Live Weight and Body Measurement of Hungarian Thoroughbred Broodmares

Magyarországi angol telivér tenyészkancák élősúlya és testméretei

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Abstract

Live weights and 21 body measurements of 110 adult brood mares from Hungarian Thoroughbred broodmares were evaluated. Body measurements and some body measure indices were determined. One way ANOVA was used to compare the studs. Regression equations were developed to estimate the live weight from body measurements. The overall mean values of body measurements were as follows: live weight 542.0 kg, height at withers with stick 160.9 cm, height at withers with tape 168.8 cm, height of back 151.9 cm, height at rump 159.9 cm, depth of chest 75.5 cm, height of bieler-point 85.4 cm, length of body 163.3 cm, diagonal length of body 167.5 cm, upper neck measure 93.6 cm, length of back 85.2 cm, length of rump 49.6 cm, width of breast 46.0 cm, width of chest 48.0 cm, 1st, 2nd, 3rd width of rump 56.0- 54.2- 23.2 cm, circumference of chest 192.1 cm, circumference of cannon bone left front- rear 19.8- 22.0 cm, length of head 59.3 cm, width of head 22.9 cm. The standard deviation and cv% values of body measurements were between 0.7-5.8 cm and 2.1-6.7%, respectively (excluding 3rd width of rump). Only few differences among studs, concerning evaluated body measurements, were presented - firstly: body measurements, related to the kilter and nutritional status (hearth girth) - were significant. Between the mentioned traits and the live weight medium positive correlation ($r = 0.47$-0.79; $P<0.01$) was found. For the estimation of live weight with regression model the necessary data are as follows: hearth girth, 2nd width of rump and diagonal length of body. The determination coefficient was 0.80 ($P<0.01$). As a conclusion it can be stated that the Thoroughbred population in Hungary is quite homogenous in terms of the most important body measurements.

Keywords: Thoroughbred, brood mare, live weight, body measurements, body measure indices, live weight estimation

Összefoglalás

A szerzők 110 kifejlett angol telivér tenyészkanca élősúlyát és 21 testméretét értékelték Magyarországon. Meghatározták a relatív testméreteket és néhány testarány indexet is. A tenyészetek összehasonlítását egytényezős varianciaanalízissel végezték. Regressziós egyenleteket dolgoztak ki az élősúly testméretekből történő becslésére. A testméretek főátlaga a következő volt: élősúly 542,0 kg, bottal mért marmagasság 160,9 cm, szalaggal mért marmagasság 168,8 cm, hátközép-magasság 151,9 cm, farbúb-magasság 159,9 cm, mellkasmélység 75,5 cm, bielerpont-magasság 85,4 cm, törzshosszúság 163,3 cm, ferde törzshosszúság 167,5 cm, nyakhosszúság 93,6 cm, háthosszúság 85,2 cm, farhosszúság 49,6 cm, vállszélesség 46,0 cm, mellkasszélesség 48,0 cm, far I.- II.- III. szélesség 56,0- 54,2- 23,2 cm, övméret 192,1 cm, szárkörméret bal mellső- hátsó 19,8- 22,0 cm, fejhosszúság 59,3 cm, homlokszélesség 22,9 cm. A testméretek szórás értékei 0,7-5,8 cm között, cv% értékei pedig 2,1-6,7% között változtak (kivétel a far III. szélesség). Statisztikailag igazolható különbségeket csak az élősúly, és néhány testméret esetén találtak a tenyészetek között. Ezek a méretek elsősorban a kondícióval, tápláltsági állapottal összefüggő testméretek (övméret) voltak, melyek az élősúllyal közepes szorosságú, pozitív ($r = 0,47-0,79$; $P<0,01$) korrelációt mutattak. Az élősúly becslésére használható regressziós modellhez az övméret, a far II. szélesség és a ferde törzshosszúság ismerete szükséges. Az illeszkedési érték 0,80 ($P<0,01$) volt. A fentiek alapján megállapítható, hogy a Magyarországon tenyészetett, kifejlett angol telivér tenyészkanca állományt a testméretek tekintetében nagyfokú egységesség (homogenitás) jellemzi.

Kulcsszavak: angol telivér, tenyészkanca, élősúly, testméretek, testarány indexek, élősúlybecslés

INTRODUCTION

All countries with a long tradition of horse breeding have been using the Thoroughbred as an improving breed. There are some features, such as nervous system stability (temperament), lack of hereditary defects, racial fidelity, high performance results, which make an individual Thoroughbred suitable for breeding as a sport horse. The basis for producing stallions is ensured by the brood mare population, where selection is based on pedigree and genetic analysis of maternal families, performance testing and evaluation of conformation. This fact implies that the breeding rules of Thoroughbreds places a great emphasis on conformation traits and zoometric body measures along with performance testing.

Body measurement data are indispensable for objective assessment of conformation. Body measurement recording can help to gain a solid basis of objectively measured data for identifying racial fidelity, for comparing the size of different parts of the body, or for estimating selection progress. Body measures also provide essential data for stud books.

Several sources of information can be found in scientific literature in connection with performance traits, movement, jumping performance, nutrition, or population genetic parameters of Thoroughbred horses (Hintz et al., 1979; Thompson and Smith, 1994;

Kavazis and Ott, 2003; Bugislaus et al., 2004; Langlois and Blouin, 2004; Wolc et al., 2006 etc).

However there have recently been relatively few data about conformation traits, body measurements and live weight of different horse breeds (Molina et al., 1999; Costa et al., 2001; Kashiwamura et al., 2001; Zechner et al., 2001; Cabral et al., 2004; McManus et al., 2005; Druml et al., 2008; Batista Pinto et al., 2008; Matsuura et al., 2008; in Thoroughbred: Hintz et al., 1978; Smith et al., 2006; Ringler and Lawrence, 2008 etc).

In Hungary most scientific data originates from textbooks written 50 years ago (Bodó and Hecker, 1992). Only few papers discuss in more detail the body measurements of different horse breeds (Mihók, 1996; Gulyás et al., 2007; Nagy et al., 2009; Bene et al., 2010 etc). There is a lack of scientific information about the entire assessment of live weight and conformation of different horse breeds.

Concerning the topic scientific resource materials were presented in Table 1 and in detail in our review article published earlier (Bene et al., 2009), so hereby we omit the itemized overview.

Table 1. Body measurements of Thoroughbred broodmares according to different authors

Body measurement	Value	Author
Height at withers*	146-155 cm	Hintz et al. (1979); Smith et al. (2006)
	149-152 cm	Thompson (1995); Kavazis and Ott (2003)
	150-165 cm	Schandl (1955); Bodó and Hecker (1992)
	150-170 cm	Hámori (1946); Mihók et al. (2001)
	160-170 cm	Bodó et al. (1995); Sambraus (2002)
Heart girth	162-164 cm	Smith et al. (2006); Kavazis and Ott (2003)
	176-193 cm	Schandl (1955)
	180-190 cm	Hámori (1946)
Cannon girth	18-22 cm	Mihók et al. (2001)
	19,2 cm	Hámori (1946); Smith et al. (2006)
	20,8 cm	Hintz et al. (1979)
Length of body	145 cm	Smith et al. (2006)
	148 cm	Thompson (1995); Kavazis and Ott (2003)
	150 cm	Thompson and Smith (1994)
Width of shoulders	38 cm	Smith et al. (2006)
Height of rump	150 cm	Smith et al. (2006)
	153 cm	Thompson (1995); Kavazis and Ott (2003)
Live weight	400-500 kg	Sambraus (2002); Back et al. (2007)
	400-600 kg	Hámori (1946); Schandl (1955)
	460 kg	Hintz et al. (1979)

*measured with stick

In Hungary, we have very little information about the live weight and body measurements of different horse breeds. Yet, these descriptive data types clarify the descriptions and standards of breeds, in developing the appropriate chapters of textbooks or can be very useful as a supplement. Therefore the aim of our observation was to collect and analyze the data of body measurements and live weight of adult Thoroughbred brood mares. The aim of the publication was to present

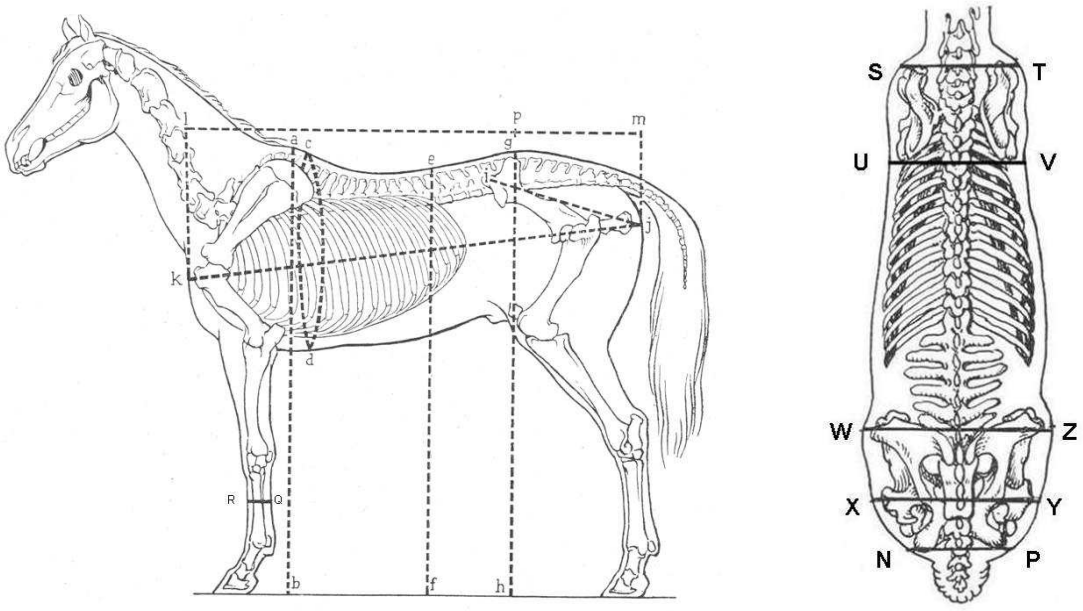
the absolute body measurements, body proportion indices and the calculated correlation values between body measurements and live weight data. Also presented is the potential of estimating live weight of adult brood mares by regression equations.

MATERIAL AND METHODS

Live weight and 21 body measurements of 110 adult (over the age of 4.5 years) brood mares from Thoroughbred breed in 4 studs - Kerteskő, Sárbogárd, Dióspuszta and Csordakút - were evaluated. Only stud measurements were taken, with at least 5 bred brood mares present. Thus, the number of the above was approx. 50% of the total Hungarian mature Thoroughbred mare population.

Live weight was measured by transportable digital animal scale (type: ICONIX F1, measuring accuracy over 500 kg was ±2 kg). The body measurement data was collected by traditional recording devices, such as measuring stick, tape measure and caliper (Figure 1.).

Figure 1. Recording body measurements on horse (Schandl, 1955)



a-b: height at withers; e-f: height of back; g-h: height of rump: l-m: length of body; k-j: diagonal length of body; p-m: length of rump; i-j: diagonal length of rump; c-d: hearth girth; d-b: height of bieler-point; R-Q: cannon girth; S-T: width of breast; U-V: width of chest; W-Z: 1st width of rump (width of hips); X-Y: 2nd width of rump; N-P: 3rd width of rump (width of sitter bulbs)

Since there was no statistically verifiable effect of the former age on the evaluated traits, one way ANOVA (F-test) was used to compare the studs and analyze the correlation between live weight and body measurement data. In cases where the F-test showed significant difference, Tukey-test (for different number of elements) was used to reveal the differences between studs.

Some body measurement indices were also determined. The calculation method of these is shown in Table 2. (Bodó and Hecker, 1992; Cabral et al., 2004, Druml et al., 2008).

Table 2. Calculation of body measure indices (Bodó and Hecker, 1992; Cabral *et al.,* 2004; Druml *et al.,* 2008)

Name of body measurement index		Calculation
Quadratic index	=	height at withers / length of body x 100
Weight index	=	depth of chest / height at withers x 100
Weight index by *Röhrer*	=	live weight / height at withers x 100
Caliber index	=	(hearth girth / height at withers) x (cannon girth / height at withers) x 1000
Overbuilt index	=	height at rump / height at withers x 100
Stubby index	=	hearth girth / diagonal length of body x 100
Body index	=	length of body / hearth girth x 100
Chest index	=	width of chest / hearth girth x 100
Conformation index	=	$(\text{hearth girth})^2$ / height at withers / 100
The index of head	=	length of head / width of head x 100
Spannung	=	hearth girth - height at withers

Phenotypic correlation values were calculated between live weight and body measurements.

Live weight was estimated from body measurement data by multivariate linear regression equation using the stepwise method (dependent variable was the actual, with scale measured live weight; independent variables were the body measurements). Such information may be particularly valuable in studs, where it is not possible to measure the weight of horses.

Data preparation was made by the Microsoft Excel 2003 program, and the SPSS 9.0 (1998) program package was used to evaluate the database.

RESULTS AND DISCUSSION

According to our research the live weight of Thoroughbred brood mares was 542.0±39.45 kg (Table 3). The smallest mare was 439 kg while the largest weighed 644 kg. Our live weight results are higher than those published by Hintz et al. (1979), or Back et al. (2007), but similar to the results of Schandl (1955) presented in their Thoroughbred description.

The height at withers was measured by measuring stick and tape measure and the average results figured 160.9±3.44 cm and 168.8±3.89 cm, respectively. The data in scientific literature is between 146 and 170 cm (Hintz et al., 1979; Bodó and Hecker, 1992; Thompson, 1995; Kavazis and Ott, 2003; Smith et al., 2006). Thus our measured height at withers data is similar to those in the scientific literature.

The average body length of Thoroughbred brood mares was 163.3 cm. Both the shortest (151 cm body length) and the longest (180 cm) mares were measured in

Dióspuszta. Our body length data is greater than those found in scientific literature (Kavazis and Ott, 2003; Smith et al., 2006).

In addition we found significant differences between the widths of hips (1st width of rump) measured in the different studs, despite the fact that there was only 2.2 cm difference between the two mares with the least wide rump (54.4 cm) measured in Csordakút and with the widest rump (56.6 cm) measured in Dióspuszta.

Table 3. Live weight and body measurements of Thoroughbred brood mares

Body measurement (kg, cm)	Stud				Total	P
	Kerteskő	Sárbogárd	Diós-puszta	Csordakút		
N	12	30	57	11	110	
Live weight	^{ab}536.1	^{a}529.6	^{b}552.0	^{ab}530.2	542.0	<0.05
Height at withers (stick)	161.0	160.6	160.9	161.7	160.9	NS
Height at withers (tape)	^{ab}167.9	^{a}167.4	^{b}170.0	^{ab}167.5	168.8	<0.05
Height of back	152.0	151.3	151.9	153.6	151.9	NS
Height at rump	160.0	159.1	160.2	160.6	159.9	NS
Depth of chest	^{ab}75.4	^{a}74.8	^{b}76.1	^{a}74.3	75.5	<0.05
Height of bieler point	85.6	85.7	84.7	87.5	85.4	NS
Length of body	160.7	163.1	164.1	163.1	163.3	NS
Diagonal length of body	164.1	167.2	168.2	168.6	167.5	NS
Length of neck	^{a}90.6	^{a}90.2	^{b}96.3	^{a}92.1	93.6	<0.01
Length of back	^{a}81.6	^{ab}84.0	^{c}86.5	^{bc}85.1	85.2	<0.01
Length of rump	^{a}47.9	^{b}49.9	^{b}50.2	^{a}48.0	49.6	<0.01
Width of breast	46.6^{a}	46.8^{a}	46.1^{a}	42.6^{b}	46.0	<0.01
Width of chest	48.3	47.9	48.1	47.3	48.0	NS
1st width of rump	^{ab}56.1	^{ac}55.5	^{b}56.6	^{c}54.4	56.0	<0.01
2nd width of rump	53.9	53.9	54.6	53.5	54.2	NS
3rd width of rump	^{a}24.5	^{a}24.7	^{b}21.9	^{a}24.2	23.2	<0.01
Hearth girth	^{ab}190.3	^{ab}191.7	^{a}193.3	^{b}188.5	192.1	<0.05
Cannon girth (front left)	19.7	19.7	19.8	19.9	19.8	NS
Cannon girth (rear left)	22.3	22.1	21.9	21.9	22.0	NS
Length of head	59.0	59.3	59.6	58.2	59.3	NS
Width of head	22.5	23.1	22.9	23.2	22.9	NS

treatments without the same superscript differ significantly (P<0.05)

In the case of hearth girth the values of brood mares in Dióspuszta were the largest (193.3 cm), so they surpassed the mares in the other three studs (Kerteskő 190.3 cm, Sárbogárd 191.7 cm, Csordakút 188.5 cm). The main average and standard deviation of the value of hearth girths were 192.1±5.48 cm, which are greater than those found in the works of Smith et al. (2006), or Kavazis and Ott (2003). However our results are similar to those of Schandl (1955). They estimated the hearth girth of Thoroughbred brood mares to be between 176 cm and 193 cm.

We have not found any differences among the studs concerning cannon girth data. The cannon girth measured at the left foreleg was 19.8 cm, while measurements taken at the left hind leg were 22.0 cm. Cannon girth data are similar to those presented by Hintz et al. (1979) and Smith et al. (2006).

Table 4 shows the constitutional and body formation indices expressing the ratio of anatomically related parts of the body. The quadratic index (98.5) and the weight index (46.9) were similar in all four studs. The calibre index was 146.9, while stubby index was 114.7. Scientific data concerning these indices can not be found in connection with English Half Blood and Anglo-Arab horse breeds. The stubby index (114.7) was smaller, but the chest index (25.8) was larger than the indices of mares in Campeiro breed, published by McManus et al. (2005). Overbuilt index was 99.4 and conformation index was 2.3 in or observations, while body index was 85.0. According to Cabral et al. (2004) a horse is well-proportioned if this number is between 85 and 88.

Table 4. Body measure indices of Thoroughbred brood mares

Name of body measurement index	Stud				Total
	Kerteskő	Sárbogárd	Diós-puszta	Csorda-kút	
Quadratic index	100.2	98.5	98.0	99.1	98.5
Weight index	46.8	46.6	47.3	45.9	46.9
Weight index by *Röhrer*	333.0	329.8	343.1	327.9	336.9
Caliber index	144.6	146.4	147.8	143.5	146.9
Overbuilt index	99.4	99.1	99.6	99.3	99.4
Stubby index	116.0	114.7	114.9	111.8	114.7
Body index	84.4	85.1	84.9	86.5	85.0
Chest index	25.2	26.0	26.0	25.5	25.8
Conformation index	2.2	2.3	2.3	2.2	2.3
Index of head	262.2	256.7	260.3	250.9	259.0
Spannung	29.3	31.1	32.4	26.8	31.2

Live weight correlated significantly with most of the body measurement data (Table 5). As we expected the strongest correlations were found in the case of hearth girth ($r = 0.79$; $P<0.01$), height at withers measured by tape ($r = 0.66$; $P<0.01$), 1st and 2nd width of rump ($r = 0.65$ and $r = 0.63$; $P<0.01$) and length of body as well as diagonal length of body ($r = 0.65$; $P<0.01$).

Table 5. Correlations between live weight and body measurements

	1	2	3	4	5	6	7	8	9	10
11	0.50*	0.66*	0.55*	0.65*	0.65*	0.57*	0.67*	0.63*	0.79*	0.48*
1		0.79*	0.42*	0.35*	0.39*	0.21#	0.30*	0.19#	0.45*	0.37*
2			0.54*	0.43*	0.44*	0.35*	0.53*	0.37*	0.64*	0.41*
3				0.30*	0.29*	0.20#	0.45*	0.36*	0.66*	0.38*
4					0.98*	0.18	0.36*	0.32*	0.40*	0.36*
5						0.19#	0.35*	0.31*	0.40*	0.39*
6							0.45*	0.34*	0.59*	0.38*
7								0.65*	0.64*	0.22#
8									0.54*	0.18
9										0.41*

#P<0,05; *P<0,01; height at withers (stick) (1); height at withers (tape) (2); depth of chest (3); length of body (4); diagonal length of body (5); width of chest (6); 1st width of rump (7); 2nd width of rump (8); hearth girth (9); cannon girth (left foreleg) (10); live weight (11)

Table 6 shows the regression equation established for estimating live weight (ŷ). Hearth girth (HG), 2nd width of rump (R2) and diagonal length of body (DLB) were built in the model by the regression process. Acquisition of this body measurement data is relatively simple; it can be carried out quickly by a tape measure. The determination coefficient was $R^2 = 0.80$ ($P<0.01$).

As a conclusion the following linear regression equation can be used to estimate live weight (ŷ) of adult Thoroughbred brood mares:

$$\hat{y} = (3.675 \times HG) + (4.836 \times R2) + (2.554 \times DLB) - 853.784.$$

Table 6. Regression model for estimating live weight from body measurements

Model	b	SE	Std. B	P	R^2
Constant	-853.784	68.880	-	<0.01	0.80 (P<0.01)
Hearth girth (HG) (cm)	3.675	0.395	0.511	<0.01	
2nd width of rump (R2) (cm)	4.836	1.087	0.235	<0.01	
Diagonal length of body (DLB) (cm)	2.554	0.330	0.374	<0.01	

As we expected, those body measurements were used in the regression model for estimating live weight which are more strongly correlate with the condition of mares, such as hearth girth, 2nd width of rump, width of chest, diagonal length of body, etc.

CONCLUSION

Some of the results were similar to, others were different from the existing scientific information. Namely height at withers measured by stick, hearth girth, and cannon girth, as the most commonly used body measurements, were similar to the existing scientific data. Nevertheless body length, height of rump and live weight were larger than the data of other authors.

Significant differences among studs were only found in the case of few body measurements. These measurements, such as height at withers measured by tape and hearth girth, are mainly in connection with the conditional and nutritional status of the animals, and showed a medium strong positive correlation ($r = 0.55$-0.79; $P<0.01$) with live weight.

We have not found considerable differences among studs concerning body measurement indices.

Based on the above mentioned facts it can be stated that the adult Thoroughbred brood mare population bred in Hungary is very homogeneous in conformation traits and body measurements.

For the estimation of live weight with linear regression equation the necessary data are as follows: hearth girth, 2nd width of rump and diagonal length of body. This body measurement data can be taken relatively quickly and precisely, therefore the live weight can be determined accurately even without an animal scale.

The Thoroughbred broodmares came from very different geographic, housing and breeding technologic circumstances. Despite this and the fact that selection is known to target the improving of racing results, the Thoroughbred breed seems to be very

homogeneous in conformation traits. It is possibly due to the closed registration work which has been done in the General Stud Book since 1793.

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