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Research Article

Craniometric analysis of Early Medieval horses *Equus przewalskii* f. *caballus* (Linnaeus, 1758) from chosen areas in Poland

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Abstract: These studies were carried out on 14 adult (9 males and 5 females) *Equus przewalskii* f. *caballus* (Linnaeus, 1758) horses, using both the skulls and mandibles. All of the material originated from 3 Polish archaeological sites that date back to the Early Medieval period. The most extensive craniometrical investigations consisted of 40 skull measurements and 16 mandible measurements. In some cases, the conditions of the artifacts narrowed the number of accessible osteometric points. The aim of this study was an estimation of the craniometric measurement differences and an examination of their statistical importance according to animal sex, age, and origin. A statistical insignificance of animal sex, age, and origin on the skull and mandible craniometry was found ($P > 0.05$) among the Early Middle Age skeletal horse remains from the 3 investigated sites. Moreover, numerous analogies were demonstrated in some craniometric measurement mean values compared with the cranial remains of other horses dating back to the Early and Late Middle Ages, and with horses having the exterior preserved primal features of their European ancestors: Poleskie horses and Polish Konik horses.

Key words: Adult horses, craniometric measurements, skull, Early Middle Ages

Introduction

The beginning of archaeozoology dates back to the second half of the 19th century. Pioneering publications in this scientific area, devoted to the description of horse skeletal remains, were published by L. Rütimeyer, in the years 1860 and 1863. He was studying primitive horse forms and the probable period of their domestication on the basis of fossil bone remains from Switzerland (1–3). These works have outlined the main directions for archaeozoological research for a long time and many scientists have subsequently further developed the field of horse origin (4–9).

Nearly 150 years of study have not fully explained the issue of horse origins and the source of its wild equid ancestors, from which the different breeds of modern horses were developed. Therefore, their investigations still continue (8,10). The first papers

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on animal remains were published in Poland, in the 1880s (11); however, they were not properly appreciated by the scientific community.

In the 20th century, fossil bone material from archaeological sites began to be transmitted to experts for analyses (3,12).

The remains of Early Medieval horses in fossil materials are rare and are usually compared with other domesticated animals such as pigs or cattle, whose preservation degree often prevents a detailed analysis (1,13,14). Studies on equine craniometry have been carried out many times, both in Poland and in other countries (1,4,10,15–20).

The aim of this study was the presentation of craniometric measurement differences according to animal sex and the examination of the statistical significance of the influence of the factors considered, such as animal sex, age, and origin. In addition, the achieved craniometric parameters were compared with the analogue measurements in Early and Late Medieval European horses, as well as in Poleski Konik and in Polish Konik (2 Polish primitive horse breeds).

Materials and methods

The investigated material consisted of the measurable skull and mandible fragments of 14 Early Medieval *Equus przewalskii* f. *caballus* (Linnaeus, 1758) horses from 3 chosen Polish archaeological sites (Ostrówek, 10th–12th century; Ostrów Tumski, 11th–13th century; and Kruszwica, 10th–13th century). All of the material was a part of an archaeozoological collection from the Department of Biostructure and Animal Physiology, Faculty of Veterinary Medicine, Wrocław University of Environmental and Life Sciences. The skulls came from 6 males (Ostrówek, 2; Kruszwica, 1; and Ostrów Tumski, 3) and 3 females (Ostrów Tumski, 2 and Kruszwica, 1). The mandibles, classified as fossil material, were fewer in number, from 3 males (Kruszwica, 1 and Ostrów Tumski, 2) and 2 females (Kruszwica, 1 and Ostrów Tumski, 1).

The horse morphotype evaluation took under consideration the craniometric points and measurements according to von den Driesch (21). Measurements were done with the use of a spring caliper and an electronic slide caliper, with an accuracy of 0.1 cm.

The skulls were measured in 3 different views (Figures 1–3):

1) **A-P (*Akrokranion-Prosthion*)**, total skull length (measurement is also accessible in the lateral view); 8) **N-P (*Nasion-Prosthion*)**, lesser facial length; 9) **A-Sp (*Akrokranion-Supraorbitale*)**, upper cranial length; 10) **Sp-P (*Supraorbitale-Prosthion*)**, greater facial length; 16) **GLN***, greatest length of the nasals; 38) **Eu-Eu (*Euryon-Euryon*)**, maximal cranial width; 39) **GWF***, greatest width of the forehead; 40) **GWSF***, greatest width between the supraorbital foramina; 41) **Ect-Ect (*Ectorbitale-Ectorbitale*)**, frontal breadth; 42) **Ent-Ent (*Entorbitale-Entorbitale*)**, minimal width between the orbits; 43) **FW***, facial width; 44) **If-If (*Infraorbitale-Infraorbitale*)**, facial width between the infraorbital foramina; and 45)

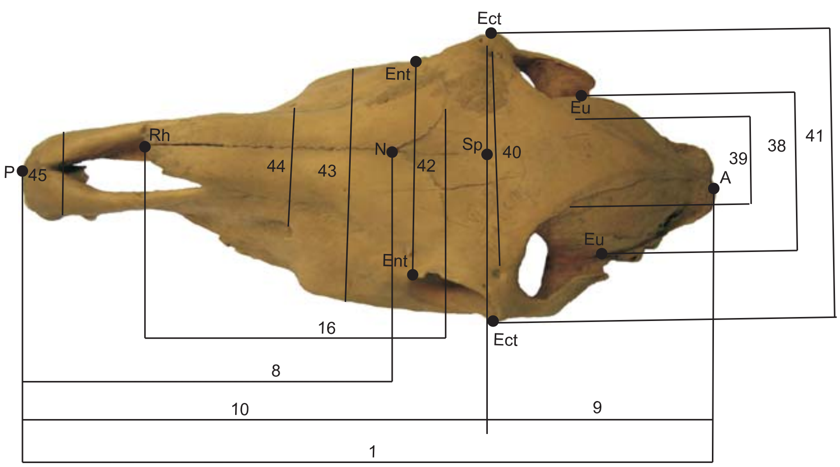

Figure 1. Craniometric measurements of Early Medieval horses (dorsal view).

MaxWMI*, greatest width of the muzzle portion measured after I^3 on both sides.

*Abbreviation introduced by the authors.

2) **CondBL***, condylobasal length; 13) **P-Ent (*Prosthion-Entorbitale*)**, greater facial length; 14) **O-Ect (*Opisthion-Ectorbitale*)**, lateral cranial length; 15) **Ect-P (*Ectorbitale-Prosthion*)**, lesser lateral facial length; 20) **Ni-P (*Nasointermaxillare-Prosthion*)**, lateral length of incisive bone; 21) **SDL***, superior diastema length; 22) **SChL***, superior cheektooth row length; 22a) **SChThCrL***, superior length of the cheektooth row measured along the crowns; 31) **Ect-Ent (*Ectorbitale-Entorbitale*)**, maximal internal length of the orbit; 32) **MaxWOR***, greatest width of the orbital ring; and 50) **MaxSH***, greatest (basion) skull height.

*Abbreviation introduced by the authors.

3) **B-P (*Basion-Prosthion*)**, basal length; 3a) **B-I^1 *Basion***, up to a point between 2 I^1, basilar length; 4) **B-Pm (*Basion-Pramorale*)**, lesser cranial length; 5) **B-H (*Basion-Hormion*)**, basocranial axis; 6) **P-H (*Prosthion-Hormion*)**, basofacial axis; 11) **B-ESCr***, dimension between the ***Basion*** and the most dorsal located point of the external sagittal crest lateral measurement view; 12) **P-ESCr***, dimension between the ***Prosthion*** and the most dorsal located point of the external sagittal crest lateral measurement view; 17) **B-St (*Basion-Staphylion*)**; 18) **St-P (*Staphylion-Prosthion*)**, palatal length; 18a) **CHP***, dimension between the choana and ***Prosthion***; 19) **Pd-P (*Postdentale-Prosthion*)**, dental length; 23) **SMThL***, superior molar teeth row length; 24) **SPmThL***, superior premolar teeth row length; 46) **MaxWIB***, greatest width of incisive bones; 47) **MinWD***, least width of the diastema; and 48) **MaxPW***, greatest palatal width.

*Abbreviation introduced by the authors.

Figure 4. Osteometric mandible measurements of Early Medieval horses (lateral view).

1) **Id-Goc (*Infradentale-Gonion caudale*)**, mandible length; 2) **CondL***, condylar length; 3) **Goc-ChThRB***, dimension between the **Goc (*Gonion caudale*)** and the most rostral located cheektooth alveolus border; 4) **Id-ChThRB***, dimension between the **Id** (***Infradentale***) and the most rostral located cheektooth alveolus border; 5) **Goc-ChThRBB***, dimension between the **Goc** (***Gonion caudale***) and the most rostral cheektooth alveolus border; 6) **IGChThL***, inferior greater cheekteeth row length **I_1-M_3**; 6a) **ILChThL***, inferior lesser cheekteeth row length, measured along the crowns; 7) **IMThL***, inferior molars row length; 8) **IPmThL***, inferior premolars row length; 15) **IDL***, inferior diastema length; 19) **Gov-Cond***, dimension between the **Gov (*Gonion ventrale*)** and the most dorsal point of the condyloid process; 20) **Gov-MdNt*** dimension

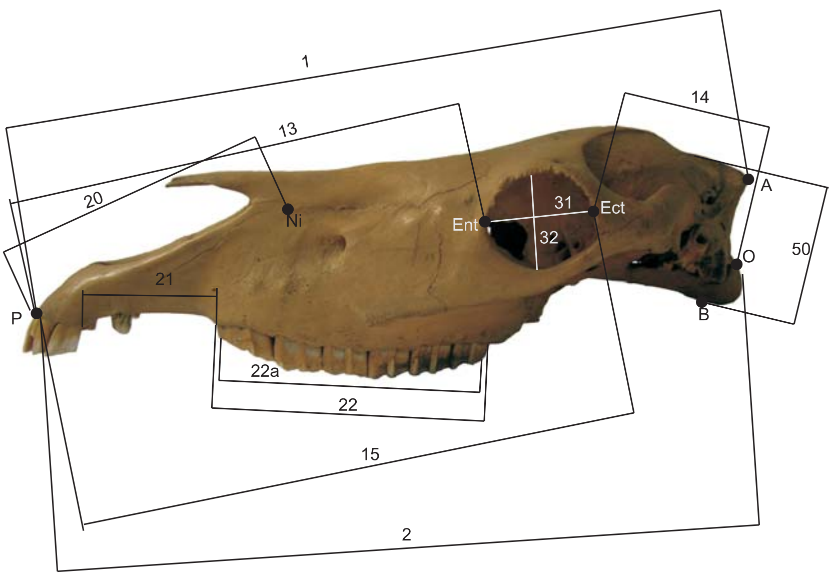

Figure 2. Craniometric measurements of Early Medieval horse (lateral view).

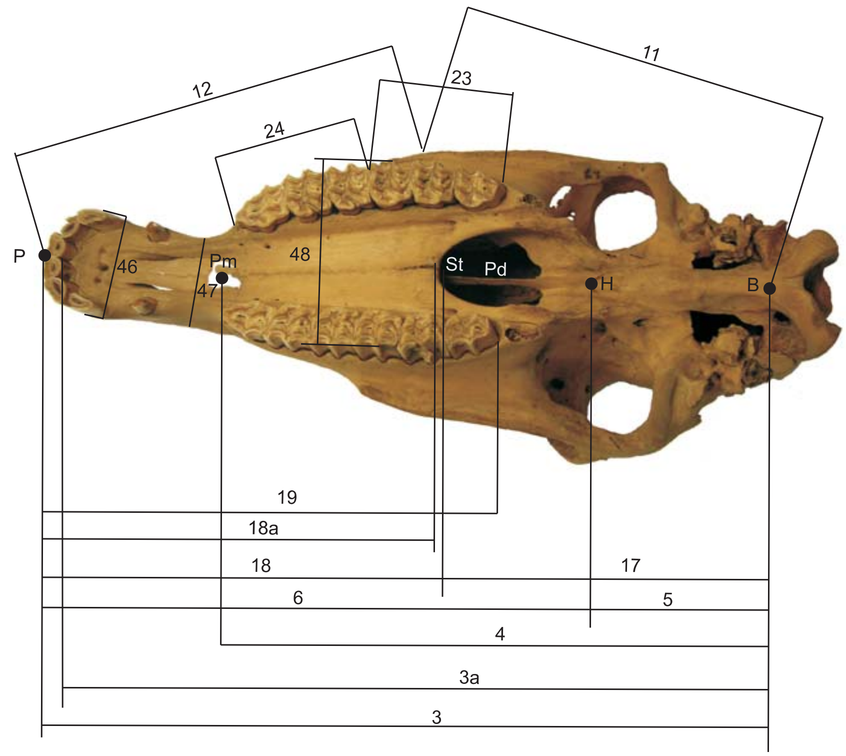

Figure 3. Craniometric measurements of Early Medieval horses (ventral view).

between the **Gov** (***Gonion ventrale***) and the most ventral point of the mandibular notch; and 21) **Gov-Cro***, dimension between **Gov** (***Gonion ventrale***) and the most dorsal point of the coronoid process (***Cronion***).

Three parallel measurements:

22a) **MHM3***, mandibular height caudal to M_3; 22b) **MHM1***, mandibular height rostral to M_1; and 22c) **MHPA***, mandibular height rostral to P2.

*Abbreviation introduced by the authors.

The achieved results were statistically analyzed (1-way ANOVA) with Statistica 9.0 ® StatSoft software. The studied factors were sex, age, and origin. All of the values were estimated at significance level $P \leq 0.05$ (22).

Analysis of the hypothetical animal ages of the examined horses was carried out on the basis of the attrition of the infundibulum of the tooth and shape changes of the occlusal surface of the incisive teeth, according to Koenig and Liebich (23).

Results

The age estimation proved that all of the investigated animal remains came from adult examples (7–21 years old). This assumption was reaffirmed via epiphyseal cartilagines closure. The basic statistical characteristic was performed for the studied horse cranial skeleton remains: mean values (cm), standard deviations, and maximal and minimal values (cm) referring to animal sex (Tables 1–4).

The craniometric measurements performed in dorsal view analysis (Figure 1) for males proved statistically insignificant higher mean values in the subsequent measurements: A-P (50.0 ± 3.08), Sp-P (34.0 ± 2.62), Eu-Eu (10.0 ± 0.67), GWSF (14.3 ± 1.11), Ect-Ect (20.4 ± 1.35), Ent-Ent (14.7 ± 1.15), FW (17.2 ± 1.94), and MaxWMI (6.1 ± 0.71) in comparison to similar measurements obtained for the female skulls (Table 1). The mean values of the measurements GWF (7.1 ± 1.03) and If-If (7.5 ± 1.06) (Table 1) were also higher for males.

The skull measurements performed in the lateral view (Figure 2) proved statistically insignificant higher mean values for males in the subsequent

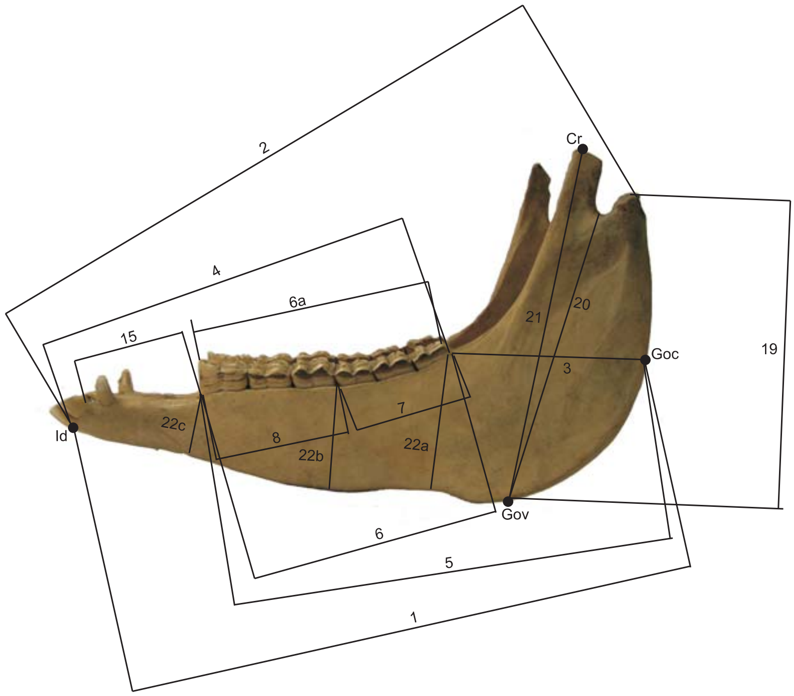

Figure 4. Measurements on the mandibles were made in the lateral view

measurements: CondBL (47.2 ± 3.98), O-Ect (18.0 ± 1.00), Ect-P (35.7 ± 2.33), Ni-P (17.1 ± 1.85), and Ect-Ent (6.2 ± 0.22) (Table 2). Similar mean values of subsequent measurements were also found in the animal sex comparison: P-Ent for males (28.6 ± 2.87) and females (28.5 ± 3.53), SDL for males (8.8 ± 1.30) and females (8.6 ± 1.91), and MaxWOR for males (5.3 ± 0.08) and females (5.2 ± 0.35) (Table 2). The mean values of the measurements SChL (16.4 ± 1.28), SChThCrL (15.8 ± 1.23), and MaxSH (13.4 ± 3.16) were higher in males (Table 2).

With respect to the measurements attained in the skull ventral view (Figure 3), statistically insignificant higher mean values for males in the measurements were proved: B-P (44.6 ± 3.23), B-I¹ (43.6 ± 3.38), P-H (34.1 ± 2.80), B-ESCr (24.7 ± 2.36), B-St (20.2 ± 1.63), and MinWD (5.7 ± 0.58) (Table 3). The mean value of the CHP measurement was statistically insignificantly higher for females (25.0 ± 2.83) (Table 3).

Similar and statistically insignificant mean values of the measurements were proved in terms of animal sex comparison: P-ESCr for males (22.3 ± 1.94) and females (22.5 ± 2.12), St-P for males (24.6 ± 2.35) and females (24.5 ± 3.53), Pd-P for males (28.4 ± 1.98) and females (28.7 ± 2.47), SMThL for males (7.6 ± 0.49) and females (7.3 ± 0.21), SPmThL for males (8.9 ± 0.74) and females (8.7 ± 0.35), and MaxPW for males (11.8 ± 0.79) and females (11.6 ± 0.92) (Table 3). It was observed that the average value of the B-Pm measurement was higher for females (32.2 ± 2.47) and the average value of the MaxWIB measurement was lower for males (6.1 ± 0.66) (Table 3). A statistically insignificantly higher mean value of the B-H measurement (10.9 ± 0.97) for males was also proved (Table 3).

Statistical analysis of the measurements made on the mandibles in the lateral view (Figure 4) revealed statistically insignificant higher mean values for males in the measurements: Id-Goc (39.0 ± 1.00), IGChThL (17.9 ± 0.47), ILChThL (17.2 ± 0.76), and IPmThL (9.1 ± 0.30) (Table 4). Statistically insignificant lower mean values for males were also noticed in the subsequent measurements: CondL (41.0 ± 1.00), Goc–ChThRB (11.7 ± 0.65), Id–ChThRB (27.3 ± 2.58), IDL (7.6 ± 0.53), and MHPA (4.9 ± 0.15) (Table 4). Similar mean values between sex groups were observed in the measurements: Goc–ChThRBB for males (29.0 ± 1.00) and females (29.5 ± 0.71), and MHM3 for males (10.0 ± 0.26) and females (10.4 ±

Table 1. Basic statistical characteristics of the skull measurements of Early Medieval horses (dorsal view).

Measurements (cm)	Male (N = 6)			Female (N = 3)		
	Minimum–Maximum	Mean	SD	Minimum–Maximum	Mean	SD
A-P	46.0–54.0	50.0	3.08	44.0–53.0	48.5	6.36
N-P	23.5–31.0	27.7	2.93	25.5–30.5	28.0	3.53
A-Sp	16.0–18.5	17.1	1.14	15.1–18.0	17.4	2.02
Sp-P	31.0–37.5	34.0	2.62	30.0–37.0	33.5	4.95
GLN	19.0–22.0	20.8	1.17	20.0–24.0	22.0	2.83
Eu-Eu	9.0–10.8	10.0	0.67	9.3–10.5	9.9	0.60
GWF	5.7–8.5	7.1	1.03	6.7–7.2	6.9	0.26
GWSF	13.0–15.5	14.3	1.11	11.1–15.3	13.3	2.10
Ect-Ect	19.0–22.0	20.4	1.35	17.5–22.0	19.5	2.29
Ent-Ent	13.5–16.0	14.7	1.15	13.0–14.0	13.5	0.71
FW	14.0–19.0	17.2	1.94	16.0–17.0	16.5	0.71
If-If	6.0–8.8	7.5	1.06	-	6.5*	-
MaxWMI	4.8–6.8	6.1	0.71	5.2–6.0	5.6	0.56

*Value obtained for 1 female only.
SD: standard deviation and N: number of horses.

0.78) (Table 4). The same average values were noticed for the subsequent measurements: Gov-MdNt for males (20.2 ± 0.35) and females (20.2 ± 1.06), and MHM1 for males (7.4 ± 0.15) and females (7.4 ± 0.71) (Table 4). The IMThL measurement values were higher in males (8.6 ± 0.20), but the Gov-Cond measurement average values were higher in females (22.0 ± 1.41) (Table 4).

Moreover, the statistically insignificant influence ($P > 0.05$) of the 3 studied factors: animal origin, sex, and age on the investigated horses' craniometric measurements was proved.

Discussion

The assessment of animal size changeability should be based on parameters that are not subject to seasonal fluctuations. The skull is an excellent material for these types of deliberations (10).

An assumption of the existence of horse skull sex dimorphism was introduced by von den Driesch and Boessneck (24). No statistical significance of sex influence on the analyzed craniometric parameters was proven in our study. Investigations of Early Medieval Silesian horse remains pointed out some interesting tendencies. Wyrost et al. (16) found a shoulder height decrease and heavy morphotype appearance increase among Silesian horses throughout history. Such a horse breeding direction had some economic explanations. Larger horses were preferred in medieval Poland due to the type of animal utilization. These hypotheses were also confirmed by Jaworski (15) and Kobryń (8). Shoulder height estimated using the Vitt and Kiesewalter method have indicated an increase in this parameter in horses dating back from 3500 BC to 1500 AD (8).

According to the division of horses introduced by Czerski (15), the investigated animals can be classified as small and medium-large horses, on the basis of the variability range of basilar length dimension ($B\text{-}I^1$) (males examined 38.0 cm–47.5 cm, females examined 40.5 cm–45.0 cm). The same author established the range of the basilar length ($B\text{-}I^1$) measurement (47.0 cm–47.5 cm) in Tarpans. The above mentioned value convergence was seen only in the upper range basilar length value in the investigated male horses (47.5 cm) and Tarpans. These results confirmed horse breeding observations in Medieval Poland, namely that horses

Table 2. Basic statistical characteristics of the skull measurements of Early Medieval horses (lateral view).

Measurement (cm)	Male (N = 6)			Female (N = 3)		
	Minimum–Maximum	Mean	SD	Minimum–Maximum	Mean	SD
CondBL	41.0–51.5	47.2	3.98	43.0–50.0	46.5	4.95
P-Ent	24.0–32.0	28.6	2.87	26.0–31.0	28.5	3.53
O-Ect	17.0–19.0	18.0	1.00	15.0–19.0	17.3	2.08
Ect-P	32.5–38.0	35.7	2.33	32.0–38.0	35.0	4.24
Ni-P	14.0–19.0	17.1	1.85	-	16.0*	-
SDL	7.5–10.5	8.8	1.30	7.3–10.0	8.6	1.91
SChL	14.4–17.6	16.4	1.28	15.4–16.7	16.0	0.92
SChThCrL	14.0–17.1	15.8	1.23	15.1–16.3	15.1	0.70
Ect-Ent	5.9–6.4	6.2	0.22	5.4–6.3	5.8	0.64
MaxWOR	5.2–5.4	5.3	0.08	5.0–5.5	5.2	0.35
MaxSH	9.7–16.5	13.4	3.16	11.6–14.0	13.2	1.38

*Value obtained for one female only.
SD: standard deviation and N: number of horses.

were smaller than Tarpans and Przewalski's horses and their shoulder height was similar to the average values achieved in Hucul and Lithuanian horses (8).

A comparison of these results with data obtained on the basis of materials from other European locations revealed remarkable similarities in the character of the morphological changes in the skull features. This fact allows us to state that the skull changes observed in this study are typical for horse evolution in the time period inquired. That is to say, it was observed that the mean value of the A-P measurement in the studied males (50.0 cm) was close to the average value (50.7 cm) of the Early Medieval horse from Kołobrzeg (2), but lower than the value of this measurement in the Early Medieval horse from Rullstorf (54.0 cm) (25) and the late Medieval horse from Chichester (55.3 cm) (26). The average value of the N-P measurement (27.7 cm) in the studied males was lower than the mean value obtained in males from Rullstorf (31.5 cm) (25) and in the horse from Chichester (31.8 cm) (26), but similar to the mean value in the Early Medieval horse from Kołobrzeg (28.5 cm) (2). The mean value of the A-Sp measurement (17.1 cm) in the investigated male horses was similar to that in the horse from Chichester (17.6 cm) (26) and significantly higher than the average value (15.0 cm) for males from Rullstorf (25). The average value of the Sp-P measurement in the investigated male horses (34.0 cm) was much lower than the same values in the medieval horses from Rullstorf (38.0 cm) (25) and in the horse from Chichester (39.0 cm) (26). A significant similarity between Early Medieval horses was observed in the average value of some of the measurements: Eu-Eu in the investigated males, 10.0 cm and 10.4 cm in horses from Kołobrzeg (2) and in the horse from Chichester (26); and St-P for the investigated males, 24.6 cm and 24.0 cm for the horses from Kołobrzeg (2). The mean value of the SThChCrL measurement in the studied males (15.8 cm) corresponded with the same measurement (15.9 cm) in the Early Medieval horse from Wolin (1), and subsequently the SChL measurement average value (16.4 cm) in the studied males and the same measurement in the horse from Wolin (16.7 cm) (1) and in the horses from Kołobrzeg (16.1 cm) (2). Similar values were also noticed for the GWF measurements [(investigated males, 7.1 cm); the males from Kołobrzeg, 7.3 cm (2); and the horse from, Wolin 7.7 cm (1)] and the Ent-Ent measurement [investigated horses, 14.7 cm; the horses from Kołobrzeg, 14.4 cm (2); and the horses from Rullstorf, 14.8 cm (25)]. Some

Table 3. Basic statistical characteristics of the skull measurements of Early Medieval horses (ventral view).

Measurements (cm)	Male (N = 6)			Female (N = 3)		
	Minimum–Maximum	Mean	SD	Minimum–Maximum	Mean	SD
B-P	39.0–48.0	44.6	3.23	41.5–46.0	43.7	3.18
B-I[1]	38.0–47.5	43.6	3.38	40.5–45.0	42.7	3.18
B-Pm	23.0–36.0	31.0	4.86	30.5–34.0	32.2	2.47
B-H	10.0–12.5	10.9	0.97	9.5–11.0	10.2	1.06
P-H	30.0–37.0	34.1	2.80	31.0–36.0	33.5	3.53
B-ESCr	21.0–27.5	24.7	2.36	22.0–25.5	23.7	2.47
P-ESCr	19.0–24.0	22.3	1.94	21.0–24.0	22.5	2.12
B-St	18.0–21.5	20.2	1.63	18.0–18.0	18,0	0.00
St-P	20.5–27.5	24.6	2.35	22.0–27.0	24.5	3.53
CHP	20.5–27.0	24.4	2.24	23.0–27.0	25.0	2.83
Pd-P	25.5–31.0	28.4	1.98	27.0–30.5	28.7	2.47
SMThL	6.9–8.1	7.6	0.49	7.2–7.5	7.3	0.21
SPmThL	7.6–9.7	8.9	0.74	8.5–9.0	8.7	0.35
MaxWIB	5.1–6.8	6.1	0.66	-	6.2*	-
MinWD	4.8–6.5	5.7	0.58	-	5.1*	-
MaxPW	10.6–12.5	11.8	0.79	11.0–12.3	11.6	0.92

*Value obtained for 1 female only.
SD: standard deviation and N: number of horses.

similarities between the skull measurements in Early Medieval horses were noticed according to the Ect-Ect measurement [in the studied males, 20.4 cm and in the males from Rullstorf, 20.5 cm (25)]. Early Medieval horses from the examined locations proved lower skull measurement values compared with Early Medieval horses from other sites: FW [investigated males, 17.2 cm and the horse from Chichester, 19.5 cm (26)], MaxWMI [investigated males, 6.1 cm; the horse from Chichester, 7.7 cm (26); and the males from Rullstorf, 7.4 cm (25)], CondBL [investigated males, 47.2 cm; the horse from Chichester, 54.5 cm (26); and the horses from Rullstorf, 52.2 cm (25)], B-P [studied males, 44.6 cm; males from Rullstorf, 49.0 cm (25); males from Kołobrzeg, 46.5 cm (2); and the horse from Chichester, 51.3 cm (26)], MinWD [studied males, 5.7 cm; the males from Rullstorf, 7.1 cm (25); and the horse from Chichester, 6.7 cm (26)], MaxPW [investigated males, 11.8 cm and the males from Rullstorf, 12.3 cm (25)].

Some analogous features were found in the mandible anatomy of the investigated horses, as well as in examples from other locations. Namely, the average value of the IGChThL measurement for the examined males (17.9 cm) corresponded with this measurement in the Early Medieval horse from Wolin (17.3 cm) (1), with the above mentioned measurement in Tarpan (17.7 cm) (5) and in the Early Medieval horses from Hornhausen (17.6 cm) (27), as well as in Poleskie horses (17.2 cm) (15). However, it was lower than this parameter in the Przewalski's horse (19.0 cm) (5) and exceeded the average value in the Polish Konik horse (16.4 cm), but fit within the variation range for this measurement (13.5 cm–17.9 cm) (4). The same average values in the investigated females (16.7 cm) corresponded with this parameter in the Early Medieval horses from Wunstorf (16.9 cm) (27) and from Grossörner-Molmeck (16.8 cm) (28).

Table 4. Basic statistical characteristics of the mandible measurements of Early Medieval horses (lateral view).

Measurements (cm)	Male (N = 3)			Female (N = 2)		
	Minimum–Maximum	Mean	SD	Minimum–Maximum	Mean	SD
Id-Goc	38.0–40.0	39.0	1.00	–	38.0*	-
CondL	40.0–42.0	41.0	1.00	–	42.0*	-
Goc-ChThRB	11.0–12.3	11.7	0.65	13.1–13.4	13.2	0.21
Id-ChThRB	27.0–28.0	27.3	2.58	–	27.5*	-
Goc-ChThRBB	28.0–30.0	29.0	1.00	29.0–30.0	29.5	0.71
IGChThL	17.5–18.4	17.9	0.47	16.6–16.8	16.7	0.14
ILChThL	16.4–17.9	17.2	0.76	15.9–16.2	16.0	0.21
IMThL	8.4–8.8	8.6	0.20	7.5–7.7	7.6	0.14
IPmThL	8.8–9.4	9.1	0.30	8.4–8.9	8.6	0.35
IDL	7.0–7.8	7.6	0.53	-	8.7*	-
Gov-Cond	18.5–22.0	20.8	2.02	21.0–23.0	22.0	1.41
Gov-MdNt	20.0–20.5	20.2	0.35	19.5–21.0	20.2	1.06
Gov-Cro	24.0–26.0	25.0	1.41	-	-	-
MHM3	9.8–10.3	10.0	0.26	9.9–11.0	10.4	0.78
MHM1	7.3–7.6	7.4	0.15	6.9–7.9	7.4	0.71
MHPA	4.8–5.1	4.9	0.15	5.5–5.7	5.6	0.14

*Value obtained for 1 female only.
SD: standard deviation and N: number of horses.

All of the investigated skulls belonged to adult animals with finished morphological growth. The statistical analysis indicated that age was not a factor statistically significantly differentiating the studied skulls.

On the basis of the numerous papers dealing with horse height at the withers for the area of Poland, it can be stated that in Medieval Poland, regardless of the geographical region, horses with a balanced morphotype were bred (8,16,29).

As is confirmed by the above animal origin studies, the horses of the analyzed locations actually showed no differentiation with regard to skull anatomy, regardless of the geographic region of Poland, from which they derived. Neither did the archaeological site location have a statistically significant effect on the craniometric measurement values. Similar conclusions can be drawn regarding the animal sex. The animal age was similar in all of the cases; therefore, no statistically significant age comparison results were noted.

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