

# Evaluation of the racial difference in body condition score and parameters of lipid metabolism in Purebred Arabian horses and Thoroughbred horses trained for racing

## *Avaliação da diferença racial na condição de escore corporal e parâmetros do metabolismo lipídico em cavalos Puro Sangue Árabes e Puro Sangue Ingleses treinados para corrida*

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### ABSTRACT

This study investigated the existence of difference of fat deposition and lipid metabolism in horses with different races and skills that were used for the same kind of sport. 20 Purebred Arabian and 20 Thoroughbred horses trained for flat race were evaluated. The analyses performed were body condition score, weight and blood collected for determination of triglycerides, total cholesterol and non-esterified fatty acids. Ultrasonography of the thickness of the subcutaneous fat layer was performed on the *Longissimus dorsi* muscle between the 17<sup>th</sup> and 18<sup>th</sup> rib, the thickness of the subcutaneous fat layer on the *Gluteus medius* muscle using the acetabulum as reference, and the cross section of the same muscle. Race-trained Arabian horses showed greater fat layer deposition in the *Gluteus medius* and *Longissimus dorsi* muscles than Thoroughbred horses. These facts indicate that there is a metabolic difference, besides the phenotype, between the races. They also indicate the need to study specific physical conditioning programs for each kind of race.

**Keywords:** Equine. Body condition score. Exercise. Triglycerides.

### RESUMO

Foi investigada a existência de diferença na deposição de gordura e no metabolismo lipídico em cavalos de duas raças distintas, com aptidões diferentes, porém, utilizadas para o mesmo esporte. Foram avaliados 20 cavalos Puro Sangue Árabe e 20 cavalos Puro Sangue Ingleses treinados para corrida. As avaliações foram escore de condição corporal, peso e colheita de sangue para determinação de triglicerídeos, colesterol total e ácidos graxos não esterificados. Foi realizada a ultrassonografia da espessura de camada de gordura subcutânea sobre o músculo *Longissimus dorsi* entre a 17<sup>o</sup> e 18<sup>o</sup> costela, a espessura de camada de gordura subcutânea sobre o músculo glúteo médio utilizando o acetábulo como referência e o corte transversal do mesmo músculo. Os cavalos Árabes de corrida apresentaram maior deposição de gordura na camada subcutânea dos músculos glúteo médio e *Longissimus dorsi* que os cavalos Puro Sangue Ingleses. Tais fatos indicam uma diferença racial que o treinamento, ainda que semelhante a todos, não foi capaz de igualar.

**Palavras-chave:** Equinos. Escore de condição corporal. Exercício. Triglicerídeos.

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## Introduction

In Brazil, 16,000 people in the countryside and cities make turf their means of earning a living. This number surpasses that of some car assemblers and the direct jobs generated by the Manaus Free Trade Zone. And this whole industry depends on the existence of haras in the interior and the evolution of the betting volume in the Jockey Clubs. Incidentally, horse betting is the only game allowed by law, in addition to state lotteries (Barcellos, 2014).

The variability of the athletic ability of the horse can be attributed to years of genetic selection to develop fitness for a particular form of exercise, as well as its remarkable muscle plasticity, which readily adapts to physical training. Significant variations in muscle fiber composition are observed among horse breeds that are known to have an aptitude for specific disciplines. For example, Arabian horses, famous for high endurance, have a higher percentage of muscle type I fibers than Thoroughbred horses, known as sprinters (Votion et al., 2007).

Body composition is an important factor for both performance and aerobic capacity in horses. Fat mass, though detrimental to high-performance sports and health, is not just a storage tissue, it also plays a critical role in energy homeostasis by secreting a variety of proteins that modulate many biological function (Kearns et al., 2006). It has been demonstrated that, in humans, success in sports is related to the free fat mass (FFM) that the athlete possesses (Thorland et al., 1987) and with the architectural properties of muscles. Of all the components of the body, fat is the most variable, in contrast to the free fat mass, which is the most constant. The variability in fat mass is related to the genetic constitution of the horse and individual and environmental factors such as nutrition and chronic training (Kearns et al., 2002).

The assessment of body condition score (BCS) condition has been widely accepted and applied as a fat monitoring measure (Dugdale et al., 2012). Ultrasonography is a practical, non-invasive procedure, which, when combined with the BSC, can be used to monitor the management, nutrition and training of horses in a more precise and objective manner, even in routine periodic monitoring in groups of animals subjected to nutritional or sports training program (Gobesso et al., 2014).

Achieving good performance in any sport requires maximum adaptation to the specific conditions of each discipline. Arabian horses are used in two very different activities: When young, they participate in flat races, and when older, endurance races. Physiologically, these two types of effort are completely different; thus, they also

require different adaptations. High intensity or speed activities require an adaptation to the anaerobic metabolism and accumulation of lactic acid produced by glycolysis. In contrast, resistance activities require aerobic adaptation and preferentially use fatty acids as an energy source (Kędzierski & Cywyńska, 2014).

The aim of this study is to verify if there is a difference of fat deposition and lipid metabolism in horses of two different races, also with different aptitudes, but used for the same sport.

## Materials and Methods

Twenty Arabian horses and Thoroughbreds both trained for flat race were tested. All horses belong to private owners, and those trained for racing were housed in the equestrian village of the Jockey Club of São Paulo.

Horses trained for racing, both Arabian and Thoroughbred, received the same nutritional management with commercial concentrate, oats and tifton hay or the same bulky fresh cut. They were also submitted to the same training protocol, elaborated according to the distances to be run and not according to racial differences.

All horses were weighed and had the body condition score (BCS) evaluated according to the areas suggested by Henneke et al. (1983), neck, withers, shoulders, side, loin and tail ranges from 1 to 9, in a double-blind fashion. Subcutaneous fat layer thickness was then performed on the *Longissimus dorsi* muscle (fat layer LD), between the 17th and 18th rib, the thickness of the subcutaneous fat layer on the *Gluteus medius* muscle (fat layer GM), using the acetabulum as reference and the cross-section (depth) of the same muscle (depth GM). For this, the GE ultrasonic device, model Logic E and macroconvex probe of 3-5 mega-hertz was used.

Blood from the jugular vein was collected through the vacuum system and tube without anticoagulant for the analysis of triglycerides, total cholesterol and NEFA (non-esterified fatty acids) performed on the Randox Rx Daytona automatic biochemical analyzer (Randox®, UK) using kits TR 2823, CH 3810 and FA 155, respectively.

Data were submitted to the Kolmogorov-Smirnov normality test, ANOVA variance analysis, means comparison by Student's t-test at a significance level of 5%, and Pearson's correlation test.

This research project was approved by the Animal Use Ethics Committee of FMVZ-USP under the number CEUA No. 2174300916.

## Results and Discussion

There was a difference in weight among the studied groups, since Thoroughbred horses were larger than the Arabian horses, as shown in Table 1. However, when the body condition score (BCS) was evaluated, no difference was observed between the races nor between individuals of the same race, which shows that all had athletic body, with a score close to 4.5.

The cross-section of the *Gluteus medius* muscle also showed a difference, being higher in the Thoroughbred, and lower in the Arabians, with no difference in the work, but in the race. This result can be explained by the propulsive muscles which, like the *Gluteus medius*, are responsible for the power required in high performance exercises, such as turf. Therefore, the increase of the musculature to obtain greater power is a consequence of the increase in the number and size of fibers, as these alterations are controlled by genetic factors and by the intensity of training (Kearns et al., 2002). Gobesso et al. (2014) evaluated the relationship of body condition score in three different races, with fat and muscle thickness measurements, by means of ultrasonography, at intervals of 30 days, and observed an increase in the thickness of the *Gluteus medius* muscle and lumbar fat in the group of Thoroughbred. Thoroughbred horses were heavier compared to the Arabian, because they were also higher horses, but when the BCS was evaluated, there was no difference between the animals studied. BCS is a subjective assessment that indicates excess fat deposition in certain predetermined areas of the body, but can be influenced by race, gender, and age (Suagee et al., 2008). When the thickness of the subcutaneous fat layer was evaluated objectively by ultrasonography, a difference was detected in both fat layer LD and depth GM, which showed higher values in Arabian horses. On the other hand, the Thoroughbred presented higher values of fat layer thickness of GM. Figure 1 shows that, although the Thoroughbred horses have lower values of the deposition of subcutaneous fat in general, there is a difference in the place where it is deposited; that is, the PSI has more fat on the *Longissimus dorsei* muscle in relation to the Arabian

horses trained for the same sport, which in turn, has greater layer of fat on the gluteus muscle.

The Arabian horses trained to race presented greater deposition of fat on the gluteus medius muscle and greater fat layer LD than the Thoroughbred horses trained for the same function, which perhaps can be explained by the underutilization of these animals. Nielsen et al. (2006) studied the speed of the three races used for turf (Quarter Horse, Thoroughbred and Arabian) during some stretches of the race and noted that the Thoroughbred horse had started but could not maintain their speed throughout the race. The Arabian horse had no speed at start, but it kept its speed longer.

Non-esterified fatty acids are metabolites capable of providing energy to the skeletal muscle when carbohydrate use is inhibited and during low intensity and long duration aerobic exercises (Piccione et al., 2008). The horses of the present study presented near levels with no statistical difference, thus not having racial or training interference, probably because the collections were made at rest. However, there was a positive correlation ( $r = 0.500$  and  $p = 0.029$ ) between NEFA and BCS in Thoroughbred horses and between NEFA and fat layer LD ( $r = 0.612$  and  $p = 0.04$ ) in Arabian horses. As the Thoroughbreds are horses with

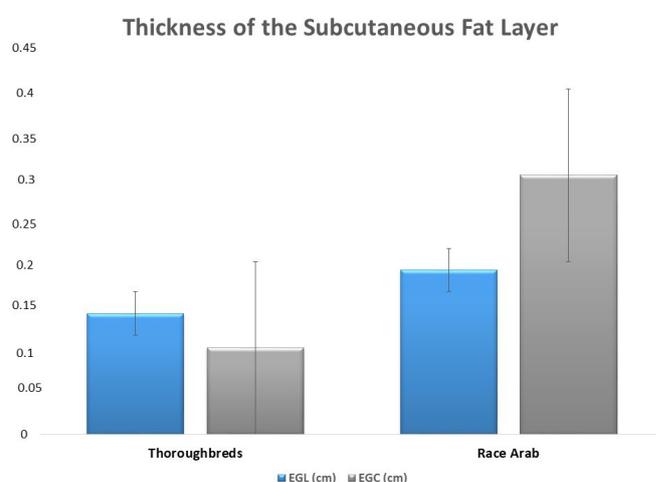


Figure 1 – Deposition of the subcutaneous fat layer on the *Longissimus dorsi* muscle and on the gluteus medius muscle in Thoroughbreds and Arabian horses.

Table 1 – Mean and standard deviation ( $\pm$ ) of the body weight, body condition score (BCS), thickness of the fat layer on the *Longissimus dorsi* muscle (LD), thickness of the fat layer on the *Gluteus medius* muscle (GM) and depth of *Gluteus medius* muscle, triglycerides, cholesterol and NEFA in Thoroughbred and Arabian horses

	N	Body Weight (kg)	BCS	Fat layer LD (cm)	Depth GM (cm)	Fat layer GM (cm)	Triglyc. (mg/dL)	Cholest. (mg/dL)	NEFA (mmol/L)
<b>Thoroughbreds</b>	20	456.15 <sup>a</sup> ( $\pm 35.20$ )	4.52 ( $\pm 0.44$ )	0.14 <sup>a</sup> ( $\pm 0.03$ )	0.10 <sup>a</sup> ( $\pm 0.01$ )	9.79 <sup>a</sup> ( $\pm 1.37$ )	41.05 ( $\pm 7.9$ )	94.29 ( $\pm 11.04$ )	0.03 ( $\pm 0.04$ )
<b>Arabians</b>	20	421.62 <sup>b</sup> ( $\pm 31.38$ )	4.55 ( $\pm 0.42$ )	0.19 <sup>b</sup> ( $\pm 0.04$ )	0.30 <sup>b</sup> ( $\pm 0.17$ )	7.50 <sup>b</sup> ( $\pm 1.46$ )	41.94 ( $\pm 17.35$ )	98.78 ( $\pm 12.02$ )	0.04 ( $\pm 0.03$ )

Different letters in the same column indicate statistical difference ( $P < 0.05$ ) of the variable between Thoroughbreds and Arabian horses; N number of analyzed horses.

predominantly anaerobic metabolism, the correlation between the subcutaneous fat layer and NEFA exists because it is not widely used as a source of energy during muscular work, while the positive correlation between NEFA and fat layer LD in Arabian horses is for the same reason, but the muscles are able to use it.

Lipids are important substrates for skeletal muscle metabolism and their use in horse athletes is influenced by the type of exercise and intensity. Generally, exercise increases the rate of lipolysis and release of adipose tissue from free fatty acids and glycerol into the blood and the free fatty acids are used by the muscles being recruited at work. In conditioned horses, the rate of lipolysis may exceed the use of fatty acids which, in this case, are re-esterified by the liver (Assenza et al., 2012). There was a positive correlation between depth GM and triglycerides in Thoroughbred and Arabian racehorses ( $r = 0.465$  and  $p = 0.045$  and  $r = 0.582$  and  $p = 0.014$ ), respectively. These alterations found in this study can be explained by the difference in muscle types. Kędzierski & Cywyńska (2014) studied the lipid metabolism of purebred Arabian horses trained for running and endurance and found the same difference and concluded that the lipolysis process occurs before in endurance horses due to prolonged aerobic work and physical conditioning time, that, as in this study, animals of different ages were compared, as was the case with Desmecht et al. (1996) and Gordon et al. (2007).

## References

- Assenza A, Tosto F, Piccione G, Fazio F, Nery J, Valle E, Bergero D. Lipid utilization pathways induced by early training in Standardbred trotters and Thoroughbreds. *J Equine Vet Sci.* 2012;32(11):704-10. <http://dx.doi.org/10.1016/j.jevs.2012.02.015>.
- Barcellos S. Turfe não é clube, e sim indústria. *O Globo*, 02/08/2014 [cited 2019 Mar 27]. Available from: <http://oglobo.globo.com/opiniao/turfe-nao-clube-sim-industria-13463819>
- Desmecht D, Linden A, Amory H, Art T, Lekeux P. Relationship of plasma lactate production to cortisol release following completion of different types of sporting events in horses. *Vet Res Commun.* 1996;20(4):371-9. <http://dx.doi.org/10.1007/BF00366544>. PMID:8865580.
- Dugdale HA, Grove-White D, Curtis GC, Harris PA, Argo CM. Body condition scoring as a predictor of body fat in horses and ponies. *Vet J.* 2012;194(2):173-8. <http://dx.doi.org/10.1016/j.tvjl.2012.03.024>. PMID:22578691.
- Gobesso AAO, Martins RADT, Gil PCN, Françoso R, Gonzaga IVF. Avaliação de escore corporal em equinos por meio da ultrassonografia. *Braz J Vet Res Anim Sci.* 2014;51(2):136-41. <http://dx.doi.org/10.11606/issn.2318-3659.v51i2p136-141>.
- Gordon ME, McKeever KH, Betros CL, Manso HC Fo. Plasma leptin, ghrelin and adiponectin concentrations in young fit racehorses versus mature unfit Standardbreds. *Vet J.* 2007;173(1):91-100. <http://dx.doi.org/10.1016/j.tvjl.2005.11.004>. PMID:16377220.
- Henneke DR, Potter GD, Krieder JL, Yeates BF. Relationship between body condition score, physical measurements and body fatpercentage in mares. *Equine Vet J.* 1983;15:371-2.
- Kearns CF, McKeever KH, Kumagai K, Abe T. Fat-free mass is related to one mile race performance in elite Standardbred horses. *Vet J.* 2002;163(3):260-6. <http://dx.doi.org/10.1053/tvjl.2001.0656>. PMID:12090768.

Further studies on other parameters of energy metabolism and on exercise or post-training animals are necessary for a full understanding of the effects of training to racing on these horses and, consequently, better design of physical fitness programs.

## Conclusion

Race-trained Arabian horses showed greater fat layer deposition in the *Gluteus medius* and *Longissimus dorsei* muscles when compared to Thoroughbred horses. These facts indicate that there is a metabolic difference, besides the phenotype, between the races. They also indicate the need to study specific physical conditioning programs for each horse.

## Conflict of Interest

The authors state that they have no conflicts of interest to declare.

## Ethics Statement

This research project was approved by the Animal Use Ethics Committee of FMVZ-USP under the number CEUA No. 2174300916.

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- Kearns CF, McKeever KH, Roegner V, Brady SM, Malinowski K. Adiponectin and leptin are related to fat mass in horses. *Vet J.* 2006;172(3):460-5. <http://dx.doi.org/10.1016/j.tvjl.2005.05.002>. PMID:15996495.
- Kędzierski W, Cywyńska A. The effect of different physical exercise on plasma leptin, cortisol, and some energetic parameters concentrations in purebred Arabian horses. *J Equine Vet Sci.* 2014;34(9):1059-63. <http://dx.doi.org/10.1016/j.jevs.2014.06.005>.
- Nielsen BD, Turner KK, Vnetura BA, Woodward AD, O'Connor CI. Racing speeds of quarter horses, thoroughbreds and arabians. *Equine Vet J.* 2006;36(Suppl):128-32.
- Piccione G, Assenza A, Borruso, M, Fazio F, Caola G. Daily pattern of some fatty acids in the athletic horse. *J Anim Physiol Anim Nutr.* 2008;93(1):7-14.
- Suagee JK, Burk AO, Quinn RW, Petersen ED, Hartsock TG, Douglass LW. Effects of diet and weight gain on body condition scoring in Thoroughbred geldings. *J Equine Vet Sci.* 2008;28(3):156-66.
- Thorland WG, Johnson GO, Cisar CJ, Housh TJ, Tharp GD. Strength and anaerobic responses of elite young female sprint and distance runners. *Med Sci Sports Exerc.* 1987;19(1):56-61. <http://dx.doi.org/10.1249/00005768-198702000-00012>. PMID:3821456.
- Votion DM, Navet R, Lacombe VA, Sluse F, Essén-Gustavsson B, Hinchcliff KW, Rivero J-LL, Serteyn D, Valberg S. Muscle energetic in exercising horses. *Equine Comparative Exercise Physiology.* 2007;4(3):105-18. <http://dx.doi.org/10.1017/S1478061507853667>.
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