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Sports achievements and morphometric characteristics of Oldenburg horse lines

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Abstract. The Oldenburg horse breed, due to its versatility, is a promising object for scientific research. Identification of regular relationships between genealogical characteristics, morphometric indicators and athletic achievements of representatives of this breed is critical for the development of effective breeding programmes. The purpose of the study was to analyse the influence of line affiliation on the morphological characteristics and athletic performance of Oldenburg horses and to identify links between morphological traits and athletic performance. The study was conducted at the equestrian complex “Schockemoehle” (Germany), including 90 Oldenburg horses, divided by sex and lineage. Morphometric indicators and sports achievements are analysed. The results show the dominance of the Cor de la Bryere lineage (48.9% of the total sample), which indicates the success of breeding programmes in improving its characteristics. Other significant lines had a share of 15.6% to 10.0% in the sample structure. Morphometric analysis showed high uniformity among horses in height at the withers and metacarpal circumference, with slight differences between the sex groups: height at the withers ranges from 168.13 cm to 169.2 cm, and metacarpal circumference – from 20.85 cm to 20.99 cm. Analysis of sporting achievements showed that geldings are highly effective in overcoming high obstacles, reaching the Grand Prix level (≥ 155 cm) in 23% of cases, compared to 10% among stallions and

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mares. Stallions and mares usually reach the level of 130-140 cm, with some predominance of mares in this category. The study of different lines shows that the Diamant de Semilly and Almé Z lines have advantages in morphometric parameters, such as height at the withers and metacarpal circumference, which can affect athletic performance. The Capitol I line has the largest number of competitions, but needs to be improved to achieve better athletic performance. The practical significance of the results lies in the possibility of optimising the breeding strategies of sports horses to achieve better achievements in competitions

Keywords: half-breeds; sport horse breeding; breeding programmes; body measurements; genealogical analysis; heritability, competition

Introduction

Modern sports horse breeding is defined by the growing demands on the performance of horses, in particular on their motor characteristics, which are crucial for achieving success at the international level. In the conditions of modern competitions, breeding efforts are aimed at creating horses that not only meet breed standards, but also demonstrate high athletic results.

One of the key aspects in the development of a sports horse is the interaction of numerous factors such as genetics, morphology, physiology, and environmental conditions, including conditions of maintenance and training. In this context, the research conducted by M. Ablondi *et al.* (2019b), which highlights the interaction of these factors and their impact on the athletic characteristics of horses, is important. The authors demonstrate that training efficiency and keeping conditions are crucial for optimising horse performance, along with their genetic and morphological aspects.

The Oldenburg breed is distinguished by its versatility and high sporting achievements. In particular, horses of this breed are actively used in such disciplines as show jumping and triathlon. The International Equestrian Federation (FEI, 2021) emphasises that show jumping combines the courage, control, and technical skills that are necessary for successful performances in international competitions. Y. Neumann *et al.* (2021) additionally note that success in such competitions depends on a set of

factors, including the makings, training of the horse, and the experience of the rider.

Despite the great interest in specific breeds and national competitions, there is not enough research to generalise the athletic performance of horses. J.E. Sackman & K.A. Houpt (2019) and M. Vidament *et al.* (2021) point to the need to expand research beyond individual breeds and national athletic quality tests to better understand the factors that drive athletic achievement internationally. In particular, E. Sobotková *et al.* (2022) note that a horse's breed, age, and sex are important factors that affect its ranking in international obstacle course competitions.

One of the main methods used in breeding Oldenburg horses is line breeding. C. Cochran (2024) and W. Nolte *et al.* (2019) confirm that line breeding allows the concentration of desired alleles in individual lines, which leads to the development of populations with predicted characteristics. The history of breeding the Oldenburg breed, which includes the use of Frisian mares and imported stallions, has significantly influenced the current breed phenotype. K. Bintz (2024) demonstrates that these historical aspects of breeding in the Oldenburg breed contributed to the development of modern sports horses.

An important aspect is also the study of the influence of genealogical factors on athletic performance. S. Vosgerau (2022) focuses on the need to consider not only morphometric

characteristics, but also genealogy to improve breeding programmes. Nowadays, breeding of the Oldenburg horses focuses on the exterior and temperament of the horse, in particular, on the harmonious structure of the body and jumping technique. Identifying the genetic basis of athletic qualities is a critical task. A. Gemma (2019) emphasises that identifying genetic components that correlate with high athletic performance can significantly improve the efficiency of the breeding process. C. Hector (2024) adds that motor characteristics are key to a horse's performance in competition, but success also depends on other factors. European countries such as Germany and the Netherlands demonstrate leadership in sports horse breeding through effective breeding programmes (Oldenburger Verband, 2023; WBFSH, n.d.). Specialised selection for different disciplines leads to the development of separate subpopulations with pronounced differences in the development of traits.

Therefore, the purpose of this study was a comprehensive assessment of the genealogical impact on the morphological and athletic characteristics of Oldenburg horses, and an analysis of the situation at international obstacle course competitions. The main hypothesis was that the proportion of thoroughbred horse blood in the pedigree, breed, age, gender of the horse and exterior data affect the athletic performance of horses at the world level. The results of this study will contribute to understanding current trends in international competitions to overcome obstacles and improve breeding programmes, which is important for the development of sports horse breeding.

Materials and Methods

The study was conducted at the specialised equestrian complex "Schockemoehle" in Germany, which provides optimal conditions for raising and training sport horses of half-breeds. The equestrian complex "Schockemoehle" is engaged in breeding and training sports horses,

in particular the Oldenburg breed, using specific methods, such as embryo transplantation for older mares and conventional mating for young horses. These methods are aimed at improving breeding results and breed development in general. Careful selection of breeding horses with an emphasis on pedigree plays an important role here. The selective approach involves a combination of conventional and innovative techniques to preserve and improve the characteristics of the breed.

The study was conducted in accordance with the European Convention for the Protection of Vertebrate Animals Used for Research and other Scientific Purposes (1986) and Procedure for Conducting Research and Experiments on Animals by Scientific Institutions (2012). During the study, a sample of 90 horses of the Oldenburg breed was established, which met certain criteria for age, athletic performance, and origin. The horses must be over seven years old, have participated in at least ten show jumping competitions, and have been born and raised in the specified complex.

Horses from this sample were divided into three groups by gender with 30 animals in each group (stallions, mares, geldings). Each gender group was additionally divided into five groups based on line affiliation (Cor de la Bryere, Diamant De Semilly, Capitol I, Almé Z, Furioso II). This division helped to conduct a comparative analysis of sports achievements and morphological characteristics of horses of different lines. Each of the 90 selected individuals was analysed according to the following indicators: bloodiness for a thoroughbred horse breed, height at the withers, metacarpal circumference, number of competitions, number of wins, number of prizes, amount of winnings in EUR.

Genealogical analysis involved identifying horses using breeding passports and open databases of breeding and sports associations (WBFSH, FEI, Hippomundo) to determine the pedigree and lineage of each horse. The thoroughbred horse blood test was used as one of

the key features for evaluating half-breed horses. Morphometric analysis was performed with the study of height at the withers and metacarpal circumference.

The analysis of the sports results of competition horses was carried out considering data on the number of competitions to overcome obstacles, the level of competitions (by the height of obstacles) achieved results. The number of wins, prizes, and the amount of prize money were considered using the Hippomundo open database (n.d.).

Statistical analysis was performed using methods of variational statistics for large samples. Mean values, standard deviations, and coefficients of variation for each of the studied indicators were calculated. Appropriate statistical tests were used to compare the groups.

Thus, the study provided a comprehensive analysis of the impact of genetic, genealogi-

cal, gender and exterior characteristics on the athletic performance of Oldenburg horses and their compliance with modern equestrian requirements.

Results and Discussion

A detailed analysis of the population structure of Oldenburg horses obtained in “Schockemoehle” revealed a clear dominance of the Cor de la Bryere line, which is a key aspect in understanding breeding work and its results. In the population structure of the Oldenburg breed presented in Table 1, the Cor de la Bryere line occupies an extremely significant share, accounting for almost half of the sample – 48.9% of the total number of horses. This high level of representation is a clear indication of the success of breeding programmes aimed at consolidating and improving the desired traits in this line.

Table 1. Sample structure, distribution by gender and line affiliation

No.	Line	Stallions		Mares		Geldings		In general	
		n	%	n	%	n	%	n	%
1	Cor de la Bryere	16	17.8	14	15.6	14	15.6	44	48.9
2	Diamant de Semilly	5	5.6	6	6.7	3	3.3	14	15.6
3	Capitol I	2	2.2	2	2.2	5	5.6	9	10.0
4	Alme Z	4	4.4	5	5.6	4	4.4	13	14.4
5	Furioso II	3	3.3	3	3.3	4	4.4	10	11.1

Source: developed by the author

The high sporting achievements of Cor de la Bryere horses can be attributed not only to the influence of outstanding breeding stallions such as Cassall ASK and Cornet Obolensky, but also to the overall genetic stability of this line. The genetic stability and qualitative characteristics of the lineage are also confirmed by the presence of numerous descendants of the outstanding Chacco-Blue in pedigrees, which highlights the importance of these genetic lines for achieving high athletic performance. Compared to the Cor de la Bryere line, other lines have a lower representation in the population. The Diamant De Semilly line accounts

for 15.6% of the total number of horses, which is a significant share, but less than the Cor de la Bryere line. The Almé Z line, which also shows significant potential, has a representation of 14.4%. On the other hand, the Capitol I and Furioso II lines have the smallest proportions – 10.0% and 11.1%, respectively, which may be the result of different breeding strategies or historical factors that influenced their development. The marked distribution of particles among the lines indicates the importance of further research to assess their contribution to the overall athletic potential of the Oldenburg breed (Oldenburger Pferde,

n.d.). Further research should focus on analysing the reasons that led to such changes in representation, and on the impact of each of the lines on the overall athletic performance of the breed.

Analysis of morphometric parameters confirms the high uniformity of the population of Oldenburg horses in the main line parameters, in particular, the height at the withers and metacarpal circumference (Table 2). This uniformity indicates the effectiveness of breeding

programmes aimed at stabilising the physical characteristics of the breed. However, despite this morphological consolidation, there is significant variability in the athletic performance of horses. This variance can be caused not only by genetic factors that are not directly related to morphology (for example, genes that affect temperament or coordination), but also by the influence of the external environment, including the level of training, feeding regime, and overall health of horses.

Table 2. Morphometric parameters of different sex groups of Oldenburg horses

	Stallions		Mares		Geldings	
	M ± m	Cv, %	M ± m	Cv, %	M ± m	Cv, %
Bloodline	36.46 ± 0.8	11.97	37.98 ± 0.88	12.71	37.85 ± 0.72	10.36
Height at the withers	169.1 ± 0.72	2.35	168.13 ± 0.68	2.21	169.2 ± 0.93	3.00
Metacarpal circumference	20.94 ± 0.11	2.98	20.85 ± 0.09	2.42	20.99 ± 0.09	2.47
Number of competitions	49.5 ± 6.69	74.07	53.43 ± 6.16	63.17	60.37 ± 7.45	67.60
Number of wins	2.53 ± 0.62	133.45	2.2 ± 0.36	88.85	1.77 ± 0.42	129.32
Number of prizes	16.17 ± 2.69	91.23	19.03 ± 2.77	79.67	17.9 ± 3.37	103.20
Prize money, EUR	7,534.73 ± 3,954.52	287.47	12,479.23 ± 8,011.19	351.62	10,917.03 ± 3,778.4	189.57

Source: developed by the author

Morphometric studies have shown that the height at the withers and metacarpal circumference have little variation among different sex groups. The average values for height at the withers are 169.1 cm in stallions, 168.13 cm in mares, and 169.2 cm in geldings; for metacarpal circumference, they are 20.94 cm, 20.85 cm, and 20.99 cm, respectively. Low coefficients of variation of these characteristics confirm the high stability of physical parameters among the sex groups.

Determination of the bloodlines of sport horses, according to the thoroughbred breed, is a key aspect of the study in the context of analysing the influence of genetic factors on the sports performance of horses of half-breeds. This parameter helps to assess the extent to which the hereditary characteristics of

thoroughbred horses can affect the characteristics of athletic performance, which is critical for the development and improvement of athletic qualities of half-blood horses. The analysis of conditional heritability by thoroughbred in Oldenburg horses shows average variation in all three sex groups with coefficients of variation of 11.97% for stallions, 12.71% for mares, and 10.36% for geldings. High coefficients of variation in athletic performance, such as the number of competitions, places won, and prize amounts, indicate significant variability in athletic performance. This highlights the impact of individual characteristics and level of training on achievements in competitions. In general, the study of morphometric indicators and sports achievements of Oldenburg horses reveals high population uniformity in the main

morphometric parameters. However, there is a significant variability in athletic performance, which highlights the influence of other factors, in particular genetic characteristics and external conditions. Analysis of the distribution of Oldenburg horses by sex and level of training,

in particular considering the height of obstacles that horses can overcome (Table 3) showed clear trends in the distribution of horses by gender and their ability to overcome obstacles of different heights, which allows drawing several important conclusions.

Table 3. Characteristics of horses of different sex groups by their ability to overcome obstacles of different heights

Sex group	n	Distribution of livestock by maximum obstacle height					
		130-140		145-150		≥155	
		n	%	n	%	n	%
Stallions	30	15	50	12	40	3	10
Mares	30	17	67	10	33	3	10
Geldings	30	10	34	13	43	7	23
Total	90	42	47	35	39	13	14

Source: developed by the author

Firstly, among the stallions that make up one-third of the sample ($n = 30$), the majority of horses (50%) successfully participate in competitions on obstacles with a height of 130-140 cm. This shows that stallions mostly show a high level of training for mid-level competitions. Only 10% of horses reach the Grand Prix level (≥ 155 cm), which confirms their weaker readiness to overcome too high obstacles compared to other sex groups.

Among mares, which also make up one-third of the sample ($n = 30$), the situation is somewhat similar, but with some differences. 67% of mares (17 out of 30) participate in competitions with an obstacle height of 130-140 cm, which is a higher percentage compared to stallions. This may indicate that the mares are well trained to overcome mid-level obstacles. However, as with stallions, only 10% of mares reach the Grand Prix level, which again indicates less frequent achievement of high levels of training. In contrast to stallions and mares, geldings, who also make up one third of the sample ($n = 30$), show a different trend. 34% of geldings (10 out of 30) compete on obstacles with a height of 130-140 cm, which is the lowest percentage of all sex groups. On the other

hand, 43% (13 out of 30) of geldings participate in competitions with an obstacle height of 145-150 cm, which indicates their superiority in overcoming obstacles of medium height. A significant percentage of geldings (23%, or 7 out of 30) reach the Grand Prix level (≥ 155 cm), which indicates their higher ability to overcome high obstacles compared to stallions and mares.

There is an assumption that castration probably concerns horses that have less breeding value. However, it turns out that better results can be achieved after castration. It is important to note that stallions and mares are selected according to similar criteria, and this hypothesis requires further clarification. Breeding strategies for geldings are also different from those applied to stallions and mares.

Analysis of the data from Table 3 shows that stallions and mares have a similar distribution in terms of athletic performance. However, the findings show that geldings have significant advantages in overcoming high obstacles and are more likely to reach the level of the Grand Prix. Instead, stallions and mares are more likely to participate in mid-level competitions. These results can be determined by both physiological and breeding characteristics of different

sex groups, which highlights the importance of taking the horse’s sex into consideration when developing training and breeding strategies to achieve optimal results in competitions.

The morphometric analysis presented in Table 4 shows different levels of physical

characteristics and athletic performance among Oldenburg horse lines. These results highlight differences in the ability of horses to succeed in competition, which can be explained by both morphological features and breeding strategies applied to each lineage.

Table 4. *Morphometric indicators of representatives of the Oldenburg breed of various line affiliation*

Line	Cor de la Bryere	Diamant de Semilly	Capitol I	Alme Z	Furioso II
Indicator	M ± m	M ± m	M ± m	M ± m	M ± m
Bloodline	38.03±0.64	36.74±1.49	36.21±1.42	38.38±1.23	35.59±0.90
Height at the withers	167.95±0.64	171.29±1.31	167.78±0.91	169.08±1.03	169.7±1.35
Metacarpal circumference	20.80±0.08	21.21±0.15	20.88±0.17	21±0.15	21.06±0.14
Number of wins	2.39±0.44	1.57±0.48	1.78±0.91	2.54±0.69	1.9±0.80
Number of competitions	53.48±5.18	53.5±12.10	64.33±14.46	56.62±9.45	48.2±12.60
Number of prizes	19.20±2.63	16.14±4.84	18.67±4.88	13.46±2.68	17.9±5.25
Prize money, EUR	8,786.57±3,023.96	18,713.5±17,132.39	6,308.44±2,381.36	5,133.54±2,149.32	15,582±9,737.17

Source: developed by the author

An analysis of the sporting achievements of horses of various lines shows that the cor de la Bryere and Diamant De Semilly lines have the most significant potential for achieving high results in various disciplines of equestrian sports. This may be due both to the specific genetic characteristics of these lines and to their popularity among breeders, which provides access to high-quality training programmes and resources. Despite the numerical representation of the Capitol I line in the study sample, it shows some differences in athletic performance. This may indicate that breeding efforts in this line were aimed at developing specific qualities that do not always meet the requirements of various sports disciplines. Thus, breeding programmes could focus on certain specialised characteristics that affected the overall athletic performance of horses in this line. Analysis of morphometric data of Oldenburg horses separated by lines shows noticeable differences that can significantly affect their athletic performance.

A comparison of different lines and their characteristics points to several key trends and differences in the context of generally accepted standards for horses of this breed.

The Diamant De Semilly line is marked by a significant height at the withers, exceeding the Cor de la Bryere and Capitol I lines by 3.34 cm and 3.51 cm, respectively. This indicates optimal physical characteristics for horses participating in competitions where height is an important parameter. According to the standards, the recommended height at the withers for Oldenburg horses varies between 165 and 175 cm, which confirms the compliance of the Diamant de Semilly line with the upper limit of this range. The Alme Z line has a height of 2.21 cm less than the Diamant de Semilly, which can affect the ability of its representatives to show athletic results in overcoming obstacles.

The Diamant de Semilly line also has the largest metacarpal circumference, exceeding Cor de la Bryere by 0.41 cm and Capitol I

by 0.33 cm. This may indirectly indicate the strength of the constitution and the superiority of horses of this line in physical fitness, which is crucial for achieving high results in competitions. The Alme Z line has a 0.21 cm smaller metacarpal circumference compared to the Diamant de Semilly, which may reduce its athletic potential, as smaller sizes can limit physical endurance.

The Capitol I line has the highest average number of competitions, surpassing the Diamant de Semilly line by 10.85 competitions. This indicates a high athletic activity of horses of this line. While the Furioso II line shows a significantly smaller number of competitions (less by 16.13 cm), which may be due to lower opportunities or other strategies for participating in competitions.

The Alme Z line shows the highest average win, surpassing the Diamant de Semilly and Capitol I lines by 1.15-1.11 wins. This indicates the high competitiveness of horses of this line. However, the Diamant de Semilly line, although it has fewer wins compared to Alme Z, still surpasses Cor de la Bryere and Furioso II, which confirms its high potential in sporting achievements. The Diamant de Semilly line has the highest average prize money, surpassing the Cor de la Bryere and Furioso II lines by EUR 10,926.93 and 10,448.46. This may indicate a high level of success in the competition. The Alme Z line has a significantly lower average prize amount (compared to Diamant de Semilly), which may be due to lower competitiveness or competition type.

According to the results of the study, significant differences were found between the lines of the Oldenburg breed in morphometric indicators and athletic performance. The Diamant de Semilly and Alme Z lines show advantages in various aspects, such as height at the withers, metacarpal circumference, number of wins, and amount of prize money. The Capitol I line shows high sports activity, but does not achieve such significant results in winnings and

prize money. The Cor de la Bryere and Furioso II lines have average performance, which allows them to be used as a basis for further improvement of breeding programmes. Thus, the results of morphometric indicators and sports achievements indicate that each line has its own unique features and potential. The Diamant de Semilly and Furioso II lines, with their outstanding physical characteristics, can be focused on achieving high results in various competitions. The Capitol I line, although it shows a large number of competitions, needs to improve the training process to improve academic performance. The Cor de la Bryere line shows the effectiveness of breeding work due to the stability of its sporting results. But the Alme Z line, despite a significant number of wins, shows limited financial results. This phenomenon can be explained by the fact that horses of this line often participate in lower-level competitions with less competition, which leads to a smaller prize pool, although the number of wins is significant. Thus, these results can be due to both limited sporting opportunities and the specifics of the level of competitions in which horses of this line are represented. The conclusion from this analysis suggests that breeding and training horses should consider not only physical characteristics, but also individual characteristics that affect their athletic performance. The results of the study highlight the importance of line affiliation in the development of athletic qualities of horses and can be useful for further improvement of training and breeding programmes.

The results of studies on the influence of line affiliation on the level of training and athletic achievements of Oldenburg horses, presented in Table 5, confirm the influence of line affiliation on the ability of horses to overcome obstacles of different heights. These data are related to both morphological and sporting features of each line, which allows evaluating their effectiveness in competitions of different levels of complexity.

Table 5. Distribution of horses of different lines of Oldenburg breed by training levels, considering the maximum height of obstacles

No.	Line	Total individuals, n	Distribution of livestock by maximum obstacle height					
			130-140		145-150		≥155	
			n	%	n	%	n	%
1	Cor de la Bryere	44	19	43	19	43	6	14
2	Diamant de Semilly	14	8	58	3	21	3	21
3	Capitol I	9	3	33	5	56	1	11
4	Alme Z	13	6	46	6	46	1	8
5	Furioso II	10	6	60	2	20	2	20

Source: developed by the author

The Cor de la Bryere line shows a relatively balanced distribution of livestock between training levels. The vast majority of horses in this line (43%) participate in steeplechase competitions with heights of 130-140 cm and 145-150 cm. Only 14% of horses reach the Grand Prix level (≥155 cm). This may indicate the versatility of the line, which performs well in mid-level tasks, but requires additional training to achieve higher results. The Diamant de Semilly line is characterised by a high proportion of horses that successfully overcome obstacles with a height of 130-140 cm (58%). A smaller proportion of horses can overcome obstacles of 145-150 cm and ≥155 cm. This suggests that horses of this line have some advantages in mid-level competitions, but their potential for achieving the highest results is limited.

The Capitol I line is mainly represented by horses that successfully pass obstacles with a height of 145-150 cm (56%). Only 11% of horses reach the Grand Prix level. This may indicate that the breeding work of this line is focused on developing qualities that ensure success in competitions relative to the average level, but there is a need for additional efforts to improve the Alme Z line. 130-140 cm and 145-150 cm, with a small proportion of horses reaching the Grand Prix level (8%). This indicates that horses of this line are mostly successful at the average level of competition, but are less likely to achieve higher results.

The Furioso II line has a high proportion of horses that successfully overcome obstacles with a height of 130-140 cm (60%), and a lower proportion of horses that can overcome higher obstacles. This may indicate that horses in this line are mostly good at mid-level tasks, but less likely to succeed at the highest levels of competition.

Thus, the findings show that different lines have their own characteristics in terms of the level of training and sports achievements. Lines like Cor de la Bryere and Alme Z have a fairly balanced distribution between average training levels, while Diamant de Semilly and Furioso II show a higher proportion of horses overcoming mid-level obstacles. The Capitol I line shows strengths at the mid-level of competition, but has less success at the higher levels. These findings suggest that breeding strategies and training programmes for each line can be adapted to improve athletic performance depending on the specific characteristics and potential of the horses.

The results of the study emphasise the importance of an integrated approach to assessing the athletic potential of Oldenburg horses, in particular in the context of the impact of different lines on athletic performance. The analysis of the distribution of shares among the lines showed that there are significant variations in the representation of horses of different lines, which indicates the need for a more detailed study of their contribution to the overall

sporting potential of the breed. If the studies by A. Tavernier (1990; 1991) and J. Duensing *et al.* (2014) showed that variations in athletic performance can be caused by both genetic and training factors, then C. Cochran (2024) and W. Nolte *et al.* (2019) confirm that line breeding allows the concentration of desired alleles in individual lines, which leads to the development of populations with predicted characteristics.

The results of the current study confirm the high uniformity of morphometric parameters among horses of different genealogical groups, which indicates the effectiveness of the influence of breeding on the stability of physical characteristics, which correlates with the results obtained by M. Ablondi *et al.* (2019a) and B.J. Ducro *et al.* (2007). However, variability in athletic performance highlights the influence of functional characteristics that do not always correlate with morphological features (Viklund *et al.*, 2015). This coincides with the conclusions of E. Bartolomé *et al.* (2018) and Y. Neumann *et al.* (2021), who note that individual characteristics and level of training play a key role in athletic performance.

In particular, the results show that geldings have an advantage in overcoming high obstacles and reaching the Grand Prix level, which may be due to their specific physiological characteristics and breeding characteristics. According to E. Sobotková *et al.* (2022), physiological factors such as greater muscle mass and more stable temperament, promote increased endurance and coordination, which are key to successfully performing challenging exercises and overcoming high barriers. This is consistent with the findings of E.P.C. Koenen *et al.* (2004), who found that geldings, due to their neutral hormonal system, have more stable energy levels and better ability to concentrate, which reduces the risk of mistakes during competition.

K. Schöpke *et al.* (2013) emphasise that genetic parameters such as inheritance certain alleles responsible for strength, stability, and the ability to quickly recover from exercise play

an important role in achieving high athletic performance. In addition, breeding approaches aimed at preserving and improving these desired traits in offspring are also important, which allows not only increasing the effectiveness of training processes, but also creates prerequisites for stable success in sports.

At the same time, stallions and mares that are more focused on average competition levels require adaptation of training and breeding strategies to achieve optimal results, as noted by A.M. Haberland *et al.* (2012). Stallions have high energy and greater muscle strength, which can be an advantage in dynamic, short-term competitions, but they can also be prone to impulsivity, which affects their stability during long-term competitions or when overcoming difficult obstacles. Mares usually have more balanced mental characteristics, which contributes to better cooperation with the rider and performing technically complex maneuvers, but they may need more specialised training programmes to reach the level of endurance and strength required for high results.

The study of different lines such as Diamant de Semilly, Furioso II, Capitol I, Cor de la Bryere and Alme Z shows that each of them has its own strengths and requires a specific approach to training and preparation. The Capitol I line, which demonstrates significant potential at medium obstacle levels, needs to improve the training process to improve academic performance at high levels, which is consistent with the findings of S. Vosgerau *et al.* (2022). However, the Cor de la Bryere and Alme Z lines, which show stable results, require optimisation of training processes to increase competitiveness. The results of the current study are also consistent with the conclusions of A. Gemma & C. Hector (2019), who emphasise that identifying the genetic components associated with high athletic performance can significantly improve the efficiency of the breeding process.

Thus, the results expand the understanding of the relationship between genetic,

morphological, and training factors that affect the athletic performance of Oldenburg horses. The identified variations in athletic performance require additional research to determine the specific effects of genealogical lines on the level of results in different types of competitions. The need for this approach is supported by the results of animal genetics research, which suggests that individual differences due to genetic background can play a crucial role in predicting athletic success (Hamann & Distl, 2008; Próchniak *et al.*, 2021).

The study also highlights the importance of a selection and training approach that considers both genetic factors and the horse's physical fitness and psychological state. This is in line with modern approaches to the training of sports horses, where the integration of comprehensive analysis of animal data helps to optimise the training process, reducing the risk of injury and increasing the chances of achieving maximum athletic results, as noted in numerous studies.

Conclusions

The study highlights the need for a comprehensive approach to assessing the athletic qualities of horses, which considers not only the genetic potential, but also individual aspects of their development and training. For successful breeding and improving athletic performance, it is important to consider all these factors together, as this will allow creating more accurate breeding and training programmes.

The apparent dominance of the Cor de la Bryere line in the structure of the Oldenburg breed is explained by the high sporting achievements of horses of this line and the success of outstanding breeding stallions such as Chacco-Blue. The Diamant de Semilly and Alme Z lines also show potential, although their athletic performance and achievements may vary. An important aspect is that physical characteristics, in particular height at the withers and metacarpal circumference, have low variability, which

indicates the stability of the line within the breed standard. However, a significant variation in athletic performance highlights the importance of an individual approach to the training process. In general, the morphological uniformity of the population indicates the success of breeding to stabilise physical characteristics.

However, significant fluctuations in athletic performance indicate that success in competition can be driven not only by genetic factors, but also by environmental conditions such as exercise, nutrition, and overall health. Each of the studied lines has its own unique features that affect the sporting achievements of its representatives. The analysis shows that although some lines, such as Diamant de Semilly and Furioso II, show high physical performance, their athletic performance may vary. The Capitol I line, despite the large number of participants in the competition, has certain differences in results, which may indicate the need to improve training approaches to improve efficiency. The distribution of horses by training level shows that representatives of different lines have different potential to achieve high athletic results. In particular, horses of the Cor de la Bryere and Alme Z lines show high performance at the average levels of competition, while horses of the Diamant de Semilly line are more likely to achieve success in competitions of the highest level.

Therefore, to achieve high athletic results, it is necessary to consider both the genetic potential of the horse and the individual characteristics of its development and training, which will help optimise breeding and training strategies. Prospects for further research in the field of equine sports genetics include several key areas. Firstly, it is important to conduct a more detailed genetic analysis aimed at identifying specific markers that correlate with high athletic performance. This will help to better understand which genes and their variations have the greatest impact on the athletic performance of horses. Secondly, it is necessary to investigate the epigenetic mechanisms that

affect the development of athletic qualities. Epigenetic modifications can significantly alter the manifestation of genetic information, so studying their role in the formation of athletic abilities will help to identify new aspects of the impact of the environment on training results. Thirdly, it is important to analyse the interaction between genetic factors and paratypical (environmental) factors in the development of the sports horse phenotype. This approach will allow understanding how external conditions, such as nutrition and training, affect the manifestation of genetic inclinations, and will contribute to the development of individual training programmes for horses.

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Conflict of Interest

None.

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Спортивні досягнення і морфометричні характеристики ліній коней ольденбурзької породи

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Анотація. Ольденбурзька порода коней, завдяки своїй універсальності, є перспективним об'єктом для наукового дослідження. Виявлення закономірних зв'язків між генеалогічними характеристиками, морфометричними показниками та спортивними досягненнями представників цієї породи є критично важливим для розробки ефективних селекційних програм. Мета дослідження полягала в аналізі впливу лінійної належності на морфологічні характеристики та спортивні результати коней ольденбурзької породи, а також у виявленні зв'язків між морфологічними ознаками та спортивними досягненнями. Дослідження проведено на базі кінноспортивного комплексу «Schockemoehle» (Німеччина), включало 90 ольденбурзьких коней, розподілених за статтю та лінійною приналежністю. Проведено аналіз морфометричних показників та спортивних досягнень. Результати демонструють домінування лінії Cor de la Bruere (48,9 % загальної вибірки), що свідчить про успіх селекційних програм у вдосконаленні її характеристик. Інші значні лінії мали частку в структурі вибірки від 15,6 до 10,0 %. Морфометричний аналіз показав високу однорідність серед коней за висотою в холці та обхватом п'ястка, з незначними відмінностями між статевими групами: висота в холці коливається від 168,13 см до 169,2 см, а обхват п'ястка – від 20,85 см до 20,99 см. Аналіз спортивних досягнень виявив, що мерини мають високу ефективність у подоланні високих перешкод, досягаючи рівня Гран-Прі (≥ 155 см) у 23% випадків, порівняно з 10% серед жеребців і кобил. Жеребці та кобили зазвичай досягають рівня 130-140 см, з деяким переважанням кобил у цій категорії. Вивчення різних ліній показує, що лінії Diamant de Semilly і Almé Z мають переваги в морфометричних параметрах, таких як висота в холці і обхват п'ястка, що може впливати на спортивні досягнення. Лінія Capitol I має найбільшу кількість змагань, але потребує покращення для досягнення вищих спортивних результатів. Практичне значення результатів полягає в можливості оптимізації селекційних стратегій спортивних коней для досягнення кращих досягнень у змаганнях.

Ключові слова: напівкровні породи; спортивне конярство; селекційні програми; проміри тіла; генеалогічний аналіз; частка спадковості; конкур