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CRIBRA ORBITALIA IN MEDIEVAL POPULATIONS FROM UKRAINE

ABSTRACT: The purpose of this work is to describe the frequency of cribra orbitalia *on the skulls found in five medieval burial grounds discovered on the right and left banks of the Dnieper river (Ukraine). The examination covered 183 adult individuals' skulls (97 male and 86 female ones). The material was collected at the burial grounds dated to the 10th through 12th centuries. The degree of* cribra orbitalia *manifestation was evaluated according to Hengen scale (1971) and according to Nathan & Haas scale (1966) as modified by Robledo* et al. *(1995). The presence of* cribra orbitalia *was studied taking into account an individual's sex, age at death and side of the body (right and left orbit). The results obtained were compared to the data for medieval populations from Central Europe.*

KEY WORDS: Cribra orbitalia *– Medieval populations – Skeletal stress marker – Ukraine*

INTRODUCTION

The term *cribra orbitalia* was first proposed by Welcher in 1885. He used it to describe osseous changes observed on the orbital roofs in human skulls (Welcher 1885). The former variety of views on the pathogenesis and aetiology of *cribra orbitalia* has been replaced by a uniform attitude (Angel 1966, Armelagos, Goodman 1991, Cybulski 1977, Carlson *et al.* 1974, El-Najjar *et al.* 1976, Fornaciari *et al.* 1982, 1989, Gleń-Haduch *et al.* 1997, Hengen 1971, Hern 1990, Hershkovitz *et al.* 1991, Mensforth *et al.* 1978, Lallo *et al.* 1977, Repetto *et al.* 1988, Stuart-Macadam 1985, 1987, 1989, 1992, Turbón *et al.* 1991/92).

Cribra orbitalia is a set of small dents, holes or, in more advanced stages, lines and lesions which, depending on their intensity, cover varying extents of the orbital vault (Nathan, Hass 1966, Hengen 1971, Goodman *et al.* 1984, Stuart-Macadam 1987, 1992, Bergman 1987, 1993, Robledo *et al.* 1995).

The authors who have studied the frequency of *cribra orbitalia* in historical populations indicate that this phenomenon might have been caused mainly by iron deficiency resulting from insufficient ingestion of iron in childhood, reduced absorption of this element by the system (due to malabsorption in the digestive system caused by factors such as contagious disease), increased iron requirement (e.g. in the period of the body's fast development and growth) or to blood loss (e.g. due to parasitic disease infection).

Goodman *et al.* (1984, 1988) introduced a classification of environmental stress markers, according to which *cribra orbitalia* could be associated with a concrete disease or nutritional deficiency. Contrary to earlier research which ascribed the occurrence of *cribra orbitalia* to iron deficiency in the system (El-Najjar *et al.* 1976, Huss-Ashmore *et al.* 1982, Martin *et al.* 1985), the current view assumes that the *cribra orbitalia* phenomenon is related to iron deficiency due to exposure of the human system to the influence of a variety of parasites, bacteria, viruses and fungi (Walker 1986, Hern 1990, Stuart-Macadam 1992, Klepinger 1992, Grauer 1993, Kent, Dunn 1996). Stuart-Macadam (1992) believes that *cribra orbitalia*, resulting from the lowering of the body iron level, may be treated as a reflection of a population's adaptation to adverse environmental conditions. This lowering of the body iron level is an individual's defence reaction against microorganisms, aiming at preventing their replication. Thus, the frequency of *cribra orbitalia* may be a good general indicator of the state of health of a given population.

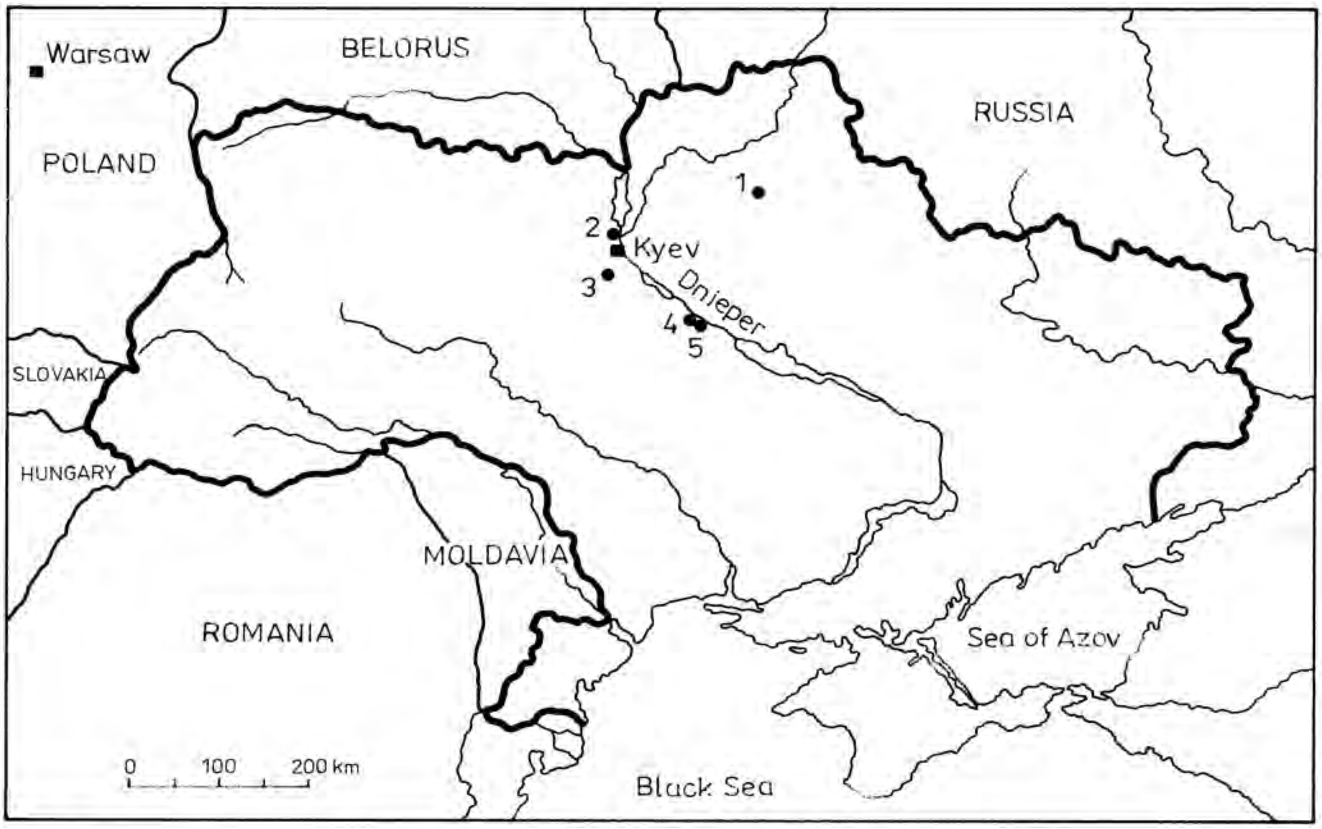

FIGURE 1. Map of Ukraine with locations of cemeteries: 1 – Lipove, 2 – Kazaroviči, 3 – Luca, 4 – Grigorovka, 5 – Bučak.

The purpose of this work is to describe the frequency of *cribra orbitalia* in the skulls coming from five medieval burial grounds, discovered on the right and left banks of the Dnieper river (Ukraine). We would like to present also the source data referring to this area for which we had had no comparative data before.

MATERIAL AND METHODS

The presence of *cribra orbitalia* was examined on 183 skulls (97 male and 86 female ones). The skulls were collected at medieval cemeteries (10th – 12th centuries) discovered on the right and left banks of the Dnieper river (Ukraine). The quantitative data referring to the number of skulls examined originating from individual burial grounds are shown in *Table 1*. The skulls belong to the collection of the Institute of Archaeology of the Ukrainian Academy of Sciences in Kiev.

The occurrence of *cribra orbitalia* in the right and left orbit was tested according to the scale devised by Hengen (1971). As suggested by Bergman (1988) the first grade of *cribra orbitalia* occurrence was treated as a physiological state. For this reason the frequency was given separately for skulls with the second and higher grades of manifestation. Further, the scale of Nathan & Haas (1966), as modified by Robledo *et al.* (1995), was used. This scale describes the intensity of the *cribra orbitalia* phenomenon on three levels classified as: the porotic, cribrotic and trabecular types (porotic: scattered, isolated fine foramina, cribrotic: conglomerate of larger but still isolated foramina, trabecular: apertures confluent resulting in the appearance of bone trabeculae). Grades 2 and 3 on Hengen scale correspond roughly to the porotic type, grade 4 to the cribrotic type, and grades 5–7 to the trabecular type according to Nathan & Haas scale.

Individuals' sex was determined on the basis of diagnostic traits observed only on the skulls, according to the scales devised by Ferembach, Schwidetzky, Stloukal (1980). Age at death was estimated based on the degree of cranial sutures' obliteration and the degree of dental crowns' attrition in the following age categories: adultus (20–35 years), maturus (35–50 years), senilis (50 and more years) – (Acsádi, Nemeskéri 1970, Buikstra, Ubelaker 1994, Piontek 1999). All the statistical computations were performed using the Excel 7.0 and Statistica 5.0 software. Differences in the frequencies of *cribra orbitalia* were estimated with the Chi-square test.

ANALYSIS

Table 2 shows the frequency of *cribra orbitalia* depending on the degree of its manifestation (Hengen scale). Changes of the *cribra orbitalia* type were present in more than a half of the individuals (55.2%, out of whom 51.1% were

TABLE 1. List of data.

Cemeteries	Male	Female	Total
Lipove	32	35	67
Kazarovići	19	15	34
Luca	16	8	24
Grigorovka	13	11	24
Bučak	17	17	34
Total	**97**	**86**	**183**

TABLE 2. Frequency of *cribra orbitalia* (Hengen scale).

Groups		Grades (in %)							
	N	1	2	3	4	5	6	1–6	2–6
Male	97	27.8	11.3	4.6	3.1	3.1	2.1	51.5	23.7
Female	86	22.1	10.5	8.1	4.6	8.1	5.8	59.3	37.2
Total	**183**	**25.1**	**10.9**	**6.0**	**3.8**	**5.5**	**3.8**	**55.2**	**30.1**

TABLE 3. Frequency of *cribra orbitalia* in different medieval populations of Central Europe.

Population	Chronology	Total number	*Cribra orbitalia* in % (grade 2–6)	Reference
Ukraine	10th – 12th	183	30.1	Piontek, Segeda
Cedynia, Poland	10th – 12th	403	26.5	Piontek (unpublished data)
Milicz, Poland	12th – 14th	436	37.0	Bergman, 1988
Ostrów Lednicki, Poland	12th – 14th	494	30.2	Łubocka, 1999
Elbląg, Poland	Medieval	89	28.9	Kozak, Krenz, 1993
Kołobrzeg, Poland	13th – 18th	190	23.1	Kozak, Krenz, 1993
Słaboszewo, Poland	14th – 17th	141	22.7	Piontek (unpublished data)
Alytus, Lithuania	14th – 17th	68	9.6	Jankauskas, 1995
Kaimas, Lithuania	14th – 17th	146	15.9	Jankauskas, 1995

TABLE 4. Distribution of *cribra orbitalia* (Nathan and Haas scale).

Groups	Porotic	Cribrotic	Trabecular	Total
Male N = 97	15	3	5	23
Female N = 86	16	4	**12**	**32**
Total N =183	**31**	**7**	**17**	**55**

Differences between sex: Chi-square p = 3.95; differences between sex in trabecular frequency Chi-square p = 3.46

TABLE 5. Distribution of *cribra orbitalia* (Hengen scale – grade 1–6).

Cribra orbitalia	Male	Female	Total
Yes	50	51	101
No	47	35	82
Total	**97**	**86**	**183**

Chi-square p = 1.11

TABLE 6. Distribution of *cribra orbitalia* (Hengen scale – grade 2–6).

Cribra orbitalia	Male	Female	Total
Yes	23	**32**	55
No	74	54	128
Total	**97**	**86**	**183**

Chi-square p = 3.95

TABLE 7. Distribution of *cribra orbitalia* in sex groups (Hengen scale).

Sex groups	N	Grade 2–6	Grade 3–6
Male	97	23	12
Female	86	**32**	**23**
Total	**183**	**55**	**35**

Chi-square for: grade 2–6 p = 3.95; grade 3–6 p = 6.09

TABLE 8. Distribution of *cribra orbitalia,* asymmetry by sex.

Sex groups	Only left side	Only right side
Male	18	11
Female	8	12
Total	**26**	**23**

Differences are not significant

TABLE 9. Distribution of *cribra orbitalia*, asymmetry by sex.

Sex groups	Right and left	Right or left
Male	15	**29**
Female	24	20
Total	**39**	**49**

Chi-square p = 3.73

TABLE 10. Distribution of *cribra orbitalia* (Hengen scale) and age at death – male.

Age groups	N	Grade 1–6	Grade 2–6	Grade 3–6
20–35 years	31	16	9	4
35–x years	66	34	14	8
Total	**97**	**50**	**23**	**12**

Differences between age groups are not significant

TABLE 11. Distribution of *cribra orbitalia* (Nathan and Hass scale) and age at death – male.

Age groups	N	Porotic	Cribrotic	Trabecular
20–35 years	31	6	1	2
35–x years	66	9	2	3
Total	**97**	**15**	**3**	**5**

TABLE 12. Distribution of *cribra orbitalia* (Hengen scale) and age at death – female.

Age groups	N	Grade 1-6	Grade 2–6	Grade 3–6
20–35 years	47	28	**24**	**19**
35–x years	39	23	**8**	**4**
Total	**86**	**51**	**32**	**23**

Chi-square for: grade 2–6 p = 4.03, grade 3–6 p = 5.94

TABLE 13. Distribution of *cribra orbitalia* (Nathan and Hass scale) and age at death – female.

Age groups	N	Porotic	Cribrotic	Trabecular
20–35 years	47	11	3	10
35–x years	39	5	1	2
Total	**86**	**16**	**4**	**12**

TABLE 14. Distribution of *cribra orbitalia* in sex groups (Hengen scale – grade 1–6) and age at death.

Age groups	N	Male	Female	Total
20–36 years	78	**16**	**28**	44
35–x years	105	34	23	57
Total	**183**	**50**	**51**	**101**

Chi-square p = 5.39

male and 59.3% were female). The most frequent form of *cribra orbitalia* observed were changes classified as grade 1. Like other authors (e.g. Bergman 1988, 1993) we came to the conclusion that *cribra orbitalia* grade 1 might be a physiological phenomenon. Thus, the computations performed, with the exclusion of the grade 1 changes according to Hengen (1971) scale, proved that *cribra orbitalia* occurred in approximately 30% of skulls (23.7% male and 37.2% female ones). These data are similar to the results obtained for other medieval populations from Central Europe (*Table 3*).

Using the Nathan & Haas (1966) system we calculated the frequency of *cribra orbitalia* according to a three-grade scale (types: porotic, cribrotic and trabecular). In this case the total frequency of *cribra orbitalia* is the same as that calculated according to Hengen scale (1971) owing to the fact that Nathan & Haas scale covers all the grades of manifestation encompassed by Hengen scale with the exception of *cribra orbitalia* grade 1 (Robledo *et al.* 1995). The highest frequency in the group of male and female skulls was noted for the porotic type (*Table 4*).

The changes were more frequent in female skulls and the degree of their manifestation in these skulls was also more frequently greater (*Tables 4, 5, 6, 7*).

Symmetry and asymmetry of the *cribra orbitalia* occurrence are shown in *Tables 8* and *9*. Asymmetrical occurrence was more frequent in male skulls, while in female skulls cases of symmetrical occurrence of *cribra orbitalia* were more frequent (*Table 8*).

Further, the dependence between the age at death and the presence of *cribra orbitalia* was studied (*Tables 10–14*). In female skulls *cribra orbitalia* was more frequent in individuals deceased before reaching the 35th year of age (*Table 12*). In these individuals the degree of manifestation of *cribra orbitalia* was also higher (from grade 3 to grade 6 according to Hengen scale, or the trabecular type according to Nathan & Haas scale).

DISCUSSION AND CONCLUSIONS

Analysis of the frequency and intensity of *cribra orbitalia* in the skulls from medieval cemeteries in Ukraine revealed a high interindividual differentiation of this phenomenon. *Cribra orbitalia* was present with varying intensity in 51.5% of male and 59.3% of female skulls. After the exclusion from the calculations of grade 1 changes, *cribra orbitalia*, of various degrees of advancement, was present in as many as 23.7% of male skulls and 37.2% female skulls.

The fact of greater frequency of *cribra orbitalia* in female skulls was recorded by a number of authors (Hengen 1971, Cybulski 1977, Walker 1986, Turbón *et al.* 1991/92). One should note, however, that *cribra orbitalia* observed in women skulls is characterised by a higher grade of expression, such as the trabecular type (*Table 4*). Thus, in the case of women there must have been other factors conducive to the occurrence of this high frequency of *cribra orbitalia*. Compared to men, women at the reproductive age are much more prone to have lowered blood iron levels. This is related directly to female physiology. Menorrhoea, pregnancy, labour, lactation are factors that may cause a considerable reduction of the iron level in the system. The comparisons involving only the frequency of occurrence in men and women may be misleading, since with similar frequency the intensity of these changes is usually greater in women.

The reasons behind the differences in the degree of intensity of these changes in men and women may also affect the observed differences in the frequency of *cribra orbitalia* depending on age at death. There is a strong relation in the group of female skulls between the frequency of *cribra orbitalia* and the age at death (*Tables 12* and *13*). This dependence is particularly conspicuous when we have to do with strongly expressed *cribra orbitalia* (grades 3 and higher in Hengen scale of expression, or the cribrotic and trabecular types according to Nathan & Haas scale). One may presume that majority of the changes observed occurred in childhood and adolescence. Children are very much exposed to infection with parasitic diseases (mainly helminthiases). Contemporary epidemiological studies (Dymowska 1975) indicate that parasitic diseases are the most frequent enteropathy among children of various age and background. For instance, the data for the contemporary Polish population show that frequency of enterobiosis in children oscillates between 19.3% and 27.9% (Dymowska, Zembrzuski 1978, Zembrzuski, Dymowska 1980, Zembrzuski 1981). In accordance with Stuart-Macadam hypothesis (1992) *cribra orbitalia* form as a result of the adaptation of an individual to environmental conditions harmful to health. These conditions are usually the same for male and female individuals in the period of growth and development. Hence, a question arises whether the differences in the frequency and intensity of *cribra orbitalia* in men and women are not an indicator of the living conditions of women in a given population in their adolescence and early adulthood.

Discussing the frequency of *cribra orbitalia*, we are aware of the fact that the collection of skulls under analysis does not furnish us with a direct representation of the intensity of the *cribra orbitalia* phenomenon in the living population (Wood *et al.* 1992, Saunders *et al.* 1995). Nevertheless, we wish to point out the strong interindividual differentiation of this phenomenon in the examined collection of skulls as well as the sexual differences and the dependence of the intensity of the phenomenon on an individual's age at death. The results of the study show also that *cribra orbitalia* was present in a high fraction of individuals from the investigated cemeteries. The comparative data (*Table 3*) reveal that the fraction was similar throughout various medieval populations from Central Europe. It also needs to be stressed that the relations we studied such as symmetry or asymmetry in *cribra orbitalia* occurrence, sexual dimorphism, intensity of the phenomenon and its relation to age at death are similar across various collections of skulls from Central Europe area. Research by Bergman (1988, 1993) revealed a strong relation between the frequency of *cribra orbitalia* and the richness of the graves' equipment reflective of an individuals' social status (social gradient). Hirata (1990) and Turbón *et al*. (1991/92) proved the occurrence of a clear secular trend with regard to *cribra orbitalia* presence, resulting from differences in the living conditions of individuals living in various prehistorical and historical periods. Thus, we can presume that investigating the *cribra orbitalia* phenomenon (its frequency and intensity) we can obtain information on the living conditions of human populations in the Middle Ages in various parts of Europe. These findings refer to the analysis of the state of health of a population under study and are not of palaeo-epidemiological nature. They are, however, an adequate research tool in the search for interindividual differences in reactions to similar living conditions.

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