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The influence of breed, age, gender, training level and ambient temperature on forelimb and back temperature in racehorses

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Abstract

A previous thermographic study of racehorses identified thirteen regions of interest (ROIs) for monitoring the impact of training. However, that investigation did not consider the influence of breed, age, gender, or training intensity level on the temperature of ROIs. The present study adopted a multivariate analysis approach to determine whether the aforementioned factors, along with ambient temperature, significantly influenced ROI temperature in the key body regions. Thermography measurements were obtained from 53 racehorses of three breeds. Horses were in regular training for over ten months, having 13 thermographic examinations in each racing season.

Backward stepwise multiple linear regression indicated that ambient temperature and breed contributed significantly to the model for predicting ROI temperature at all 13 ROIs. Training intensity level contributed significantly to the model only at the thoracic vertebrae, the left third metacarpal bone, and left fetlock joint. Neither gender nor age contributed to the model significantly at any ROI.

Our data suggest that ambient temperature, breed and training level affect racehorse body surface temperature in some areas of the distal parts of the forelimbs and the back. This contributes to a better understanding of the normal range of thermographic findings in racehorses undergoing intensive training.

1. Introduction

Thermography has found a broad range of applications in equine veterinary medicine and sport performance [1]. The utility of thermography in veterinary medicine has been demonstrated in the evaluation of soft tissue injury and superficial bone lesions, associated mainly with inflammatory processes of the distal parts of the forelimbs and back [2-6]. The main advantage of thermography is the detection of inflammation prior to the onset of clinical signs of pathology [7-10].

In performance racing, thermography is useful in monitoring changes of horse surface temperature resulting from exercise, allowing evaluation of the function of individual parts of the body. Assessment of body surface temperature indicates inflamed areas that could account for a decreased level of sporting performance [9-11]. In a previous study, ten months of regular thermographic examination of racehorses identified thirteen body regions of interest (ROIs) at the forelimbs and back to be recommended for monitoring the impact of training [12]. However, that study did not consider the influence on ROI temperature of breed, age, gender or training intensity level. Therefore, the present study adopted a multivariate analysis approach to determine whether the aforementioned factors, along with ambient temperature, significantly influenced ROI temperature in the key body regions of racehorses.

2. Material and methods

2.1. Study population and data collection

The study was approved by the Local Ethical Committee for Experiments on Animals of Wroclaw University of Environmental and Life Sciences. Thermography measurements were obtained from 53 clinically healthy racehorses as detailed in table 1. All horses were trained over ten months for flat racing in a clockwise direction at Partynice Race Course (Poland) during the 2011 or 2012 season, and were housed in individual stalls with common management and training regimes. In each season, horses were trained at three training intensity levels:

- light training level - training mainly in trot at a distance of 2 – 4 km and in canter at a distance 1500m, introducing elements of speed training from 200m up to 400m
- medium training level - training in canter and first races, training in trot at a distance of 1km, and in canter at distances of up to 3000m

• high training level - intensive training, taking part regularly in races, racing in canter twice a week at a distance of 500m to 800m.

A total of 13 imaging sessions in either the 2011 or 2012 season were conducted over a period of 10 months. The protocol for thermography was as previously described by Van Hoogmoed et al. [13] and Soroko et al. [12]. Horses were examined at rest before daily exercise. To minimise the effect of environmental factors, thermography was always performed at the same place within an enclosed stable by the same person (MS). The distance of the animal from the camera was fixed for all imaging at 1m, and the emissivity (ε) was set to 1 for all readings. At each imaging session, thermographic images were taken of the dorsal, lateral and medial aspects of the distal part of the forelimbs (figures 1 – 3) and the dorsal aspect of the back (figure 4) using a VarioCam hr Resolution infrared camera (uncooled microbolometer focal plane array, resolution 640 x 480 pixels, spectral range 7.5 – 14 µm, InfraTec, Dresden, Germany). At each session, the ambient temperature in the stable Tamb was measured by a TES 1314 thermometer (TES, Taipei, Taiwan).

Based on the results of our previous study, we measured the temperature at 13 ROIs recommended for monitoring the impact of training on the distal parts of the forelimbs and the back [12]. These anatomical sites, along with their ROI labels, are listed in table 2.

The temperature was calculated manually using IRBIS 3 Professional software (InfraTec, Dresden, Germany) by one person (MS) using the mean pixel value in the circular ROI for joints, hoofs and heels, the mean pixel value along the linear ROI for long bones and the mean value within the polygon for ROIs at the back as previously described [12]. The average temperature was obtained from a total of 8951 ROIs. Six ROIs were unavailable for analysis due to inaccessibility of the body region for imaging at some sessions.

Every three months, standard veterinary methods were used for palpation examinations of the distal parts of the forelimbs and back, and additional ultrasonographic and radiographic examinations were performed. These were conducted by a veterinarian to diagnose any pathological conditions [12].

2.2. Statistical Analysis

All statistical analysis was performed using STATISTICA v. 10 (StatSoft, Tulsa, USA). The distribution of mean pixel temperatures from the analyzed ROIs differed significantly from the theoretical normal distribution as verified by the Shapiro-Wilk test at $p < 0.05$. Therefore statistical analysis was based on non-parametric tests (Mann-Whitney U-test or Kruskal Wallis ANOVA).

3. Results

During the research period none of the horses were identified as injured by the ultrasonographic, radiographic or palpation examinations. Mean and median temperatures of the measured ROIs, and the correlation coefficient of ROI temperature with ambient temperature Tamb are presented in table 3.

Temperatures for all ROIs were strongly correlated with ambient temperature ($r > 0.85$, $p<0.001$). Results of the univariate analyses of the influence on ROI temperature of breed, age, gender and training intensity level are presented in tables 4 - 7. With the exception of the caudal part of the thoracic vertebrae (B2), Thoroughbreds were significantly warmer ($p < 0.05$) than the Arabians at all ROIs (table 4). Thoroughbreds were also significantly warmer ($p < 0.05$) compared to the Polish Half Breeds at all ROIs. There were no statistically significant differences in temperature comparing Arabians to Polish Half Breeds at any ROI.

Two year-old horses were significantly warmer ($p < 0.01$) than three year-old horses at all ROIs (table 5). Additionally, four year-old horses were significantly warmer ($p < 0.05$) than three year-old horses at the left 3rd metacarpal bone (LF4) and at the left fetlock joint (LF6). There were no statistically significant differences in temperature comparing two year-old horses to four year-old horses at any ROI.

There was no statistically significant difference in temperature between mares and stallions at any ROI (table 6).

There was a statistically significant difference in temperature at all ROIs ($p < 0.001$) between horses undergoing light and medium intensity training (table 7). There was also a significant difference in temperature at all ROIs ($p < 0.001$) between horses undergoing light and high intensity training. There were no statistically significant differences in temperature between horses undergoing medium and high intensity training at any ROI. As indicated at the foot of table 4, differences in ambient temperature during the training season may have an important influence on this data.

To determine the impact of breed, age, gender, training intensity level and ambient temperature on ROI temperature, a multiple linear regression, backward stepwise method was used. The linear model employed was:

Results of the multiple linear regression are shown in table 8. Variables were included in the model if they were strongly correlated with the dependent variable (T_{ROI}) and lowly correlated with each other.

4. Discussion

Thermography detects the heat emitted by radiation from the body surface. Metabolic heat is generated continuously through the body, and spread to the skin by means of blood flow and conduction, providing information about tissue physiology. Variations in skin temperature due to changes in the local circulation are caused by stress of the musculoskeletal system [4]. Therefore, documenting changes of horse surface temperature resulting from exercise could be useful in the evaluation of the function of individual parts of the body in racing performance [2,14]. In a previous thermographic study of racehorses [12], our group identified thirteen important ROIs in the distal parts of the limbs and back for monitoring the impact of training. Based on those results, we considered the influence on the important ROIs of increasing training level during the training season, age, gender and breed, along with ambient temperature.

4.1. Influence of ambient temperature

The influence of ambient temperature on body surface temperature has been addressed in several studies [2,15,16].As expected, we found a strong correlation between ROI temperature and ambient temperature at all ROIs. Ambient temperature varied over a nearly 20°C range during the 10-month racing season. Our previous study [12] developed a linear regression model to correct for variation in ambient temperature when considering ROI temperature. In the present study, ambient temperature contributed significantly to the multivariate model describing body surface temperature at every ROI.

4.2. Influence of breed

Our study showed Thoroughbreds to be significantly warmer than Arabian and Polish Halfbreed horses at most ROIs in the univariate analysis, and Thoroughbred breed contributed significantly to the multivariate model explaining every ROI temperature. Similar results were found in a previous study [11] where Thoroughbreds were significantly warmer ($p < 0.05$) compared to Arabians and Polish Halfbreeds in the distal parts of the forelimbs, hindlimbs and back. According to Cymbaluk and Christison [17], horse breed affects coat growth. Therefore, there is considerable variation in the thermal insulation of the coat between different breeds [18].

4.3. Influence of age

Our univariate analysis showed significantly warmer ROI temperatures in two-year-old horses compared to three-year-olds. These results are in part consistent with Czarnecki [19], who found that the body surface temperature of young stallions was higher than older stallions.

At two ROIs in the forelimbs on the left side, we found four-year-olds to be significantly warmer than three-year-olds. Hinchcliff et al. [20] reported that training racehorses for two years causes an increased oxygen-carrying capacity, as evidenced by raised haemoglobin levels. This metabolic change may contribute to a rise in body surface temperature due to increased skin circulation.

All of the horses in our study were trained in a clockwise direction, but it is unclear why the temperature differences we observed with age were restricted to the left side. Further investigation is required to establish how these findings might relate to equine biomechanics.

Interpretation of our data on the influence of age is likely to be limited by confounding factors. Older racehorses are more physically mature, and often participating in competitive racing more frequently; these factors also have a probable influence on body surface temperature. In our multivariate analysis, the age of the horse did not contribute significantly to the model explaining body surface temperature at any ROI.

4.4. Influence of gender

We found no differences in ROI temperature between male and female horses, and gender did not contribute significantly to our multivariate model explaining temperature at any ROI. Interestingly, our results appear to be at variance with some other published work. Jodkowska et al. [21] found that mares were warmer compared to stallions in the racehorse forelimb and hindlimb. Similar results were obtained in another study based on racehorses, where the dorsal aspects of the distal parts of the forelimbs were also significantly warmer ($p < 0.05$) in mares than in stallions [11]. According to the blood analysis of Arabian racehorses by Kedzierski and Podolak [22], mares have an increased level of primary metabolic processes compared to stallions. The results of that study suggest that a higher metabolic rate is likely in mares compared to stallions. Further work is required to ascertain why no temperature difference was detected between the genders in our current study. The different findings amongst studies may in part be explained by variations in training regimes and imaging protocols.

4.5. Influence of increasing training level

In our univariate analysis, we found significant increases in temperature at all ROIs when comparing both medium and high training levels to light training. The gradual increase in ambient temperature through the early part of the racing season is likely to have been an important confounding factor. Indeed, with the onset of cooler ambient temperatures later in the racing season, there was a trend towards lower ROI temperatures when the horses commenced high intensity training.

Nonetheless, training intensity level contributed significantly to our multivariate model explaining ROI temperature at the caudal part of the thoracic vertebrae, the lateral aspect of the left 3rd metacarpal bone, and both the lateral and medial aspects of the left fetlock joint.

The type of training has an influence on changes of body temperature distribution. Horses undergoing training put a lot of strain on the distal parts of the forelimbs and back, leading to frequent injuries in those parts of the body [9,14,23]. In the distal parts of the forelimbs, the bones and digital flexor tendons are subjected to extreme overloads [24] predisposing the horse to later injuries [25]. Soroko [26] documented abnormalities of the forelimbs associated with strains and overloads using regular thermographic examinations. In our previous study [12], all body regions in the best performing racehorses were warmer than their poorer performing peers.

Changes of the body surface temperature across the back area can be associated with inflammatory processes caused by intensive performance of the horse, the rider's imbalance, or an incorrectly fitted saddle [27-29]. Temperature distribution changes at the back have been characterised in response to increasing training intensity in regular racing training [30]. The study indicated the warmest temperature in the thoracic vertebrae compared to the lumbar vertebrae and sacroiliac joint area.

Our study has some limitations. In order to minimise stress and limit the impact on the daily routine of the horses, we were asked to restrict our measurements to entirely non-invasive imaging. Rectal measurements of core temperature, and haematological data from blood samples would have supplied valuable additional information, and this should be considered for future thermographic studies so that skin temperature can be correlated with other physiological data.

5. Summary

To the best of our knowledge, our study is the first to consider the influence of age, gender, breed and training intensity level on body surface temperature in racehorses throughout the racing season. The data suggest that, in general, ambient temperature, breed and training intensity level are the most important factors affecting skin temperature at the distal parts of the forelimbs and the back. This work will help to contribute to a better understanding of the normal range of thermographic findings for racehorses undergoing intensive training.

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Tables:

Table 1. *Horse characteristics*

Breed	Male N = 19			Female N = 34		
	Age (years)			Age (years)		
	2	3	4	2	3	4
Polish Half Breed	0	9	0	0	18	0
Thoroughbred	5	0	2	5	0	3
Arabian	0	3	0	0	8	0

Table 2. *Labels for the 13 ROIs, and their anatomical sites*

ROI label	Anatomical site
B2	caudal part of thoracic vertebrae, dorsal aspect
DF1	right carpal joint, dorsal aspect
DF2	left carpal joint, dorsal aspect
LF1	right carpal joint, lateral aspect
LF2	left carpal joint, lateral aspect
LF4	left 3rd metacarpal bone, lateral aspect
LF6	left fetlock joint, lateral aspect
LF8	left short pastern bone, lateral aspect
MF1	right carpal joint, medial aspect
MF2	left carpal joint, medial aspect
MF3	right 3rd metacarpal bone, medial aspect
MF4	left 3rd metacarpal bone, medial aspect
MF6	left fetlock joint, medial aspect

Table 3. *Basic ROI temperature data*

ROI	$M \pm SD$	Me (Q_1, Q_3)	Min - Max	r	p
B2	29.24 ± 4.54	30.8 (26.1, 32.9)	15.2 to 35.8	0.930	<0.001
DF1	24.50 ± 5.40	25.8 (20.9, 28.9)	9.1 to 33.4	0.883	<0.001
DF2	24.68 ± 5.34	26.0 (21.3, 29.0)	9.6 to 33.3	0.870	<0.001
LF1	25.70 ± 5.33	27.1 (22.1, 30.2)	11.7 to 33.9	0.900	<0.001
LF2	25.77 ± 5.27	27.3 (21.9, 30.3)	10.1 to 33.6	0.892	<0.001
LF4	23.70 ± 5.90	25.5 (19.5, 28.6)	6.5 to 32.6	0.904	<0.001
LF6	24.13 ± 6.02	25.9 (19.7, 29.1)	6.5 to 33.5	0.882	<0.001
LF8	25.32 ± 5.53	26.7 (21.8, 30.0)	7.3 to 33.5	0.865	<0.001
MF1	26.96 ± 5.05	28.6 (23.6, 31.1)	10.6 to 34.4	0.898	<0.001
MF2	26.69 ± 5.11	28.2 (23.1, 31.0)	12.1 to 34.2	0.899	<0.001
MF3	23.81 ± 5.85	25.5 (19.7, 28.6)	7.3 to 33.9	0.902	<0.001
MF4	23.63 ± 5.88	25.3 (19.6, 28.6)	7.1 to 32.6	0.901	<0.001
MF6	23.87 ± 5.93	25.5 (19.7, 28.8)	7.2 to 33.1	0.886	<0.001
$T_{amb.}$ - ambient temperature	14.60 ± 5.67	15.6 (10.4, 19.0)	2.8 to 22.7	×	

M± *SD*: mean temperature in measured ROIs ± standard deviation [°C]; Me (Q_1, Q_3): median temperature in measured ROIs and interquartile range [°C]; Min: minimum temperature value [°C]; Max - maximum temperature value [°C]), r: Pearson correlation coefficient of ROI temperature with $T_{amb.}$

Table 4. *Univariate analysis of dependence of ROI temperature on breed*

ROI	Breed						Thoroughbred vs. Arabian	Thoroughbred vs. Polish Half Breed	Arabian vs. Polish Half Breed
	Thoroughbred *n* = 195		Arabian *n* = 143		Polish Half Breed *n* = 351				
	Me	*QR*	*Me*	*QR*	*Me*	*QR*			
B2	31.93	5.71	31.02	6.20	30.27	7.41	$p = 0.122$	**$p = 0.001$**	$p = 1.000$
DF1	27.55	6.42	24.88	6.64	24.73	8.61	**$p = 0.007$**	**$p < 0.001$**	$p = 1.000$
DF2	27.55	6.50	25.78	6.37	24.76	8.75	**$p = 0.005$**	**$p < 0.001$**	$p = 1.000$
LF1	28.63	6.67	25.45	7.80	26.74	8.37	**$p = 0.023$**	**$p = 0.006$**	$p = 1.000$
LF2	28.83	6.69	26.32	7.58	26.60	8.35	**$p = 0.004$**	**$p = 0.001$**	$p = 1.000$
LF4	27.12	7.84	24.41	8.72	24.86	9.41	**$p = 0.013$**	**$p = 0.002$**	$p = 1.000$
LF6	28.01	8.44	24.09	8.63	25.39	9.58	**$p = 0.001$**	**$p = 0.001$**	$p = 1.000$
LF8	28.23	7.09	25.60	7.27	25.75	8.49	**$p = 0.011$**	**$p < 0.001$**	$p = 1.000$
MF1	30.10	6.51	27.24	7.12	27.84	8.02	**$p = 0.005$**	**$p = 0.001$**	$p = 1.000$
MF2	29.75	6.43	27.19	7.32	27.52	8.41	**$p = 0.002$**	**$p < 0.001$**	$p = 1.000$
MF3	27.22	8.55	24.23	8.05	24.75	8.90	**$p = 0.018$**	**$p = 0.004$**	$p = 1.000$
MF4	26.96	8.08	24.19	7.87	24.51	9.60	**$p = 0.011$**	**$p = 0.002$**	$p = 1.000$
MF6	27.56	8.04	23.90	7.68	24.90	9.65	**$p = 0.003$**	**$p = 0.001$**	$p = 1.000$
Tamb.	15.8	8.5	16.6	6.7	15.6	9.2	$p = 1.000$	$p = 1.000$	$p = 1.000$

Me - median temperature in measured ROIs [°C], QR – interquartile range, Multiple comparisons p values (2-tailed)

Table 5. *Univariate analysis of dependence of ROI temperature on age*

ROI	Age						2 years vs. 3 years	2 years vs. 4 years	3 years vs. 4 years
	2 years *n* = 130		3 years *n* = 494		4 years *n* = 65				
	Me	*QR*	*Me*	*QR*	*Me*	*QR*			
B2	31.92	6.24	30.31	7.20	31.94	4.47	**$p = 0.009$**	$p = 1.000$	$p = 0.094$
DF1	27.87	5.85	24.75	8.01	27.17	6.33	**$p < 0.001$**	$p = 0.484$	$p = 0.264$
DF2	28.07	6.38	24.79	8.10	26.68	6.39	**$p < 0.001$**	$p = 0.542$	$p = 0.186$
LF1	29.13	6.37	26.32	8.10	27.63	7.60	**$p = 0.001$**	$p = 0.512$	$p = 0.884$
LF2	29.03	6.28	26.51	8.16	28.63	7.09	**$p < 0.001$**	$p = 1.000$	$p = 0.111$
LF4	27.05	7.77	24.80	8.94	27.46	8.40	**$p = 0.005$**	$p = 1.000$	**$p = 0.047$**
LF6	27.87	8.09	25.01	9.23	28.33	8.47	**$p = 0.001$**	$p = 1.000$	**$p = 0.027$**
LF8	28.39	6.92	25.68	8.16	27.85	7.44	**$p = 0.001$**	$p = 1.000$	$p = 0.063$
MF1	30.34	6.68	27.76	7.77	29.37	6.22	**$p < 0.001$**	$p = 1.000$	$p = 0.206$
MF2	29.78	6.33	27.48	8.10	29.71	7.68	**$p < 0.001$**	$p = 1.000$	$p = 0.087$
MF3	27.38	8.25	24.58	8.69	27.17	8.72	**$p = 0.006$**	$p = 1.000$	$p = 0.143$
MF4	26.96	7.93	24.33	9.10	27.17	8.95	**$p = 0.002$**	$p = 1.000$	$p = 0.097$
MF6	27.54	7.53	24.64	9.23	27.63	9.28	**$p = 0.001$**	$p = 1.000$	$p = 0.080$
Tamb.	15.8	10.1	15.6	8.7	15.6	7.3	$p = 0.982$	$p = 1.000$	$p = 1.000$

Me - median temperature in measured ROIs [°C], QR – interquartile range, Multiple comparisons p values (2-tailed)

Table 6. *Univariate analysis of dependence of ROI temperature on gender*

ROI	Gender				Mann-Whitney U Test
	Mare *n* = 442		Stallion *n* = 247		
	Me	*QR*	*Me*	*QR*	
B2	30.55	6.83	31.46	6.35	$p = 0.089$
DF1	25.24	8.10	26.31	8.05	$p = 0.674$
DF2	25.63	7.80	26.43	7.88	$p = 0.426$
LF1	26.74	8.46	27.63	7.84	$p = 0.421$
LF2	26.79	8.40	27.75	7.98	$p = 0.634$
LF4	25.23	9.13	26.05	8.90	$p = 0.401$
LF6	25.53	9.31	26.41	9.49	$p = 0.246$
LF8	26.05	8.13	27.08	8.23	$p = 0.702$
MF1	28.12	7.59	28.90	7.19	$p = 0.808$
MF2	27.69	8.03	28.80	7.37	$p = 0.358$
MF3	25.03	8.93	26.12	8.54	$p = 0.547$
MF4	24.58	9.22	25.94	8.44	$p = 0.209$
MF6	24.91	9.07	26.30	9.10	$p = 0.138$

Tamb.	15.8	9.2	15.6	7.6	p = 0.802

Me - median temperature in measured ROIs [°C], QR – interquartile range, Multiple comparisons p values (2-tailed)

Table 7. *Univariate analysis of dependence of ROI temperature on training intensity level*

ROI	Training intensity level: Light training intensity level n = 318		Medium training intensity level n = 212		High training intensity level n = 159		Light training intensity level vs. Medium training intensity level	Light training intensity level vs. High training intensity level	Medium training intensity level vs. High training intensity level
	Me	*QR*	*Me*	*QR*	*Me*	*QR*			
B2	25.09	4.83	32.62	2.28	32.52	2.01	**p < 0.001**	**p < 0.001**	p = 0.837
DF1	20.45	6.40	28.54	3.17	28.36	3.62	**p < 0.001**	**p < 0.001**	p = 0.393
DF2	20.56	6.35	28.76	3.09	28.33	3.60	**p < 0.001**	**p < 0.001**	p = 0.377
LF1	21.48	6.01	30.11	3.19	29.57	2.94	**p < 0.001**	**p < 0.001**	p = 0.358
LF2	21.29	5.72	29.96	2.78	29.59	3.11	**p < 0.001**	**p < 0.001**	p = 0.323
LF4	18.53	5.72	28.27	3.45	27.82	3.49	**p < 0.001**	**p < 0.001**	p = 0.867
LF6	18.71	5.99	28.19	3.23	29.35	3.42	**p < 0.001**	**p < 0.001**	p = 0.095
LF8	21.07	5.50	29.59	3.15	29.26	3.50	**p < 0.001**	**p < 0.001**	p = 1.000
MF1	22.55	5.61	30.89	2.72	30.58	2.67	**p < 0.001**	**p < 0.001**	p = 0.427
MF2	22.20	5.85	30.78	2.78	30.42	2.83	**p < 0.001**	**p < 0.001**	p = 0.975
MF3	18.68	5.92	28.16	3.44	27.86	3.28	**p < 0.001**	**p < 0.001**	p = 0.652
MF4	18.18	6.20	28.25	3.36	27.87	3.62	**p < 0.001**	**p < 0.001**	p = 1.000
MF6	18.24	6.46	28.03	3.19	29.04	3.69	**p < 0.001**	**p < 0.001**	p = 0.097
Tamb.	8.40	5.60	18.50	4.10	18.25	4.40	**p < 0.001**	**p < 0.001**	p = 0.733

Me - median temperature in measured ROIs [°C], QR – interquartile range, Multiple comparisons p values (2-tailed)

Table 8. *Results for multiple linear regression*

ROI	Intercept	$T_{amb.}$ (°C)	Breed Thoroughbred no = 0, yes = 1	Breed Arabian no = 0 yes = 1	Age (years)	Gender mare = 0 stallion = 1	Training level (1, 2, 3)	R^2
	b_0	b_1	b_2	b_3	b_4	b_6	b_5	
B2	17.95	0.67	0.88	-	-	-	0.70	0.866
DF1	12.05	0.83	1.49	-	-	-	-	0.790
DF2	12.53	0.86	1.52	-	-	-	-	0.769
LF1	13.35	0.83	1.38	-	-	-	-	0.823
LF2	13.39	0.82	1.44	-	-	-	-	0.812
LF4	9.44	0.87	1.37	-	-	-	0.61	0.833
LF6	9.53	0.77	1.64	-	-	-	1.57	0.812
LF8	12.78	0.83	1.39	-	-	-	-	0.762
MF1	15.1	0.79	1.34	-	-	-	-	0.817
MF2	14.46	0.81	1.43	-	-	-	-	0.826
MF3	9.92	0.92	1.29	-	-	-	-	0.824
MF4	9.57	0.94	1.35	-	-	-	-	0.827
MF6	9.38	0.79	1.42	-	-	-	1.42	0.816

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Figures:

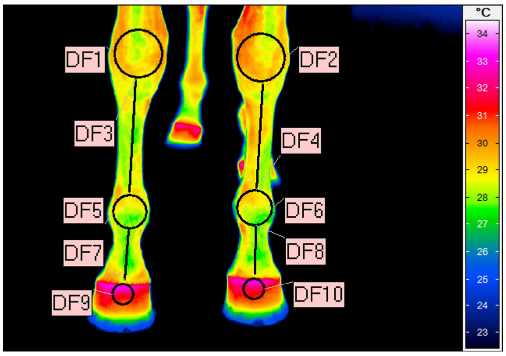

Fig. 1. *Thermogram of dorsal aspect of distal part of forelimbs. Measured ROIs: DF1 - right carpal joint, dorsal aspect; DF2 - left carpal joint, dorsal aspect; DF3 - right 3rd metacarpal bone, dorsal aspect; DF4 - left 3rd metacarpal bone, dorsal aspect; DF5 - right fetlock joint, dorsal aspect; DF6 - left fetlock joint, dorsal aspect; DF7 - right short pastern bone, dorsal aspect; DF8 - left short pastern bone, dorsal aspect; DF9 - right hoof, dorsal aspect; DF10 - left hoof, dorsal aspect.*

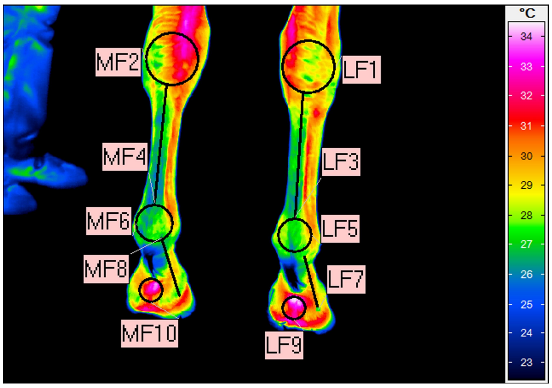

Fig. 2. *Thermogram of the right lateral and left medial aspects of the distal part of the forelimbs. Measured ROIs: LF1 - right carpal joint, lateral aspect; MF2 - left carpal joint, medial aspect; LF3 - right 3rd metacarpal bone, lateral aspect; MF4 - left 3rd metacarpal bone, medial aspect; LF5 – right fetlock joint, lateral aspect; MF6 - left fetlock joint, medial aspect; LF7 - right short pastern bone, lateral aspect; MF8 - left short pastern bone, medial aspect; LF9 - right heel, lateral aspect; MF10 - left heel, medial aspect.*

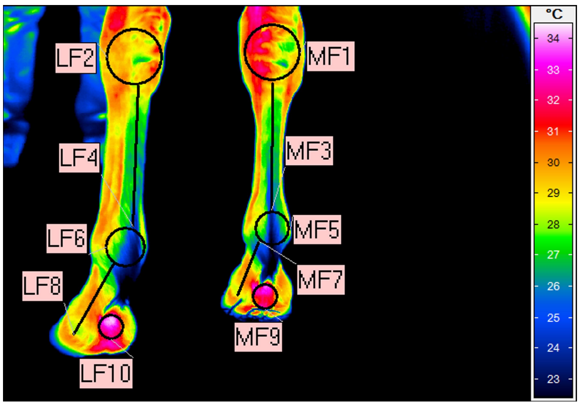

Fig. 3. *Thermogram of the left lateral and right medial aspects of the distal part of the forelimbs. Measured ROIs: MF1 - right carpal joint, medial aspect; LF2 - left carpal joint, lateral aspect; MF3 - right 3rd metacarpal bone, medial aspect; LF4 - left 3rd metacarpal bone, lateral aspect; MF5 - right fetlock joint, medial aspect; LF6 - left fetlock joint, lateral aspect; MF7 - right short pastern bone, medial aspect; LF8 – left short pastern bone, lateral aspect; MF9 - right heel, medial aspect; LF10 - left heel, lateral aspect.*

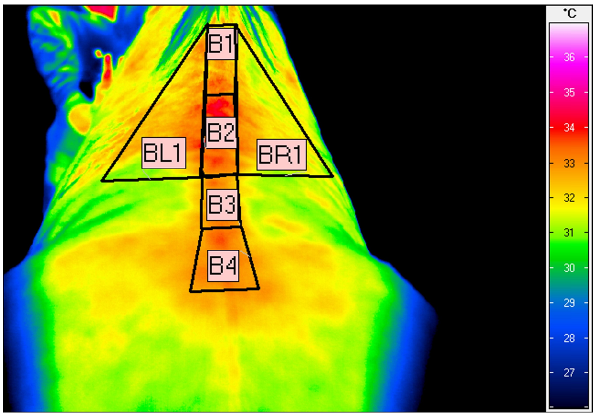

Fig. 4. *Thermogram of the dorsal aspect of the back. Measured ROIs: B1 – cranial part of the thoracic vertebrae, dorsal aspect; B2 - caudal part of the thoracic vertebrae, dorsal aspect; BL1 - left side of the thoracic vertebrae, dorsal aspect; BR1 - right side of the thoracic vertebrae, dorsal aspect; B3 - lumbar vertebrae, dorsal aspect; B4 - sacroiliac joins.*