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OBSERVATIONS ON BODY WEIGHT AND CONDITION OF HORSES IN A 150-MILE ENDURANCE RIDE

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SUMMARY

Competitors in the 1990 Race of Champions (a 150-mile, 2-day endurance ride) were asked to participate in a study on body weight and condition of endurance horses. Prior to the race, the following information was collected: body weight, rider and tack weight, previous race record, hours and miles trained per week, body condition score, and rump fat thickness. When possible body weights were obtained at veterinary checks during the race.

The majority of the horses in the race were of Arabian or part-Arabian breeding. Average age was 11 years. The average horse weighed 410 kg and carried 79.9 kg of weight (rider and tack). Mean condition score (1-9 scale) was 4.67 (n=57). Using rump fat thickness, mean body fat was estimated at 7.8%. Approximately 60% of the horses were eliminated during the race for injury, lameness, or failure to meet metabolic criteria. The most competitive horses (finishers in the top 7) tended to have lower condition scores ($p < .05$) and less rump fat ($p < .1$) than non-competitive horses eliminated for metabolic criteria. Horses with faster race times also tended to have won more "best condition" awards in past-performances ($p < .05$).

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INTRODUCTION

Many factors can influence a horse's ability to perform in endurance competition. Several studies have evaluated the metabolic responses of horses to endurance exercise¹⁻³ and at least one study has examined feeding practices.⁴ However, no studies have evaluated body condition or weight changes in horses participating in endurance competition. The relationship of body composition to human athletic performance has been well studied, and in events where the body must be moved horizontally or vertically, excess fat is considered a detriment to optimal performance.⁵ Therefore, highly trained athletes, especially long distance runners, will tend to be much leaner than age-matched controls.⁶ Lohman suggests that although the mean body fat for male athletes is about 12%, the optimal body fat percentage for male athletes involved in running sports may be between 4 and 10%.⁷ One objective of this study was to characterize the level of fatness of horses competing in endurance competition and to determine whether body condition influences performance. Another objective was to evaluate weight changes in the horses during an endurance race.

METHODS AND MATERIALS

Observations were made on the horses competing in the 1990 Race of Champions (ROC). The 1990 ROC was held at the Land-Between-the-Lakes Kentucky State Park on October 5 and 6. The two-day race covered about 75 miles/d for a



Table 1. Location of veterinary checks in the 1990 Race of Champions.

	Miles from Start
VC 1	15.8
VC2	34.3
VC 3	54.2
VC 4	65.0
VC 5	75.5
VC 6	93.8
VC 7	107.8
VC 8	120.1
VC 9	135.5
VC 10	146.3
Finish	151.3

total of 151.3 miles. During the race, veterinary checks (VC) were situated at 5 to 20 mile intervals (Table 1). At the veterinary checks each horse was evaluated by a veterinarian for soundness and rate of recovery. Horses that did not meet the criteria⁸ were eliminated from the race. To be eligible for the ROC horses must have completed at least five 100 mile rides and finished in the "Top Ten" in two rides. Riders must have completed at least one 100 mile ride. All competitors were asked to participate in the study on a voluntary basis.

When possible the following observations were made on each horse: initial body weight, body weight at VC3, body weight at VC5, body weight at finish, body condition score, and rump fat thickness. Body weights were obtained using a portable platform scale.^a Initial body weights were obtained the day before the race on 52 horses. Body weights at the various vet checks were obtained when possible. Assessment of body condition was made by three independent observers one or two days before the race. The condition scoring methodology was adapted from the system of Henneke et al.,⁹ with individual scores recorded for the neck, withers, shoulder, loin, tailhead, and ribs. A mean for each location was calculated from the scores of the three observers and then all measurements were used to determine a mean condition score for each horse. Fifty-seven horses were condition scored. Rump fat thickness was determined by ultrasound at five sites over the croup as described by Kane et al.¹⁰ A 12.5 cm 3 MHz transducer with a Johnson and Johnson 210 Dx

^aEquimetrix, EQ39, Equimetrix Inc., PO Box 216, Redfield, AR 72132.
^bManufactured by Aloka; distributed by Corometrics Medical Supply Inc., Wallingford, CT.

Table 2. Description of the horses competing in the 1990 Race of Champions.

	n	Mean ± S. D.	Range
Age	60	11.2 ± 2.5	7 - 19
Weight (kg)	52	410.2 ± 40.8	336.4 - 509.1
Rider & tack (kg)	60	79.9 ± 10.0	70.5 - 114.1
Mean CS*	57	4.67 ± .3	3.57 - 5.18
CS Neck	57	4.66 ± .4	3.25 - 5.17
CS withers	57	4.62 ± .37	3.30 - 5.30
CS loin	57	4.83 ± .34	3.37 - 5.33
CS tail	57	4.51 ± .34	3.25 - 5.30
CS ribs	57	4.68 ± .42	3.67 ± 5.50
CS shoulder	57	4.71 ± .34	3.60 - 5.25
Rump fat 1 (cm)**	38	.895 ± .48	.3 - 2.3
Rump fat 2	38	.968 ± .54	.3 - 2.9
Rump fat 3	38	.742 ± .37	.3 - 2.1
Rump fat 4	38	.695 ± .35	.3 - 1.7
Rump fat 5	38	.447 ± .13	.3 - 1.0
Miles trained/wk	50	38.4 ± 17.5	7.5 - 85.0
Hours trained/wk	51	7.7 ± 4.71	1 - 28

*Condition scores based on 1 to 9 system.⁹

1 = emaciated; 9 = obese.

**Rump fat thickness measured by ultrasound at 5 sites over the croup.

Ultrasound machine was used to take the measurements.^b Rump fat thickness was determined on 37 horses 2 days before the race. Information on prior performance record, rider and tack weight, and horse age was obtained from the ride management. Information on training practices was obtained on survey forms filled out by the competitors prior to the race.

Data management was handled as a three phase process. Initially, measurements on all horses were used to provide a description of the average horse entered in the race. These data were also used to determine correlation coefficients for the relationship between condition score and rump fat thickness. In the second phase, horses were divided into groups based on their race performance. Group 1 included horses that were eliminated at a vet check for lameness; group 2 included horses eliminated at vet checks for metabolic reasons (thumps, failure to recover heart rate or respiration rate); group 3 included horses placing in the "Top Ten;" and group 4 included all other finishers. Analysis of variance was used to test for differences between groups for body weight, condition score, rump fat thickness, age, and prior performance record. These groupings did not reveal differences between groups so in the third phase of the analysis the groups were redefined as follows: Group 1 was eliminated. Many

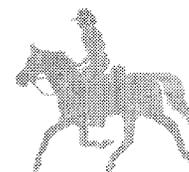


Table 3. Correlation coefficients for rump fat (RF) thickness vs condition score (CS).

	rf 1	rf 2	rf 3	rf 4	rf 5
CS mean	.29 (.075)*	.29 (.076)	.26 (.11)	.39 (.01)	.05 (.78)
CS neck	.20 (.22)	.24 (.14)	.24 (.15)	.33 (.04)	.05 (.75)
CS withers	.25 (.13)	.23 (.17)	.24 (.15)	.37 (.03)	.1 (.5)
CS loin	.18 (.28)	.21 (.21)	.21 (.22)	.35 (.03)	.01 (.94)
CS tail	.21 (.19)	.23 (.16)	.21 (.22)	.23 (.17)	-.108 (.52)
CS ribs	.46 (.004)	.43 (.008)	.32 (.051)	.5 (.002)	.2 (.23)
CS shoulder	.21 (.19)	.189 (.25)	.15 (.38)	.24 (.14)	.05 (.76)

*Level of significance.

horses in this group were eliminated for lamenesses that resulted from losing shoes or traumatic injury; since body condition would not be expected to affect the incidence of these lamenesses, the inclusion of these horse in further analysis was not considered useful. Group 2 was narrowed to Group 2a by excluding horses that were ridden at a competitive pace, at or near the lead. A "competitive pace" was defined as being a pace that resulted in the horse being listed in the top 15 finishers at any point in the race. In most cases these horses were eliminated after an unusually fast leg (from one vet check to another) when the rider was trying to improve their position in the race. The removal of these horses from the "metabolic" group was justified in that it appeared the reason for elimination was more related to rider error than horse condition. Consequently, group 2a was defined to consist of horses eliminated for metabolic reasons that never held a competitive position in the race. Group 3 originally contained all "top Ten" finishers, however only 22 min separated the tenth, eleventh, and twelfth place finishers, whereas the seventh and eighth place horses were separated by more than 1.5 hours. Therefore to gain more accuracy in defining the condition of the most competitive horses in the race, only the top seven finishers were used in group 3a. Group 3a also included one horse that was eliminated for lameness at the last VC (while leading the race). Group 4a contained all horses finishing the race that were not in group 3. Using the new groups, analysis of variance was used to identify differences in condition score, rump fat thickness, prior performance record, and training practices.

Table 4. Body weight and condition of horses in each finish group.*

	Group			
	1	2	3	4
Career wins	3.7±1.1	4.36±1.2	2.5±.66	2.0±.55
Best condition	2.6±3.0	3.14±.93	3.7±.66	1.67±.37
Body weight	409.5±11.0	418.8±15.3	404.9±10.4	407.7±9.1
Rider/tack wt.	77.6±3.9	82.1±2.2	82±3.0	79.7±6.7
Wt. loss % bw				
VC3	6.5±.57	6.4±.47	6.13±.6	4.9±.33
Finish			5.12±.73	4.73±.53
Rump fat 1 (cm)	.79±.09	1.04±.22	.73±.19	1.04±.18
Rump fat 2	.85±.10	1.25±.31	.80±.16	1.04±.19
Rump fat 3	.62±.05	.89±.22	.70±.12	.84±.14
Rump fat 4	.59±.06	.89±.15	.53±.07	.82±.14
% Fat	7.1±.54	9.34±1.66	6.85±.86	8.15±1.04
CS mean	4.54±.09	4.74±.04	4.67±.10	4.76±.05
CS ribs	4.62±.10	4.72±.08	4.59±.19	4.78±.09
Mls trained/wk	40.08±4.12	41.78±5.9	38.7±4.68	33.3±5.6
Hrs trained/wk	8.8±1.6	7.4±1.0	7.6±.93	6.42±.94

*Mean±S.E.; Group 1=non-finishers (lameness or injury); Group 2=non-finishers (metabolic); Group 3=Top Ten finishers; Group 4=finishers not in Top Ten.

RESULTS

Sixty-one horses started the ROC. Twenty-five horses finished the race. The winning horse completed the 151.3 mile course in 17 h 19 min 35 sec. The last horse to finish required 27 h 54 min 41 sec. Forty-eight of the horses were Arabian or part-Arabian breeding but the Morgan, Quarter Horse, Saddlebred, and Spanish Mustang breeds were also represented. Six horses were described as grade horses. There were 44 geldings, 14 mares, and 3 stallions.

Mean initial body weight was 410 kg (Table 2). For the 39 horses weighed at VC3 (54.2 mi), mean weight loss was 54 lb, which was approximately 6% of initial body weight. After VC3 weight loss was negligible. It should be noted that initial body weights were taken on the afternoon of the day before the race and therefore may have overestimated actual weight at the start of the race.

Mean condition score was 4.67, with a range of 3.57 to 5.18. In the condition scoring system used, a "3" was described as thin, a "4" was moderately thin, and a "5" was described as moderate. Thus, most of the horses entered in the ROC would be described as "moderately thin" to "moderate"

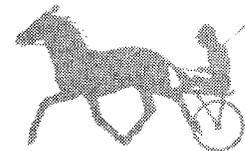


Table 5. Characteristics of horses in groups 2a, 3a, and 4a.

	Group 2a	Group 3a	Group 4a
Career wins	1.89±.59	4.5±1.91	2.16±.5
Best cond. awards**	1.44±.50 ^a	5.1±1.2 ^b	2.00±.38 ^a
Total career miles	1377±143	1730±198	1727.4±188.3
Body wt (Kg)	425±143	398±16.1	406.2±7.4
Wt. loss % bw			
VC3	6.06±.78	6.28±.8	4.91±.26
Finish		5.39±1.1	4.68±.26
Rump fat 1 (cm)	1.32±.19	.66±.12	1.02±.17
Rump fat* 2*	1.56±.34 ^a	.74±.14 ^b	1.02±.16 ^b
Rump fat 3	1.06±.27	.66±.13	.83±.12
Rump fat 4	1.04±.17	.52±.08	.78±.12
% Fat	11.0±1.86	6.52±.79	8.03±.90
CS mean**	4.76±.05 ^a	4.43±.16 ^b	4.77±0.5 ^a
CS ribs**	4.80±.10 ^a	4.28±.18 ^b	4.82±.09 ^a
Mls trained/wk	30.7±2.02	43.06±5.9	33.8±4.77
Hrs trained/wk	5.8±.53	9.31±2.1	6.7±.82

Mean±S.E.; Group 2a: Horses that were eliminated for metabolic reasons and that were not competitive at any point in the race. Group 3a: Top seven finishers and one horse eliminated for lameness at last vet check while leading race. Group 4a: All finishers not in 3a.

*Significant differences between groups at $p < .1$.

**Significant differences between groups at $p < .05$.

in condition. Rump fat thickness at the five sites is also given in Table 2. The equation of Kane et al.¹⁰ for site 2 predicts average percent body fat to be 7.8%. Rump fat and condition score were positively correlated, but the correlations were not strong (Table 3). The strongest correlations existed between condition score at the ribs and rump fat at locations 1 to 4. The relatively low correlations are probably a result of the narrow range of condition scores in these horses.

In Table 4 the information on body condition, body weight, and prior race performance is separated according to initial categorization of finish groups. There were no differences between the initial groups for any parameter ($p > .05$). When finish time was correlated to these characteristics, there were no significant relationships between finish time and condition score or rump fat thickness at any site. However, there was a significant correlation between finish time and number of previous best condition awards ($r = -.48$; $P < .02$), and finish time and weight lost at VC3 ($r = -.61$, $p < .01$).

Table 5 presents the information on body condition, body weight, prior performance, and training practices once the finish groups were redefined. Horses finishing in a competitive position in the race (group 3a) had a higher number of best condition awards ($p < .05$), and lower condition scores ($p < .05$)

than horses in the other two groups. Rump fat thickness and percent body fat tended to be lowest in this group as well. Not surprisingly, the horses that were unable to complete the race (group 2a) had higher rump fat and calculated percent body fat than horses in either of the two groups finishing the race ($p < .1$). The values supplied by the rider on number of miles and hours trained per week suggest that the horses in group 3a received the most conditioning, however the variability in responses was so great that the means are not statistically different ($p > .1$). There were also no differences in amounts of weight lost by the horses in each group during the race. Not all horses were weighed at each point, so it is difficult to make comparisons relative to weight loss within a group at VC3 and at the end of the race.

DISCUSSION

The objective of this study was to characterize the body condition of competitive endurance horses and to determine whether any relationships exist between body condition and performance. The data from the 1990 ROC suggest that the horses with the best performance times had lower condition scores and tended to be leaner than the horses that could not finish or that finished slowly. Parizokova et al. reported body fat percentages in human athletes to average 8.2% in long distance runners and 3.8% in marathoners.⁶ The average body fat percentage for all horses starting the ROC was estimated to be 7.8%. The top finishers were slightly lower than the average, at 6.5%, while the horses that could not finish were estimated at 11.0% body fat. Excess body fat is believed to be detrimental to performance by increasing the amount of work needed to move the body horizontally or vertically. At 6.5% fat, the top finishers were carrying about 26 kg of fat, whereas the horses that could not finish averaged about 45 kg of fat. It has also been suggested that a greater subcutaneous fat cover will increase the thermal load of working horses.¹¹

A decrease in body fat percentage may be obtained by either increasing caloric expenditure or decreasing caloric intake. When weight loss is attained by caloric restriction alone, a portion of the weight lost may result from a reduction in lean body mass.⁵ The amount of lean body mass lost from caloric restriction will vary depending upon the condition of the individual; lean body mass losses will be greater in thin individuals than in fat individuals.¹² However, when weight is lost through a combination of increased caloric expenditure (via exercise) and decreased caloric intake, the loss of lean body mass is minimized and the reduction in body fat is increased.^{13,14} It has also been suggested that when positive

energy balance can be maintained in the face of increased energy expenditure, losses in body fat can actually be accompanied by increases in lean body mass.¹⁵ Thus, it is critical that any reduction in fatness of competitive horses occurs as a result of training, not from diet restriction. It is interesting that the most competitive horses in this race appeared to also train the most miles and hours. Presumably, these horses obtained a lean body condition through training and not through caloric restriction. The information obtained from the riders on feeding practices could not be used to calculate daily energy intake because many of the horses received forage (hay or pasture) on a free choice basis which was not quantifiable.

The strongest predictor of success in the 1990 ROC appeared to be prior race performance, especially the number of best conditioned awards. Although career wins followed the same trend as best conditioned awards, the correlation to finish time was not as strong. Number of career wins may have been less useful because it included winning performances at shorter distances.

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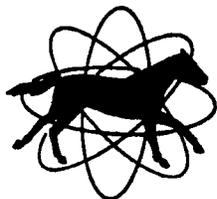
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