

# Total Blood Volume and Thoroughbred Racing Performance

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## SUMMARY

Total blood volume (TBV) was measured on 47 mature race-retired Thoroughbreds and compared with individual performance records. TBV had a near normal distribution with a mean of  $49.2 \pm 5.0$  L. Thirty-three of the 47 horses (70.2%) were stakes horses (SH). There was a difference ( $P < .01$ ) in the percentage of SH with below average (BA) TBV (36.4%) compared with the percentage of SH with average (A) TBV (73.1%) and an even greater difference ( $P < .001$ ) when compared with horses with above average (AA) TBV (100%). Further, there was a difference ( $P < .001$ ) in the percentage of graded stakes horses (GSH) with BA-TBV (0%) compared with those with A-TBV (23.1%) and AA-TBV (30%). TBV was related ( $P < .05$ ) to overall performance level ( $r = 0.45$ ). There was no difference in the average earnings per start (AEI) of horses with BA- and A-TBV; however, horses with AA-TBV had a higher ( $P < .05$ ) AEI, and overall TBV was related to AEI ( $r = 0.34$ ). TBV is a measure of oxygen delivery capacity, and since it is inherent to the individual, values from yearlings and unraced 2-year-olds should provide buyers with an objective, performance-related physiologic parameter to use in selection.

## INTRODUCTION

TBV varies among horses even of the same breed, body size, and gender and has been positively related to exercise performance in Standardbreds.<sup>1</sup> Since TBV is a function of plasma volume and circulating red blood cell volume, of which up to one third of the total can be stored in the spleen of the resting horse,<sup>2</sup> there has been debate as to the usefulness of TBV values taken during quiescence.<sup>1,2</sup> Consequently, studies have been conducted estimating TBV values taken immediately following exercise<sup>1,3</sup> or post-treatment with epinephrine to simulate the effects of exercise.<sup>1,4</sup>

However, if any benefit of an aerobic parameter like TBV is to be used as a selection tool in the marketplace, the research protocol must conform to the restrictions that environment presents.

Some procedures such as weighing would be cumbersome and impractical, while others such as injections for sedation, excitation, the use of a canula, and exercise via a treadmill would be prohibited.

Since Thoroughbreds constitute a significant portion of the horse-racing marketplace and no performance-related studies have been reported using that breed, the aim of this study was to determine if resting TBV values collected in a manner conducive to a presales environment were related to racing performance.

## A STUDY

Heart girth, heart rate (HR), and TBV were determined on 29 geldings and 18 mares between the ages of 4 and 16 years that were confined to a stall for at least 1 hour, with hay and water provided ad libitum. Heart girth was used to make the adjustment for variation in body size, and HR was used to monitor the amount of excitation of the animal before the collection of blood and injecting the marker. If HR was 50 or more, the individual was allowed 5 to 10 minutes before a second HR reading was taken and recorded regardless of rate. Evans blue dye was used as the marker and was injected at the rate of 80 mg per horse. Marker injection was preceded by aspiration of approximately 1 mL of blood into the syringe with the marker to ensure the needle was in the lumen of the jugular, followed by a second aspiration/injection post-injection of the marker to ensure the needle had remained in place. Fifteen minutes were allowed for complete mixing. All samples were held at 5°C for 24 hours before centrifugation and spectrophotometry at 650 nm. Of the 47 horses, 33 were SH, and of those, 9 were GSH.

Mean heart girth, HR, red blood cell volume, plasma volume, and TBV for geldings, mares, and combined are presented in Table 1. There was no difference ( $P > .05$ ) owing to gender among any of the blood parameters,

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**Table 1** Mean  $\pm$  SD for HG, HR, RCV, PV, and TBV for Geldings, Mares, and Combined

No./Gender	HG	HR	RCV	PV(L)	TBV(L)
29/Geldings	73.4 $\pm$ 2.8 <sup>a</sup>	45.7 $\pm$ 4.2	38.3 $\pm$ 2.8	29.8 $\pm$ 3.4	48.4 $\pm$ 5.1
18/Mares	75.6 $\pm$ 2.7 <sup>b</sup>	44.6 $\pm$ 3.9	38.3 $\pm$ 2.9	31.2 $\pm$ 3.2	50.5 $\pm$ 4.6
47/Total	74.2 $\pm$ 3.0	45.3 $\pm$ 4.1	38.3 $\pm$ 2.8	30.3 $\pm$ 3.4	49.2 $\pm$ 5.0

<sup>a,b</sup>Numbers within columns are different ( $P < .01$ ).

HG, heart girth; HR, heart rate; RCV, red blood cell volume; PV, plasma volume; TBV, total blood volume.

**Table 2** Mean TBV, % SH, GSH, and mean AEI for horses with BA-, A-, and AA-TBV

No./Group	SH/Horses(%)	GSH/Horses(%)	AEI
11/BA-TBV	4/11 (36.4) <sup>ac</sup>	0/11 (0.0) <sup>a</sup>	2.3 <sup>e</sup>
26/A-TBV	19/26 (73.1) <sup>d</sup>	6/26 (23.1) <sup>b</sup>	3.7 <sup>e</sup>
10/AA-TBV	10/10 (100) <sup>b</sup>	3/10 (30.0) <sup>b</sup>	10.8 <sup>f</sup>

Numbers within columns with different superscripts are different.

<sup>a,b</sup>( $P < .001$ ); <sup>c,d</sup>( $P < .01$ ); <sup>e,f</sup>( $P < .05$ )

A, average; AA, above average; AEI, average earnings per start; BA, below average; GSH, graded stakes horses; SH, stakes horses; TBV, total blood volume.

which agrees with reports by Persson<sup>1</sup> that unlike stallions, there was no difference in mean TBV between mature mares and geldings in Standardbreds. Mean variation (SD/mean) was 10.8% for geldings and 9.1% for mares, with an overall mean variation of 10.2%. This was in agreement with Persson<sup>5</sup> that TBV varied approximately 10% among Standardbreds of the same age and gender after correction for body size. There was a trend toward mares having a higher (50.5 L) TBV compared with geldings (48.4 L); however this trend was likely due to the fact that 17 of the 18 mares were SH or GSH, whereas only 16 of the 29 geldings were SH or GSH. A repeatability trial consisting of 3 horses where TBV was determined on 4 different occasions yielded a coefficient of variation of 3.2%.

Horses were grouped by BA-, A-, or AA-TBV depending on whether their TBV was less than, within, or more than 4 L from the mean. There was a difference ( $P < .01$ ) in the percentage of SH with BA-TBV compared with those with A-TBV and an even greater difference ( $P < .001$ ) when compared with the percentage of SH with AA-TBV (Table 2). Although there was no difference ( $P > .05$ ) in the percentage of GSH with A- and AA-TBV, there was a large difference ( $P < .001$ ) between these 2 groups and the BA-TBV group, which had 0.0 GSH. TBV was related ( $P < .05$ ) to overall performance level ( $r = 0.45$ ). Since some SH and GSH can earn significantly more than others, which impacts their residual value, TBV was compared

with AEI. Although there was no difference ( $P > .05$ ) in AEI between horses with BA-TBV (2.5) and A-TBV (3.8), horses with AA-TBV earned more ( $P < .05$ ) per start (11.2), and overall, TBV was related ( $P < .05$ ) to AEI ( $r = 0.34$ ). Mean TBV was higher ( $P < .01$ ) for the 33 SH (50.4 L) compared with the 14 non-SH (46.2 L).

## CONCLUSIONS

Racing performance is based on many factors, but mechanical efficiency, which affects oxygen demand, and the individual's physiologic capacity to supply that demand are central. Of the aerobic indices, TBV, by virtue of its role during exercise, may well be the most comprehensive indicator of oxygen delivery capacity. The purpose of this study was to determine not only if TBV values taken at rest were associated with performance, but also how this value was distributed in a performance-rich population. The results indicate that even when tested in a high-performance group, TBV was still an effective indicator, placing 50% (7 of 14) of the non-stakes performers in the BA-TBV group and the remaining in the A-TBV group. Since horses with AA-TBV earned significantly more per start than the others, TBV would be useful in increasing the chances of selecting not only SH, but horses with greater earnings potential. Since TBV is inherent to the individual, the results of this study indicate this should be an effective selection tool in the yearling and 2-year-old marketplace.

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