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HUMAN SKELETAL BIOLOGY FROM THE ÁRPÁDIAN AGE OF NORTHEASTERN HUNGARY

ABSTRACT: In 1993, the authors initiated a project to examine temporal trends in morbidity and mortality established from studies of archaeologically recovered skeletal samples from northeastern Hungary. Data are reported here from the analysis of 248 individuals (97 adults and 151 immature individuals) from the 11th century AD Árpádian site of Tiszalúc–Sarkadpuszta. Comparison of the Árpádian Age data with those previously published in this project dating from the Neolithic, Copper Age, Bronze Age and the Iron Age reveal minimal differences in frequencies of periosteal lesions, measures of robusticity, dental hypoplasia, carious lesions and estimated living stature. A temporal decrease was documented in life expectancy at birth. Temporal increases were revealed in bone fractures, alveolar abscesses, ante mortem permanent tooth loss, cribra orbitalia *and life expectancy at age fifteen.*

KEYWORDS: Northeastern Hungary – Árpádian Age – Skeletal biology – Morbidity

INTRODUCTION

With increasing frequency, research projects in human skeletal biology have focused on attempting to elucidate past conditions of morbidity and mortality from the analysis of archaeologically recovered samples. Such attempts have been augmented with the development of standard data collection protocols (e.g. Buikstra, Ubelaker 1994) and the assemblage of large, well-documented collections of human remains. This research has documented patterns of both temporal change and geographic variation, especially in the Americas (Ubelaker 2006). Studies of samples in the Americas have documented long term temporal trends of increasing morbidity and mortality (with some regional variation) likely linked to changes in settlement pattern and diet (Armelagos *et al.* 1991, Cohen, Armelagos 1984, Larsen, Milner 1994, Steckel, Rose 2002, Ubelaker 1994, Verano, Ubelaker 1992).

In 1993, the authors initiated a project to examine long-term temporal trends in the skeletal biology of samples from northeastern Hungary. This area of Hungary was selected for the project since large, well-dated samples of human remains were available for all of the key time periods needed to properly examine temporal change. Data were chosen that would enable broad comparison and target the key issues in morbidity and mortality. The primary goal of the research is to elucidate if populations in northeastern Hungary experienced temporal patterns of change in morbidity and mortality similar to those documented in the Americas and other parts of the world.

This project was initiated with the examination of a large Bronze Age sample from the archaeological site Tiszafüred–Majoros (Ubelaker, Pap 1996). Study of this large sample of 593 individuals documented key information on sex, age at death, living stature, trauma, dental disease, and other pathological conditions. The Bronze Age study provided a database for comparison of data collected subsequently from other time periods. The Bronze Age sample was dated to the Middle and Late Bronze Age, approximately 1700–800 BC.

Subsequent research has focused on samples from the Neolithic (Ubelaker *et al.* 2006), the Copper Age (Ubelaker, Pap in press) and the Iron Age (Ubelaker, Pap 1998). Ubelaker and Pap collected all data in these studies using the same format as employed in the original Bronze Age study.

The Neolithic sample is represented by 71 individuals recovered from excavations at various sites in northeastern Hungary.

The sample from the Copper Age consists of 183 skeletons recovered from the archaeological sites of Mezőcsát, Bodrogkeresztúr, Tiszapolgár–Basatanya, Tiszapolgár-Csőszhalom and Tiszapolgár.

The Iron Age sample consisted of 171 individuals recovered from excavations at two sites, Mezőcsát and Tápiószele. These samples date from approximately 800 BC to the beginning of the Christian era.

THE ÁRPÁDIAN SAMPLE

This study presents results from the study of human remains from the more recent Árpádian Age. The Árpádian Age dates from 1000 AD to 1301 AD. The skeletons in this study originate from the archaeological site of Tiszalúc–Sarkadpuszta, which dates from the 11th century, the first part of the Árpádian Age. The excavations were conducted by Pál Patay in 1974 (Patay 1975) and in 1976 (Patay 1977), and by László Kovács in 1977–1982 (Kovács 1978, 1982, Patay, Kovács 1979, 1980, 1981, 1986).

The Árpádian Age was inaugurated in 1000 AD with the establishment of the Christian Hungarian state by King Stephan I. The period was named after Árpád who was an earlier ruler. The end of the Árpádian Age occurred in 1301 with the death of the last male descendant of Árpád.

Analysis of archaeologically recovered plant and animal remains suggests that subsistence during the Árpádian Age was mixed (Hartyányi *et al.* 1968, Bökönyi 1974, Matolcsi 1982). Although reliance on domestic animal products was maintained, the period witnessed increasing dietary incorporation of agricultural foods, as the practice of agriculture became more widespread.

Although no previous scientific studies have been conducted on the Tiszalúc-Sarkadpuszta sample, considerable research has been reported from other samples dating to the Árpádian Age (Szathmáry 2000). Such published research includes studies of stature (Éry 1996, 1998), infant mortality patterns (Éry *et al.* 1997), stress markers (Józsa, Pap 1989, Fóthi, Pap 1990, Józsa 2006), *cribra orbitalia* (Józsa, Pap 1991), pathological alterations (Józsa 1996, Molnár *et al.* 1996, Bernert *et al.* 2003, Hajdu 2006, Hajdu *et al.* 2004, 2006, in press, Kustár *et al.* 2005, Józsa, Farkas 2008), way of life (Fóthi, Pap 1990), trauma (Pap 1984, Bernert *et al.* 2001a, b, Bereczki, Marcsik 2005, Bernert 2005), oral pathology (Lenhossék 1917, Bruszt 1952, Huszár 1945, Huszár, Schranz 1952, Tóth 1966, 1970, Frayer 1984, Pap 1986a, Szikossy 1999), and paleosomatology (Lotterhof 1974, Pap 1986b).

METHODS

The remains examined in this study from the Árpádian Age site of Tiszalúc–Sarkadpuszta are generally well preserved and curated at the Department of Anthropology of the Hungarian Natural History Museum in Budapest. Following the procedures established for the project, each unit of skeletal remains was removed from storage, unpacked and arranged in anatomical order on an examining table. Detailed skeletal and dental inventory was conducted following protocols established previously for the project. Dental inventory documented both permanent and deciduous teeth as being present, but not in occlusion, present, fully developed and in occlusion, missing with no associated alveolar bone, missing ante mortem, missing post mortem and incompletely formed. Observations of pathological conditions and stress indicators included enamel defects, dental caries, alveolar abscesses, ante mortem loss of permanent teeth, abnormal bone porosity (especially on the orbits and cranial vault), vertebral osteophytosis, trauma and abnormal periosteal bone formation likely related to infection.

Ages at death of immature individuals were estimated through evaluation of the extent of dental formation when possible. In the absence of information on dental formation, bone size and morphology was considered.

In regards to the evaluation of age at death in adults, all available information was considered. Skeletons were evaluated for the morphology of the pubic symphysis, auricular area of the pelvis, dental attrition, ante mortem dental loss, vertebral osteophytosis and other non-invasive general age indicators (Ubelaker 1999).

The sex of adult skeletons was estimated using standard methodology (Ubelaker 1999). Special emphasis was given to features of the pelvis. In the absence of pelvic indicators, cranial morphology and other skeletal features were observed.

RESULTS

Of the 248 individuals in this sample, 31 (13%) were less than one year of age, 151 (61%) were less than age 15 and 97 (39%) were adults older than 15 years of age. Sex could be estimated reliably for only 99 individuals. Of these, 44 (44%) were male and 55 (56%) were female. The 44 males ranged in age from 14 to 65, with a mean age at death of 39 years. The 55 females ranged in age from 14 to 65, with a mean age at death of 38 years.

Demographic characteristics

The life table reconstructed for the Árpádian Age sample is presented in *Table 1*. Standard methodology was employed to calculate the values for this life table (Ubelaker 1999) from the age at death data. This calculation assumes a stationary population model. The life table suggests a life expectancy at birth of about 22 years and at age 15 of about 24 years. The distribution of deaths within the various age categories appears reasonable and argues that the sample is generally representative with no major age categories underrepresented.

TABLE 1. Life table for the Árpádian sample.

x	Dx	dx	lx	qx	Lx	Tx	$e^o x$
0–1	31	12.50	100.00	.1250	468.75	2208.17	22.08
2–4	82	33.06	87.50	.3778	354.85	1739.42	19.88
5–10	28	11.29	54.44	.2074	243.98	1384.57	25.43
11–15	10	4.03	43.15	.0934	205.98	1140.59	26.43
16–20	9	3.63	39.12	.0928	186.53	934.91	23.90
21–25	7	2.82	35.49	.0795	170.40	748.38	21.09
26–30	12	4.84	32.67	.1481	151.25	577.98	17.69
31–35	7	2.82	27.83	.1013	132.10	426.73	15.33
36–40	12	4.84	25.01	.1935	112.95	294.63	11.78
41–45	19	7.66	20.17	.3798	81.70	181.68	9.01
46–50	9	3.63	12.51	.2902	53.48	99.98	7.99
51–55	13	5.24	8.88	.5901	31.30	46.50	5.24
56–60	6	2.42	3.64	.6648	12.15	15.20	4.18
61–65	3	1.22	1.22	1.000	3.05	3.05	2.50
66–70	0	0	0	0	0	0	0

Dental caries

Observations for carious lesions were made on 2,067 permanent teeth (*Table 2*). Of these, 80 teeth (3.8%) were carious. Caries frequencies were similar in the maxilla (4.2%) and the mandible (3.5%). Of 412 maxillary teeth from males, 22 (5.3%) were carious. Caries frequency was slightly lower (4.1%) in maxillary teeth from females. Regarding mandibular teeth, 3.1% were carious in males and 4.5% in females. Carious lesions occurred more commonly in molars than in other tooth groups. Overall, frequencies were similar in males (4.2%) and females (4.3%).

The 80 carious permanent teeth presented 82 lesions. Of these 82 lesions, 27 were occlusal, 21 cervical, 15 large involving much of the crown, 12 mesial crown, 5 distal crown, and 2 in roots.

Dental hypoplasia

Within the Árpádian Age sample, 2,178 permanent teeth were examined for the presence of dental hypoplasia (*Table 3*). Of these, only 1.7 percent presented evidence of dental hypoplasia. The frequency (1.7%) was the same for the 1,091 maxillary teeth and the 1,087 mandibular teeth. Within the maxilla, enamel defects were most commonly found in the left central incisor (6.9%), right canine (6.3%), and left canine (5.3%). In the mandibular teeth, the highest frequency occurred in the right canine (8.6%) and left canine (6.4%). Frequencies were higher in females (2.6%) than in males (0.7%). All defects were of the linear type.

The 38 hypoplasia defects were found in 19 individuals. Of these individuals, 11 had one defect each, five had two defects each, two individuals had five defects, and one individual had 7 defects.

Alveolar abscesses

Alveolar abscesses were noted as bony defects associated with individual teeth (*Table 4*). Of 2,596 observations, 82 abscesses (3.2%) were noted. Abscesses were more common in the maxilla (5.1% of maxillary teeth) than in the mandible (1.4%). Values for the two sexes were similar. In the maxilla, abscesses were found associated with teeth in males at a frequency of 5.8% and in females of 5.4%. Similarly, in mandibular teeth the frequency for males was 1.4% and 1.6% in females. In the maxilla, abscessed teeth were most commonly left second premolars (11.1%) followed by right first molars (9.5%) and left first and second molars (8.6%). In mandibular teeth, the highest frequency was found in right first molars (5.7%) and left first molars (4.0%). Overall, the frequency in males was 3.6% and 3.4% in females.

Ante mortem tooth loss

The evidence for ante mortem tooth loss consisted of absence of a tooth and the presence of remodelling at the appropriate site on the alveolus. Of 2,593 observations on ante mortem tooth loss, 350 teeth (13.5%) had been lost ante mortem (*Table 5*). The frequency of ante mortem tooth loss was higher in the mandible (15.1%) than in the maxilla (11.8%). Ante mortem tooth loss was also more common in females (20.5%) than in males (7.8%). Ante mortem tooth loss was most common in molars.

Deciduous teeth

A total of 808 deciduous teeth were examined for the conditions discussed above. Of 577 observations for carious lesions, 0 teeth with lesions were noted. Of 808 observations for ante mortem loss of teeth, 0 teeth had

TABLE 2. Frequencies of permanent teeth with carious lesions (comparison of number of teeth with carious lesions to the number of teeth examined).

	Maxilla																	
	Right								Left									
	M³	**M²**	**M¹**	**PM²**	**PM¹**	**C**	**I²**	**I¹**	**I¹**	**I²**	**C**	**PM¹**	**PM²**	**M¹**	**M²**	**M³**	**Total**	**%**
Male	3/17	0/31	4/27	1/33	0/30	0/34	0/19	0/23	0/21	0/20	1/29	4/32	0/27	2/29	4/27	3/13	22/412	5.3
Female	0/21	4/32	4/35	1/32	0/35	1/38	1/32	0/28	0/27	1/30	1/36	1/36	0/33	2/30	3/27	1/20	20/492	4.1
?	0/1	0/7	0/13	0/8	0/8	0/5	0/7	0/7	0/6	0/10	0/6	0/5	0/5	1/17	0/7	0/1	1/113	.9
Total	3/39	4/70	8/75	2/73	0/73	1/77	1/58	0/58	0/54	1/60	2/71	5/73	0/65	5/76	7/61	4/34	43/1017	4.2
%	7.7	5.7	10.7	2.7	0.0	1.3	1.7	0.0	0.0	1.7	2.8	6.8	0.0	6.6	11.5	11.8		
	Mandible																	
	Right								Left									
	M³	**M²**	**M¹**	**PM²**	**PM¹**	**C**	**I²**	**I¹**	**I¹**	**I²**	**C**	**PM¹**	**PM²**	**M¹**	**M²**	**M³**	**Total**	**%**
Male	1/20	2/31	1/27	0/28	0/32	0/33	0/27	0/26	1/23	0/23	0/29	0/30	0/27	1/27	3/30	4/13	13/426	3.1
Female	3/24	1/29	2/28	1/35	1/35	1/35	1/34	0/31	1/30	1/31	1/33	0/33	0/30	3/30	4/32	2/19	22/489	4.5
?	0/2	1/6	0/20	0/6	0/6	0/6	0/13	0/10	0/11	0/11	0/7	0/5	0/6	0/20	1/6	0/0	2/135	1.5
Total	4/46	4/66	3/75	1/69	1/73	1/74	1/74	0/67	2/64	1/65	1/69	0/68	0/63	4/77	8/68	6/32	37/1050	3.5
%	8.7	6.1	4.0	1.4	1.4	1.4	1.4	0.0	3.1	1.5	1.4	0.0	0.0	5.2	11.8	18.8		

TABLE 3. Frequency of dental hypoplasia in permanent teeth (comparison of the number of teeth with hypoplasia with the number of teeth examined).

	Maxilla																	
	Right								Left									
	M³	**M²**	**M¹**	**PM²**	**PM¹**	**C**	**I²**	**I¹**	**I¹**	**I²**	**C**	**PM¹**	**PM²**	**M¹**	**M²**	**M³**	**Total**	**%**
Male	0/17	0/31	0/27	0/33	0/30	0/34	0/19	1/23	2/21	0/20	1/29	0/32	0/27	0/29	0/27	0/15	4/414	1.0
Female	0/23	0/33	0/35	0/32	1/35	4/38	1/32	1/28	1/27	0/30	3/35	1/36	0/33	0/30	0/28	0/22	12/497	2.4
?	0/1	0/8	0/32	0/10	0/11	1/8	0/8	1/15	1/10	0/11	0/12	0/7	0/5	0/28	0/12	0/2	3/180	1.7
Total	0/41	0/72	0/94	0/75	1/76	5/80	1/59	3/66	4/58	0/61	4/76	1/75	0/65	0/87	0/67	0/39	19/1091	1.7
%	0.0	0.0	0.0	0.0	1.3	6.3	1.7	4.5	6.9	0.0	5.3	1.3	0.0	0.0	0.0	0.0		
	Mandible																	
	Right								Left									
	M³	**M²**	**M¹**	**PM²**	**PM¹**	**C**	**I²**	**I¹**	**I¹**	**I²**	**C**	**PM¹**	**PM²**	**M¹**	**M²**	**M³**	**Total**	**%**
Male	0/19	0/31	0/27	0/29	0/32	1/33	0/27	0/26	0/23	0/23	1/29	0/30	0/27	0/26	0/30	0/13	2/425	0.5
Female	0/25	0/29	0/28	1/34	1/35	4/35	0/34	1/31	1/29	0/31	3/33	2/33	1/30	0/30	0/31	0/17	14/485	2.9
?	0/2	0/8	0/26	1/10	0/7	0/10	0/17	0/17	0/14	0/11	2/8	0/5	0/6	0/28	0/8	0/0	3/177	1.7
Total	0/46	0/68	0/81	2/73	1/74	5/78	0/78	1/74	1/66	0/65	6/70	2/68	1/63	0/84	0/69	0/30	19/1087	1.7
%	0.0	0.0	0.0	2.7	1.4	6.4	0.0	1.4	1.5	0.0	8.6	2.9	1.6	0.0	0.0	0.0		

TABLE 4. Frequency of alveolar abscesses associated with permanent teeth (comparison of the number of abscesses associated with individual teeth with the number of observations).

	Maxilla																	
	Right								Left									
	M^3	M^2	M^1	PM^2	PM^1	C	I^2	I^1	I^1	I^2	C	PM^1	PM^2	M^1	M^2	M^3	Total	%
Male	1/21	1/35	7/36	0/36	1/35	1/38	2/30	0/32	0/31	0/30	1/32	3/35	6/37	4/35	2/34	1/21	30/518	5,8
Female	2/31	3/44	2/46	3/42	3/44	2/45	0/39	1/36	1/34	1/37	2/42	2/43	3/39	4/42	5/40	0/30	34/634	5,4
?	0/1	0/6	0/13	0/8	0/8	0/5	0/6	0/8	0/6	0/10	0/6	0/5	0/5	0/16	0/7	0/1	0/111	0
Total	3/53	4/85	9/95	3/86	4/87	3/88	2/75	1/76	1/71	1/77	3/80	5/83	9/81	8/93	7/81	1/52	64/1263	5,1
%	5.7	4.7	9.5	3.5	4.6	3.4	2.7	1.3	1.4	1.3	3.8	6.0	11.1	8.6	8.6	1.9		
	Mandible																	
	Right								Left									
	M^3	M^2	M^1	PM^2	PM^1	C	I^2	I^1	I^1	I^2	C	PM^1	PM^2	M^1	M^2	M^3	Total	%
Male	0/22	1/36	3/37	1/34	0/34	0/34	0/31	0/31	0/32	0/32	0/34	0/33	0/34	2/35	0/35	0/17	7/511	1,4
Female	0/40	0/50	3/52	1/50	0/44	0/41	0/44	0/40	2/40	2/38	0/41	0/39	0/44	2/45	0/44	1/32	11/684	1,6
?	0/2	0/6	0/20	0/6	0/6	0/6	0/14	0/10	0/12	0/11	0/7	0/5	0/6	0/20	0/7	0/0	0/138	0
Total	0/64	1/92	6/109	2/90	0/84	0/81	0/89	0/81	2/84	2/81	0/82	0/77	0/84	4/100	0/86	1/49	18/1333	1,4
%	0.0	1.1	5.7	2.2	0.0	0.0	0.0	0.0	2.4	2.5	0.0	0.0	0.0	4.0	0.0	2.0		

TABLE 5. Antemortem loss of permanent teeth in the Árpádian sample (comparison of the number of teeth lost with the number of observations).

	Maxilla																	
	Right								Left									
	M^3	M^2	M^1	PM^2	PM^1	C	I^2	I^1	I^1	I^2	C	PM^1	PM^2	M^1	M^2	M^3	Total	%
Male	3/20	3/35	6/35	2/36	2/34	2/38	2/31	1/32	1/31	1/30	0/32	1/35	3/35	4/34	4/32	6/34	41/524	7.8
Female	8/28	10/44	11/46	8/44	6/43	4/44	3/39	4/36	2/34	4/39	4/40	5/42	6/38	11/42	12/39	10/30	108/628	17.2
?	0/1	0/6	0/13	0/8	0/8	0/5	0/6	0/7	0/6	0/10	0/6	0/5	0/5	0/17	0/7	0/1	0/111	0.0
Total	11/49	13/85	17/94	10/88	8/85	6/87	5/76	5/75	3/71	5/79	4/78	6/82	9/78	15/93	16/78	16/65	149/1263	11.8
%	22.4	15.3	18.1	11.4	9.4	6.9	6.6	6.7	4.2	6.3	5.1	7.3	11.5	16.1	20.5	24.6		
	Mandible																	
	Right								Left									
	M^3	M^2	M^1	PM^2	PM^1	C	I^2	I^1	I^1	I^2	C	PM^1	PM^2	M^1	M^2	M^3	Total	%
Male	2/23	4/36	8/33	3/34	1/33	0/34	0/31	1/31	1/32	0/32	0/34	0/33	2/34	8/35	5/35	4/18	39/508	7.7
Female	15/40	21/50	21/51	12/50	5/44	3/41	5/44	4/41	3/38	4/38	2/41	5/38	12/44	19/49	16/49	15/32	162/690	23.5
?	0/2	0/6	0/20	0/6	0/6	0/5	0/9	0/11	0/11	0/11	0/7	0/5	0/6	0/20	0/7	0/0	0/132	0.0
Total	17/65	25/92	29/104	15/90	6/83	3/80	5/84	5/83	4/81	4/81	2/82	5/76	14/84	27/104	21/91	19/50	201/1330	15.1
%	26,2	27.2	27.9	16.7	7.2	3.8	6.0	6.0	4.9	4.9	2.4	6.6	16.7	26.0	23.1	38.0		

TABLE 6. Osteophyte formation in the sample (data represent the maximum osteophyte formation found within each vertebral group of each individual).

	Cervical		Thoracic		Lumbar	
	No.	%	No.	%	No.	%
Lacking Osteophytes	40/86	46.5	26/92	28.3	28/93	30.1
Stage 1	31/86	36.0	28/92	30.4	24/93	25.8
Stage 2	11/86	12.8	32/92	34.8	23/93	24.7
Stage 3	4/86	4.7	6/92	6.5	18/93	19.3

been lost abnormally ante mortem. Of 753 observations for dental hypoplasia, 0 teeth presented evidence of hypoplasia. Of 808 observations for alveolar abscesses, 0 abscesses were noted.

Vertebral osteophytosis

In the adult sample, vertebral osteophytosis was scored as the maximum expression within each vertebral group following the classification system presented in Ubelaker (1999). Results are presented in *Table 6*. These data reveal that the cervicals registered the highest frequency of vertebrae lacking osteophyte formation as well as the initial stage of development. The highest frequency of stage 2 occurred in the thoracics. The greatest frequency of the more extreme stage 3 formation was found in the lumbar vertebrae.

Cribra orbitalia

Within the subadult sample (individuals younger than 15 years) observations of the presence or absence of *cribra orbitalia* were made on 85 left orbits and 83 right orbits. Evidence of *cribra orbitalia* (*Figure 1*) was observed in 37 (43.5%) of the left orbits and 36 (43.4%) of the right orbits. *Cribra orbitalia* was noted in 47 individuals. Of these 47 individuals, 35 exhibited fine porosity, 5 extensive porosity, one bone deposits and one fine porosity associated with bone deposits.

Within the adult sample, observations on *cribra orbitalia* were made on 85 left orbits and 80 right orbits. Evidence of *cribra orbitalia* was found on 16 left orbits (18.8%) and 13 right orbits (16.3%). All of these examples consisted of fine porosity except for one example of extensive porosity in both orbits of an adult of undetermined sex.

Within male individuals, *cribra orbitalia* was found in 8 of 36 left orbits (22.2%) and 5 of 34 right orbits (14.7%). Within females, *cribra orbitalia* was detected in 7 of 47 (14.9%) left orbits and 7 of 44 (15.9%) of right orbits. Overall (both orbits combined), the frequency was slightly greater in males (18.6%) than in females (15.4%).

Porotic hyperostosis

Observations for porotic hyperostosis were made on 123 left and 123 right sides of the crania of subadults. Of these observations, only one (0.8%) example was noted. One infant with an age at death between one and two years displayed abnormal fine porosity on the posterior aspect of both parietals.

In regards to the adult sample, no examples were noted in observations of 38 left and 39 right sides of the crania of males, 47 left and right sides of females, and two left and right sides of crania from individuals of undetermined sex.

Trauma

All remains were carefully evaluated for the presence of skeletal trauma. This examination revealed healed trauma in 45 bones from 19 individuals. All of the fractures were well remodelled suggesting they were sustained ante mortem, long before death.

The 46–50-year-old male of 82.1.4. displays a fracture of the right third rib.

The 41–45-year-old male of 82.1.13. presented a fracture of the midshaft of the right femur.

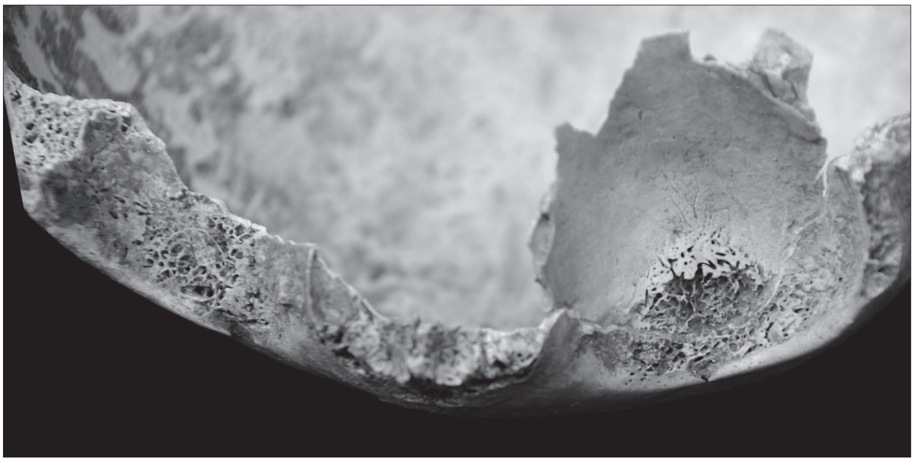

FIGURE 1. An example of *cribra orbitalia* (82.1.30.).

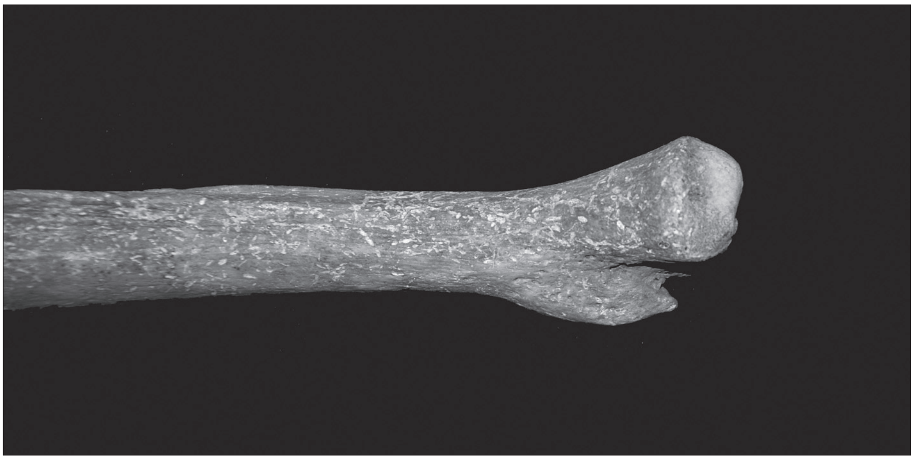

FIGURE 2. Healed fracture of distal right ulna (82.1.14.).

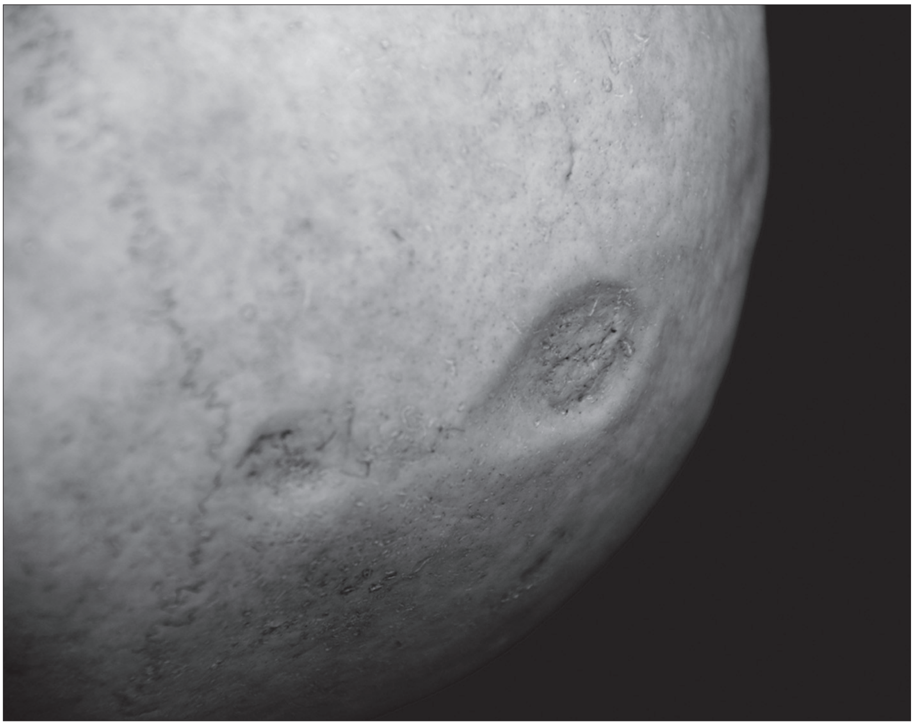

FIGURE 3. Depressed fractures (82.1.19.).

The 51–55-year-old male of 82.1.14. has fractures of the left radius and distal right ulna (*Figure 2*).

The 61–65-year-old male of 82.1.15. displays fractures of the sternal thirds of six right ribs.

A fracture of the right second metacarpal is present in the 51–55-year-old female of 82.1.17.

The 41–45-year-old female of 82.1.19. presents fractures of a variety of bones. These consist of two circular depressed fractures (*Figure 3*) on the parietals near the sagittal suture (20 mm and 15 mm in diameter), Colles fractures of the right radius and ulna, and a fracture of the neck area of the right second rib.

The 46–50-year-old male of 82.1.37. presents fractures of the vertebral third of two left upper ribs.

The 36–40-year-old male of 82.1.57. displays a fracture of the distal left ulna.

A variety of fractures are located in the remains of the 56–60-year-old male of 82.1.94. These are located in the neck area of a right lower rib, the midshaft area of a right lower rib, the midshaft area of a right middle rib, the midshaft of the right clavicle, a left first rib and the distal left femur (medial condyle area).

The 51–55-year-old male of 82.1.137. displays fractures of six left lower ribs, the lower third of the diaphysis of the right tibia (*Figure 4*), the lower fifth of the diaphysis of the right fibula, and fracture and fusion of the right calcaneus and navicular of the foot.

The 51–55-year-old male of 82.1.143. presents a fracture of the diaphysis of the right fibula near the distal articular surface.

A fracture of a right clavicle occurs on the 51–55-year-old female of 82.1.152.

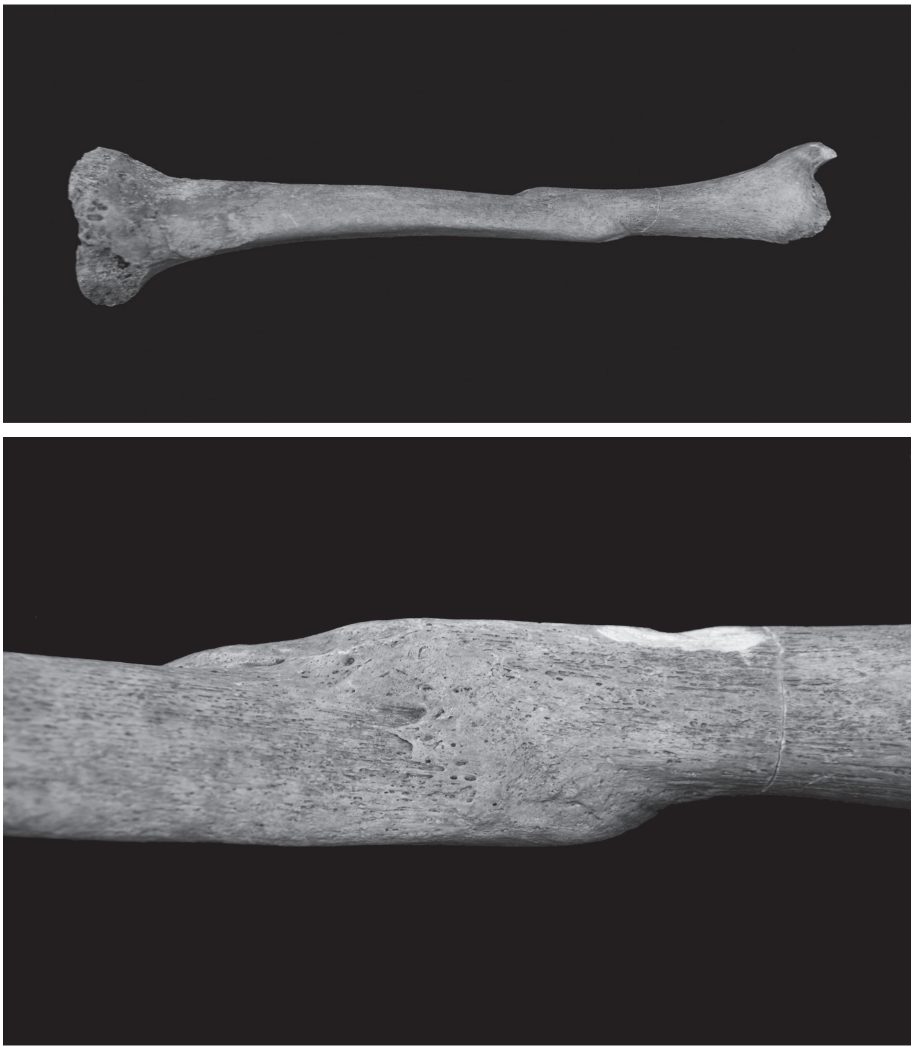

FIGURE 4. Healed fracture of right tibia (82.1.137.).

The 26–30-year-old male of 82.1.158. has a depressed fracture on the right parietal near the coronal and sagittal sutures. The fracture is circular, 8 mm in diameter.

The 56–60-year-old female of 82.1.167. displays a depressed fracture of the left parietal near the coronal and sagittal sutures. The defect is circular and 10 mm in diameter.

The 61–65-year-old female of 83.1.2. has Colles fracture of the left radius.

The 36–40-year-old female of 83.1.5. displays a fracture of the left fibula in the lower segment of the diaphysis.

Two fractures occur in the 41–45-year-old male of 83.1.9. These are located in the left proximal fibula, 100 mm from the proximal end and in the midshaft left clavicle.

The 26–30-year-old male from 227 displays a fracture of the distal third of the left tibia with slight lateral displacement of the distal end.

The 31–35-year-old male from 239 presents a fracture of the left clavicle.

The ratio of the number of bones with fractures (45) to the number of adults in the sample (97) is 0.46. The ratio of the number of bones with fractures to the number of individuals in the sample (248) is 0.18. The ratio of the number of adults with evidence of trauma (19) to the number of adults in the sample (97) is 0.20. The ratio of the number of adults with trauma to the number of individuals in the sample is 0.08. No evidence of trauma was detected on juvenile remains.

Fractures were found more commonly in males (13) than females (6), despite the fact that females outnumbered males in the total sample 55 to 43.

Abnormal periosteal lesions

Abnormal periosteal lesions consist of deposits of bone on the periosteal surface of bones that cannot be attributed to normal processes. Such lesions are frequently associated with infection although other stimuli such as traumatic events may also be involved.

Abnormal periosteal deposits were noted on seven bones of five individuals.

The 2.5-year-old of 82.1.88. displayed fine reactive bone on the anterior proximal surface of the right tibia.

The 14–15-year-old likely female from 226 presented well-remodelled healed osteomyelitis on the distal diaphysis of the right femur. No other bones were involved.

TABLE 7. Attributes demonstrating minimal variation between the Árpádian and previous periods.

Period	Periosteal lesions, ratio: bones to adults	Maximum circumference midshaft (mm)				Dental hypoplasia (%)			Dental caries (%)			Estimated living stature (cm)	
		Femur		Tibia		Total	Male	Female	Total	Male	Female	Male	Female
		Male	Female	Male	Female								
Neolithic	.09	90	81	85	75	1.4	2.2	0.7	6.3	5.6	6.7	168	155
Copper Age	.01	89	82	86	75	0.7	0.3	1.7	2.3	3.6	2.2	168	157
Bronze Age	.08	91	81	86	76	0.5	0.5	0.1	3.2	3.7	3.9	168	157
Iron Age	.08	90	80	84	73	4.9	1.8	5.7	3.7	3.1	4.8	169	154
Árpádian	.07	92	81	82	72	1.7	0.7	2.6	3.8	4.2	4.3	168	156

TABLE 8. Attributes demonstrating decreases between the Árpádian and previous periods.

Period	Life expectancy at birth	Osteophytosis: % with 0
Neolithic	29	38
Copper Age	28	49
Bronze Age	24	55
Iron Age	27	55
Árpádian	22	35

TABLE 9. Attributes demonstrating increases between the Árpádian and previous periods.

Period	Trauma, ratio: bones to adults	Life expectancy at age 15	Alveolar abscesses (%)			Ante mortem tooth loss (%)			*Cribra orbitalia* (% of orbits)	
			Total	Male	Female	Total	Male	Female	Adult	Immature
Neolithic	.22	21	2.6	2.8	2.0	6.0	6.5	6.1	13.1	25
Copper Age	.03	17	0.8	1.5	0.5	5.2	5.1	8.2	4.3	33
Bronze Age	.04	17	0.4	0.6	0.4	4.7	4.7	6.5	7.4	25
Iron Age	.03	16	1.5	2.3	1.3	5.0	6.8	5.1	8.5	27
Árpádian	.46	24	3.2	3.6	3.4	13.5	7.8	20.5	17.6	44

The cloaca was still visible but significantly remodelled. The alteration was mostly concentrated on the posterior surface.

A 41–45-year-old female of 82.1.92. presents reactive bone formation on the posterior fifth of a left second or third metatarsal. Reactive bone is also present on the left cuboid.

The medial surface of the distal right tibia of the 56–60-year-old male of 82.1.94. presents abnormal reactive bone.

The 26–30-year-old male of 82.1.113. presents periosteal reactive bone on the medial surfaces of both distal tibia diaphyses.

The ratio of the number of bones with alterations (seven) to the number of individuals in the sample (248) is 0.03. The ratio of the number of bones with lesions to the number of adults in the sample is 0.07. The ratio of the number of individuals with alterations to the number of individuals in the sample is 0.02.

Other pathology

In addition to the evidence of trauma and periosteal lesions described above, bone pathology was documented in two additional individuals.

The 1–4-year-old juvenile of 82.1.139. presented abnormal bone formation on the endocranial surface of the bones of the cranial vault.

The 51–55-year-old female of 82.1.149. displayed major focal areas of bone destruction with some remodelling on the bodies of two lumbar vertebrae.

Skeletal robusticity

Measurements of mid-diaphyseal circumference of the tibia and femur were recorded to examine robusticity. All measurements were recorded in mm using a flexible tape measure. Measurements were taken on the left side if available. If the bone from the left side was not available, measurements were taken on the bone from the right side. Measurements were possible on 49 tibiae and femora of females and 40 tibiae and 41 femora of males. For females, values of the femur ranged from 71 to 93 with a mean of 81. Values of female tibiae ranged from 65 to 83 with a mean of 72. For males, values of the femur ranged from 80 to 100 with a mean of 92. For male tibiae, values ranged from 70 to 95 with a mean of 82.

Living stature

Measurements of long bones permitted estimates of living stature for 45 females and 37 males. All estimates were made from femora except for one male for which the fibula was used. Formulae used to estimate stature were those of Trotter (1970) for White males and females. Stature was estimated from the left bone when available; in its absence that from the right side was utilized.

For adult females, estimated living statures ranged from 143 cm to 178 cm with a mean of 156 cm. For adult males, the values ranged from 160 cm to 180 cm with a mean of 168 cm.

DISCUSSION

These new data from the Árpádian Age allow key comparisons with those previously reported from earlier time periods in northeastern Hungary. Morbidity and mortality information is available from published studies of northeastern Hungary resulting from analysis of samples from the Neolithic (Ubelaker *et al.* 2006), Copper Age (Ubelaker, Pap in press), Bronze Age (Ubelaker, Pap 1996), and the Iron Age (Ubelaker, Pap 1998). Data from these studies are directly comparable since they originate from the same region of Hungary and were collected by the same investigators utilizing a standard protocol.

Many of the attributes examined exhibit minimal variation between the Árpádian sample and those from previous periods (*Table 7*). These include the frequency of bones with periosteal lesions (ratio of bones with lesions to the number of adults), measurements of maximum circumference at midshaft of the femur and tibia, the percentage of permanent teeth with dental hypoplasia and carious lesions, and estimated living stature.

Values for life expectancy at birth and the percentage of vertebral groups with no evidence of osteophytosis were lower in the Árpádian sample than in those from previous periods (*Table 8*). The lower life expectancy at birth values are largely a product of a larger proportion of immature remains in the Árpádian sample. While birth rates and taphonomic issues could affect these values, they likely reflect greater immature mortality in the Árpádian Age.

Table 9 presents those attributes that demonstrated increases in the Árpádian sample over those values documented for samples from previous periods. All of the attributes listed in the table present the highest mean values recorded in this study of samples from northeastern Hungary. These data suggest that the Árpádian individuals suffered from record high levels of fractures, alveolar abscesses, ante mortem tooth loss and *cribra orbitalia*. They also showed the highest values recorded for life expectancy at age 15.

Many of these indicators may be correlated positively with increased adult life expectancy. If more adults are living longer, the opportunities increase for fractures, alveolar abscess and tooth loss. The elevated *cribra orbitalia* values, especially in the immature sample, suggest that problems persisted in morbidity that also contributed to the relatively high levels of immature mortality.

CONCLUSIONS

Coupled with previously published results from the study of skeletal samples from northeastern Hungary, the data from the Árpádian Period provide a growing vision of the long-term changes (or lack of change) in various measures of morbidity and mortality. While these studies document some temporal change, the overall variation is not dramatic. These studies suggest that factors contributing to morbidity and mortality in northeastern Hungary varied through time. Additional perspective on these issues awaits additional research in northeastern Hungary and other regions.

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