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Past inhabitants of Garbary – a biocultural perspective

Introduction

As one of the most populous suburbs of Krakow, Garbary was related both economically and functionally with the city as early as the Middle Ages. The unique character of the place was due to its natural conditions. The waters of Rudawa were used by households, which were built above the river's flood elevation. Inhabitants most commonly included tanners, groatsmakers and potters. Since tanners did not enjoy a particular social prestige, they worked outside the city walls[1]. A tanner's colony in front of Brama Szewska (the Szewska Gate) was called Cerdonia (Garbary) already in the 16th century. In 1498, thanks to the endeavours of Jan Weis, who was both a professor at Wszechnica Jagiellońska and the parish priest of St Stephen's Church, St Peter the Little's Church was erected in Garbary (fig.1). Destroyed several times during an invasion by Maximilian Habsburg in 1587 and the Swedish deluge of 1655–57 and 1702, it was repeatedly rebuilt, only to be ultimately pulled down in 1801[2].

The church was surrounded by a graveyard in which inhabitants of Garbary, parishioners of St Stephen's Church, St Anne's Church, as well as people from Bronowice were buried. The graveyard was also the burial site of the victims of epidemics which frequently struck the city of Krakow: in 1515–1543, 1555 and

[1] J. Wyrozumski, *Dzieje Krakowa – Kraków do schyłku wieków średnich*, t. 1, Kraków 1992, p. 344.

[2] J. Bieniarzówna & J. M. Małecki, *Dzieje Krakowa – Kraków w latach 1796–1918*, t. 3, Kraków 1979, pp. 15, 415.

1707, when as many as 670 people died in Garbary. „All" inhabitants of Garbary murdered during Maximilian's inroad were also inhumed there, and the village itself was burnt[3].

The area of the graveyard next to what used to be St Peter the Little's Church partly includes the properly located at Łobzowska 8 (fig. 2), where in 2012 rescue archaeological excavations took place[4]. The tombs at the graveyard were first explored in 1872[5].

Material

Bone material unearthed during the studies of 1872 and 2012 was subjected to anatomical and anthropological analysis. The 1872 series contained 46 skulls from the cemetery of St Peter the Little's Church located at the former suburb Garbary[6]. According to objects found next to the corpses, the material dates back to 17th–18th century[7]. In 2012, rescue archaeological work was carried out at Łobzowska St. 8 (current street address) in Krakow. The tombs were reported as the remains of the graveyard established at St Peter the Little's Church in Garbary at the end of the 15th century and active until the beginning of the 19th century. 61 human skeletons as well as clusters of loose bones were unearthed; among them animal bones were also identified. All bones included in the analysis date back to the modern age. The material lay at the depth of over a dozen centimetres to over a meter, mostly in sandy soil of high water permeability. The deceased had been lain on their backs with their arms along the body or crossed at the waist. Skeletons were placed along the east-west axis, heads facing any of the two directions. The absence of any traces of coffins or unnatural relocations suggests that the dead had been buried in shrouds. No objects except for single

[3] J. Bieniarzówna & J. M. Małecki, *Dzieje Krakowa – Kraków w wiekach XVI–XVIII*, t. 2, Kraków 1984, pp. 43, 163, 454–455.

[4] S. Dryja et al., *Sprawozdanie z badań archeologicznych przy przebudowie kamienicy przy ulicy Łobzowskiej 8 w Krakowie*, Kraków 2012.

[5] I. Kopernicki, *Czaszki przedmieszczan Krakowskich z XVII–XVIII wieku*, „Zbiór wiadomości do antropologii krajowej" 11 (1887) z. 2, pp. 1–25.

[6] D. Jagocka, *Charakterystyka antropologiczna XVII–XVIII-wiecznych czaszek z cmentarzyska Garbary w Krakowie*, Kraków 1988.

[7] I. Kopernicki, *Czaszki przedmieszczan…*, op. cit.

ceramic fragments dating back to Middle Ages or the modern age were found[8]. The general preservation condition of the bone material is regarded as medium, with possible impact of secondary excavations, levelling of a part of the graveyard, as well as multiple cross-cuts, the way the material was unearthed, and the structure of soil layers (fig.3,4,5). Only one skeleton is preserved as complete (grave 13).

Biological distance assessment. Cluster analysis

In view of the fact that the bone material unearthed in 1872 and 2012 originates from the same area, i.e. the graveyard at St Peter the Little's Church in Garbary, its level of diversity was analysed by means of biological distance assessment.

Craniometric data obtained in research procedures in 1872 (N=46) and 2012 (N=17) were used. Ward's method for selected measurements of the neurocranium (g-op; eu-eu; ft-ft; ba-b) (Fig. 1) and the facial skeleton (zy-zy; n-pr; mf-ek; sbk-spa; n-ns; apt-apt) (Fig. 2) was applied.

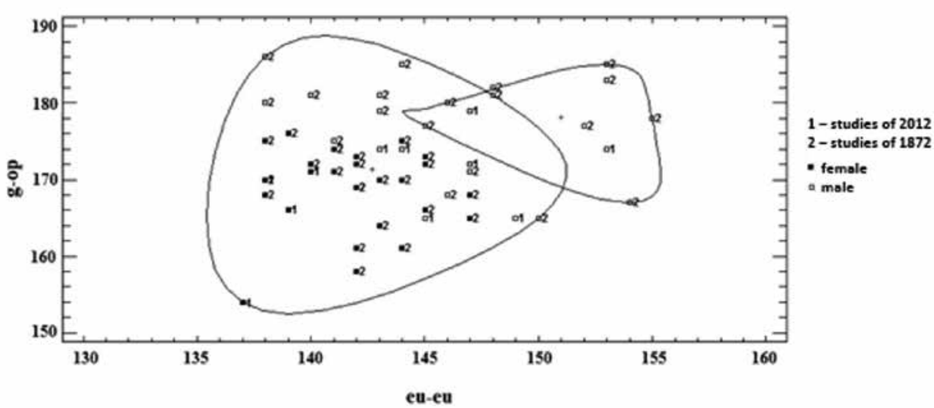

Fig. 1. Morphological diversity of the neurocranium in individuals from Garbary

[8] S. Dryja et al., *Sprawozdanie z badań…*, op. cit.

In both cases two clusters containing skulls discovered in 1872 and 2012 studies were designated. The location of each individual within the clusters is dependent on the diversity of cranial dimensions as well as sexual dimorphism. The diversification of cranial features and proportions was noticed by Izydor Kopernicki, who substantiated it by the origin not only of the residents of the suburb Garbary and the parishioners of St Stephen's Church, but of Krakow inhabitants in general. Such observations were supported by an analysis of a census of Garbary parishioners, in which Kopernicki ascertained a considerable proportion of foreigners of German and Italian origin. This is also confirmed by the fact that services in St Peter the Little's Church were celebrated in the German language[9]. A large proportion of the inhabitants of 16th century Krakow comprised immigrant population from other villages and towns of Lesser Poland as well as from abroad. The population was therefore a mosaic of people of different social status, economic status, of various professions and nations[10].

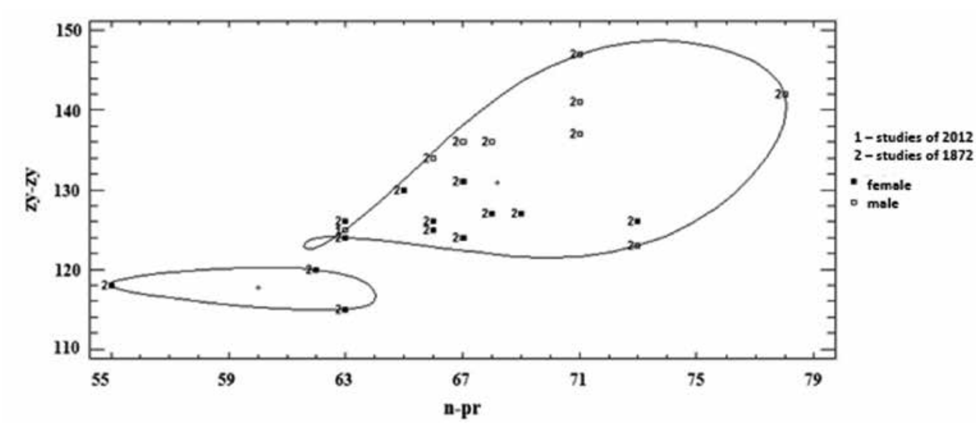

Fig. 2. Morphological diversity of the facial skeleton in individuals from Garbary

Due to the above, bone material from the graveyard at S. Peter the Little's Church in Garbary excavated in 1872 and 2012 may be considered a single series of skeletons representative of the Krakow population from the 15th to early 19th century.

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[9] J. Bieniarzówna & J. M. Małecki, *Dzieje Krakowa…*, Kraków 1984.

[10] J. Bieniarzówna & J. M. Małecki, *Dzieje Krakowa…*, Kraków 1984.

Methods

Individuals' sex was determined by a composite method commonly applied in anthropology, on the basis of skull and pelvic bone morphology[11].

Individuals' age at death was determined on the basis of deciduous and permanent teeth eruption sequence in children[12], ossification level of various parts of skeleton in teenagers, and intensifying obliteration of cranial sutures at the endo- and exocranial side, degree of tooth attrition on occlusal surfaces according to Brothwell (1981)[13], morphology of the surfaces of the pubic symphysis and the *facies auricularis* of the hip bone in the remains of adults[14]. Individuals were accordingly allocated to biological age classes[15].

Measurements were taken according to Martin's method[16]. Skull shapes and proportions were analysed according to cranial indices. In the postcranial skeleton, maximum and physiological lengths of left and right long bones, their minimum circumferences, sagittal and transverse sections, and widths of upper and lower epiphyses were measured. Shoulder breadth was recreated on the basis of the length of the clavicle [17]; bone massiveness indices, proportions and length of upper and lower limbs were calculated.

A reconstruction of *intra vitam* stature was performed using regression formulas according to, among others, M. Trotter & G. Gleser, Hauser et al., Ross & Konigsberg and G. Vercellotti et al.[18]. The authors used only those formulas

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[11] G. Acsadi, J. Nemeskeri, *History of human life span and mortality*, Budapest 1970; J. Piontek, *Biologia populacji pradziejowych*, Poznań 1985, pp. 134–143; T. D. White, P. A. Folkens, *The Human Bone Manual*, Academic Press 2005.

[12] J. E. Buikstra, D. H. Ubelaker, *Standards for Data Collection from Human Skeletal Remains*, Fayetteville 1944 (Arkansas Archeological Survey Research Series, 44).

[13] D. R. Brothwell, *Digging Up Bones*, Natural History Museum Publications, London 1981.

[14] T. W. Todd, *Age changes in the pubic bones: I. The white male pubis*, „American Journal of Physical Anthropology" 1920 vol. 3, pp. 467–470; C.O. Lovejoy, *Chronological metamorphosis of the auricular surface of the ilium: a new method for the determination of adult skeletal age at death*, „American Journal of Physical Anthropology" 1 (1985), pp. 15–28; T. D. White, P. A. Folkens, *The Human Bone*…, op. cit.

[15] A. Malinowski, W. Bożiłow, *Podstawy antropometrii. Metody, techniki, normy*, Warszawa–Łódź 1997, p. 303; T. D. White, P. A. Folkens, *The Human Bone*…, op. cit.; J. Piontek, *Biologia populacji*…, op. cit.

[16] R. Martin, K. Saller, *Lehrbuch der Anthropologie*, Stuttgart 1957–1959.

[17] J. Piontek, *Biologia populacji*…, op. cit.

[18] G. Vercellotti et al., *Stature Estimation in an Early Medieval* (*11th-12th c.*) *Polish Population: Testing the Accuracy of Regressions Equations in a Bioarcheological Sample*, „American Journal of Physical Anthropology" 140 (2009), pp. 135–142.

the application of which was possible in view of the bone's condition of preservation.

Confidence intervals for stature were calculated according to the formula:

$$95\%\ \text{CI}: \hat{y}_i \pm (t_{0,05,n-2} * (\hat{s}_y)_i)$$

$\hat{\mathbf{y}}_i$: estimated stature for individual (i);
$\mathbf{t}_{0.05,n-2}$: critical value of distribution t for significance level 0.05 for (n-2) degrees of freedom;
$(\hat{\mathbf{s}}_y)_i$: standard error calculated for individual (i)
$\hat{\mathbf{s}}_y$ was calculated for the individual and the group according to formulas:

$$(\hat{s}_y)_i = \sqrt{(s^2_{\hat{y}x}) * [1 + \frac{1}{N} + \frac{(x_i - \bar{x})^2}{\Sigma x 2}}$$

$$(\hat{s}_y)_n = \sqrt{(s^2_{\hat{y}x}) * [\frac{1}{n} + \frac{1}{N} + \frac{(x_i - \bar{x})^2}{\Sigma x 2}}$$

s^2_{yx}: mean square deviation;
x_i: bone length measurement value for the individual;
x_n mean length bone value for the group;
n: sample size;
Σx^2: adjusted sum of squares calculated according to formula $(\Sigma x^2 = {}^2 * (N-1))$

On the basis of long bone measurements, bone massiveness and pilaster indices were obtained, according to the following formulas[19]:

Clavicula: circumference in the middle*100/maximum length
Humerus: minimum circumference*100/maximum length
Ulna: minimum shaft circumference*100/physiological length
Radius: minimum shaft circumference*100/physiological length
Femur: (sagittal section + transverse section)*100/physiological length
Tibia: maximum width of the proximal epiphysis*100/maximum length

[19] A. Malinowski, W. Bożiłow, *Podstawy antropometrii…*, op. cit., pp. 193–200; J. Piontek, *Biologia populacji…*, op. cit., pp. 104–112.

Pilaster: (reflecting the extent to which the *linea aspera* of the femoral epiphysis is developed): sagittal section of the shaft*100/transverse section of the shaft

On the basis of measurement data, Index of Sexual Dimorphism (ISD) according to Borgognini & Repetto's formula (1986) for measurements and indices of the skull and post-cranial skeleton were calculated with the formula[20]:

$$\text{ISD} = \frac{\overline{M} - \overline{F}}{\overline{M}} * 100\%$$

$\overline{M}$ mean value of the feature for males

$\overline{F}$ mean value of the feature for females

Age structure of the skeletal series was analysed based on the biometric functions of the life expectancy table[21]. Its parameters were calculated allowing for child count underestimation adjustment applied by Henneberg (1977)[22]. This enabled the palaeodemographic analysis of the series. The following indices were calculated[23]:

R_{pot} – potential reproduction index, being a measure of the likelihood of the group's limited reproductive abilities due to individuals' mortality at reproductive age

l_x – the fraction of individuals surviving up to the early 'x' years of age class

q_x – the probability of death at the age of x

L_x – the number of years survived by all persons aged x

T_x – total number of the remaining years of life for all individuals aged x

e_x – remaining life expectancy for persons aged x

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[20] T. S. Borgognini, M. E. Repetto, *Methodological considerations on sexual dimorphism in past human populations*, „Human Evolution" 1 (1986), pp. 51–66.

[21] M. Henneberg, *Notes on the reproduction possibility of human prehistorical populations*, „Przegląd Antropologiczny" 41 (1975), pp. 75–89.

[22] M. Henneberg, *Proportion of dying children in paleodemographcal studies*, „Przegląd Antropologiczny" 43 (1977), pp. 105–114.

[23] J. Strzałko, M. Henneberg, J. Piontek, *Populacje ludzkie jako systemy biologiczne*, Warszawa 1980, p. 109.

Results

Sex and age structure of Garbary inhabitants

The analysis covered 111 skeletons, 51 of which were male, 40 female, with 13 skeletons of individuals below the age of 15. For 7 remaining skeletons of adult individuals the sex was not determined. The number of individuals in each age category grouped according to sex was presented in Table 1 and Figure 3.

Table 1. Age and sex structure in Garbary skeletons

Biological age	female	male	indeterminate	Total N	Total %
Infans I	–	–	5	5	4.50
Infans II	–	–	8	8	7.21
Juvenis	3	1	1	5	4.50
Adultus	7	5	–	12	10.82
Adultus/Maturus	4	2	–	6	5.41
Maturus	13	30	1	44	39.64
Maturus/Senilis	3	2	–	5	4.50
Senilis	6	4	–	10	9.00
Adult	4	7	5	16	14.41
Total	**40**	**51**	**20**	**111**	100.00

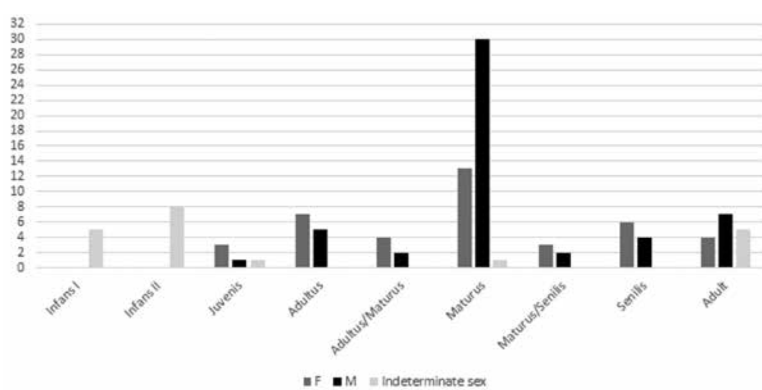

Fig. 3. Age and sex structure in Garbary skeletons (number of individuals)

Cranial measurements and indices

Basic cranial indices are shown in Table 2.

Considering mean values of calculated indices, we may conclude that the Garbary series is characterised by short skulls according to the main index, low-arched as per the length-width index, with medium-sized eyes (frontal-width index)[24]. According to the height-length index, female skulls are medium high, and male skulls are high. Kočka index classifies skulls as low. The facial skeleton in both sexes could be described as broad (total facial index) and medium high in the view of the upper-facial index, with medium-sized orbits (orbital index) and a nose which is broad in females and medium broad in males (nasal index). Nevertheless, the variability range of each index reveals a very high diversity of the proportions and shapes of the skull in the series. This was previously reported by I. Kopernicki[25]. This diversity is illustrated by the arrangement of individual items within clusters (Figures 1 and 2).

Neurocranial parameters provided the basis for designating two clusters sharing a small common section (Fig. 1). The first cluster groups male skulls, mostly from the 1872 studies. The second cluster contains skulls of both sexes, from Kopernicki's studies as well as from the year 2012. The second cluster comprises individuals from both groups, which indicates that the presented neurocranial features share a common area. Extreme values are found for two individuals: a male (studies of 1972) with a long and narrow skull, and a woman (studies of 2012) with a short and narrow skull. A considerable percentage of male skulls from the studies of 1872 are elongated or even long-headed. Male skulls are wider and higher, whereas female skulls are noticeably narrower and shorter.

Two clusters were also designated based on the dimensions of the facial skeleton (Fig. 2). One cluster is represented by three females (studies of 1872), whose faces were narrow (zy-zy) and short (n-pr). The other cluster comprises skulls of individuals of both sexes, with clearly distinguished male and female skull series. This is primarily the effect of sexual dimorphism. One female skull (studies of 1872) reveals strongly male features in the facial skeleton and was accordingly placed in the 'male' part of the cluster.

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[24] A. Malinowski, W. Bożiłow, *Podstawy antropometrii*…, op. cit., pp. 182–189.

[25] I. Kopernicki, *Czaszki przedmieszczan*…, op. cit.

Table 2. Garbary. Cranial indices

Index		**female skulls**							**male skulls**							**M-F***
		N	$\bar{x}$	s^2	**SD**	**min**	**max**	**CV**	**N**	$\bar{x}$	s^2	**SD**	**min**	**max**	**CV**	
main	(eu-eu):(g-op)	31	84.87	16.11	4.01	78	96	4.73	31	83.32	22.42	4.74	74	93	5.68	−1.55
height-length	(ba-b):(g-op)	27	73.70	12.60	3.55	69	82	4.82	28	75.75	15.16	3.89	68	83	5.14	2.05
height-width	(ba-b):(eu-eu)	27	87.59	14.32	3.78	80	95	4.32	28	90.71	26.51	5.15	79	100	5.68	3.12
frontal-width	(ft-ft):(eu-eu)	30	66.93	6.27	2.50	62	71	3.74	31	68.03	12.83	3.58	59	76	5.26	1.10
total face	(n-gn):(zy-zy)	4	84.5	8.33	2.88	81	88	3.42	4	83.25	10.92	3.30	81	88	3.97	−1.25
upper-facial	(n-pr):(zy-zy)	14	51.93	15.46	3.93	45	60	7.57	9	51.44	11.78	3.43	48	59	6.67	0.49
orbital	(sbk-spa):(mf-ek)	19	80.37	47.69	6.91	68	94	8.59	26	78.69	50.70	7.12	65	95	9.05	−1.68
nasal	(apt-apt):(n-ns)	19	51.32	15.11	3.88	44	60	7.58	22	49.82	13.77	3.71	44	56	7.45	−1.5
Kočka	(ba-b) *2:[(g-op)+(eu-eu)]	28	71.01	22.26	4.72	65	85.53	6.64	29	75.84	54.12	7.36	65	88	9.70	4.83

* M-F: difference between the value of the feature in males and females

Table 3. Maximum lengths (measurement M1 acc. to R. Martin) [mm] of the long bones on the right and left body side in male and female series (grave numbers as per archaeological documentation)

Individual no.	Sex	left side							right side						
		Clavicula M1	Humerus M1	Radius M1	Ulna M1	Femur M1	Tibia M1	Fibula M1	Clavicula M1	Humerus M1	Radius M1	Ulna M1	Femur M1	Tibia M1	Fibula M1
3	m			249		474					248	275	476		
6.1	m												391		
12	m					456	356		133	331	240	265	457	356	
13	m	146	315	228	247	416	345	343	135	315	232	250	414	341	336
14	m						370							372	
23	m		296			432									
24	m			254			372		131	328	255	276		377	
26	m					423		326						332	
27.2	m		325						147	330	235		425		
30	m						355							353	
31	m					428	354	340						350	338
30, 34-36.2	m														
34, excavation II	m						355						438	357	
40 I (ind. 1)	m					441	345	325					442	349	
40 I (ind. 2)	m					427									
41.3	m					447	347						450	345	
2	f			238					125					310	
7	f	133	311	223	244	440	360		132	316		245	431		
11	f			202	214	400	305						400		
27a 28	f											270			345
28	f	121	302		238					290			432	345	331
38	f													302	292
39.1	f			214					124						
39.2	f										195	214	377		
39 Cd.	f		293			407	297			299		237	409		
41.1	f					404	369						414		

Analysis of long bone measurements

Long bone measurements allowed us to analyse symmetry only in the instances where right and left limb parts of the individual were preserved. Measurements are included in Table 3.

The F test revealed no statistically significant differences ($p>0.05$) between the maximum long bone length on the right and left side of the body in females and males. However, a small individual asymmetry is observable in the maximum long bone length between females and males. The asymmetry was present in most analysed sections in individuals 13 and 7, whose long bones are completely preserved. In both cases the shoulder girth contains longer left clavicle, whereas long bones of the upper limb are longer on the right side. Measurements of preserved lower limb bones indicate left-side domination.

When basic long bone measurements have been performed, for every individual whose bones were properly preserved upper limb length was separately calculated as a sum of the physiological length of the humerus (M2) and the radius (M2), as well as lower limb length as a sum of the physiological length of the femur (M2) and the maximum length of the tibia (M1). Next, limb proportions and massiveness indices were calculated. The results are presented in Tables 4–6.

Table 4. Garbary. Length [mm] of upper and lower limbs in male and female series

Individual no.	Sex	Upper limb		Lower limb	
		left	right	left	right
7	f	521	523	790	–
11	f	–	–	694	–
28	f	511	–	–	770
39	f	–	–	695	–
41.1	f	–	–	764	–
3	m	–	581	–	–
12	m	–	–	800	801
13	m	530	532	753	746
24	m	–	571	–	–
27.2	m	–	549	–	–
31	m	–	–	773	–
40 I	m	–	–	776	782
41.3	m	–	–	786	786

Individuals whose analysed right- and left-side sections were preserved to the extent which enabled the comparison of limb length display a small, statistically insignificant ($p>0.05$) limb length asymmetry. A comparison of upper right and upper left limb bones was possible in the case of two individuals (asymmetry with right-side domination), whereas a comparison of lower limb lengths was possible for four males (asymmetry with right-side domination or lack of asymmetry). Only in the case of individual 13 the condition of the material enabled us to observe length asymmetries and expressed by the index of proportion for upper and lower limb sections, dependent mostly on greater length of the bones of the right forearm (radial and ulnar) and lower left limb bones (cf. Table 3).

Table 5. Garbary. Limb proportion indices in male and female series

Individual no.	Sex	left side					right side				
		R-H	T-F	H-F	R-T	across limbs	R-H	T-F	H-F	R-T	across limbs
3	m	–	–	–	–	–	72.51	–	74.03	–	–
12	m	–	80.18	–	–	–	72.51	80.00	74.38	67.42	–
13	m	72.38	84.56	77.21	66.09	70.38	73.65	84.20	77.78	68.04	71.31
24	m	–	–	–	68.28	–	77.74	–	–	67.64	–
27.2	m	–	–	–	–	–	71.21	–	79.52	–	–
31	m	–	84.49	–	–	–	–	–	–	–	–
40 I	m	–	80.05	–	–	–	–	80.60	–	–	–
41.3	m	–	79.04	–	–	–	–	78.23	–	–	–
7	f	71.70	83.72	72.33	61.94	65.95	–	–	74.88	–	–
11	f	–	78.41	–	66.23	–	–	–	–	–	–
28	f	–	–	–	–	–	–	81.18	68.24	–	–
39 cd.	f	–	74.62	73.62	–	–	–	–	75.13	–	–
41.1	f	–	93.42	–	–	–	–	–	–	–	–

R-H: (Radius-Humerus) – radial-humeral index
T-F: (Tibia-Femur) – tibial-femoral index
H-F: (Humerus-Femur) – humeral-femoral index
R-T: (Radius-Tibia) – radial-tibial index
(H+R): (F+T) – inter-limb index

Limb proportions were expressed by means of the following indices: radial-humeral and tibial-femoral (Table 5). According to the former, which refers to the upper

Table 6. Garbary. Bone massiveness indices in male and female series

Individual no.	Sex	left side							right side						
		Clavicula	Humerus	Ulna	Radius	Femur	Tibia	Pilaster	Clavicula	Humerus	Ulna	Radius	Femur	Tibia	Pilaster
3	m				19.50	14.72		94.29		20.47	18.37	19.83	14.07		103.13
6.1	m												13.95		89.29
6.3	m		20.24					106.06							
8	m		20.00							19.81					
12	m					12.61	21.63	115.38	39.85	20.85	19.57	20.78	13.93	21.07	100.00
13	m	23.97	19.68	15.84	18.10	13.97	22.32	128.00	25.19	19.68	16.96	17.41	14.07	22.58	111.11
14	m													20.16	
23	m		18.58					92.86							
24	m				18.85			85.71	27.48	21.34	16.80	17.55		20.42	122.22
26 related to	m							125.00						20.48	
27.2	m		20.92						23.81	21.21			14.70		84.85
30	m													19.83	

31	m					12.65	20.62	112.00						20.57	
34 excavation II	m						15.77							18.77	103.70
39.3	m														
41.3	m					13.90	20.46	90.63					14.06	20.58	93.75
40 I	m					12.76		89.66					12.70	19.48	89.66
40 I	m					15.63		116.67							
2	f				19.48									21.61	
7	f	26.32	19.29	15.45	18.60	13.49	18.33	100.00	25.76	18.99	15.00	18.69	13.03		96.43
11	f			18.82	18.13	12.85		100.00					12.33		100.00
27 a 28	f														
28	f	26.45	19.87	17.79	19.05					20.00			12.47	11.30	96.30
38 small	f													20.86	
39.1	f				18.54				26.61						115.38
39.2	f										18.33	18.18	13.89		88.89
39 cd.	f		19.45			13.82	20.88	96.43		19.06	17.21		14.07		107.41
41.1	f					13.67	19.78	92.86					14.11		90.00
excavation II, loose bones	f								26.83						

limb, the forearm is short, with the exception of individual 24, whose forearm is medium[26]. In terms of the tibial-femoral index, left-side bones proved proportionally slightly longer; the humeral-femoral index reached slightly higher values on the right side. The radial-tibial index is higher in individual 13 for left-side bones, whereas in individual 24 – for the right side.

Bone massiveness indices were calculated according to formulas shown on page 7.

The greatest range of variability is displayed by the pilaster index, which expresses the growth of the *linea aspera* in the femur, ranging from zero (e.g. individuals 6,1; 23; 27) through poor (individuals 6,3; 34; 40; 41), through medium (individuals 31; 40 I) to strong pilaster (individuals 13; 24; 26), with frequent variations in the degree of development in right and left body side for the same individual. Female bones were characterised either by the absence (individuals 7; 28; 39,2; 39 cd.; 41.1) or a weakly developed *linea aspera* (individuals 7; 11; 39 cd.), except for one individual (39.1), who displayed medium pilaster. The radial bone had the smallest diversity in terms of massiveness in both sexes. Female clavicles are massive, while male clavicles are medium to massive[27].

Shoulder breadth was established on the basis of the length of the clavicle[28]. In the analysed population male shoulders were broader by 37 mm on average than female shoulders. The differences were statistically significant (p=0.01) at the level determined by a 95% confidence interval. The results are included in Table 7.

Table 7. Garbary. Shoulder breadth [mm] in male and female series

Individual no.	sex	shoulder breadth
12	m	360
13	m	375
24	m	355
26	m	390
2	f	330
7	f	345
28	f	325
39.1	f	330
excavation II, loose bones	f	322

[26] A. Malinowski, W. Bożiłow, *Podstawy antropometrii…*, op. cit., pp. 195–196.
[27] A. Malinowski, W. Bożiłow, *Podstawy antropometrii…*, op. cit., pp. 193–194.
[28] J. Piontek, *Biologia populacji…*, op. cit.

Reconstruction of intra vitam stature

Regression formulas proposed by various authors were used. Values calculated according to M. Trotter & G. Gleser's regression formulas are shown in Table 8[29].

Reconstructed stature values based on Vercellotti's (2005) regression formulas are listed in Tables 9 and 10.

Reconstructed stature values are presented in section 1 of Tables 9 and 10 for individuals in the case of whom all long bones in the condition allowing measurements to be taken and appropriate regression formulas to be used. Section 1a of tables shows the results of reconstructed *intra vitam* stature for individuals whose skeletons contained only single long bones of the lower or upper limb.

Highest stature values for individuals were estimated on the basis of the maximum length of the humerus and physiological length of the femur, which is used in reconstructing stature by means of the anatomical method. The regression formula for the humerus and the tibia provided the highest mean stature estimations.

Statures were also reconstructed with the use of regression formulas proposed by other authors; such formulas were based on the measurements of the maximum length of the femur. The values obtained are presented in Tables 11 and 12 as well as Figures 4 and 5.

No statistically significant differences (p=0.06) between mean *intra vitam* stature values determined on the basis of femur length calculated according to various methods applied in osteological research were found. The highest estimated stature was provided by regression formulas by Bach (1965) and Hauser et al. (2005).

Differences between mean stature in the male series estimated on the basis of the femur and calculated by various methods are statistically insignificant (Table 12). Highest reconstructed *intra vitam* statures were provided by regression formulas by Černy and Komenda (1982), Trotter and Gleser (1952, 1958), while the Pearson's (1899) formula supplied the lowest values.

[29] M. Trotter, G. C. Gleser, *Estimation of Stature from Long Bones of American Whites and Negroes*, „American Journal of Physical Anthropology" 10 (1952), pp. 463–514.

Table 8. Garbary. Stature [cm] of male and female series estimated according to Trotter and Gleser method

Females						
Individual no.	**Femur** 2.38*F+61.41	SD	**Tibia** 2.52*T+78.62	SD	**Humerus** 3.08*H+70.45	SD
2	–		144.43		–	
7	161.67		158.93		163.31	
11	152.9		142.9		–	
28	160.8		154.58		157.43	
38	–		142.11		–	
39.2	147.22		–		–	
39 cd.	154.87		140.66		157.43	
41.1	155.12		161.54		–	
Without no.	162.53		–		–	
$\bar{x}$	**156.45**	5.55	**149.32**	8.76	**159.39**	3.40
Males						
Individual no.	**Femur** 2.38*F+61.41	SD	**Tibia** 2.52*T+78.62	SD	**Humerus** 3.08*H+70.45	SD
3	174.46		–		175.79	
6.1	154.47		–		–	

6.3	–		–		173.94	
8	–		–		167.93	
12	170.06		168.33		172.4	
13	160.18		165.06		167.47	
14	–		172.11		–	
23	164.23		–		161.68	
24	–		017.00		171.47	
26	162.08		162.28		–	
27.2	162.56		–		171.32	
30	–		167.83		–	
31	163.27		167.32		–	
34 excavation II	165.65		168.33		–	
40 I	166.49		166.06		–	
40 I	163.04		–		–	
41.3	168.15		165.81		–	
Without no.	–		169.84		–	
Without no.	167.8		–		–	
Without no.	168.51		–		–	
$\bar{x}$	**165.07**	4.83	**167.82**	3.09	**170.25**	4.44

Table 9. Garbary. Stature [cm] in the male and female series estimated using Vercellotti's method according to the length of the bones of the lower limb.

	Lower limb													
	Males													
	Individual no.	**Femur + Tibia** 1.50*(Fem2 + Tib) + 46.9	**95% CI** $(\hat{s}y)i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Femur** 2.70*Fem2 + 48.1	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Tibia** 2.91*Tib + 63.1	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$
1	12	167.05	8.17			168.25	6.32			166.70	2.32		
	13	158.80	8.71			157.45	6.87			162.33	2.27		
	31	162.25	7.31			161.23	5.96			164.95	1.98		
	40 I	164.20	7.25			165.01	5.80			164.66	1.97		
	41.3	164.80	7.35			167.17	6.09			163.50	2.03		
	$\bar{x}$	**163.42**		**3.10**	**4.93**	**163.82**		**4.46**	**3.84**	**164.43**		**1.64**	**1.35**
1a	**Individual no.**					**Femur** 2.70*Fem2 + 48.1	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Tibia** 2.91*Tib + 63.1	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$
	3					172.84	19.49						
	6.1					150.7	18.76						
	14									171.35	6.56		
	24									172.81	6.87		
	26 related to cluster 21									159.71	7.46		
	27.2					160.15	16.20						
	30									165.82	6.24		
	34, excavation II									166.99	6.19		
	40 I					160.42	16.19						
	$\bar{x}$/SD					**161.03**		**9.08**	**13.50**	**167.34**		**5.16**	**4.37**

Females													
	Individual no.	**Femur + Tibia** 1.55*(Fem2 +Tib) + 39.0	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Femur** 2.89*Fem2 + 36.5	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Tibia** 2.79*Tib + 61.4	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$
1	7	160.21	16.66			158.46	5.87			161.84	12.00		
	11	146.57	17.29			148.92	6.16			146.50	12.31		
	28	158.35	16.04			159.33	6.07			157.66	11.44		
	39 cd.	146.73	17.22			151.52	5.62			144.26	12.86		
	41.1	158.82	16.18			153.26	5.43			164.35	12.54		
	$\bar{x}$/SD	**154.13**		**6.87**	**10.35**	**154.30**		**4.48**	**3.61**	**154.92**		**9.07**	**7.63**
1a	**Individual no.**					**Femur** 2.89*Fem2 + 36.5	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Tibia** 2.79*Tib + 61.4	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$
	2									147.89	40.70		
	38 (small box)									145.66	43.06		
	39.2					142.56							
	loose bones at NE from 40									159.61	48.08		
	$\bar{x}$/SD									**151.05**		**7.49**	**32.34**

95% CI (s_y)i: 95% confidence interval for estimated individual stature
SD: standard deviation
95% CI $(s_y)_n$: 95% confidence interval for estimated mean stature for the group

Table 10. Garbary. Stature [cm] in the male and female series estimated using Vercellotti's method according to the length of the bones of the upper limb

Upper limb													
Males													
	Individual no.	**Humerus + Radius** 1.51*(Hum+ Rad) + 82.9	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Humerus** 3.11*Hum + 67.7	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Radius** 1.92*Rad + 123	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$
1	3	171.99	6.55			174.06	3.93			170.62	3.43		
	12	169.12	5.82			170.64	3.37			169.08	3.31		
	13	165.50	6.98			165.67	4.05			167.54	3.66		
	24	170.93	6.12			169.71	3.36			171.96	3.89		
	27.2	168.22	5.91			170.33	3.36			168.12	3.48		
	$\bar{x}$/SD	**169.15**		**2.52**	**3.93**	**170.08**		**2.99**	**2.38**	**169.46**		**1.82**	**2.25**
1a	**Individual no.**					**Humerus** 3.11*Hum + 67.7	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Radius** 1.92*Rad + 123	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$
	6.3					172.20	34.14						
	8					166.60	29.42						
	23					159.76	34.77						
	$\bar{x}$/SD					**166.18**		**6.23**	**23.24**				

Females													
1	**Individual no.**	**Humerus + Radius** 1.72*(Hum + Rad) + 65.7	**95% CI** (Sy)i	**SD**	**95% CI** $(\hat{s}_y)_n$	**Humerus** 3.11*Hum + 63.0	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Radius** 3.45*Rad + 78.5	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$
	7	158.41				161.28				155.44			
1a	**Individual no.**					**Humerus** 3.11*Hum + 63.0	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$	**Radius** 3.45*Rad + 78.5	**95% CI** $(\hat{s}_y)_i$	**SD**	**95% CI** $(\hat{s}_y)_n$
	2									160.61	11.11		
	11									148.19	9.43		
	28					153.19							
	39.1									152.33	9.09		
	39.2									145.78	10.04		
	39 cd.					155.99							
	$\bar{x}$/SD					**154.59**		**1.98**		**151.73**		**6.51**	**7.82**

Table 11. Garbary. *Intra vitam* stature – female series [cm]

Method	N	$\bar{x}$	S^2	SD	min	max	CV
Pearson (1899)	6	152.69	16.11	4.01	146.17	156.87	2.63
Telkkä (1950)	6	155.45	13.80	3.71	149.42	159.32	2.39
Černy & Komenda (1982)	6	153.24	22.67	4.76	145.51	158.20	3.11
Hauser et al. (2005)	6	**157.13**	28.57	5.34	148.46	162.70	3.40
G. Vercellotti (2009)	6	153.93	35.57	5.96	144.25	160.15	3.87
Trotter & Gleser (1952, 1958)	6	155.49	25.98	5.10	147.22	160.80	3.28
Bach (1965)	6	**160.59**	7.34	2.71	156.19	163.41	1.69

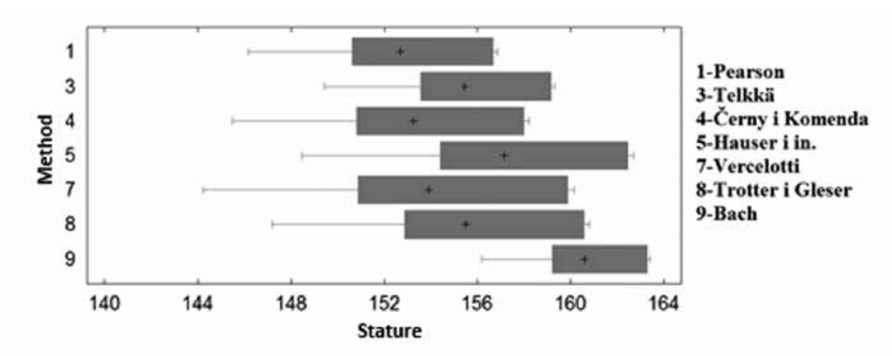

Fig. 4. Garbary. *Intra vitam* stature – female series [cm]

Table 12. Garbary. *Intra vitam* stature – male series [cm]

Method	N	$\bar{x}$	S^2	SD	min	max	CV
Pearson (1899)	18	162.82	16.60	4.07	154.81	170.79	2.50
Breitinger (1937)	18	165.63	12.71	3.56	158.63	172.61	2.15
Telkkä (1950)	18	164.90	20.71	4.55	155.96	173.81	2.76
Černy & Komenda (1982)	18	**166.38**	25.39	5.04	156.48	176.24	3.03
Hauser et al. (2005)	18	163.34	39.50	6.28	150.99	175.64	3.85
Ross & Konigsberg (2002)	18	165.88	26.21	5.12	155.82	175.90	3.09
Vercelotti (2009)	18	164.67	32.00	5.66	153.55	175.74	3.43
Trotter & Gleser (1952, 1958)	18	**166.12**	25.28	5.03	156.24	175.96	3.03

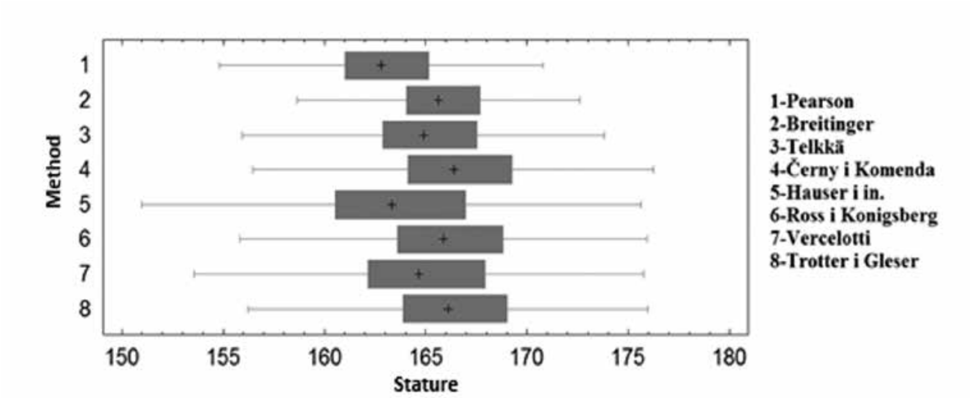

Fig. 5. Garbary. *Intra vitam* stature – male series [cm]

Sexual dimorphism

Values of metric features, cranial indices and postcranial skeleton indices were analysed; estimated *intra vitam* stature was also investigates. Values most representative of each designated group were selected for the assessment of dimorphic diversification. Sexual dimorphism indices for the long bones, the skull and cranial indices are included in Table 13. Somatic features are presented in Table 14.

The greatest dimorphic diversification in the facial skeleton is observable in the morphology of the orbits, the neurocranium (ba-b) and Kočka's index (Table 13).

The postcranial skeleton displays stronger dimorphic diversification in the long bones of the right side (maximum length of the radius, the circumference of the clavicle's epiphysis), massiveness index of the clavicle and the radial-tibial index. The length of the upper limb was more strongly diversified in terms of sexual dimorphism than the length of the lower limb. The greatest dimorphic differences in reconstructed stature were revealed in formulas by Černy and Komenda (Table 14).

Table 13. Sexual dimorphism indices for cranial indices and measurements

Neurocranium	F measurement	M measurement	**WDP** [%]
g-op	165.91	174.02	4.66
ba-b	124.23	136.36	**8.9**
eu-eu	144.59	146.39	1.23
ft-ft	97.60	98.59	1.00
Facial skeleton	F measurement	M measurement	**WDP** [%]
n-pr	65.41	67.90	3.67
mf-ek	37.91	40.1	5.46
orbital height	33.56	31.74	**-5.73**
n-ns	48.13	49.88	3.51
width of *apertura piriformis*	24.27	24.65	1.54
Cranial indices	F measurement	M measurement	**WDP** [%]
Main	84.87	83.32	-1.86
Height-length	73.70	75.75	2.71
Height-width	87.59	90.71	3.44
Frontal-width	66.93	68.03	1.62
Total facial	84.5	83.25	-1.50
Upper-facial	51.93	51.44	-0.95
Orbital	80.37	78.69	-2.13
Nasal	51.32	49.82	-3.01
Kočka	71.01	75.84	**6.37**

Table 14. Sexual dimorphism indices for post-cranial skeleton indices and measurements

Extracranial skeleton	F measurement	M measurement	**WDP** [%]
Maximum length of humerus R	302	327.33	7.74
Maximum length of humerus L	302	317.4	4.85
Smallest circumference of humerus R	57	64.36	11.43
Smallest circumference of humerus L	59.83	63.92	6.40
Maximum length of radius R	195	242	**19.42**
Maximum length of radius L	219.25	243.67	10.02
Smallest circumference of radius R	37.5	44	14.77
Smallest circumference of radius L	38.9	45.63	14.74
Maximum length of ulna R	241	266.8	9.67
Maximum length of ulna L	232	247	6.07

Smallest circumference of ulna R	35.78	42.9	16.60
Smallest circumference of ulna L	35.75	42	14.88
Maximum length of femur R	410.5	437.78	6.23
Maximum length of femur L	418	439.4	4.87
Maximum length of tibia R	321.25	354.00	9.25
Maximum length of tibia L	336.6	355.44	5.30
Maximum length of fibula R	330	337.00	2.08
Maximum length of clavicle R	126	136.40	7.62
Maximum length of clavicle L	127	146.00	13.01
Clavicle R shaft circumference	32.75	41.50	**21.08**
Clavicle L shaft circumference	34	37.86	10.20
bone massiveness indices	F measurement	M measurement	**WDP [%]**
Clavicular	27.8	26.4	**5.04**
humerus	20.27	19.33	4.64
ulna	17.6	17	3.41
radius	19	18.71	1.53
femur	13.93	13.3	4.52
pilaster	101.31	96.83	4.42
tibia	21.33	20.4	4.36
limb proportion indices	F measurement	M measurement	**WDP [%]**
T-F	79.37	80.7	-1.68
H-F	76.58	72.84	4.88
R-T	68.97	65.05	**5.68**
across limbs	70.82	69.22	2.26
upper limb length	552.6	518.33	**6.20**
lower limb length	778.11	742.6	4.56
shoulder breadth	367.75	330.8	**10.05**
stature (cm)	F measurement	M measurement	WDP [%]
T & G (F,T,H)	166.73	158.3	5.06
Vercelotti			
F+T	163.42	154.13	5.68
F	163.82	154.3	5.81
T	164.43	154.92	5.78
Pearson	162.82	152.69	6.22
Telkkä	164.9	155.45	5.73
Černy & Komenda	166.38	153.24	**7.90**
Hauser et al.	163.34	157.13	3.80
Vercelotti	164.67	153.93	6.52
Trotter & Gleser	166.12	155.49	6.40

Functional morphology

In order to evaluate build type, an analysis of markers of muscular-skeletal stress on bones was performed, i.e. at locations in which muscles, tendons and ligaments connect to the bone. Determining their stage of development (a 3-degree scale was assumed) allowed us to reconstruct the level of muscular activity[30].

Due to the pervasive incompleteness of postcranial skeletons, only stress markers on single bones could be observed, and a complex analysis of body build was possible in few cases[31].

For 4 skeletons of individuals aged below 15 the structure of bones complies with standards characteristic of their biological age.

A comparison of the development level of muscle attachments revealed that female skeletons are more delicately built, a finding consistent with sexual dimorphism analysis. Two of them deserve special attention. In skeleton 7 (*maturus*) there are strongly developed (level 3) attachments of muscles moving the shoulder joint, observable on the clavicle and the upper epiphysis of the humerus (scapula missing) on the right side. Much less developed are attachment locations of muscles moving the ulnar joint (level 1–2), also with a slight right-side domination. Individual 28's (*adultus*) upper and lower epiphyses of the humeral bones have very distinct attachment locations of muscles moving, respectively, the shoulder joint and the ulnar joint, albeit with a slight left-side domination. In all female skeletons the muscles of the girdle and the free section of the lower limb are poorly or weakly developed.

More diversity in terms of reaction to muscle stress is observed in male skeletons. Two skeletons, no. 13 (*adultus*), 24 and 27 (*maturus*) stand out from the male group. Individual 27 has particularly strongly developed muscle attachment location on the right clavicle and the right scapula (level 3) with rather delicately built bones of the left side. Other upper limb muscles were also poorly or weakly developed, with a slight right-side domination. In individual 13, shoulder girth muscles and muscles moving the ulnar joint and other joints of the upper limb are very strongly developed, with a slight left-side domination. Such developed muscle attachments in an *adultus* (20–30/35 year-old) individual indicate

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[30] E. Weiss, L. Corona & B. Schulz, *Sex Differences in Musculoskeletal Stress Markers: Problems with Activity Pattern Reconstructions*, „International Journal of Osteoarchaeology" 22 (2010), pp. 70–80.

[31] A. Lempart, *Morfologia funkcjonalna szkieletów z cmentarzyska na Garbarach w Krakowie*, Kraków 2014.

intensive physical activity already in an early period of life[32]. The musculature of individual 24, considering his sex, was relatively weakly developed (level 1–2). Quite strongly (level 2–3) developed, particularly on the right, are lower limb muscle attachments in skeletons 13 and 24.

Taking into account the fact that at least part of individuals buried at the graveyard at St Peter the Little's Church in Garbary originated from the same region, one may suppose that the type of build described above could have been shaped due to high level of physical activity related to everyday work.

Palaeodemography

Based on data from Table 1, bone material unearthed at the graveyard at St Peter the Little's Church in Garbary (Table 1) was subjected to palaeodemographic analysis. According to the procedure proposed by Henneberg[33], following the disaggregation of individuals whose biological age at death was not determined, a table (Table 15) presenting distribution of the deceased across biological age categories was created. Then, in order to identify various aspects of mortality processes, a life expectancy table (Table 16) was designed, based on the total number of deaths in each age class.

Table 15. Garbary. Number of individuals in age classes (N=111)

	N	%
Inf. I	5.00	4.50
Inf. II	8.00	7.20
Juv.	5.00	4.50
Ad.	15.20	13.69
Ad./Mat.	9.20	8.29
Mat.	47.20	42.52
Mat./Sen.	8.20	7.39
Sen.	13.20	11.90
Total	111.00	100.00

[32] D. Hawkey & C.F. Merbs, *Activity-induced musculoskeletal stress markers* (MSM) *and subsistence strategy changes among ancient Hudson Bay Eskimos*, „International Journal of Osteoarchaeology" 5 (1995), pp. 324–338.

[33] M. Henneberg, *Proportion of dying children*…, op. cit., pp. 105–114.

The division of individuals into classes according to age at death is shown in Fig. 6

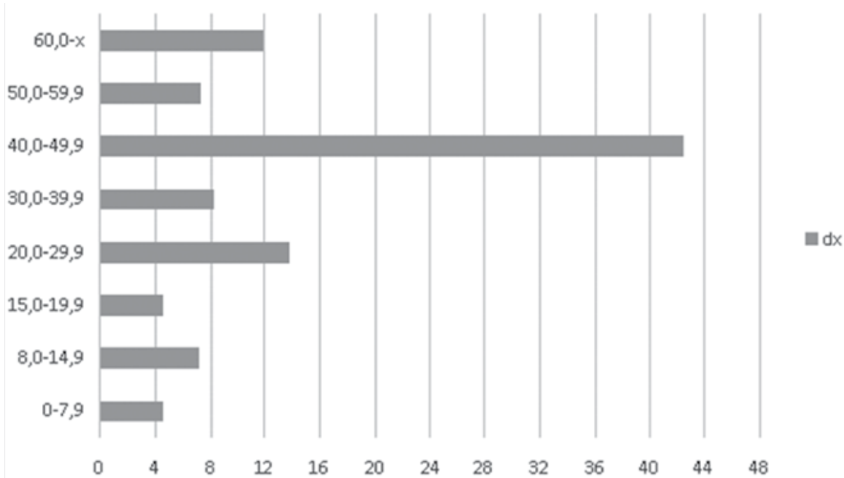

Fig. 6. Garbary. Age at death classes

Table 16. Life expectancy table for stationary population based on original material from Garbary (N=111)

age	d_x	l_x	q_x	L_x	T_x	e^o_x
0 – 7.9	4.50	100.00	0.01	781.98	3904.95	**39.05**
8.0 – 14.9	7.21	95.50	0.01	643.24	3122.97	32.70
15.0 – 19.9	4.50	88.29	0.01	430.18	2479.73	28.09
20.0 – 29.9	13.69	**83.78**	0.02	769.37	2049.55	**24.46**
30.0 – 39.9	8.29	70.09	0.01	659.46	1280.18	18.26
40.0 – 49.9	42.52	61.80	0.07	405.41	620.72	10.04
50.0 – 59.9	7.39	19.28	0.04	155.86	215.32	11.17
60.0 – x	11.89	11.89	0.10	59.46	59.46	5.00

Due to the unique character of material from this type of cemetery and a high probability that not all child skeletons could have been found, Henneberg's (1977) child count underestimation adjustment was applied, in which the author assumed that every woman gave birth to 7 children (Uc=7) on average, according to the non-Malthusian fertility archetype. The results are shown in Table 17.

Table 17. Life expectancy table for individuals from Garbary after child count adjustment (N=271.39)

age	D_x	d_x	l_x	q_x	L_x	T_x	e^o_x
0 – 7.9	66.69	24.57	100.00	0.03	701.71	2106.31	**21.06**
8.0 – 14.9	106.70	39.32	75.43	0.07	390.38	1404.60	18.62
15.0 – 19.9	5.00	1.84	36.11	0.01	175.95	1014.22	28.09
20.0 – 29.9	15.20	5.60	**34.27**	0.02	314.68	838.28	**24.46**
30.0 – 39.9	9.20	3.39	28.67	0.01	269.72	523.60	18.26
40.0 – 49.9	47.20	17.39	25.28	0.07	165.81	253.88	10.04
50.0 – 59.9	8.20	3.02	7.89	0.04	63.75	88.07	11.17
60.0 – x	13.20	4.86	4.86	0.10	24.32	24.32	5.00

A clear disproportion in the distribution of the age at death for *Infans I* and *Infans II* individuals in relation to the classic 3:1 ratio is noticeable.

A comparison of the population from the Garbary site in Krakow with diachronic and synchronic populations

Results obtained in a series of studies on modern-age skeletons from the Garbary graveyard (16th–19th c.) and in voivodeships: Wielkopolskie (Łekno village, modern-age population, graveyard chronology estimated between the 14th and 17th century and Giecz village: 11th–12th c.)[34], Kujawsko-Pomorskie (a graveyard in the village of Słaboszewo, modern-age population, dating back to the period between the second half of the 14th century and the first half of the 17th century), Zachodniopomorskie (the town of Cedynia, a late medieval graveyard, 13th–14th century), Warmińsko-Mazurskie (the city of Elbląg, 13th c.)[35]. The list comprises stature values estimated on the basis of the formula for the maximum length of the femur (Table 18) used in this study and applied by authors of publications on the biological condition of comparative populations.

[34] J. Piontek, B. Iwanek, S. Segeda, *Antropologia o pochodzeniu Słowian*, Poznań 2008, p. 31 (Monografie Instytutu Antropologii UAM, 12); G. Vercellotti et al., *Stature Estimation…*, p. 137.

[35] J. Piontek, B. Iwanek, S. Segeda, *Antropologia o pochodzeniu Słowian*, op. cit., pp. 32, 50.

Table 18. A comparison of stature [cm] of medieval and modern populations

Site	female series		male series	
	N	$\bar{x}$	N	$\bar{x}$
Giecz 16th-17th c.	20	157.21	40	172.37
Cedynia 18th-19th c.	19	161.6	22	170.8
Elbląg 18th c.	16	158.7	25	169.9
Garbary 15th-18th c.	7	156.4	14	165.07
Słaboszewo 14th-17th c.	65	155.3	72	164.6

Individuals from Garbary were shorter in stature than comparative populations. Only males and females from Słaboszewo were slightly shorter. Females from Cedynia were characterised by the highest stature in proportion to other populations. The value of the investigated characteristic of Garbary individuals was juxtaposed with the stature of medieval and modern Krakow populations. The results are presented in Fig. 7.

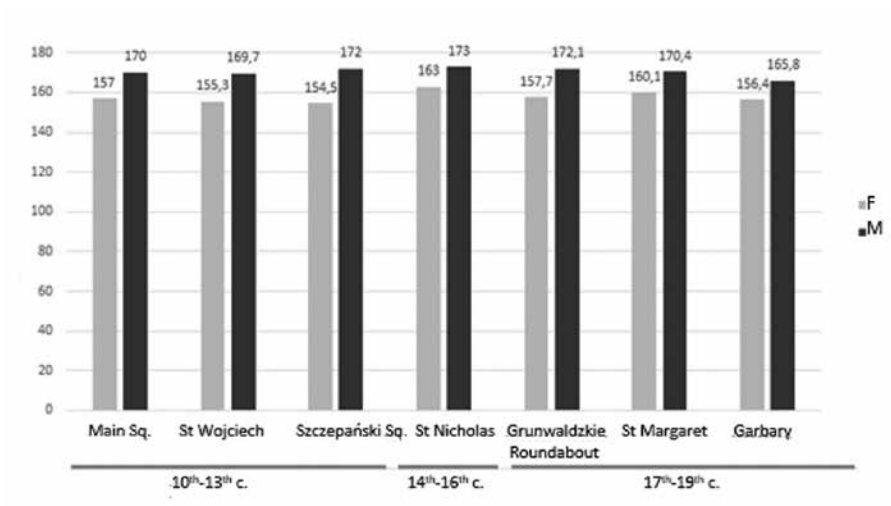

Fig. 7. Stature of inhabitants of medieval and modern Krakow[36]

The Garbary series was compared in terms of key palaeodemographic parameters with series of skeletons from the area of medieval and modern-age Krakow.

[36] K. Szostek et al., *Mieszkańcy Krakowa ostatniego millenium*, Conference materials 2013.

Table 19 contains a set of indicators of the biological condition of the juxtaposed series. Figures 8 and 9 show the distribution of indexes e_{20}^{o} and R_{pot}.

Table 19. Palaeodemographic parameters of Krakow and Wieliczka historical populations[37]

Site	Dating	N	d_{0-14}		R_{pot}	mat. orig.	after upward adjustment	
			mat. orig.	Uc=7		e_{o}^{o}	e_{o}^{o}	e_{20}^{o}
Zakrzówek	**16th-18th**		17.15	57.47	0.67	32.84	20.71	19.33
BVM's Church	**15th-18th**		1.87	63.48	0.78	44.21	21.94	26.66
St Anne's	**14th**		1.18	58.04	0.68	38.13	20.34	20.48
St Mark's	**13th-15th**	**93**	1.89	59.85	0.71	37.09	19.53	18.67
Szczepański Sq.	**15th-17th**	**39**	1.63	65.01	0.82	44.69	21.22	26.20
BVM's Church Crypt	**16th-18th**		0	67.94	0.89	49.02	21.40	31.11
St Bronislava's	**18th-19th**		13.85	65.14	0.82	40.79	21.67	29.30
Holy Cross Church, Wieliczka	**15th-18th**		5	53.3	0.62	34.76	21.08	19.26
Garbary	**16th-18th**	**111**	11.71	63.89	0.79	39.05	21.06	24.46
All Saints' Square	**17th-18th**		17.86	63.6	0.78	36.95	21.16	25.72
Main Square	**10th-11th**	**221**	-	59.13	0.70	-	18.64	20.31
St Wojciech's	**16th-18th**	**270**	-	62.82	0.77	-	24.16	26.98

The value of e_{20}^{o}, representing mean remaining life expectancy of 20 year-old individuals, is greatly diversified over the centuries. The Garbary individuals reached values approximating those of the series from the All Saint's Square. Those series are also similar to each other in terms of the R_{pot} ratio. The highest values of the investigated indicators were found for a series from the BVM's Church crypts, comprising individuals from the highest social strata. An analysis of each parameter in the expectancy table allows us to observe that the Garbary individuals did not represent the progressive population type. They were characterised by a high child mortality rate, and a medium potential reproduction

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[37] K. Kaczanowski, E. Wiśniewska, *The History of Cracow Population in the Light of Demographical Analysis*, [in:] Čs. Společnosti Anthropologickē, při Čs. akademii věd, Brno 1989, pp. 5–8; A. Przesmycka, *Dymorfizm płciowy mieszkańców nowożytnego Krakowa na podstawie analizy anatomo-antropologicznej szkieletów pochodzących ze stanowiska Garbary w Krakowie*, Kraków 2014.

ratio. However, in comparison to other Krakow populations, mean remaining life expectancy of twenty-year-olds approached one of the higher values.

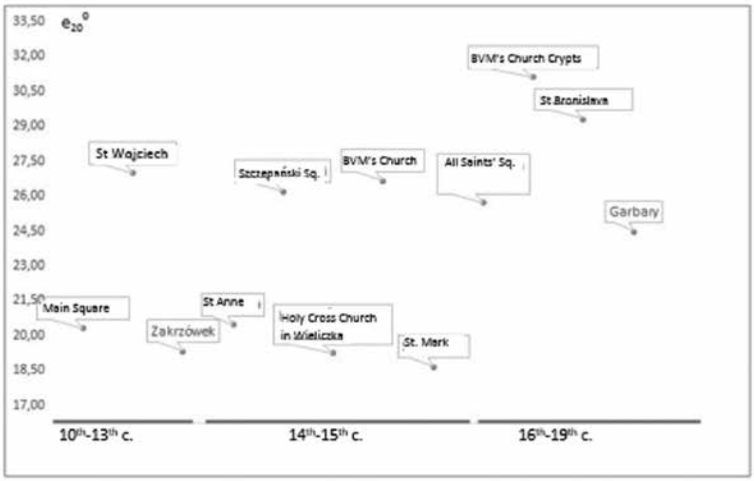

Fig. 8. A comparison of indicator e_{20}^{o} in medieval and modern-age Krakow series[38]

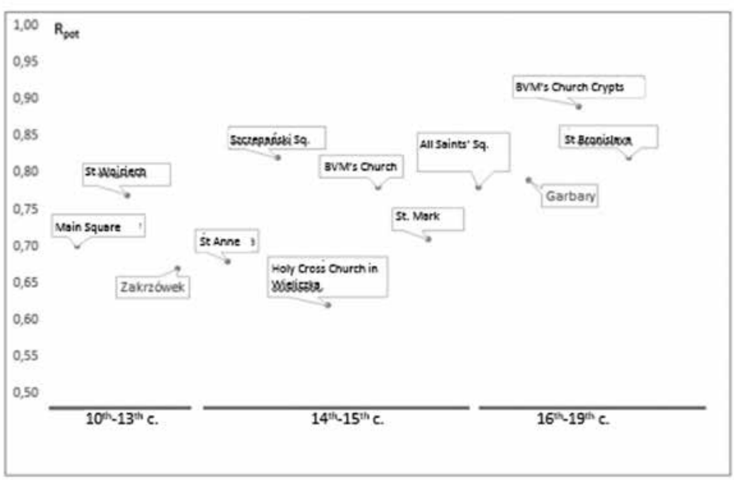

Fig. 9. A comparison of indicator R_{pot} in medieval and modern-age Krakow series[39]

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[38] K. Szostek et al., *Mieszkańcy Krakowa*…, op. cit.

[39] K. Szostek et al., *Mieszkańcy Krakowa*…, op. cit.

Conclusions

Despite a low item count and sometimes fragmentary condition of the analysed skeletal material, it was possible to characterise part of the population of the past inhabitants of Garbary. The study was based on the assessment of the individuals' sex and age. In the case of completely preserved skeletons, a macroscopic assessment of sexual dimorphism – manifested in a different development of traits corresponding to male and females sex – was successfully carried out. The investigated series contained mostly males at the age *maturus*. An analysis of the material by means of the biological distance method allowed us to confirm its homogeneity, albeit on the basis of the range of variability of each cranial index one may notice a diversity in the proportions and the shape of the skull. An analysis of symmetry conducted on the basis of postcranial skeleton measurements revealed a slight (or the absence of) individual asymmetry in lengths of body sections and bone massiveness. Reconstructed stature allowed us to evaluate the impact of socio-cultural factors on the biological structure of the population. The use of regression formulas proposed by various authors enabled a multi-planar reconstruction of this characteristic. Reconstructed female stature ranged from 149.32 cm (Trotter & Gleser, regression formula for the tibia) to 161.28 cm (Vercellotti, regression formula for the humerus). In contrast, male stature ranged from 164.43 cm (Vercellotti, regression formula for the tibia) to 170.25 cm based on the maximum length of the humerus (Trotter & Gleser). Individuals from Garbary nevertheless revealed differences in stature from comparative populations. An analysis of the muscular and skeletal stress markers on bones allowed us to observe that individuals aged below 15 did not display patterns untypical of their biological age; female skeletons were delicately built, whereas male skeletons had a varying level of the development of muscle attachments. For two of the analysed ratios (e_{20}°, R_{pot}) the Garbary individuals reached values nearest to the series from the All Saint's Square. A palaeodemographic analysis supplied a set of data on various aspects of mortality processes such as life expectancy, potential reproduction and probability of death.

ANNEX

Table 1. Mean measurement values for skulls from Garbary [mm] (study of 2012)

Measurement	Females							Males							M-F	Kruskal-Wallis	
	N	$\bar{x}$	s^2	SD	min	max	CV	N	$\bar{x}$	s^2	SD	min	max	CV		F	p
g-op	6	162.83	114.57	10.7	150	178	6.57	10	170.8	22.4	4.73	165	179	2.77	7.97	2.01	0.16
n-b	6	102.33	60.27	7.76	92	112	7.59	9	109.78	97.69	9.88	99	130.00	9.00	7.45	2	0.16
n-L	6	154.17	147.77	12.16	138	170	7.88	9	164.89	35.11	5.93	159	176	3.59	10.72	2.95	0.09
n-i	6	149.67	116.67	10.8	139	163	7.22	9	163.22	41.94	6.48	151	172	3.97	13.55	5.03	0.02
b-L	6	101.67	19.47	4.41	96	108	4.34	10	106.1	153.43	12.39	77	118	11.67	4.43	2.00	0.16
b-i	6	142.83	58.97	7.68	130.00	154	5.38	10	148.8	120.84	10.99	130	170	7.39	5.97	1.32	0.25
L-i	6	65.17	188.57	13.73	48	84	21.07	10	60.8	45.96	6.78	50	75	11.15	-4.37	0.14	0.7
L-o	5	87.8	34.2	5.85	83	96	6.66	10	90.8	13.73	3.71	84	96	4.08	3	1.26	0.26
i-o	5	37.6	242.3	15.57	17	56	41.40	10	41.8	32.84	5.73	30	50	13.71	4.2	0.18	0.67
L-ba	3	104	100	10	94	114	9.62	8	105.88	52.13	7.22	91	114	6.82	1.88	0.10	0.76
n-ba	3	90.33	12.33	3.51	87	94	3.89	7	103.14	158.48	12.59	92	128	12.21	12.81	3.85	0.04
ba-o	3	32.33	6.33	2.52	30	35	7.78	10	34.1	39.43	6.28	22	46	18.42	1.77	0.59	0.44
ba-b	3	123.67	69.33	8.33	117	133	6.73	8	138.88	219.27	14.81	118	170	10.66	15.21	3.79	0.051
po-b	6	131.5	219.1	14.8	118	157	11.26	10	129	39.33	6.27	118	139	4.86	-2.5	0.05	0.83
eu-eu	6	146.67	81.87	9.05	137	157	6.17	10	146.4	20.71	4.55	138	153	3.11	-0.27	0	1
ast-ast	4	114	78	8.83	106	126	7.75	10	114.5	32.06	5.66	108	123	4.94	0.5	0.13	0.72
ft-ft	6	99.5	31.5	5.61	94	108	5.64	11	96	26	5.10	86	104	5.31	-3.5	0.83	0.36

co-co	6	127	46.8	6.84	117	135	5.39	7	122.71	53.57	7.32	114	132	5.96	-4.29	1.01	0.32
au-au	4	118.75	5.58	2.36	117	122	1.99	8	127.5	29.43	5.42	120	135	4.25	8.75	6.12	0.01
ms-ms	4	97	11.33	3.37	93	101	3.47	7	102.29	35.9	5.99	96	111	5.86	5.29	1.78	0.18
sz.f.m	3	28.67	2.33	1.53	27	30	5.33	8	28	6	2.45	25	32	8.75	-0.67	0.39	0.53
head circ.	6	503.33	372.67	19.3	480	536	3.84	10	512.8	123.96	11.13	500	530	2.17	9.47	2.03	0.15
n-pr	2	65	8	2.83	63	67	4.35	7	65.71	17.9	4.23	59	70	6.44	0.71	0.09	0.76
n-ns	2	49	18	4.25	46	52	8.66	6	49.83	3.37	1.83	48	53	3.68	0.83	0.12	0.73
ol-sta	3	30.33	6.33	2.52	28	33	8.30	7	40	11.33	3.37	34	44	8.42	9.67	5.76	0.01
zm-zm	2	87.5	12.5	3.54	85	90	4.04	4	93	8.67	2.94	90	97.00	3.17	5.5	2.7	0.1
ek-ek	2	93.5	4.5	2.12	92	95	2.27	5	96.4	18.8	4.34	90	100	4.50	2.9	0.61	0.43
mf-mf	2	21.5	0.5	0.71	21	22	3.29	10	22.6	7.38	2.72	18	26	12.02	1.1	0.3	0.59
Mf-ek	-	-	-	-	-	-	-	10	38.2	7.28	2.70	32	42	7.07	-	-	-
orb. height	2	35.5	12.5	3.54	33	38	9.96	10	31.3	3.57	1.89	29	36	6.03	-4.2	3.9	0.04
sz.a.pr.	3	24	1	1	23	25	4.17	9	24.44	5.28	2.3	22	28	9.40	0.44	0.04	0.85
enm-enm	2	41.5	12.5	3.54	39	44	8.52	3	37.67	25.33	5.03	33	43	13.36	-3.83	1.33	0.25
ekm-ekm	2	63	18	4.24	60	66	6.73	3	61	64	8	53	69	13.11	-2	0	1
go-go	5	90.2	25.7	5.07	86	99	5.62	7	100	80.33	8.96	81	106	8.96	9.8	3.55	0.05
bicond.	3	112.33	2.33	1.53	111	114	1.36	3	120	13	3.61	116	123	3.00	7.67	3.86	0.04
gn-id	6	23.17	10.17	3.19	20	29	13.76	9	28.89	11.61	3.41	23	35	11.80	5.72	5.9	0.01
gn-go	6	81.17	80.17	8.95	70	91	11.03	8	88.38	26.55	5.15	76	93	5.83	7.21	2.91	0.08
enm-enm(m)	5	43	1.5	1.22	41	44	2.85	4	42	11.33	3.37	37	44	8.02	-1	0	1
ekm-ekm(m)	5	60.2	37.7	6.14	51	66	10.20	4	63.5	16.33	4.04	58	67	6.36	3.3	0.98	0.32

Table 2. Mean measurement values for selected skulls from Garbary (study of 1872)

Measurement	Females							Males						
	N	$\bar{x}$	s	min	max	Sx	v	N	$\bar{x}$	S	min	max	Sx	v
g-op	25	**169**	4.6	158	176	0.92	2.72	20	**177.8**	5.9	165	186	1.3	3.31
ba-b	24	**124.8**	4.9	117	135	1.0	3.92	19	**133.9**	4.0	123	140	0.9	2.98
po-b	25	**109.3**	3.9	102	117	0.78	3.56	20	**118.1**	8.7	103	135	1.9	7.36
eu-eu	25	**142.5**	2.9	138	150	0.58	2.03	20	**146**	4.9	138	155	1.08	3.35
ft-ft	24	**95.7**	2.9	91	103	0.59	3.03	20	**101**	4.7	95	111	1.04	4.65
co-co	24	**120.3**	5.1	110	129	1.04	4.2	20	**125.2**	4.9	115	132	1.08	3.91
n-gn	4	**108**	3.3	103	111	0.8	3.0	5	**116.2**	3.4	111	120	1.5	2.9
n-pr	17	**65.8**	4.2	55	73	1.02	6.4	10	**70.1**	3.4	66	78	1.1	4.8
n-ns	18	**47.3**	2.8	40	50	0.66	5.91	6	**49.9**	2.5	46	54	0.62	1.72
zy-zy	14	**125.2**	4.8	115	134	1.29	3.83	15	**135.5**	6.7	123	147	1.7	4.94
zm-zm	16	**91.8**	4.0	84	98	1.0	1.1	17	**95.6**	4.24	87	102	1.03	4.4
mf-ek	17	**39.8**	1.7	34	42	0.41	4.2	16	**42**	1.8	39	45	0.45	4.28
orb. height	19	**31.6**	2.1	28	35	0.5	6.6	16	**32.2**	2.1	29	37	0.52	6.5
a.pir.width	18	**24.5**	2.3	22	28	0.54	9.38	16	**25.5**	3.2	22	27	0.8	12.5

Abstract

The present work analyses the bone material unearthed at the graveyard of St Peter the Little's Church in Garbary. The study is based on research from the years 1978 and 2012. A total of 111 skeletons were analysed, all of them of medium condition, dating back to the modern period. The material's diversity level was verified by biological distance assessment. Ward's method was used for selected measurement features of the neurocranium and the facial skeleton. Sex and age were established simultaneously by means of methods commonly applied in anthropology. The assessment was based on the morphology of the skull and pelvic bones as well as the deciduous and permanent teeth eruption sequence. Cranial measurements and indices were subjected to analysis. Osteometric data provided the basis for an analysis of long bone symmetry, limb length and proportions and bone massiveness indices. A multi-planar reconstruction of individuals' stature was performed by means of regression formulas developed by various authors. Sexual dimorphism index served indirectly as a measurement of the living conditions of individuals in the population, whereas an analysis of muscular and skeletal stress markers on bones allowed us to evaluate build types. Calculated life expectancy table parameters were used to recreate e.g. individuals' lifespans and life expectancy structure (by age at death) characteristic of historical populations of Krakow.

Keywords

Garbary, stature, Index of Sexual Dimorphism, osteology

Streszczenie

Dawni mieszkańcy Garbar w ujęciu biokulturowym

W pracy dokonano analizy materiału kostnego wyeksplorowanego z obszaru cmentarza przy kościele św. Piotra Małego na Garbarach. Badania prowadzone były w latach 1978 i 2012. Analizie poddano 111 szkieletów, o średnim stanie zachowania, datowanych na okres nowożytny. Sprawdzono stopień różnorodności materiału z wykorzystaniem oceny odległości biologicznej. Zastosowano metodę Warda dla wybranych cech po-

miarowych mózgoczaszki i twarzoczaszki. Płeć i wiek zostały ocenione kompleksowo z zastosowaniem metod powszechnie przyjętych w antropologii. Wykorzystano ku temu morfologię czaszki i kości miednicznych, jak również sekwencję wyrzynania się zębów mlecznych i stałych. Analizie poddano pomiary i wskaźniki czaszek. W oparciu o pomiary osteometryczne wykonano analizę symetryczności kości długich, długości i proporcji kończyn oraz wskaźników masywności kości. Wielopłaszczyznową rekonstrukcję wysokości ciała osobników przeprowadzono przy użyciu równań regresji różnych autorów. Wskaźnik dymorfizmu płciowego pośrednio posłużył jako miara warunków życia osobników w populacji, natomiast analiza wyznaczników stresu mięśniowo-szkieletowego na kościach pozwoliła na ocenę typu budowy ciała. Obliczone parametry tablicy wymieralności posłużyły odtworzeniu m.in. długości życia osobników i struktury wymieralności według wieku zmarłych zachodzącej w jednej z dawnych populacji krakowskich.

Słowa kluczowe

Garbary, wysokość ciała, wskaźnik dymorfizmu płciowego, osteologia

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