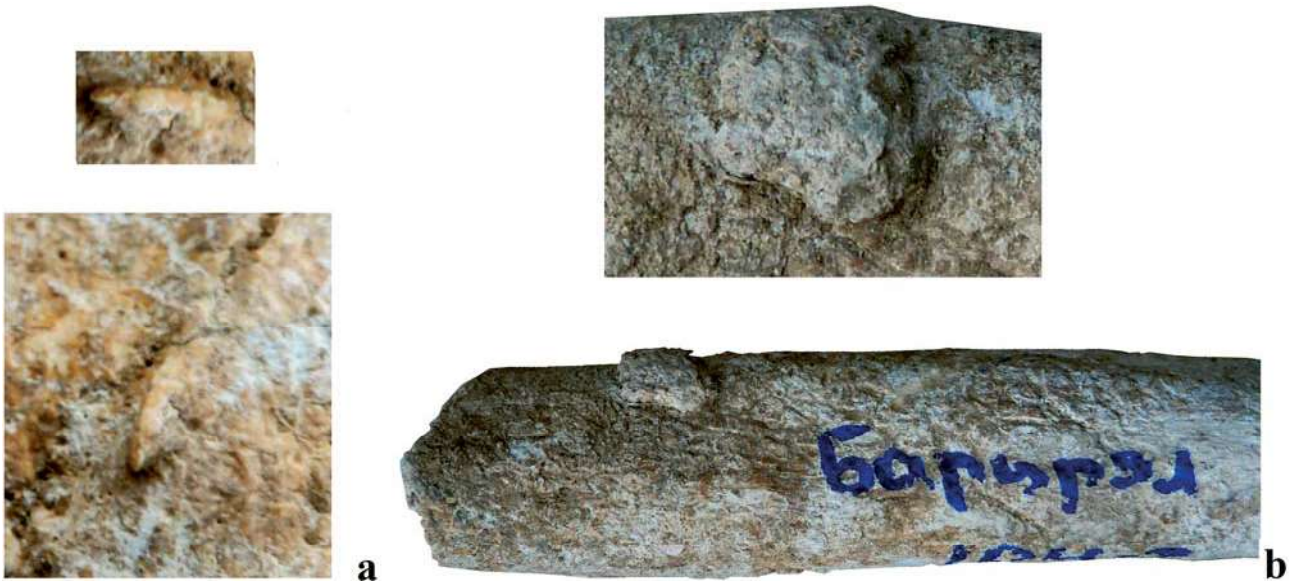

FIGURE 8: Exostosis on the left temporal bone (a), button osteoma on the right humerus (b).

The lesions, which occur on the vault of the skull of the man from Burial 104-2 (*Figure 8a*) are generally smaller, usually about four millimeters in diameter, and are smooth and not regular in outline. Burial 13, a middle adult male, possessed a small, neoplastic lesion upon her occipital bone. The lesion was 6 × 4mm in size. Burial 97, a young adult female, possessed a large, generalized nonspecific neoplastic lesion upon her occipital bone (in the region of the lambdoid suture. The lesion was 16.6 × 8mm in size and irregular in shape.

Activity Patterns

The ectocranial superstructure is a generalized term which refers to crests, tubercles, processes, and tuberosities of the cranium. Along with the more spatially specific term of occipital superstructures, it was first used to describe morphological features used in the phylogenetic analysis of early hominids (Capasso *et al.* 1999, Heathcote *et al.* 1996, Weidenreich 1940). These structures are associated with specific muscle insertions rather than with the general morphological features of the cranium (*Figure 9*). We will consider two

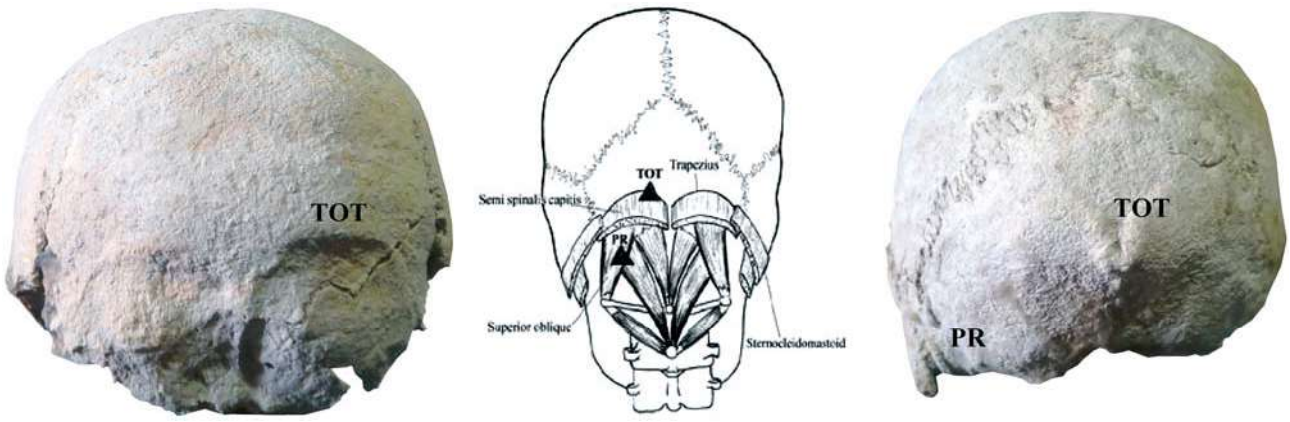

FIGURE 9: Schematic view of posterior cranium and upper cervical vertebral region, showing locations of the retromastoid process (PR) and tubercle on the occipital torus (TOT), with associated and proximal muscles (Bardzryal: Burials 76 and 99).

of the superstructures that occur directly on the occipital. Structures located at the origin of the upper trapezius muscles are referred to as tubercles on the occipital torus (TOT) and those located where the superior oblique muscles insert (below the inferior nuchal line and lateral to the rectus capitis muscles) are known as retromastoid processes (PR). Our bioarchaeological studies indicate that the people of Bardzryal led active lives. On 3 of men the tubercle on the occipital is poorly developed (score=1), on 6 it is developed moderately (score=2) (*Figure 9*). The retromastoid processes is poorly developed (score=1) in skull bones of 2 men.

Porotic Hyperostosis and Cribra Orbitalia

Almost 73% of the individual in the Bardzryal sample displays porotic hyperostosis in the form of both active (on the sub-adults) and healed porosity along the sagittal, lambdoidal sutures and in the external auditory canal. This porosity ranges from slight to severe, with the most severe expressions on the parietal bones and external auditory canal. Males are more affected (54.6%) than females (9.1%). Many individuals (57.15%) also display cribra orbitalia in the form of porosity on the superior wall of the eye orbit. These pores range from slight to severe. Interestingly, most of the cases of cribra orbitalia are displayed in the males.

Infectious Diseases

Eleven individuals (two are children, nine are males) in Bardzryal group were observed to have foci of inflammation on the frontal and parietal bones. Not high frequencies of mastoiditis have been found among individuals from Bardzryal site (36.4%, 4/11: 4 male) (*Figure 10*). The destruction of the mastoid wall and mastoid cells suggests that most cases of mastoiditis were probably acute. Acute mastoiditis may develop into necrosis and demineralization of the normal mastoid air cells, osteitis of the mastoid bone, and general damage of the mastoid air cells (Anderson, Adam 2009). S. Berman (1995) lists the complications of mastoiditis that can result in death, including sepsis, meningitis, brain abscess, subdural emphysema, lateral sinus vein thrombosis, and disabilities of the central nervous system, such as spasticity, paralysis, mental retardation, cortical blindness, seizures, labyrinthitis, and facial nerve paralysis.

A brain abscess is a focal infection of the central nervous system frequently characterized by areas of localized cerebritis and central necrosis surrounded by a well-vascularised capsule (Cantiera *et al.* 2019, Sonneville *et al.* 2017). Three males (Burials 1, 57, 99) and one woman (Burial 98: *Figure 11*) show evidence of a brain abscess. Although a large percentage of brain abscesses are polymicrobial, the most frequently isolated pathogens are *Staphylococcus aureus* and *Streptococcus viridans* (Brouwer *et al.* 2014, Wu *et al.* 2019).

A typical manifestation of osteomyelitis is the formation of cloacae (drainage canals) that may be present in many cases. If the blood flow in the affected bone is restricted, the entire diaphyses may become necrotic (Aufderheide, Rodriguez-Martin 1998). Chronic osteomyelitis is of the left tibial in a 30 to 40-year-old male (*Figure 12*). The disease is either caused by the pusproducing microorganism *Staphylococcus aureus* (occurs in 80–90% of cases in modern populations) or by the bacterium *Streptococcus* (Larsen 1997, Ortner 2003).

Two individuals (40%) in Bardzryal group were observed to have periosteal lesions. The commonly affected bone is the tibia. In periostitis, the formation of woven bone is usually activated which causes the incorporation of the latter into the underlying cortex and the remodeling into lamellar bone (Ortner 2003). In most cases, the lesions appear to be healed and not active at the time of death, as they are characterized by thickened areas with slight porosity, longitudinal striations, and smooth edges.

The skeletal material from Bardzryal presents only 2 cases of tuberculosis (33.3%). There is a direct human-

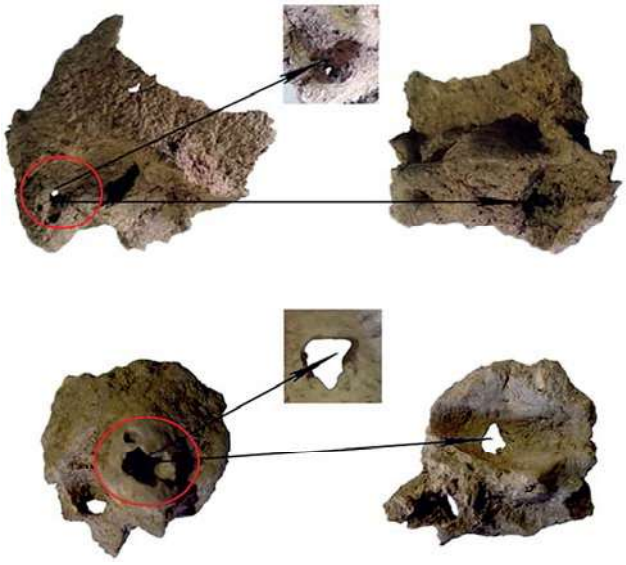

FIGURE 10: Mastoiditis (Burials 96, 67).

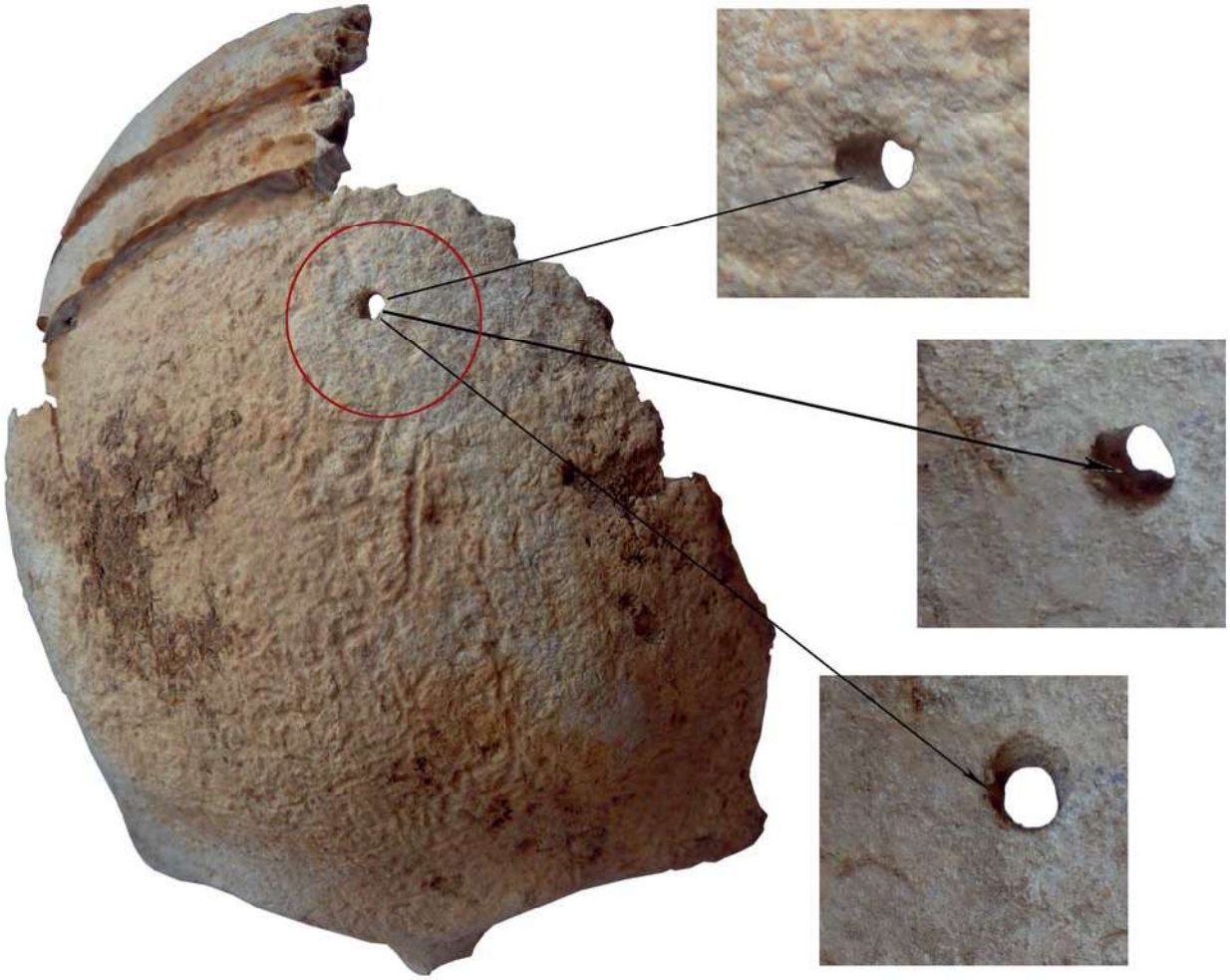

FIGURE 11: Evidence of a brain abscess in a young female (Burial 98).

FIGURE 12: Osteomyelitis of the left tibia (Burial 96-2).

human transmission caused by *Mycobacterium tuberculosis*, and there is transmission to humans from the consumption of bovine products caused by *Mycobacterium bovis*, and the latter transmission occurs relatively rarely (Aufderheide, Rodriguez-Martin 1998, Roberts, Buikstra 2003, Ortner 2003). The predilection sites of osseous tuberculosis are the thoracic and lumbar spine with typical ventral destruction. The spinal affection seems to result from a spread from the thorax (pulmonary, pleuritis tuberculosa) to the adjacent vertebral bodies (vialymphatics, the paravertebral venous plexus) or the systemic spread by the bloodstream.

Taphonomic Processes

In cases of scavenging by animals, it is often the bones that are disturbed, and the spongy, marrow-rich bone that is preferred for gnawing (Gill-King 1997). Thirteen individuals - ten men, a woman, a child, and one indeterminate sex of bones showed considerable surface cracking and exfoliation of the periosteal surfaces. A "taphonomic agent" refers to the "immediate physical cause" of modifications to animal remains and skeletal tissues (Gifford-Gonzalez 1991: 228). Many areas of the bones were fragmented and/or eroded. The survival of human bone is dependent on many variables, such as soil pH, soil type, bone type and size, age, and sex of the individuals.

Dental Pathologies

Sixteen individuals (57.2% of individuals: 7 male (43.75%), 5 female (83.34%), 4 undetermined sex (44.45%)), all adults, were observed to have enamel hypoplasias. The Bardzryal site shows a high frequency of dental calculus (59.4%; 10 males, 3 females, 6 undetermined sex). The most severely affected teeth were the incisors and molars. Caries affected 29.04% of individuals (7 males, 2 females). In terms of the number of caries, the molars were most commonly affected. Dental abscesses were found on 7 individuals (3 males, 2 females, 2 undetermined sex), which is 21.9% of those observable. The teeth most commonly affected by abscesses were the molars, followed by the premolars, and canines.

Dental Asymmetry

The human dentition is a good model system for examining the nature and extent of asymmetries in morphology and development because teeth are arranged in the dental arches as antimeric pairs within different tooth classes, i.e., incisors, canines, premolars, and molars. Asymmetry is said to be directional when one side regularly displays greater and/or earlier development than the other. Random, nondirectional differences termed fluctuating asymmetry are thought to indicate an inability of the individual to buffer against developmental disturbances (Van Valen 1962). Analyses did not uncover significant variation by sex and therefore data were combined to increase sample sizes. The maxillary dentition showed greater levels of fluctuating asymmetry as compared to the mandibular dentition (20/6). The MD mean was consistently higher, suggesting increased fluctuating asymmetry in this dimension, but not to a statistically significant degree. Comparisons of anterior and posterior teeth for both the mandible and the maxilla showed that the posterior teeth were significantly more variable than the anterior teeth (21/4). This was especially true for the maxilla, in which the posterior teeth present marked increases in fluctuating asymmetry as compared to the anterior teeth.

DISCUSSION

The above research results from the analysis of the Late Bronze and Early Iron Ages Lori region sample complement those previously reported from samples from the region. These published analyses are available: Bakheri chala (Khudaverdyan, Hobosyan 2017), Bover (Khudaverdyan *et al.* 2021). The data presented here from the Bardzryal are the most recent of those previously reported. All data from all of these North Armenia samples were collected by the same individual using the same standard protocol; thus they are directly comparable. Collectively, they provide a temporal perspective on the mortality and morbidity variables examined.

Uneven sex ratios, in terms of more males to females, have been reported at Bardzryal site. Yet, the unbalanced sex ratios at this site may be the result of other factors that have nothing to do with the differential treatment of the sexes after death. Poor skeletal preservation may have skewed paleodemographic assessments. Another vexing paleodemographic problem that is found in the Bardzryal sample is the paucity of subadults (birth to 20 years of age). Subadults make up only 10.9% of the sample. This dearth of young individuals is mirrored at other sites in the region (see Khudaverdyan 2012, Khudaverdyan, Hobosyan 2017, Khudaverdyan *et al.* 2021). There are several lines of speculation that can be explored in order to explain this situation. One possibility is that most of the young individuals in the

population survive to adulthood. Nutrition was good, diseases were few, and the amount of physiological stress facing the youngsters was slight. This should translate into an excellent state of health not only for the children but for the population at large. However, this scenario is not likely. Another possibility for the lack of subadult skeletons is the taphonomic process. The soil type of the Bardzryal site is not conducive to good skeletal preservation. Insects are known to destroy human remains, their influence varies with conditions of burial and factors such as season, latitude, and altitude (Erzinclioglu 1983). They can cause destruction of small bones and teeth. Mammals can prey on human remains, destroying bones by gnawing, thus causing damage which can lead to alternations suggestive of pathology (Henderson 1987). It would be reasonable to deduce that the lighter, less dense skeletal elements of subadults simply did not preserve at the same rate as older individuals. Only 18.2% of the individuals in the group were assessed as old adults. This dichotomy has implications concerning the health and adaptation of the Late Bronze Age and Early Iron Age.

Skeletal remains provide one of the most important and direct sources of evidence for the occurrence of violence in the past, and warfare as a context in which interpersonal violence is known to occur has been the focus of significant bioarchaeological examination (Ortner 2003, Knüsel *et al.* 2007). The prevalence of skull traumas at Bardzryal is 23.7%. They are found mostly on the male skulls. The injuries were observed on the frontal bone (Burials 1, 12, 57, 34, 67), on the parietal bone (Burials 57, 60, 12), and the occipital bone (Burial 12). The locations, types, and mechanisms of the trauma at Bardzryal indicate a predominance of direct fracture in skulls. In general, depressed skull fractures are considered to be produced by intentional violent behaviors. The round depression fractures were likely caused by close proximity assaults with slingstones or thrown rocks.

The frequency of cranial trauma is quite variable in all of the samples from Bronze and Iron Ages in Armenia and ranges from 14.3% to 56.3% (Khudaverdyan 2014, Khudaverdyan *et al.* 2014, Khudaverdyan, Hobosyan 2017). The highest frequencies of cranial lesions are observed at Lori Berd (57.2%), Black Fortress (50%) and Sarukhan (41.7%) groups, and they mainly involved males (Khudaverdyan 2009, Khudaverdyan *et al.* 2014). Approximately 32.5% of the combined sample from Shirak plateau (12 of 37) showed injuries to the cranium. Evidence of trauma was present in the combined sample from the Sevan Region (19.2%, 18 of 94); however, the frequency of injuries in the Sevan Region was lower than that of Shirak plateau (Khudaverdyan 2014). The cranial trauma rate among the population from the Bakheri chala and Bover (Lori Region, Late Bronze and Early Iron Ages) also was lower 15.63% (Khudaverdyan, Hobosyan 2017) and 12.59% (Khudaverdyan *et al.* 2021).

Often after cranial trauma, there is internal bleeding which causes the brain to swell. The investigators assume that trepanation was an attempt to reduce this swelling. Traces of surgery that unmistakably point to trauma were observed in the Bardzryal case. The trepanation from Bardzryal site (Burial 9) was performed on an individual with the purpose of removing the effect of the trauma and it was ultimately successful.

The analysis of skeletal features of the specimen 97 shows convincing evidence of intravitam complex trepanation of skull neurosurgical technology in the prehistoric period. Detailed X ray evaluation of the main lesion revealed that in this case, the orifice was most probably produced by scraping. The different angle resulting from the variation in thickness gradient between external and internal surfaces of the cranial vault at the top/bottom (frontal plane) and front/back (sagittal plane) bone surrounding the hole was most likely produced by clockwise rotation applied during scraping. There was some bone regeneration occurring on the skull so it is highly likely that this man survived the surgery and lived for some time afterward. We presume that the oval depression observed on the left part of the frontal bone is a discontinued case of trepanation or incomplete trepanation. The second trepanation seems to be also carried by scraping, involving only the external cortical layer. Considering trauma (i.e., blunt trauma) as the possible cause of skull lesion, the presence of short, fine marks or scraping marks over the surface of the frontal bone, and the absence of radiating or concentric fractures provide evidence that the defect is not due to an injury. The external surface of the skull of a young female from Bardzryal shows flat, porous, and thick new bone formations. Porotic hyperostosis can be caused by different conditions such as anemia, scurvy, rickets, osteomyelitis, periostitis, inflammatory processes of the scalp (Larsen 1997, Ortner 2003). Many researchers suggest iron deficiency anaemia as the main cause for porotic hyperostosis (Aufderheide, Rodriguez Martin 1998, Fairgrieve, Molto 2000, Rothschild 2000, Stuart MacAdam 1997). Other researchers suggest parasitic invasion as the major cause that affects the bone due to blood loss (Holland, O'Brien 1997).

F. Facchini *et al.* (2004) suggest changes in alimentary habits, poor diet and/or gastro-intestinal infections, and parasite infections as the main cause's foracquired anaemia. The skeletal changes evident in this individual are suggestive of achronic infectious disease. There are severe erosive lesions on fragments to the scapulae, clavicles, humeral, radius, ulnae, with lytic destructions. It is uncertain whether the changes observed in the skull are directly related to the infectious changes in the postcranial skeleton, though this seems highly likely. A possible alternative explanation is that they represent secondary changes (possibly even secondary infection?) brought about by the weakened state of the individual.

Surgical trepanations of different state of preservation and healing can be mistaken for different forms of trauma, tumorous, infectious, etc. conditions, developmental defects like meningioceles and even post-mortem alterations (Aufderheide, Rodrguez-Martn 1998, Ortner 2003). In the cases of individuals 9 and 97, the clearly defined edges are mostly covered by secondary cortical bone which implies a longer period of survival of the intervention and healing. Surgical trepanations are usually induced by blunt trauma (individual 9), after which a need occurs for artificial smoothing of the edges of the fracture site in order to facilitate faster healing and closure of the wound (Aufderheide, Rodrguez-Martn 1998, Ortner 2003). In most cases, the healed lesions do not exhibit signs of the original trauma as the damaged bony units are cut out in the course of the trepanation. This may be the case for individual 9 too.

In the second case mentioned, the scraping method was used on the skull. The scraping method probably presented a slower, more subtle method that dissipated the force over a larger area of the skull while also avoiding forceful penetration into the inner table and tearing of the meninges – contributing to improved healing and survival. It is possible that there were several kinds of surgery: operations carried out by trained surgeons with considerable knowledge and skill; and trepanation undertaken as a supernatural curative procedure by shamans with little technical ability as surgeons. Surgeons appear to have avoided cutting the meningeal vessels and underlying dura, which would have resulted in higher rates of infection and increased fatalities from hemorrhaging. The surgeons apparently used instruments of both stone and metal. Sharp flakes of obsidian (volcanic glass) were quite efficient cutting and scraping implements. Scalpels of copper or bronze, and champi were also made and apparently used in trephining. We may reasonably assume that the purpose of trepanation was to free the individual from generalized or focal uncontrolled seizures. In this respect, this case is a unique example of prehistoric neurosurgery, which documents in detail the consummate skill of early surgeons in successfully adopting different techniques to perforate the skull as a treatment for Dyke–Davidoff–Masson syndrome. To the best of our knowledge, this is the only case of reported evidence of the syndrome in Armenia's skeletal remains (Khudaverdyan *et al.* 2018).

There were 14 cases in total in Armenia (Late Bronze and Early Iron Ages): 10 were male, two were female, and two were unsexed individuals; with the adhesion signs on eight of them (Lchashen: Burials 71, 83, 193/6; Artsvakar: Burial 5; Tekhut: Burial 1; Bardzryal: Burials 9, 97; Shirakavan I: bur. 9; Bover: Burial 7) (Khudaverdyan 2021). In general, more males than females are trepanned: 10 versus two, respectively. The ages ranged from 7 to 65 years. Nine of the skulls had single lesions, and five ranged from two to three lesions.

Cranial muscle markers are rarely examined perhaps due to an assumption that crania are less plastic than post-cranial bones. However, studies of cranial bone biology have provided evidence of cranial plasticity in humans and animals. G.M. Heathcote *et al.* (1996), for example, scored posterior cranial muscle markers of male Mariana Islanders with a sample size of about 100 that dated between 1000 CE and 1521 CE with regard to muscles used for carrying and constructing megalithic structures. G. M. Heathcote *et al.* (2012, 2014) also noted that a small minority of Chamorro Mariana Islanders had extremely well-developed posterior cranial muscle markers that could be tied to coral limestone quarrying and monument building. The uneven distribution of these traits among the Chamorrosuggests that a particular group of individuals was chosen for these tasks; it may be that they also had a genetic predisposition to strength. Many adult Bardzryal males possessed great upper body strength. Such strength is inferred, in part, from the degree of occipital superstructure development at 2 pairs of neck and pectoral girdle muscle attachment sites on his posterior cranium (Heathcote *et* al. 1996). Given the association of tubercle on the occipital torus (TOT) and retromastoid process (PR) with neck and shoulder girdle muscles, the apparent geographic circumscription of marked developments of these superstructures prompts the question: "What habitual activity patterns, specific to populations so circumscribed, could have induced such distinctive morphological patterning?" Anatomy texts and atlases uniformly state that the trapezius

attaches to the occipital by way of a thin aponeurosis, but the presence of stout and sometimes pedunculated tubercles in Late Bronze Age and Early Iron Age Armenian populations raises questions about variable bone-muscle- interfaces within populations. The tubercle on the occipital torus development could relate to the shouldering of loads that force the head down, which is resisted by the trapezius muscle.

The incidence of supernumerary teeth generally affects 0.1–1% of the population (Thawley, Ferriere 1977). The most common ectopic-tooth which arises in the maxillary midline is known as a mesiodens. This unusual condition should be supposed to be present in individuals with nasal blockage/obstruction and unilateral purulent rhinorrhoea (Alexandrakis *et al.* 2000, El-Sayed 1995, Martinson, Cockshott 1972, Moreano *et al.* 1998, Wurtele, Dufour 1994). Supernumerary teeth develop either from a third tooth bed that arises from the dental lamina near the permanent tooth bud or, possibly, from splitting of the permanent bud itself (Thawley, Ferriere 1977). Another theory is that their development is a reversion to the dentition of extinct primates, which had three pairs of incisors (Thawley, Ferriere 1977), and also defect in migration of neural crest derivatives to reach the jaw (Ray *et al.* 2006), or a multi-step epithelial-mesenchymal interaction (Ray *et al.* 2006, Büyükkurt *et al.* 2005). Although the cause of ectopic growth is not well understood, it has been attributed to obstruction at the time of tooth eruption secondary to crowded dentition, persistent deciduous teeth, or exceptionally dense bone (Moreano *et al.* 1998). Other proposed pathogenetic factors include a genetic predisposition; developmental disturbances, such as a cleft palate; rhinogenic or odontogenic infection; and displacement as a result of trauma or cysts (Moreano *et al.* 1998). Ectopic eruption of teeth may happen near by the orbit, chin, maxillary sinus, palate and even nose (Di Felice, Lombardi 1995). The differential diagnosis of nasal teeth includes radiopaque foreign body; rhinolith; inflammatory lesions due to syphilis, tuberculosis, or fungal infection with calcification; benign tumors, including hemangioma, osteoma, calcified polyps, enchondroma, and dermoid; and malignant tumors, such as chondrosarcoma and osteosarcoma (Chen *et al.* 2002). The diagnosis is done because of macroscopic findings. An intranasal tooth is seen as a white mass in the nasal cavity surrounded. On the surface of the skull, there were foci of inflammation, exostosis, and cleft palate. Since cleft palate has a multifactorial etiology, including environmental and genetic factors (Antunes *et al.* 2018), genetic predisposition as an etiology for the ectopic eruption of the dysmorphic tooth cannot be neglected. The occurrence of a cleft lip and palate is not a rare phenomenon with a prevalence of 1 in 800 births (Damle 2017). Despite the corrective procedures, these individuals suffer a number of dental and skeletal abnormalities such as anodontia, oligodontia, supernumerary teeth, delayed or premature eruption, and maxillary arch hypoplasia (Harris, Hullings 1990). One of the rare complications of cleft lip and alveolus is nasally erupting tooth. A. S. Medeiros *et al.* (2000) stated that the prevalence of intranasal teeth was found 0.40 % in unilateral cleft lip and palate, and 0.61 % in bilateral cleft lip and palate. It is seen to occur more in females than males.

The male from Bardzryal cemetery had severe inner ear infections that breached into the brain cavity. The prevalence of infection and infectious disease correlated with fluctuating levels of environmental, social, and economic stress. Nasal teeth result from the ectopic eruption of supernumerary teeth and may cause a variety of symptoms and complications.

The first case reported for intranasal tooth in cleft lip and palate patient was in 1934 by Endicott. Other authors also reported similar cases (King, Lee 1987, Harris, Hullings 1990). A. Kakade *et al.* (2006) presented the case of a 4-year-old boy with a right nasally erupted canine operated previously for bilateral cleft lip and palate. Y. D. Al-Ahmari and A. M. Al-Hayan (2015) reported a case of intranasal tooth in 22 years old male. Y. K. Gupta and N. Shah (2001) reported a case in a 4-year-old child. G.S. Dalben *et al.* (2013) reported a case in a 9-year-old girl. There are only 8 cases reported in the literature (Al-Ahmari, Al-Hayan 2015) and we believe this is the first case reported in paleopathological materials from Armenia.

There are three dental studies on the ancient Anatolian populations whose samples are considered as nasal teeth. The first of these was found in Havuzdere (Medieval Age) in two individuals, a female and a child. The upper left central incisor of a female, aged 45–50, extended into the nasal cavity. In addition, the crown and root of this tooth had a distinct angle in neck region of the tooth. The upper left canine of another 15-year-old individual, whose root has not been formed, reflected the characteristic of a nasal tooth at the developmental stage (Özer *et al.* 2016). İznik (Late Byzantine) is the second population that had a nasal tooth as a canine-like tooth on the maxilla of one of the population members. The crown of this tooth had moved on up to the nasal cavity (Erdal 1996). In Kayalıpınar population

(Hellenistic-Early Byzantine periods) a 12-years-old child had a nasal tooth on the maxilla (Sarı, Açıkkol 2021). The nasal tooth sample in this study is located at the floor of the nasal cavity. It is not possible to determine whether the man was aware of the presence of this extra tooth (inverted mesiodens), whether there were any signs/symptoms caused by this tooth, or the tooth was surrounded by mucosa or granular tissue while the man was alive. Unfortunately, due to this insufficient comparison data, the nasal tooth in the Bardzryal male was mainly compared with clinical studies and these three populations.

In this study, a composite measure of total weighted dental (fluctuating) asymmetry was calculated as the sum of asymmetries for particular measurements in each individual. According to A. R. Palmer and C. Strobeck (2003), such composite measures of asymmetry are much more effective for assessing developmental instability than measures of fluctuating asymmetry for individual variables. Some previous studies showed also higher asymmetry of maxillary than mandibular teeth (Harris, Nweeia 1980, Khalaf *et al.* 2005, Sciulli 2003, Townsend, Brown 1983). Maxillary teeth were more asymmetric in MD dimensions than mandibular teeth. E. F. Harris and M. T. Nweeia (1980) observed that the pattern of asymmetry corresponds closely with morphogenetic fields of teeth pointing to the importance of genetic and ontogenetic patterns in human dentition. They also observed higher fluctuating asymmetry in more distal teeth (premolars and molars) (Harris, Nweeia 1980). The results imply that the upper jaw is more sensitive to both environmental and genetic stress. The lower jaw appears to be better buffered and displays a lower amount of asymmetry.

Enamel hypoplasias were widespread in Bardzryal site. The total frequency of enamel hypoplasias in Bover and Bardzryal sites is somewhat higher than the frequencies recorded in the skeletal samples from Bakheri chala of Armenia (Khudaverdyan, Hobosyan 2017). This suggests that the Late Bronze and Early Iron Ages were a time of great nutritional stress. The archeological record indicates that the population increased in the Late Bronze and Early Iron Ages, which would have meant greater competition for resources.

Cases of benign neoplasms observed in the group should be viewed as non-life-threatening disorders. Osteomas are uncommon (3 cases) findings on the Bardzryal and should be looked at as having little to no effect on health or adaptation. The Bardzryal site showed a high frequency of auditory exostosis (54.55%). Bakheri chala (51.73%) and Bover (63.64%) sites (Lori region) showed a high also frequency of auditory exostosis (Khudaverdyan, Hobosyan 2017, Khudaverdyan *et al.* 2021). The exostoses, although allowing lateral open passages toward the tympanic membrane had grown to full occlusion intra vitam, indicative of cumulative osteoblastic responses to prolonged exposure and irritation to external stimuli/causative agents. The presence of auditory exostosis has been related with a specific activity: individuals diving in cold water. Ecological conditions of the Bardzryal population, close to the river, were suitable for exploitation. It is probable that one of the work activities was diving. The frequency of auditory exostosis supports this hypothesis.

Total frequency of cribra orbitalia in Bardzryal (57.15%) is some what lower than the frequency recorded of the Bakheri chala (83.34%) and Bover (72.73%) samples from the territory of the Lori Region (Armenia) (Khudaverdyan, Hobosyan 2017, Khudaverdyan *et al.* 2021). The frequencies in Barcryal are close to those recorded in most of the skeletal samples of Bronze and Iron Ages from the territory of the Armenia (Khudaverdyan 2010, 2011, 2012). The adults in the sample of Bardzryal display healed cribra orbitalia. Porotic hyperostosis was seen in 73%. Due to a diet consisting of milled cereal grains and cow milk, individuals from Lori province were susceptible to illnesses. Furthermore, they were exposed to infectious agents. Additionally, children can be affected by diarrheal infections when they stop feeding on sterile breast milk and begin ingesting food and water that may be contaminated by microorganisms (Facchini *et al.* 2004).

Another large class of pathological bone conditions is labeled as infections (or chronic infections), and they may be sometimes identified more precisely as related to a particular pathogen (as tuberculosis). In most cases, however, non-specific infections are divided into those that penetrate bone or bone marrow (osteomyelitis) and those that affect periosteum only (periostitis). In most cases, they resulted in an injury and bone exposure to the pathogens. Were observed to have foci of inflammation on the skulls (eleven individuals), mastoiditis (four individuals), brain abscess (four individuals), tuberculosis (two individuals), chronic osteomyelitis (one individual), and periosteal lesions (two individuals). The chronic non-specific infections (periostitis, osteomyelitis) were always rare (Khudaverdyan, Hobosyan 2017, Khudaverdyan *et al.* 2021) and their frequency even decreased in Bardzryal group. The frequency of periostitis also was relatively low in Late Bronze and Early Iron Ages populations

(Khudaverdyan, Hobosyan 2017, Khudaverdyan *et al.* 2021). Not high frequencies of mastoiditis and tuberculosis have been found among individuals from Bardzryal and Bover sites (Khudaverdyan *et al.* 2021). Many cases of abscesses were noted in the Bardzryal and Bover samples and interpreted as examples of poor oral hygiene in low-class populations.

Lori province group displays an increased frequency of lesions does not necessarily mean that the population had especially poor health. Indeed, the increased frequency of lesions can mean either that the living population was in poor health or that the population enjoyed relatively good health because individuals survived the illnesses long enough for the lesions to develop. On the other hand, a skeletal series showing few or no lesions could mean that either the population was quite healthy or the members of the population were dying quickly, not allowing enough time for the appearance of the lesions. Additional perspective on these issues awaits further research in Armenia from other regions.

CONCLUSION

The skeletal remains of fifty-five people buried at Bardzryal provide new evidence of the health status and living conditions of Armenia's inhabitants. In consideration of the given data, we have concluded that the demographic profile of the individuals placed within the burial ground indicates that it was not a burial place for all members of society but instead held a special meaning for those decidedly and selectively placed there. This study has shown that the average age at death was relatively high. Life expectancy at birth for the Bardzryal population is 36.3 years. Traumatic injuries appear to have been commonly (23.7 %). Six individuals show evidence of strenuous physical activity. Recent discoveries in Lori province have revealed that this area represents one of the most active centers of cultural transformation in the medical field. The Bardzryal individuals (2 cases) represent an important example of successful surgery in the Late Bronze and Early Iron Ages. Cases of benign neoplasm's observed in groups (3 individuals) should be viewed as non-life-threatening disorders. The Bardzryal site showed a high frequency of auditory exostosis (54.6%). Four men from this cemetery are of special interest owing to the presence of lesions associated with a chronic ear infection. Tuberculosis (33.3%), brain abscess (36.4%), and chronic osteomyelitis (1 individual), also were present in the Bardzryal population. The dental pathology conditions of this population were numerous. Agriculture introduced people to carbohydrates, or sugars, which affect the teeth and cause dental caries (29.04%). The staple diet of the ancient population from Lori Region (Shnogh River) consisted of wine, bread, vegetables, and fruits.

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