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Evaluation of jumping ability of half-bred mares by means of the measurable method

Ocena możliwości skokowych klaczy półkrwi za pomocą metody wymiernej

Summary. The aim of this study was to design a formula to evaluate the jumping ability of young mares on the basis of an analysis of the correlation between the judge rating and parameters of the length and the height of the jump. The material consisted of recordings of 30 free jumping mares representing Polish Warmblood and Halfbred Angloarab breeds, which were subjected to the performance test (60-day test). Each mare jumped over an oxer, with a successively increased height. Notes given by the judge included the jump length, jump height, courage and the willingness to jump. In MultiScanBase software measurements were also made which were determined by the length of jump stride, length of jump suspension, distance between the sternum and the pole of the second part of the obstacle. The statistical analysis was performed by PQStat software, while differences between the means were verified by T-Tukey test. To design a formula of a measurable method of jumping ability Pearson correlation coefficients were used. The results indicate that the evaluation of the jumping ability of young mares with measurable traits should be conducted on an obstacle of a minimum 115 cm in height. A high variation of the length of the jump stride, length of jump suspension, distance between the sternum and the pole, offers the opportunity to use the trait as a selection criterion. A formula designed in this paper can be helpful to complement and objectify the system of testing mares in training centers.

Key words: half-bred mares, jumping ability, digital image analysis, measurable evaluation methods

INTRODUCTION

The persisting interest in show jumping makes that attaches key importance in jumping horse breeding [Górecka-Bruzda *et al.* 2012, Annual Report FEI 2011], and leading horse breeding associations have recently begun to work on the improvement of sub-population of animals predisposed only for overcoming the obstacles

[www.hanoverian.com 2013, www.kwpn.org 2013]. This activity is expected to contribute to increased breeding progress, and thus, to produce horses with outstanding performance features [Kapron 1999]. Popularity of this equestrian discipline indicates the need to improve methods for early assessment of the jumping predispositions of young stallions and mares [Maršálek *et al.* 2010]. Jumping capabilities of a modern sport horse, i.e. the ability to perform long and high jumps, is considered one of its most important features [Szaszkiewicz 2010, Back and Clayton 2001], although courage and willingness to overcome an obstacles is also important [www.pzhk.pl 2013]. Up to this time, the features have been scored in an immeasurable manner and have been included within the overall score for free jumping. Another problem is low height of obstacles that are overcome by young horses. It is often makes scores issued by judges are more subjective [Lewczuk 2008].

The objective of this study was design a formula suitable for assessing the jumping ability of young mares, based on an analysis of the correlation between the judge's scores and parameters of a jump length and height.

MATERIAL AND METHODS

The study involved 30 half-bred mares representing Polish Warmblood (sp) and HalfbredAngloarab (xo). The number of animals in each group was equal. Their age ranged from 33 to 41 months.

Mares were subjected to training in the stationary performance test called *the 60-day test* [www.pzhk.pl 2013]. On the day of conducting research, horses were practiced free jumps (without a rider). Each mare performed five jumps over an oxer of 100 cm width and 100 to 120 cm height. After each jump, the obstacle was raised by 5 cm. All mares overcome every obstacle faultlessly.

For the purposes of this study, the judge give his scores for courage and willingness to jump, as well as for the length and height of the jump, to each of mares. These features were considered to be components of a horse *jumping ability*. Each of these was assessed separately after five consecutive jumps. Scoring were as follows: from 1 to 10 points (pts.). The judge used the following guidelines when evaluating the characteristics of a mare's jump: very poor (1 pt.), bad (2 pts.), almost bad (3 pts.), insufficient (4 pts.), enough (5 pts.), satisfactory (6 pts.), fairly good (7 pts.), good (8 pts.), very good (9 pts.), and excellent (10 pts.) [www.pzhk.pl 2013].

Mares during jump were filmed using a digital camera set on a tripod in front of the obstacle. The film was transferred to a computer's memory through *wire-fire*. The resulting 24 frames per every minute of the record were selected in Pinnacle Studio software ver. 9.0.0. The following parameters of the *jump length and height* were measured with a help of MultiScanBase (MSB) CSS Scan software ver. 14.02:

- length of the jump stride (cm) – measured from the hoofprint of the right hind leg during take-off to the hoofprint of the right hind leg during landing (Fig. 1);
- length of jump suspension (cm) – measured from the hoofprint of the hind leg that is closer to the obstacle during take-off to the hoofprint of the fore leg being closer to the obstacle during landing (Fig. 2);

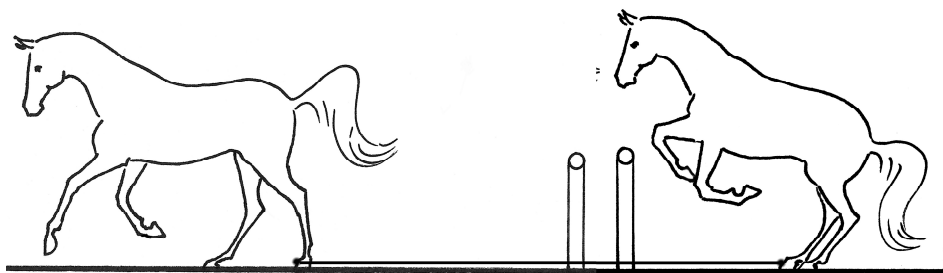


Fig. 1. Length of the jump stride
Rys. 1. Długość kroku skoku

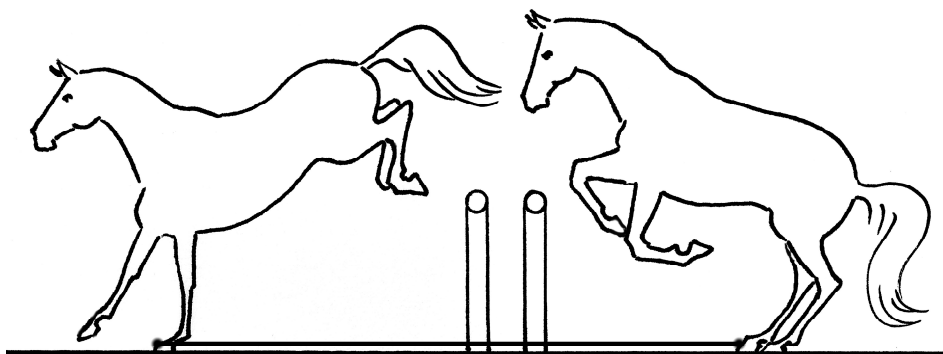


Fig. 2. Length of jump suspension
Rys. 2. Długość lotu

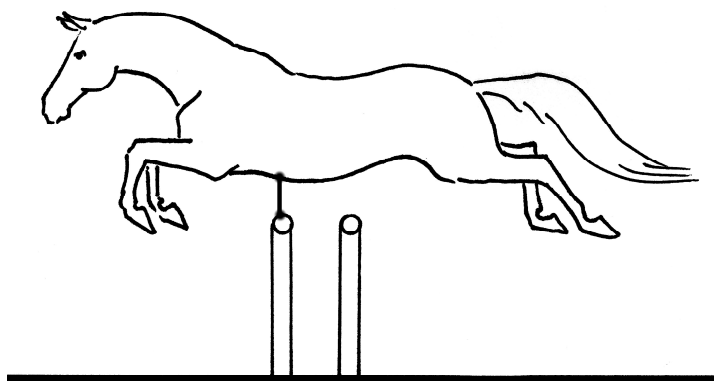


Fig. 3. Distance between sternum and pole
Rys. 3. Odległość mostka od drąga

– distance between sternum and pole (cm) – measured from the lower edge of sternum to the upper edge of pole in the second part of an obstacle (Fig. 3).

All three parameters were measured in each of the following jumps of mare.

To designing a formula for measurable assessment of jumping ability, were taken into account correlations between the judge's scores vs. jump length and height parameters. Selected only those jumps for which there were at least two significant correlations between *jumping ability* (four elements assessed by the judges) and each of *jump length and height* parameters. Values of selected parameters were sorted from the largest (indicating the most powerful jumping ability) to the smallest (indicating the poorest jumping ability). Such sorted sequences of numbers were divided into five equal intervals. Each of the interval assigned number of points, from 1 point (lowest values range) to 5 points (highest values range). Scores achieved within each jump became the components of the summary formula used for measurable assessment of mare's jumping ability.

Results were analyzed applying PQStat ver. 1.2.4 software. Multifactorial variance analysis was performed taking into account the horse breed, judge's scores, and consecutive jumps. Differences between mean values were determined using T-Tukey test. The coefficients of variation V (as a percentage of the standard deviation relative to the average value) was calculated as well. The extreme values and specific rank intervals were also provided.

RESULTS

Scores issued by a judge to Polish Warmblood mares ranged from 6.56 points for willingness to jump to 8.34 points for jump height (Table 1). The extreme values of these features ranged from 3 to 10 points. Variability coefficient remained at the same level. In the case of HalfbredAngloarab mares, average values amounted from 6.76 points for willingness to jump to 8.66 points for the jump length. The minimum values did not exceed 5 pts., while maximum ones most often reached 9 points. Coefficients of variation were around 10–13%, remained at a level similar to that recorded in the group of Polish Warmblood. Differences between mean values were not significant.

The progress in the length of the jump stride along with the raising the obstacle height was noticeable for both breeds (Table 2). Length of the first three strides of the jump considerably differed from the last two ones. Mares of tested breeds significantly varied in reference to the lengths of stride of the first and the second jump. The average length of consecutive strides of Polish Warmblood mare's jumps ranged from 465.11 cm to 602.33 cm, which referred to overcoming the lowest and highest obstacles. The HalfbredAngloarab mares were characterized by longer jump stride. Limit values of the range were 498.90 and 610.30 cm. Considering the last three jump stride, the coefficients of variation was higher, than during overcoming the 100–105 cm obstacle. The highest values were obtained during the third and the fifth stride of the jump, which referred to HalfbredAngloarab and Polish Warmblood mares, respectively.

Tabela 1. Statystyczna charakterystyka ocen wystawianych przez selekcjonera badanym klaczom
Table 1. Statistical characterization of scores issued by judge to tested mares

Cecha Trait	Długość skoku Jump length	Wysokość skoku Jump high	Odwaga Courage	Chęć do skoku Willingness
Rasa polski koń szlachetny półkrwi/Polish Warmblood breed				
Średnia Mean	7,16	8,34	6,89	6,56
Min	4	3	5	4
Max	10	9	10	9
V	11,12	13,42	10,34	10,67
Rasa angloarabska półkrwi/HalfbredAngloarab breed				
Średnia Mean	8,66	7,21	7,56	6,76
Min	5	4	5	5
Max	9	8	9	10
V	12,14	13,74	9,98	11,38

Nie odnotowano istotnych różnic między średnimi.
No significant differences between mean values were recorded.

Tabela 2. Statystyczna charakterystyka analizowanych parametrów długości i wysokości skoku
badanych klaczy
Table 2. Statistical characterization of analyzed jump length and height parameters for tested mares

Nr skoku Jump No.	1	2	3	4	5	1	2	3	4	5
Rasa polski koń szlachetny półkrwi Polish Warmblood breed					Rasa angloarabska półkrwi HalfbredAngloarab breed					
Długość kroku skoku (cm) Length of jump stride (cm)										
Średnia Mean	465,11 AA'	467,09 AA'	517,41 AA'	578,71 AB'	602,30 AB'	498,908 BA'	501,34 BA'	520,20 AA'	587,91 AB'	610,30 AB'
V	13,11	15,22	24,41	23,41	25,06	10,66	13,13	30,17	24,43	23,12
Długość lotu (cm) Length of jump suspension (cm)										
Średnia Mean	311,45 AA'	345,65 AA'	369,16 AA'B'	408,11 AB'	427,92 AB'	333,12 AA'	367,42 AA'B'	404,32 BB'	411,43 AB'	469,23 BC'
V	11,13	14,76	15,87	20,11	17,23	12,12	10,43	16,13	18,11	17,62
Odległość mostka od drąga (cm) Distance between sternum and pole (cm)										
Średnia Mean	35,11 AA'	38,23 AA'B'	41,12 AA'B'	44,16 AB'	47,41 AB'	31,11 AA'	30,41 BA'	40,23 AB'	41,62 AB'	45,07 AB'
V	7,34	10,34	11,12	14,08	12,14	8,15	9,34	10,11	9,88	11,43

Średnie w obrębie każdego z parametrów oznaczone tymi samymi literami (A, B: w kolumnach, A', B': w wierszach) nie różnią się istotnie (w innych przypadkach $P \leq 0,05$).
Mean values marked the same letter within each of parameter (A, B in columns, A', B' in rows) did not significantly differ (other cases $P \leq 0.05$).

As the height of the obstacle increased, a gradual increase in the length of jump suspension was recorded for mares of both breeds. There were significant differences between mean values within the consecutive jumps, which occurred mainly during overcoming the lowest and highest obstacles. Differences between breeds concerned the length of jump suspension over obstacles of 110 and 120 cm height. Polish Warmblood mares gained an average value of this parameter from 311.45 cm during the first to 427.92 cm during the last jump. The limit values between the extreme average length of jump suspension of HalfbredAngloarab mares ranged from 333.12 cm (jump No. 1) to 469.92 cm (jump No. 5). For both breeds, the coefficients of variation exceeded 10% during each of jumps.

Tabela 3. Korelacje między ocenami selekcjonera a parametrami skoku badanych klaczy
Table 3. Correlation between judge's scores and jump parameters for tested mares

Nr skoku Jump No.	Cecha Trait	Długość skoku Jump length	Wysokość skoku Jump height	Odwaga Courage	Chęć do skoku Willingness
Długość kroku skoku Length of jump stride					
1		-0,123	0,388*	-0,123	0,209
2		0,098	0,402*	-0,201	0,083
3		0,207	0,404*	0,309	-0,109
4		0,409*	0,387*	0,371*	0,607*
5		0,366*	0,391*	0,299	0,407*
Długość lotu Length of jump suspension					
1		-0,099	0,287	0,127	-0,056
2		0,209	0,243	0,226	0,128
3		0,398*	0,222	0,205	0,187
4		0,511*	0,198	0,405*	0,297
5		0,362*	0,388*	0,399*	0,399*
Odległość mostka od drąga Distance between sternum and pole					
1		-0,122	0,154	-0,188	-0,176
2		0,007	-0,111	0,126	-0,129
3		0,109	0,205	0,197	0,304
4		0,311	0,099	0,388*	0,208
5		0,388*	0,411*	0,209	0,399*

* Współczynnik korelacji istotny przy $P \leq 0,05$.

* Correlation significant at $P \leq 0,05$.

It was observed that the distance between sternum and pole during jump suspension over the first two obstacles were significantly smaller than those characterizing the other ones. Mares of both tested breeds were characterized by an increase in the jump height along with rising the obstacle height. The resulting average values ranged from 35.11 cm (jump No. 1) to 47.41 cm (jump No. 5). For HalfbredAngloarab mares, the parameter

oscillated from 31.11 cm (jump No. 1) to 45.07 cm during the last jump. Coefficients of variation for Polish Warmblood mares were usually higher than those recorded in HalfbredAngloarab.

Due to the fact that differences between the results obtained for the tested breeds were non-significant, the correlation analysis between the judge's scores (*jumping ability*) and *jump length and height* parameters was performed for both breeds analyzed together.

Tabela 4. Przedziały rzeczywistych wartości parametrów długości i wysokości skoku oraz odpowiadająca im punktacja

Table 4. Intervals of actual values of jump length and height parameters, as well as corresponding scores

Przedział wartości długości kroku skoku (cm) Intervals for length of jump stride value (cm)	Punktacja Scores	Przedział wartości długości lotu (cm) Intervals for length of jump suspension value (cm)	Punktacja Scores	Przedział wartości odległości mostka od drąga (cm) Intervals for distance between sternum and pole value (cm)	Punktacja Scores
Rasa polski koń szlachetny półkrwi Polish Warmblood breed					
Skok nr 4 Jump No. 4					
417 – 461	1	341 – 382	1	-	-
462 – 506	2	383 – 424	2	-	-
507 – 550	3	425 – 465	3	-	-
551 – 594	4	466 – 506	4	-	-
595 – 638	5	507 – 547	5	-	-
Skok nr 5 Jump No. 5					
521 – 550	1	327 – 382	1	8–21	1
551 – 580	2	383 – 438	2	22–35	2
581 – 610	3	439 – 494	3	36–49	3
611 – 640	4	495 – 550	4	50–63	4
641 – 670	5	551 – 607	5	64–76	5
Rasa angloarabska półkrwi HalfbredAngloarab breed					
Skok nr 4 Jump No. 4					
513 – 546	1	328 – 367	1	-	-
547 – 580	2	368 – 406	2	-	-
581 – 614	3	407 – 445	3	-	-
615 – 647	4	446 – 484	4	-	-
648 – 680	5	485 – 523	5	-	-
Skok nr 5 Jump No. 5					
438 – 492	1	382 – 445	1	2–16	1
493 – 547	2	446 – 509	2	17–31	2
548 – 602	3	510 – 573	3	32–46	3
603 – 656	4	574 – 637	4	47–61	4
657 – 710	5	638 – 701	5	62–76	5

All significant correlation coefficients between the judge's scores and *jump length and height* parameters were positive (Table 3). Their largest group related to scores given for the jump height and the length of jump stride. They covered all the jumps. For other characteristics to be assessed by a judge, important factors occurred primarily in combination with the values describing the jumping over 115–120 cm obstacles. Significant correlations within the length of jump suspension concerned mostly the scores for the jump length, while most rarely for the jump height. In the case of scores for courage and willingness, significant relationships characterized two of the five analyzed jumps. Considerable correlations between judge scores and distance between sternum and pole were found for four cases, three of which referred to jump over the highest obstacle.

Table 4 presents ranges of the actual values of jump length and height parameters, as well as corresponding scores helpful in the calculation of the formula used for measurable assessment of jumping ability of half-bred horses.

Based on the results of the correlation analysis, to design the formula qualifies the jumps over 115 cm obstacle, during which the length of jump stride, length of jump suspension can be tested. Jumps over 120 cm obstacle can be use to measure every tree analyzed parameter. The following formula for assessing the jumping ability of half-bred horses (OMSK) was proposed:

$$\text{OMSK} = A4 + A5 + B4 + B5 + C5$$

where:

A4–A5 – scores for the length of stride of jumps No. 4 and 5,

B4–B5 – scores for the length of jump suspension of jumps No. 4 and 5,

C5 – scores for the distance between sternum and pole during jump No. 5.

Higher jumping ability are indicated by higher value of the formula, which is the sum of scores given for parameters of the jump length and height on selected size of obstacles.

DISCUSSION

Described by researchers and practitioners weaknesses of assessments issued by the judges for jumping ability, focus mainly on their subjectivity and large narrowing score scale [Janczarek 2011, Szaszkiewicz 2010, Lewczuk 2008]. Results of present study often do not confirm these observations. Both the coefficients of variation and differences in the values of extreme scores indicate quite clear differentiation of issued scores, which made opportunity of performing an effective individual's selection when using this type of method [Kapron 1999]. Most likely, this situation stems from four separate scores (jump length, jump height, courage, and willingness) issued for a single feature called *jumping ability* that, during the performance tests, is a part of more generalized score for free jumps [www.pzhk.pl 2013]. The alleged subjectivity accompanying assessments of judges [Lewczuk 2008] may result from their need to issue a single general score for free jumps. It seems that the separation of the component features of the jump may be helpful during immeasurable ways of assessing the performance value. The need to make the horse testing system more detailed was also indicated by [Lewczuk and Słoniewski 2004]. The attention

should also be paid to the mean values recorded within each of the evaluated elements. It appears that judge assessed majority of mares above the average. The jump height of Polish Warmblood and jump length of HalfbredAngloarab mares can be considered as positive qualities. It should also be noted that horses assessed at the level below five points occurred more frequently in the group of mares representing the former breed. Achieved results confirm the results obtained by Janczarek *et al.* [2012] describing differentiation of population of Polish Warmblood referring to the parameters describing the approach to an obstacle by representatives of various saddle breeds.

The results also indicate that the measurable parameters describing the length and height of mare's jump are more precisely than the assessment by a judge. It is evidenced by significant differences between the mean that do not occur in the case of subjective scores application. This opinion is shared by Lewczuk [2008], who considers it necessary to introduce a measurable characteristics as a mandatory evaluation of horses during performance tests. More opportunities conduct selection use measurable methods provide higher coefficients of variation, especially in the analysis of the jumps by highest obstacles. This is confirmed by the results obtained within each of the three jump parameters, which may indicate a need for the more detailed assessment of young horses for jumping predispositions [Samtamaria *et al.* 2006].

Mares breed is not a significant factor in the assessment of jumping ability. No differences within judge's scores and their small number in the case of analyzed jumping parameters indicates the fact that the progressive uniformity of half-bred horses, mentioned by Kaproń *et al.* [2004], is so advanced that the assessment of a horse's jumping ability can be carried out without regarding its breed. Possibility of a standardized system of performance tests for warmblood horses bred in different countries, is also considered by the *Interstallion* group [Koenen *et al.* 2004]. These reasons made that analysis of the relationship between scores issued by the judge and particular parameters of jump length and height was performed for both breeds analyzed together. It is worth mentioning in this case, that significant correlation coefficients appear most frequently during analysis of the jumping over the highest obstacles. Evaluation of jumping ability should therefore be performed on obstacles, the height of which is at least 115–120 cm. Such level of difficulty seems to be sufficient to carry out an effective test of jumping ability. According to Santamaria *et al.* [2006], highly variable traits, which are offers the opportunity for using the trait as a selection criterion, are most commonly manifested during jumping over relatively high obstacles. Similar results were reported by Janczarek [2011] and Wejer *et al.* [2009], who indicated that the assessment of horse's jumping predispositions using phenotypic indices should be performed on an oxer with a minimum height of 120 cm.

It is also characteristic that all calculated correlations are positive sign. This indicates that the judge preferred horses predisposed to both long and high jumps. This situation is especially evident when analyzing the relationship of judge's scores with the length of jump stride as well as the jump suspension. Another issue are features such as courage and willingness to jump, which are hard to define. For this reason, the assessment is possible only using the human factor [Szaszkiewicz 2010]. As a part of this study, they are also associated with analyzed jump parameters. Perhaps, this is another indication emphasizing that the practical assessment of jumping predispositions of young horses will be possible at the exclusive use of automated computer methods. However, up till now, such methods are used only under experimental conditions [van den Bogert

et al. 2009]. Use of measurable methods of assessment jumping predisposition confirmed positive correlation coefficients, that were achieved in the present study. Second reason is lack of relationship between the judge's scores for the jump height and the distance between pole and sternum, which is a measurable reflection of jump height. Most likely, this situation was caused by focusing the human's attention on the legs level over the pole. The reason may result from the lack of a unified description of a horse jump, which can be regarded as the standard in the evaluation of a young horse. According to Clayton *et al.* [1996], the horse's trunk position over the obstacle should be the most desirable feature of a jumper. This feature determines a great impact of hind limbs during take-off causing an increase in the vertical forces at the first phase of the flight. The limbs position during the jump of a young horse can be largely corrected through training [Palman 1979]. It seems that the results demonstrated in this study are so transparent that allow for selecting both the jump parameters and the obstacle height, which would help in an objective assessment of the jumping ability of young half-bred mares. Formula used in this paper to assess the feature may become in the future an effective complement of the scores issued by the board and director of the training center during the performance tests [www.pzhk.pl 2013].

CONCLUSIONS

Results achieved in the present study allowed to draw the following conclusions:

1. More detailed guidelines upon the assessment of the horse jumping ability by judges can contribute to an increase in the objectivity degree of their scores issued.
2. Significant variation of the length of jump stride, length of jump suspension, and the distance between sternum and pole offers the opportunity for using the traits to determine of measurable method for evaluating the jumping ability of young half-bred horses.
3. Testing the jumping ability by means of measurable and subjective methods should be done on an obstacle with a minimum height of 115 cm.
4. Formula for assessing the measurable assessment of jumping ability of young half-bred horses can complement the performance testing system.

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Streszczenie. Celem pracy było zaprojektowanie wzoru służącego wymiernej ocenie możliwości skokowych młodych klaczy w oparciu o analizę korelacji między ocenami selekcjonera a parametrami długości i wysokości skoku koni. Materiał do badań stanowiły nagrania skoków luzem 30 klaczy półkrwi reprezentujących rasę polski koń szlachetny półkrwi i angloarabską półkrwi, które poddawane były treningowi w ramach stacjonarnej próby wierzchowej (test 60-dniowy). Każda z klaczy pokonywała pięciokrotnie przeszkodę typu okser, której wysokość była sukcesywnie zwiększana. Noty wystawiane przez selekcjonera obejmowały takie elementy, jak długość skoku, wysokość skoku, odwaga oraz chęć do skoku. W programie MultiScanBase wykonano także pomiary parametrów długości i wysokości skoku, które określane były za pomocą długości kroku skoku, długości lotu oraz odległości mostka od drąga drugiej części przeszkody. Analizę statystyczną wykonano w programie PQStat, różnice między średnimi określono testem T-Tukeya. Podczas projektowania wzoru wymiernej oceny możliwości skokowych zastosowano współczynniki korelacji Pearsona. Uzyskane wyniki wskazują, iż ocena możliwości skokowych młodych klaczy za pomocą cech mierzalnych powinna się odbywać na przeszkodzie o minimalnej wysokości 115 cm. Znaczna zmienność długości kroku skoku, długości lotu oraz odległości mostka od drąga wskazuje na możliwość zastosowania ich jako kryterium selekcyjnego. Zaprojektowany w niniejszej pracy wzór może stanowić uzupełnienie i zobiektywizowanie obowiązującego systemu testowania klaczy w zakładach treningowych.

Słowa kluczowe: klacze półkrwi, możliwości skokowe, cyfrowa analiza obrazu, wymierne metody oceny