Acta zoologica cracoviensia, 68 (2) 2025
Kraków, 2025
http://www.isez.pan.krakow.pl/en/acta-zoologica.html

e-ISSN 2300-0163
https://doi.org/10.3409/azc.68.04

Changes in the body size of domestic cattle from archaeological sites in Northeastern Poland from the Middle Ages to the Early Modern period

Małgorzata Zalewska-Nowak

Received: 27 June 2025 *Accepted 3 December 2025* *Available online: 19 December 2025* *Issue online 19 December 2025*

Original article

Zalewska-Nowak M. 2025. Changes in the body size of domestic cattle from archaeological sites in Northeastern Poland from the Middle Ages to the Early Modern period. *Acta zoologica cracoviensia* **68**: 57-71.

Abstract. In this study, changes in the body size of domestic cattle in Northeastern Poland, from the Middle Ages to the Early Modern period, are investigated based on over 800 measurements of metapodial bones from sites in Mazovia, Podlachia and Western Polesie. The focus is on estimating the withers height and examining sex-based differences, in order to better understand the breeding strategies and herd composition over time. While earlier research has addressed cattle morphology in Poland, data from post-Early Medieval eastern regions remains limited. This analysis reveals regional and chronological patterns, including greater diversity in the cattle withers height during the Early Modern period. In Mazovia, bulls decreased in size while cows became more variable, likely due to crossbreeding with imported livestock. In Podlachia, cows grew larger and more diverse; while in Polesie, the steer height declined, which was possibly linked to changes in castration practices. The findings confirm that small and medium-sized cattle predominated, with larger individuals appearing sporadically. The data suggests long-term herd management prioritising milk production and cow-dominant herds. These results underscore the need for further research in underrepresented areas, to better understand the transition from the Late Medieval to the Early Modern period.

Key words: cattle husbandry, withers height, Mazovia, Podlachia, Polesie, osteometry, zooarchaeology, metapodial bones.

✉ *Małgorzata Zalewska-Nowak, Institute of Archaeology and Ethnology, Department for the History of Material Culture of the Middle Ages and Modern Times, Polish Academy of Sciences, Al. Solidarności 105, 00-140 Warsaw, Poland.*
E-mail: m.zalewska@iaepan.edu.pl

I. INTRODUCTION

The size and build of domestic cattle have changed over time, under the influence of both environmental conditions and human breeding decisions. One useful parameter for studying these changes is the height at the withers, which can be reconstructed using osteometric measurements and information about the sex of the animals. This allows for a better understanding of the herd composition, breeding practices and the role of cattle in past economies.

This paper presents the results of a zooarchaeological analysis of cattle remains from three regions of eastern Poland – Mazovia, Podlachia and Western Polesie dating from the Middle Ages (6-15th century) to the Early Modern period (16-18th century). By examining osteometric data from the metacarpal and metatarsal bones, the study aims to assess the variability in body size and to infer patterns of the herd structure and breeding goals in local livestock populations. The research covers a wide temporal and geographical range, enabling the comparison

of regional dynamics and the potential indicators of cattle hybridisation, specialisation or continuity.

Although many researchers have explored this subject, the question of the withers height of the animals in the regions of Mazovia, Podlachia and Polesie after the early Middle Ages remains largely unexamined. The first scholar to study the withers height of cattle in Polish territories was Alicja Lasota-Moskalewska (1989). She traced changes in cattle size from the Middle Neolithic to the early Middle Ages, demonstrating a gradual decrease in the body size of these animals over time.

Many years later, Michał Skibniewski revisited the topic, focusing on cattle throughout the Medieval period. He published two articles – one on withers height (Skibniewski et al. 2007a) and another on the morphological types (Skibniewski et al. 2007b) – covering 102 archaeological sites across Poland. Notably, he introduced sex differentiation in his analysis, which allowed for more detailed and nuanced data. Shortly afterward, Urszula Iwaszczuk addressed the issue of size variation in early Medieval cattle across Poland (Iwaszczuk 2014). Her comprehensive study had a broader thematic scope, as it focused on animal husbandry in the early Middle Ages more generally. Nevertheless, it included a detailed discussion of cattle, drawing on data from as many as 248 sites, including those in Mazovia and Podlachia. The analysis featured chronological stratification and took into account the sex of the animals when considering the withers height. The most recent research on the dimensions of ancient cattle comes from Daniel Makowiecki (2018). His work extended beyond cattle to include other members of the so-called 'farm five'. Focusing on animals from Western Poland, Makowiecki provided valuable insights into the body size of the livestock in that region.

II. MATERIAL AND METHODS

In this study, the bones of the metacarpus and metatarsus of cattle from sites in Northern Mazovia, Podlachia and Western Polesie (Fig. 1; Table 1)

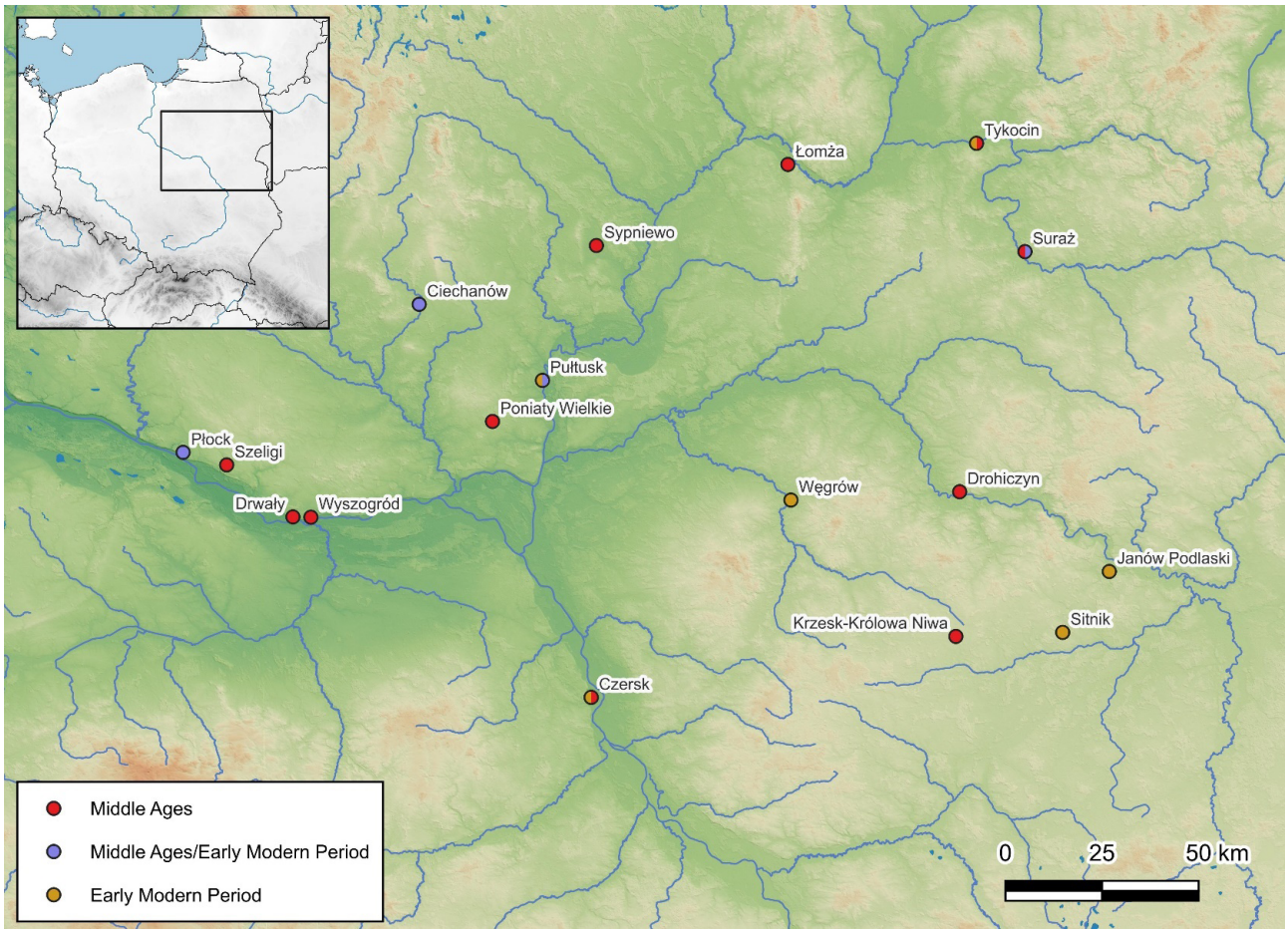

Fig. 1. Sites mentioned in the text (by Michał Jakubczak).

Table 1

Osteometric observations of metapodial bones of cattle from Mazovia and Podlachia in the Middle Ages; n – number of bones, GL – greatest length, WH – height at the withers, min – minimum value, max – maximum value, x – mean, SD – standard deviation

Site	Site function	Region	Anatomical element	Sex	n	GL				WH			
						min	max	x	SD	min	max	x	SD
Krzesk - Królowa Niwa	stronghold	Mazovia	metacarpus	cow	1	178	178	–	–	106	106	–	–
Wyszogród - Drwały	stronghold		metacarpus	steer	1	228	228	–	–	140	140	–	–
Poniaty Wielkie	settlement		metacarpus	cow	1	175	175	–	–	105	105	–	–
Szeligi	stronghold and settlement		metatarsus	cow	2	192	204	–	–	103	109	–	–
Sypniewo	stronghold and settlement		metacarpus	cow	2	174	178	–	–	104	106	–	–
			metatarsus		2	191	192	–	–	102	103	–	–
Czersk	stronghold		metacarpus	cow	2	162	187	–	–	97	112	–	–
			metatarsus		3	186	197	191.0	4.5	99	105	102.0	2.4
Wyszogród	castle		metacarpus	cow	3	162	175	167.3	5.6	97	105	100.1	3.3
			metacarpus	bull	1	153	153	–	–	95	95	–	–
Łomża	town		metacarpus	cow	15	162	186	173.5	6.8	97	111	103.8	4.0
			metatarsus		13	194	207	199.2	4.6	104	111	106.4	2.4
			metacarpus	bull	1	165	165	–	–	103	103	–	–
			metatarsus		1	203	203	–	–	113	113	–	–
			metacarpus	steer	2	209	219	–	–	128	134	–	–
All sites (Mazovia)			metacarpus	cow	24	162	187	173.3	7.2	97	112	103.6	4.3
			metatarsus		20	186	207	197.1	5.7	99	111	105.3	3.0
			metacarpus	bull	2	153	165	–	–	95	103	–	–
			metatarsus		1	203	203	–	–	113	113	–	–
			metacarpus	steer	3	209	228	218.7	7.8	128	140	134.0	4.8
Total				**cow**	**44**	–	–	–	–	**97**	**112**	**104.4**	**4.9**
				bull	**3**	–	–	–	–	**95**	**113**	**104.0**	**8.0**
				steer	**3**	–	–	–	–	**128**	**140**	**134.0**	**4.8**
Drohiczyn	town	Podlachia	metatarsus	cow	4	197	205	199.3	3.3	105	109	106.4	1.8
Tykocin	stronghold and settlement		metacarpus	cow	1	170	170	–	–	102	102	–	–
			metatarsus		1	190	190	–	–	101	101	–	–
			metacarpus	bull	2	164	174	–	–	102	109	–	–
Suraż	stronghold		metacarpus	cow	2	170	180	–	–	102	108	–	–
All sites (Podlachia)			metacarpus	cow	3	170	180	173.3	4.7	102	108	104.0	2.8
			metatarsus	cow	5	190	205	197.4	4.8	101	109	105.4	2.5
			metacarpus	bull	2	164	174	–	–	102	109	–	–
Total				**cow**	**8**	–	–	–	–	**101**	**109**	**104.8**	**2.8**
				bull	**2**	–	–	–	–	**102**	**109**	–	–
Total (Mazovia & Podlachia)				**cow**	**52**	–	–	–	–	**97**	**112**	**104.4**	**3.7**
				bull	**11**	–	–	–	–	**95**	**113**	**104.5**	**6.0**
				steer	**3**	–	–	–	–	**128**	**140**	**134.0**	**4.8**

were selected for the analysis. These remains were dated to the Middle Ages (6-15th century) and Early Modern period (16-18th century). No distinction was made between the early and late Middle Ages. This is because the dating of the materials in the archival studies was preliminary and the chronology was broad. The assemblages from four sites were dated too broadly to be strictly assigned to one of the two periods mentioned and it was decided to separate an additional chronological category for them, called 'Medieval/Early Modern'.

The presented data has been derived from a range of sources, including published studies, archival catalogues and the author's own unpublished research. The origins of the individual data have been marked accordingly in the database (Zalewska-Nowak 2025).

In the initial phase of the analysis, a catalogue was created containing the name of the site, its location, the type of bone described and its dimensions: GL (Greatest length), Bp (Greatest breadth of the proximal end), SD (Smallest breadth of the diaphysis) and Bd (Greatest breadth of the distal end). The measurements were obtained in accordance with the guidelines established by Angela von den Driesch (1976). Subsequently, the width-length measurements were converted into shaft width and distal end width indexes, in order to assess the sex of the animals according to Howard's criteria (1963). The aforementioned criteria indicate that for metacarpal bones, a distal end width index value ranging from 32.5 to 37.8 and a shaft width index ranging from 18.6 to 24.5 is indicative of the origin of the bone from a bull. A range from 24.8 to 33.6 for the first index and from 12.9 to 19.5 for the second indicates an origin from a cow. In the case of metatarsal bones, a distal end width index of 24.8 to 30.3 and a shaft width index of 14.7 to 19.2 have been shown to indicate an origin from bulls, while ranges of 22.1 to 28.6 for the first index and 11.5 to 14.7 have been shown to indicate an origin from cows. However, the values given for steers' remains are problematic, as they partially overlap with the values indicated for bull and cow remains. For metacarpal bones, the range is from 29.3 to 32.9 for the distal end width index and from 14 to 18.3 for the distal end width index. In the case of metacarpal bones, these ranges are 24.6 to 27.5 for the first index and 12.7 to 15.8 for the second.

When the distinction between cows, bulls and steers was not clear on the basis of these indexes, the sex distribution in the correlation plot was used (Fig. 2A-4B) – the bones to which this procedure was applied were marked accordingly in the catalogue (Zalewska-Nowak 2025). Finally, the height at withers (WH) of the animals was reconstructed using the V.J. Zalkin coefficients (1960), calculated not only for bulls and cows, but also for steers. In instances where multiple elements were derived from a single individual, the WH was averaged.

The Ciechanów Castle case deserves a comment – in the original archival study, bone measurements were given as ranges rather than individual records. The decision was made to include this data in the analyses.

III. RESULTS

Mazovia. A total of 732 metapodial bones were recovered from the study area. The most numerous collection was dated to the 'Medieval/Early Modern' period and consisted of 380 elements. 347 of these elements were from cows, with 30 from bulls and three from steers. Fewer remains came from the Early Modern period with 302 elements, of which 282 belonged to cows, 15 to bulls and five to steers. The smallest collection was from the Middle Ages with only 50 elements: 44 from cows, three from bulls and three from steers.

In the Middle Ages, animals were bred in Mazovia with a height of between 95 and 113 cm, with cows reaching 97 to 112 cm (Table 1). Bulls were not significantly larger than cows, as their sizes ranged from 95 to 113 cm. The exception was steers, which significantly exceeded both females and males in height, reaching heights of 128, 134 and 140 cm.

The most common WH values in the Medieval population ranged from 104 to 106 cm (Fig. 5), with the others occurring less frequently. In spite of the small sample size, it can be tentatively concluded from the distribution shown that the breeding was guided by a certain key and it seems that the animals were not reproduced completely at random – the graph is unimodal and symmetrical, with a clear concentration around the indicated values (104-106 cm), while extreme values occurred less frequently in the sample.

There have been some changes in the material in

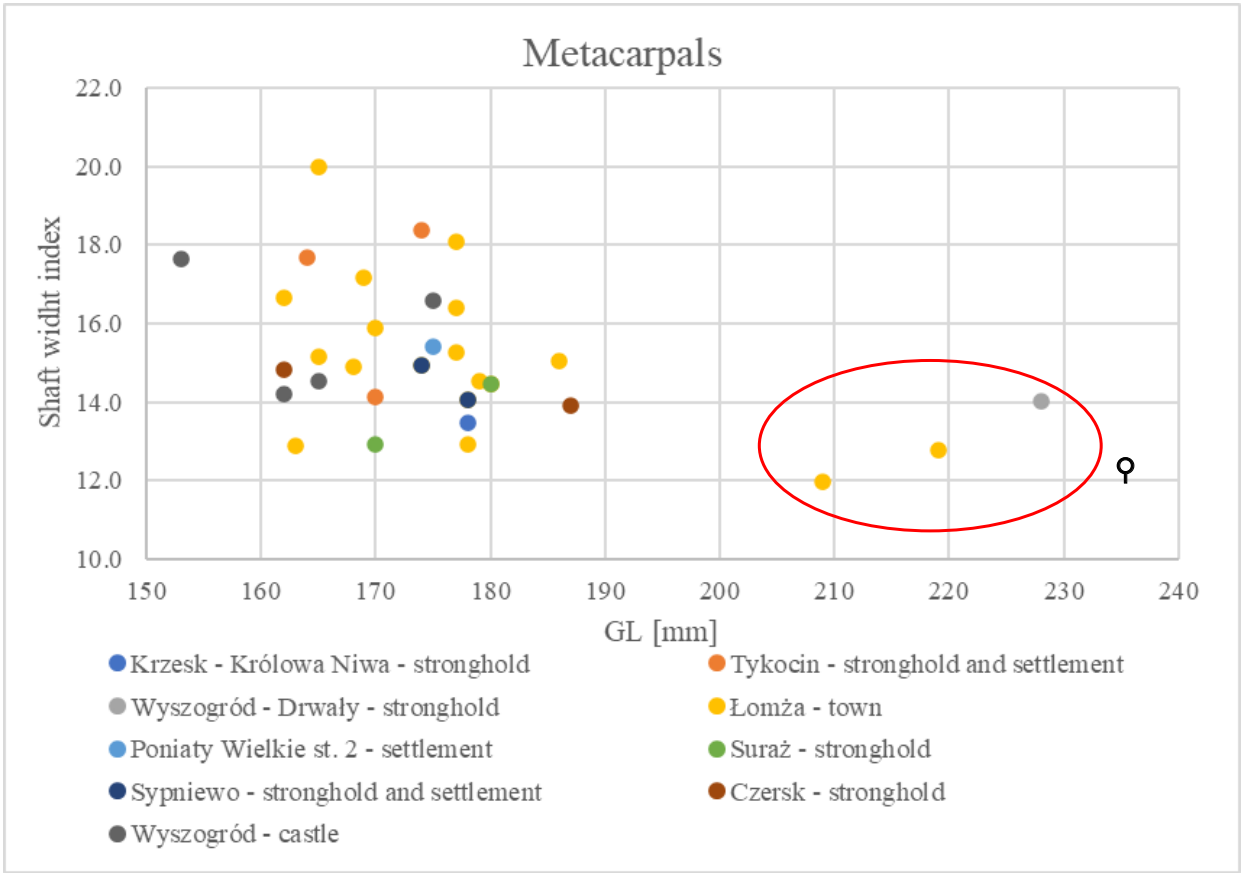

Fig. 2A. Middle Ages. Gender distribution of the cattle in a correlation plot. Points marked with a red circle and a symbol Q indicate bone measurements of steers.

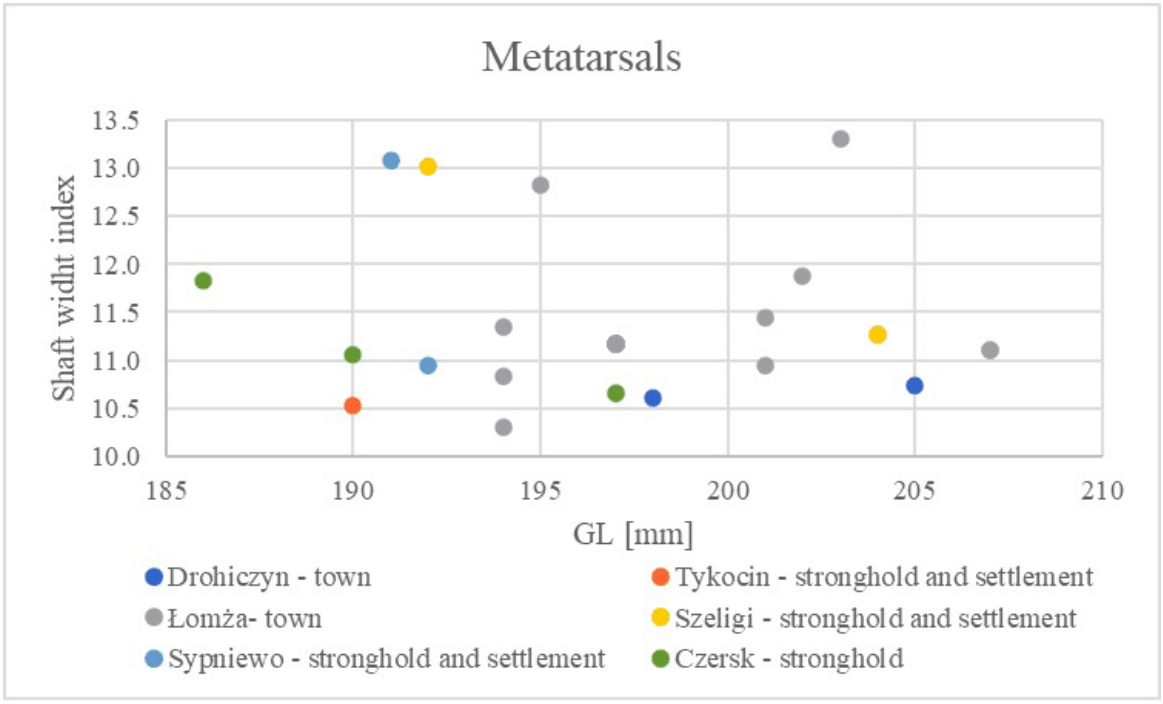

Fig. 2B. Middle Ages. Gender distribution of the cattle in a correlation plot.

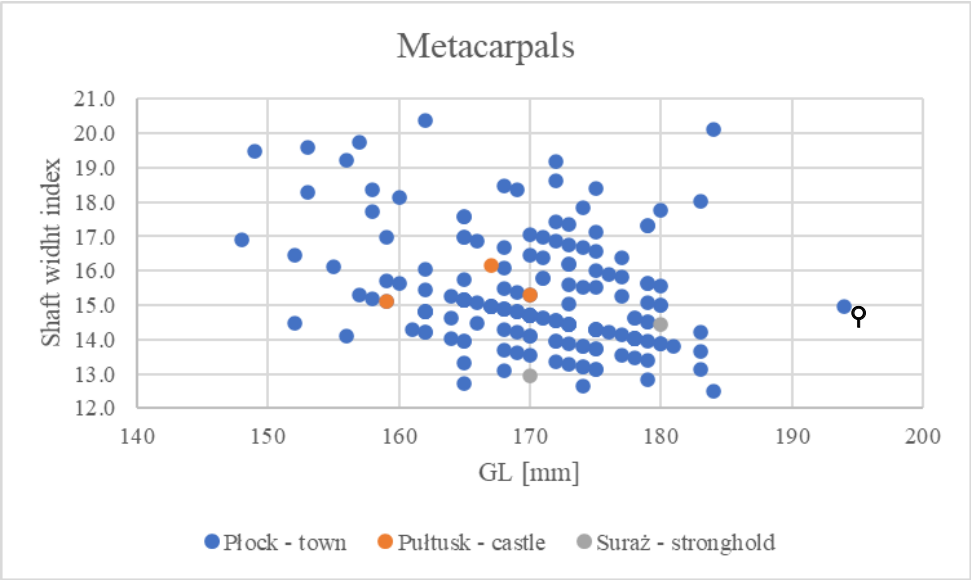

Fig. 3A. Medieval/Early Modern period. Gender distribution of the cattle in a correlation plot. A point marked with symbol Q indicate measurements of a steer remain.

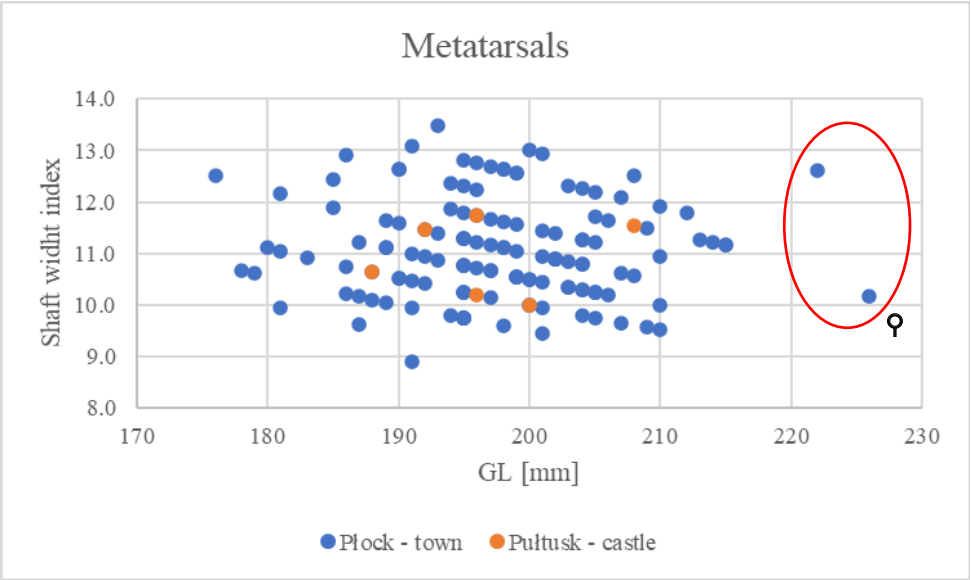

Fig. 3B. Medieval/Early Modern period. Gender distribution of the cattle in a correlation plot. Points marked with a red circle and a symbol Q indicate bone measurements of steers.

the 'Medieval/Early Modern' category. First, the height of the largest cows increased by 3-7 cm making the largest cows larger than the largest bulls. Secondly, the population diversified, as the smallest cows reached a height at the withers of 91 cm (Table 2). The same changes happened with the bulls: the smallest bulls grew to a height of 92 cm, while the largest bulls did not exceed the size of the cows. The most common WH values also varied, ranging from 101 to 108 cm (Fig. 6). This suggests a further specialisation in breeding. The presence of larger individuals in the group with the most common values suggests that the procedure of 'adding fresh blood' was used by allowing larger animals to reproduce. This could have occurred through the importation of grey steppe cattle from Ukraine, Podolia, Volhynia or Moldova, resulting from intensive cattle trading (Baszanowski 2017). In addition, when the material from Ciechanów Castle is taken into account, the cattle population was even more diverse, reaching a minimum of 82 cm and a maximum of 119 cm for cows, with a range of 93 to 101 cm for bulls. How-

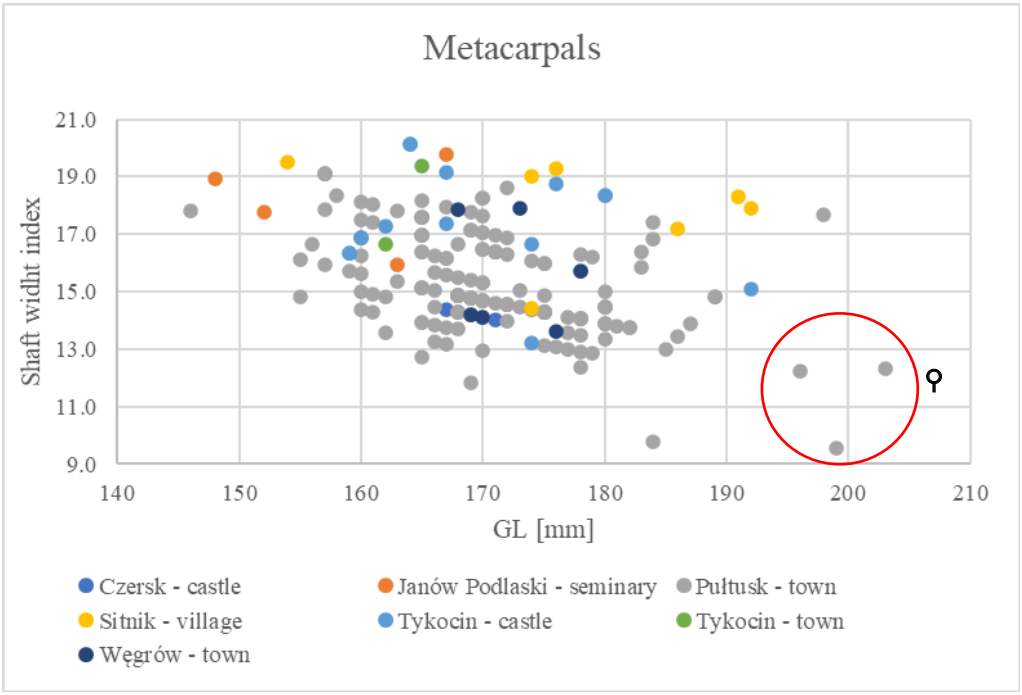

Fig. 4A. Early Modern period. Gender distribution of the cattle in a correlation plot. Points marked with a red circle and a symbol Q indicate bone measurements of steers.

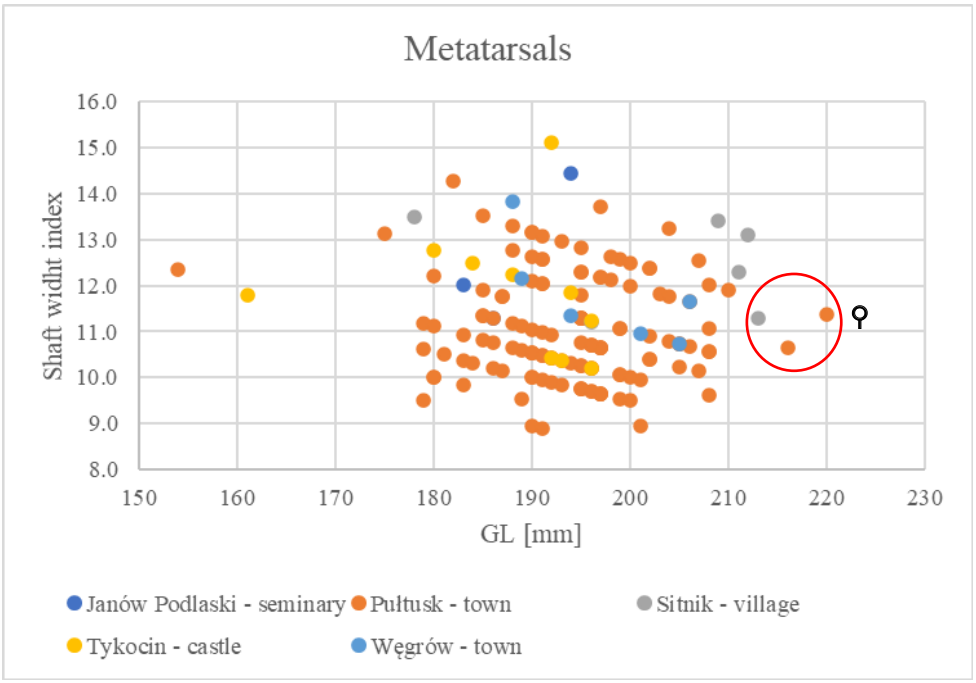

Fig. 4B. Early Modern period. Gender distribution of the cattle in a correlation plot. Points marked with a red circle and a symbol Q indicate bone measurements of steers.

ever, the lack of raw catalogue data for this material makes it impossible to infer the most common size of the animals and the height structure of the herd.

It is noteworthy that the height at withers of the steers fell significantly during the period in question. This may have been related to a change in the view of the appropriate time to castrate bulls, as perhaps in the Late Medieval/Early Modern period the

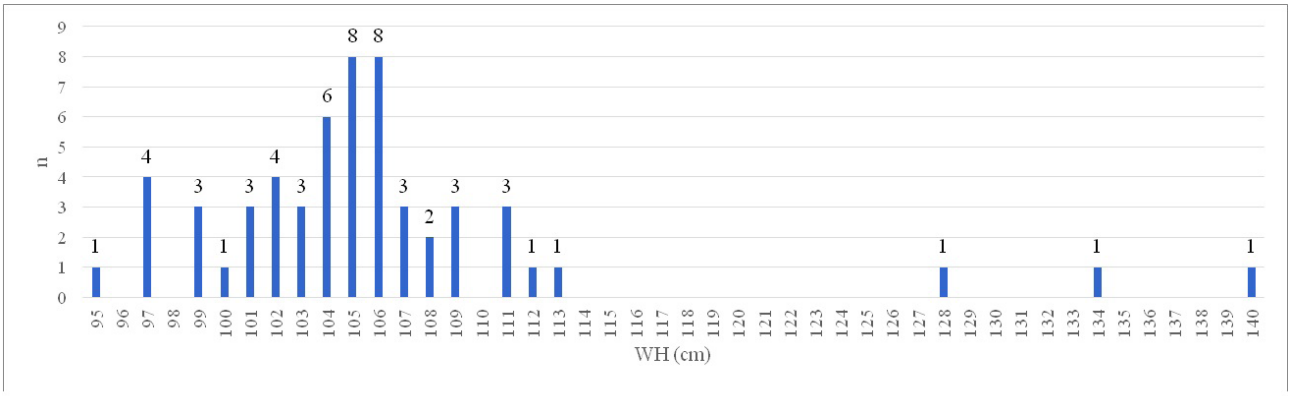

Fig. 5. Bar chart showing the number of individuals with each recorded withers height (WH) in cattle in the Middle Ages in Mazovia.

Table 2

Osteometric observations of metapodial bones of cattle from Medieval/Early Modern Mazovia and Podlachia (*excluding material from Ciechanów)

Site	Site function	Region	Anatomical element	Sex	n	GL				WH			
						min	max	x	SD	min	max	x	SD
Płock	town	Mazovia	metacarpus	cow	163	152	184	170.7	6.5	91	110	102.1	3.9
			metatarsus		134	176	215	197.4	8.1	94	115	105.4	4.3
			metacarpus	bull	21	148	184	165.2	10.3	92	115	103.1	6.4
			metatarsus		2	190	193	–	–	106	108	–	–
			metacarpus	steer	1	194	194	–	–	119	119	–	–
			metatarsus		2	222	226	–	–	122	124	–	–
Ciechanów	castle		metacarpus	cow	16	157	198	169.5	11.0	94	118	–	–
			metatarsus		23	152	159	154.2	2.6	81	85	–	–
			metacarpus	bull	5	154	215	196.1	9.0	96	134	–	–
			metatarsus		2	167	182	–	–	93	102	–	–
Pułtusk	castle		metacarpus	cow	3	159	170	165.3	4.6	95	102	98.9	2.8
			metatarsus		6	188	208	196.7	6.3	100	111	105.0	3.4
Suraż	castle	Podlachia	metacarpus	cow	2	170	180	–	–	103	108	–	–
All sites			metacarpus	cow	168*	152	184	170.7	6.5	91	110	102.1	3.9
			metatarsus		140*	176	215	197.3	8.0	94	115	105.4	4.3
			metacarpus	bull	21*	148	184	165.2	10.3	92	115	103.1	6.4
			metatarsus		2*	190	193	–	–	106	108	–	–
			metacarpus	steer	1	194	194	–	–	119	119	–	–
			metatarsus		2	222	226	–	–	122	124	–	–
Total				**cow**	**308**	–	–	–	–	**91**	**115**	**103.6**	**4.4**
				bull	**23**	–	–	–	–	**92**	**115**	**103.4**	**6.3**
				steer	**3**	–	–	–	–	**119**	**124**	**121.6**	**2.1**

procedure was performed later than in the Middle Ages. Perhaps this was related to the high demand for working steers (Baranowski 1957) – animals intended for this purpose were recommended to be castrated at six months of age (Baszanowski 2017), after reaching puberty. The subsequent castration was intended to yield a working animal with a well-developed neck and hindquarters (Baranowski 1957).

The timing of castration is of crucial significance from a physiological perspective. In a scenario where

the bull is castrated prior to puberty, the fusion of the bone epiphysis with the shaft is consequently delayed due to a decrease in sex hormone levels. The role of these hormones, amongst other functions, is to stimulate the closure of the epiphyseal plates. In the absence of sex hormones following castration, the duration of the phase of bone growth is prolonged (Silverthorn 2019).

There was a decline in the height at withers for both cows and bulls during the Early Modern period. The decrease observed in the case of cows was three cm. In bulls, on the other hand, the largest animals reached a height of only 109 cm (Table 3), which represents a decrease of as much as six cm. At the same time, the population did not diversify and the result of 82 cm at the withers in the collection of cow remains is an isolated case. In the case of bulls, this diversification was smaller than in the previous collection, but this is probably due to the fact that there were fewer bull remains in the Early Modern material. The decline in the height at the withers during this period may have been related to numerous military conflicts that took place from the mid-17th century to the early 18th century (Baranowski 1957). During these conflicts, livestock was often seized by the military, and the herds were likely rebuilt using all available breeding stock. Furthermore, military operations could significantly complicate the effective obtaining of animal fodder, resulting in undernourishment. In the Early Modern period, the height at the withers of the steers remained unchanged. It is likely that the timing of castration in these animals was postponed until later in the life of the bulls, resulting in smaller working animals, as was the case with the material dating from the Late Medieval/Early Modern period.

The most common height at withers in the Early Modern material was between 99 and 108 cm (Fig. 7.). This means that the most typical animals, in terms of height, were slightly smaller than in the material from the Late Medieval/Early Modern period. Values of 96 cm and values between 109 and 111 cm were less frequent. The remaining values were represented by single observations. The distribution of the height at withers suggests that breeding was specialised and that the selection of animals was not random. The histogram demonstrates a concentration of individuals within a narrow range (mainly 99-108 cm), with very small and very large animals occurring only sporadically. Such a pattern is characteristic of populations that have been subjected to intentional selection. This interpretation is corroborated by the historical accounts, which indicate that breeding bulls were meticulously selected for their strength (Baranowski 1957), a trait that is associated with their substantial body size. Systematic selection is a process that is known to result in a population that exhibits reduced variability and an accumulation of values around the higher withers heights (peaking at 102-105 cm).

Podlachia. A total of 48 elements came from the Podlachia region and were found in two periods: Middle Ages and Early Modern (the assemblage from the 'Medieval/Early Modern' category included 2 bones from Podlachia, but is included in the discussion of the Mazovian sites due to its very low abundance). The Medieval collection was less numerous and consisted of 10 elements. Eight of them came from cows and two originated from bulls. There were no bones obtained from oxen. The Early Modern collection consisted of 31 remains from cows and seven from bulls.

During the Middle Ages, there was almost no difference in height at the withers between cows and bulls. The range for cows was 101-109 cm (Table 1), and both of the results obtained for bulls fell within this range (102 and 109 cm). The most common height at the withers was 103 cm. Animals with a WH of 105 and 109 cm were less common. The remaining withers heights were represented by single individuals. On the basis of such a small sample, it is impossible to draw any other conclusions about cattle husbandry

In the Early Modern period, the cattle from Podlachia slightly increased in size and the cow population became more diverse than in the Middle Ages. The height range of cows grew, reaching limits of 95-115 cm at the withers (Table 3). This represents an increase in the maximum value of three cm and a decrease in the minimum value of as much as six cm (the result of 82 cm at the withers represents an isolated case). Therefore, on the one hand, larger animals appeared through breeding than before; and on the other hand, some factor caused the presence of smaller animals. In the case of the bulls, the situation was almost unchanged – only the upper limit rose by one centimetre, from 109 to 110 cm. The most common height at the withers was between 100 and 105 cm and 96 cm (Fig. 8.). Animals reaching

Table 3

Osteometric observations of the metapodial bones of cattle from Mazovia, Podlachia and Polesie from the Early Modern period

Site	Site function	Region	Anatomical element	Sex	n	GL				WH			
						min	max	x	SD	min	max	x	SD
Czersk	castle	Mazovia	metacarpus	cow	2	167	171	–	–	100	102	–	–
Pułtusk	town		metacarpus	cow	150	155	196	171.3	7.3	93	117	102.4	4.4
			metatarsus		130	154	210	193.6	8.3	82	112	103.4	4.4
			metacarpus	bull	14	146	172	161.6	6.7	91	107	100.9	4.2
			metatarsus		1	195	195	–	–	109	109	–	–
			metacarpus	steer	3	198	203	200	2.2	121	124	122.6	1.3
			metatarsus	steer	2	216	220	–	–	119	121	–	–
Total (Mazovia)				**cow**	**282**	**–**				**82**	**112**	**102.8**	**4.4**
				bull	**15**	**–**				**91**	**109**	**101.4**	**4.5**
				steer	**5**	**–**				**119**	**124**	**121.4**	**1.9**
Węgrów	town	Podlachia	metacarpus	cow	6	168	176	172.3	3.7	100	106	103.1	2.2
			metatarsus		6	188	206	197.2	7.2	100	110	105.3	3.9
Tykocin	castle		metacarpus	cow	9	159	192	168.4	9.3	95	115	102.3	5.7
			metatarsus		9	161	196	187.1	10.6	86	105	99.9	5.8
			metacarpus	bull	5	162	176	166.6	5.0	101	110	104	3.1
			metatarsus		1	192	192	–	–	107	107	–	–
	town		metacarpus	cow	1	162	162	–	–	97	97	–	–
			metacarpus	bull	1	165	165	–	–	103	103	–	–
All sites			metacarpus	cow	16	161	206	191.1	10.6	86	110	102.1	5.7
			metatarsus		15	160	192	170.1	8.8	95	115	101.7	5.3
			metacarpus	bull	6	162	176	166.3	4.6	101	110	103.8	2.9
			metatarsus		1	165	165	–	–	103	103	–	–
Total (Podlachia)				**cow**	**31**	**–**	**–**	**–**	**–**	**86**	**115**	**101.9**	**5.5**
				bull	**7**	**–**	**–**	**–**	**–**	**101**	**110**	**104.3**	**2.9**
Sitnik	village	Polesie	metacarpus	cow	6	174	193	181	15.0	104	115	107	5.9
			metatarsus	cow	5	177	212	194	15.1	95	113	107	6.1
			metacarpus	bull	1	154	154	–	–	96	96	–	–
			metatarsus	steer	1	213	213	–	–	117	117	–	–
Janów Podlaski	seminary		metacarpus	cow	2	163	168	–	–	97	100	–	–
			metatarsus	cow	3	183	194	187.7	4.6	98	104	100.3	2.6
			metacarpus	bull	3	148	167	155.7	8.2	181,08	104	97.1	5.1
All sites			metacarpus	cow	8	163	193	182	18.4	97	115	104	7.2
			metatarsus	cow	7	176	212	186	15.9	95	114	106	6.6
			metacarpus	bull	4	148	167	155.2	7.0	92	104	96.8	4.3
			metatarsus	steer	1	213	213	–	–	117	117	–	–
Total (Polesie)				**cow**	**15**	**–**	**–**	**–**	**–**	**95**	**115**	**107**	**7.2**
				bull	**4**	**–**	**–**	**–**	**–**	**92**	**104**	**96.8**	**4.3**
				steer	**1**	**–**	**–**	**–**	**–**	**117**	**117**	**–**	**–**

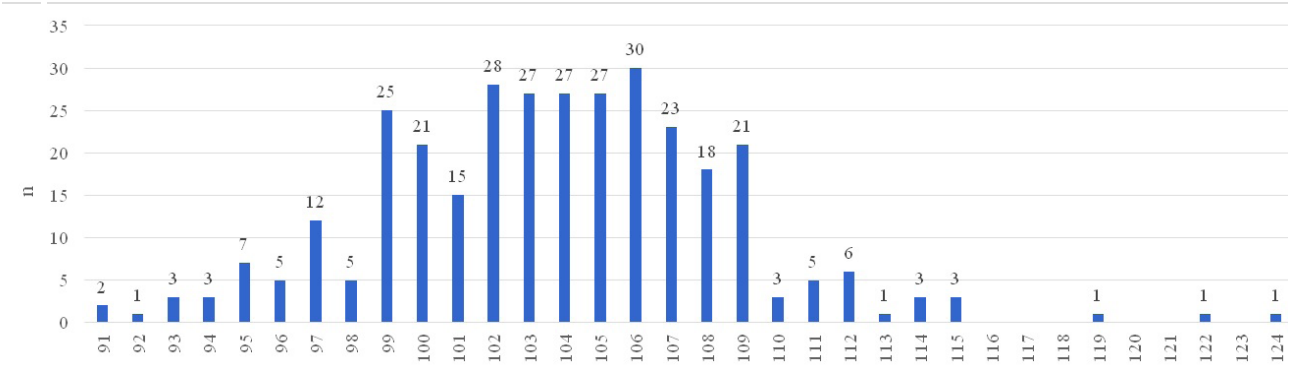

Fig. 6. Bar chart showing the number of individuals with each recorded withers height (WH) in cattle in the Medieval/Early Modern period.

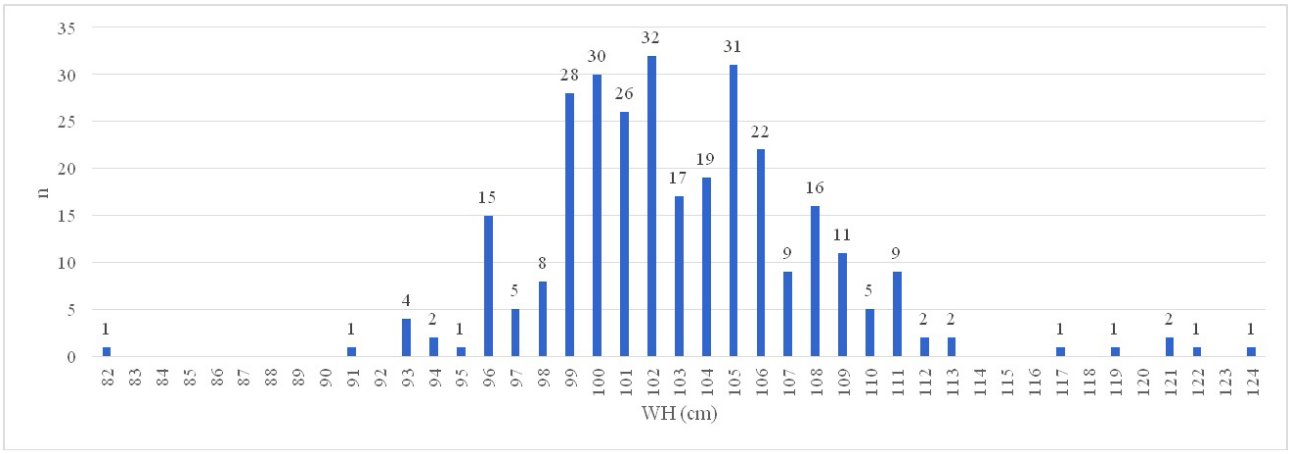

Fig. 7. Bar chart showing the number of individuals with each recorded withers height (WH) in cattle in the Early Modern period in Mazovia.

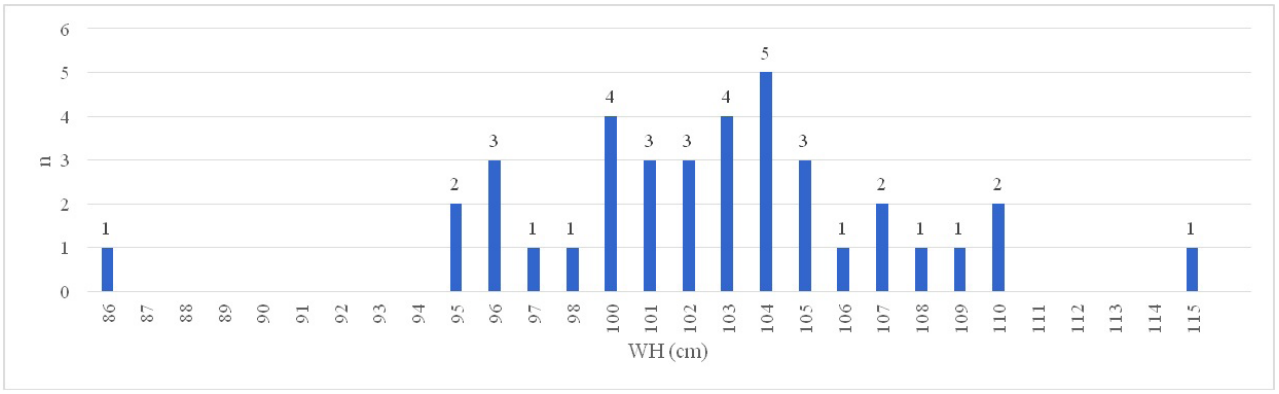

Fig. 8. Bar chart showing the number of individuals with each recorded withers height (WH) in cattle in the Early Modern period in Podlachia.

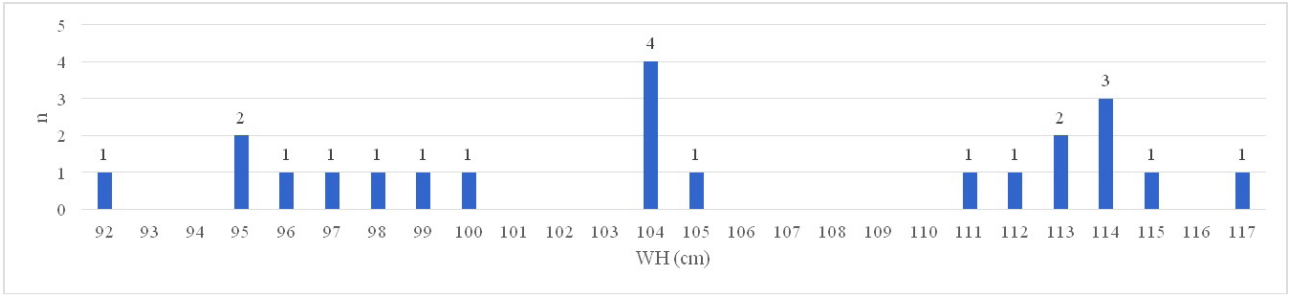

Fig. 9. Bar chart showing the number of individuals with each recorded withers height (WH) in cattle in the Early Modern period in Polesie.

a WH of 95, 107 and 110 cm were less frequent. The remaining results were represented by single individuals. Because of the small sample size, drawing further conclusions is unjustified.

Polesie. The material from Polesie occurred only in the Early Modern period. They numbered a total of 20 items. Most of the remains, 15 elements, came from cows, while four bones belonged to bulls and only one to a steer.

At the analysed sites, some of the cows were larger than bulls, with the WH ranging from 95 to 115 cm (Table 3). Among the bulls, the smallest individual measured 92 cm and the largest reached only 104 cm. The only element originating from a steer belonged to an individual with a height at the withers of 117 cm (Fig. 9).

The dominance of cows is evident in the material. This suggests that from the Medieval to Early Modern times, the same procedures were used to regulate the sexual structure of the herd. The low representation of bull remains may be related to the fact that only the strongest and largest animals were kept alive for breeding purposes. The rest were either slaughtered for meat before reaching 2-2.5 years of age, which is the moment when the epiphyses fuse with the metapodial bone shafts (Habermehl 1975), or were castrated to be used for fattening or work.

On the other hand, the low representation of steer remains may be related to two factors. The first is the late age of castration of the bulls – some historical sources indicate that this could have taken place as late as 3 years of age (Baszanowski 2017) – which means that the proportions of their bones did not differ from those of uncastrated males (Rannamäe et al. 2022). The second factor is that the bulls castrated at an early age were used for fattening and then sold. Researchers also found information in the sources that oxen whose usefulness for work had declined with age (7-9 years of use) were fattened at the age of 10-12 and then sold for slaughter abroad (Baszanowski 2017; Baranowski 1957).

IV. DISCUSSION

The analyses show that the heights at the withers of cows and bulls in the Medieval and Medieval/Early Modern collections were similar in the study area, with an average height at the withers of 103-105 cm for both sexes. However, significant changes occurred in the Early Modern period. In Mazovia there was a diversification of the cattle population with a smaller height at the withers than in the Middle Ages, while in Podlachia there was an increase in the height at withers of cows and a diversification of the population. In the case of the bulls in Mazovia, the animals reached the same size in the Medieval and Medieval/Early Modern categories, but then in the Early Modern period the animals decreased and the population diversified in favour of smaller animals than before. In Podlasie, there were no changes in the height at the withers of bulls.

Throughout the entire period under consideration, small and medium-sized animals were reared in the study area. Incidentally, slightly larger specimens appeared, but only at one site – at Ciechanów Castle. Values above 119 cm obtained for steers do not indicate that they belonged to the primigenius type, but resulted from the previously described relationship between the castration time and bone growth (cattle of the primigenius type are of a strong build, with high growth and a skull with long horns; Guliński 2021). The values obtained for the Middle Ages are similar to observations by Urszula Iwaszczuk (2014) made for early Medieval material. She indicated the predominance of small and medium-sized animals (ranging from 82 to 114 cm), with a small addition of primigenius type specimens (WH in the range of 115 to 129 cm) in Poland. She also noted that in the early Middle Ages, cows were represented in higher numbers than bulls throughout Poland. According to her findings, Mazovian cattle in the early Middle Ages reached sizes similar to those of Greater Poland and were larger than those of Podlachia. These, in turn, were similar in size to the animals in Western Pomerania and Silesia.

Similar dimensions were also reached by the animals from Western Poland in the Early Middle Ages whose height at the withers averaged at 102-103 cm (Makowiecki 2018). These sizes did not change in the late Medieval period. However, as in the study area, changes occurred in the Early Modern period.

The results obtained for the height at withers of cattle from the Medieval period coincide for cows (with a slight deviation) with the results obtained by Michał Skibniewski for Polish territories (Skibniewski et al. 2007a). However, the situation is different for bulls, where the individuals from my study area were lower on average. This is due to the fact that in his study, the author divided the meta-

podial bones into those from cows and those from bulls, but did not separate the remains from steers. Bones from steers could have been included in the set of bones from cows (by the overlapping ranges of the shaft and distal end width ratios), making it appear that the cows were much larger than bulls. Similar results for the average height of bulls were obtained by Alicja Lasota-Moskalewska (1989) but, as with a study of Skibniewski (op. cit.), she did not include steers in her research. On the other hand, the results obtained by the author for cows coincide with those of the current study.

What is non-standard for the studied sites from the Medieval period are the proportions of metatarsal and metacarpal bones from small, medium and large animals, according to Michał Skibniewski's criteria. The material from Mazovia and Podlachia is marked by a lower proportion of small and large animal remains (14.6% each) and a very high proportion of medium-sized animal remains (70.8% compared to 54.3%) than is standard for Poland. Small animals, according to Michał Skibniewski, are local cattle or those from places with adverse environmental influences. However, the bones from animals with large metacarpal and metatarsal dimensions, which were believed to belong to primigenius forms, should be treated with caution, as some of them came from steers, which were usually characterised by a higher height at the withers than cows and bulls. As for the medium-sized cattle, they predominated in the study area.

In the material, as already mentioned, there were remains of individuals that had reached a very small size, i.e. less than 90 cm at the withers. The presence of such small animals may suggest feeding deficiencies during the prenatal or growth period. Also, in the case of the Early Modern period, perhaps the interbreeding of local cattle with the lower, but very resistant to poor living and feeding conditions, Belorussian cattle occurred (Baranowski 1978).

The increase in height at the withers, which occurred at the end of the Middle Ages or as early as the Early Modern period, can be linked to the fact that at that time, cattle from different regions of Europe arrived in what is now Poland and the hybridisation of animals took place (Makowiecki 2018). It is also worth noting that the cattle trade became massive as early as in the 14th century (Obuchowska-Pysiowa 1973). Basically, two main directions of the influx of cattle that may have been mixed with the local animals can be distinguished – from the south and west. On the one hand, these are the territories of Podolia, Volhynia, Wallachia and Hungary (Klonder 2022), from which cattle were driven further westwards through the present Polish territories from as early as the Middle Ages. Jan Basznowski points out that the cattle trade with Podolia, Ukraine, Ruthenia, Wallachia, Moldavia and Hungary focused mainly on oxen (Baszanowski 2017). Cows and bulls that were intended for breeding were probably traded only occasionally. For this reason, even though towns in Mazovia, such as Przasnysz, Ciechanów, Łowicz, Płońsk and Mława, as well as Bielsko in Podlachia, hosted major fairs along the so called 'beef route', this had little impact on increasing the height at the withers of the local cattle. The growth in the animal size likely had a different cause.

One possibility is the import of Friesian, or Dutch, cattle. These animals began arriving in the second half of the 17th century and were valued on dairy farms for their higher milk yield compared to native breeds. In Mazovia special cowsheds, called holendernia, were owned, e.g. by the Radziwiłł family at their palace in Stara Wieś (Perzyna1994) and in Podlachia by the Branicki family in Białystok (Niecіecki 2001). Evidence of the diversity of cattle in the Early Modern period in Eastern Poland can be inferred from the colouring of the animals, for example in the inventory of the village of Smolewo (Radziszewski 2019) or Nieświn and the Otfinów (Pielas & Justyniarska-Chojak 2016) estate, where the colours of the cows' outer coats in the cowsheds are listed. These were reported as 'sade' (i.e. grey or ashen), fawn, bay, red, black and birch cows and bulls. This indicates crossbreeding between different types of cattle.

V. CONCLUSIONS

This study provides new insight into the evolution of cattle morphology in Northeastern Poland from the Middle Ages to the Early Modern period. The analysis confirms that throughout this timeframe, small and medium-sized cattle predominated, with only occasional appearances of larger individuals, often linked to specific sites like Ciechanów Castle. A key finding is the height diversification of cows and a reduction in the stature of bulls during the Early Modern period, particularly in Mazovia. This suggests selective breeding

practices, possibly influenced by external cattle imports and shifting economic or agricultural strategies.

In Podlachia, a moderate increase in cow stature and population diversity also supports the theory of hybridisation with non-local breeds, including possibly resilient Belarusian cattle. In Polesie, the relatively consistent presence of medium-sized animals and a drop in steer height again point to changes in castration practices. Across the regions, the dominance of cows in the archaeological record reflects longstanding herd management practices prioritising milk production and herd sustainability.

In summary, the research on the height at the withers of cattle in Poland requires further study, especially with regard to the south-eastern lands, which have not yet received a dedicated study. Moreover, such studies should be repeated in the future for the areas of Mazovia, Podlachia and Polesie due to the still unsatisfactory state of the research, especially in the Early Modern period. It is possible that future archaeological research will provide better-dated material, especially for the late Medieval period, which will make it possible to trace the changes taking place in the past more precisely.

VI. ACKNOWLEDGEMENTS

I would like to express my gratitude to the anonymous reviewers for their constructive feedback, which proved to be a valuable asset in enhancing the quality of the manuscript. I would also like to thank Anna Grężak for her assistance in identifying relevant materials and for her valuable remarks during the preparation of this paper, Professor Alicja Lasota-Moskalewska for granting permission to use the results of her research, and finally, Michał Jakubczak for preparing the map.

VII. CONFLICT OF INTEREST

The author declare no conflict of interest.

REFERENCES

Baranowski B. 1957. Chów bydła w drugiej połowie XVII i w XVIII wieku w Łęczyckiem i na terenach sąsiednich. *Studia z Dziejów Gospodarstwa Wiejskiego* I: 198-258. [In Polish, with English summary].

Baranowski B. 1978. Zdobywanie surowców organicznych. [In:] A. Keckowa, D. Molenda (eds) Historia Kultury Materialnej polski w zarysie. Tom III. Od XVI do połowy XVII wieku. Wrocław-Warszawa-Kraków-Gdańsk. [In Polish].

Baszanowski J. 2017. Handel wołami w Polsce w XVI-XVIII w. 2nd edition, supplemented. Klinika Języka, Szczęsne, 280 pp. [In Polish].

Driesch A. von den. 1976. A guide to the measurement of animal bones from archaeological sites: as developed by the Institut für Palaeoanatomie, Domestikationsforschung und Geschichte der Tiermedizin of the University of Munich. Cambridge, Mass: Peabody Museum of Archaeology and Ethnology, Harvard University, 136 pp.

Guliński P. 2021. Cattle breeds – contemporary views on their origin and criteria for classification: a review. *Acta Scientiarum Polonorum Zootechnica,* **20**(2): 3-18. https://doi.org/10.21005/asp.2021.20.2.01.

Habermehl K.-H. 1975. Die Altersbestimmung bei Haus- und Labortieren; mit 22 Tabellen. 2., vollst. neubearb. Aufl., Parey, Berlin, 216 pp.

Howard M. 1963. The metrical determination of the metapodials and skulls of cattle. [In:] A. E. Mourant (ed) Man and cattle, pp: 91-100. London.

Iwaszczuk U. 2014. Animal husbandry on the Polish territory in the Early Middle Ages. *Quaternary International* **346**: 69-101. https://doi.org/10.1016/j.quaint.2014.03.012.

Klonder A. 2022. Mięso na rynkach miejskich w Koronie w XVII wieku. Wybrane problemy. *Kwartalnik Historii Kultury Materialnej* **70**(2): 165-182. [In Polish, with English summary]. https://doi.org/10.23858/KHKM70.2022.2.003.

Lasota-Moskalewska A. 1989. Differences in the body size of cattle in the archaeozoological materials in the polish territories. *Przegląd Archeologiczny* **36**: 89-95.

Makowiecki D. 2018. Diachronic Changes in the Size of Domestic Mammals in Medieval and Post-Medieval Poland. *Annalen des Naturhistorischen Museums in Wien, Serie A* **120**: 335-354.

Niecieckі J. 2001. Plan rezydencji białostockiej w czasach Jana Klemensa Branickiego. *Biuletyn Konserwatorski Województwa Podlaskiego* **7**: 48-59. [In Polish, with English summary].

Obuchowska-Pysiowa H. 1973. Handel wołami w świetle rejestru celnego komory krakowskiej z 1604 roku. *Kwartalnik Historii Kultury Materialnej* **21**(3): 507-512. [In Polish, with English summary].

Perzyna B. 1994. *Pałac książąt Radziwiłłów w Starejwsi*. Warszawa. Available at: https://zabytek.pl/pl/obiekty/palac-889089/dokumenty/PL.1.9.ZIPOZ.NID_N_14_EN.321724/2, [In Polish]. Accessed April 18, 2025.

Pielas J., Justyniarska-Chojak K. 2016. Inwentarze dóbr ziemskich z XVII-XVIII wieku. Cz. 2.Wydawnictwo Uniwersytetu Jana Kochanowskiego, Kielce, 242 pp. [In Polish].

Radziszewski M. 2019. Inwentarz i konnotacya całego klucza smolewskiego. *Szlachta Północnego Mazowsza*. Available at: https://szlachtapolnocnegomazowsza.pl/dokumenty/ Accessed April 18, 2025. [In Polish].

Rannamäe E., Saarma U., Bläuer A. 2022. Cultural influences on the castration age of cattle in the northern Baltic Sea region during the medieval and post-medieval periods. *Journal of Archaeological Science* **137**: 105517. https://doi.org/10.1016/j.jas.2021.105517.

Silverthorn D.U. 2019. Human Physiology: An Integrated Approach, 8th edition, Pearson Education, London, 984 pp.

Skibniewski M., Kobryń H., Skibniewska E. 2007a. Wysokość w kłębie bydła domowego średniowiecznej Polski. *Medycyna Weterynaryjna* **63**(3): 369-372. [In Polish, with English summary].

Skibniewski M., Kobryń H., Skibniewska E. 2007b. Typy morfologiczne bydła domowego średniowiecznej Polski. *Medycyna Weterynaryjna* **63**(2): 250-253. [In Polish, with English summary].

Zalewska-Nowak M. 2025. Dimensions of metapodial bones of medieval and early modern cattle from Mazovia, Podlachia and Western Polesie. Available at: https://zenodo.org/records/17794281 [Accessed: December 12, 2025]

Zalkin V.J. 1960. Izmenchivost metapodia i jego znachenije dla izuchnija krupnogo rogatogo skota drevnosti. *Biulletin Moskovskogo Obshchestva Ispytatelej Prirody. Otdel Biologicheskij* **65**(1): 109-126. [In Russian].