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# Do racehorses and Greyhound dogs exhibit a gender difference in running speed?

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## Abstract

At any level of competition, men run faster than women. Consequently, a male speed advantage is often presumed for other species. This assumption was tested in two animals bred for speed: horses and dogs. Results from Thoroughbred (TB), Standardbred (STB) and Greyhound (GH) races were analysed by ANOVA to compare the speeds of victorious males, neutered males (TB and STB only) and females. Separate analyses were run for shorter (TB: $\leq 1609$ m, GH: 503 m) and longer (TB: $>1609$ m, GH: 603.5 m) TB and GH races. All STB races (trotters and pacers) were 1609 m. In TB races, intact males were 0.7% faster than females at $\leq 1609$ m ($n = 305$; $P < 0.01$) and 1.4% faster at $>1609$ m ($n = 194$; $P < 0.01$). The speed of neutered males was equivalent to that of females at both distances. Gender accounted for 3.8 and 10.7% of the variance in speed at short and long distances, respectively. In STB pacers, intact males were 1.5% faster than females and gender accounted for 10.1% of the variance in speed ($n = 96$; $P < 0.01$). Gender was not a significant predictor of STB trotter ($n = 95$) or GH speed at 503 m ($n = 146$) or 603.5 m ($n = 23$). In conclusion, gender has a significant effect on speed of TBs and STB pacers. Although the effect size is small, it may be significant for racing; in a 7 furlong (1408 m) TB race, the 0.7% difference translates to an advantage of several lengths.

**Keywords:** dog racing; Thoroughbred; Standardbred; sexual dimorphism; sex difference; maximum aerobic capacity

## Introduction

On 3 May 1980, a filly named Genuine Risk made headline news by defeating a field of colts in the Kentucky Derby. Four years later, in the inaugural Breeder's Cup Mile turf race, another filly outpaced her male rivals. In fact, in the 22-year history of the Breeder's Cup, there have been multiple female winners of the Sprint, Mile and Turf races. Despite these notable exceptions, horse races are typically segregated by gender; indeed, a distaff race similar to the Breeder's Cup Turf was added to the Breeder's Cup slate in 1999. While the occasional victories of female horses over males in such premier events hint at gender parity, the standard practice of racing females only against each other, as well as the five pound (2.25 kg) allowance given to females contesting males, implies that horsemen believe that there is a significant male speed advantage. In contrast, a presumption of equality appears to prevail among handlers of Greyhound (GH) dogs, for in GH racing the two genders are regularly placed in direct competition.

The assumption of a significant difference in speed between male and female horses, as well as the assumption that no such difference occurs in dogs, has little scientific foundation. In 1935, Stone[1] used several lines of reasoning to conclude that male Thoroughbreds (TBs) were faster than females; however, his methodology precluded estimation of the magnitude of the difference or a test of its statistical significance. Furthermore, Stone[1] did not distinguish between unaltered males and geldings (neutered males), which, as castration is typically performed before a horse is mature, are not necessarily equivalent groups. A half century after Stone[1], Buttram *et al.*[2] used racing results to compare the running speeds of male and female Quarter Horses. They found that intact males were significantly faster than females at distances from 210 to 796 m, but the differences were $<0.7\%$. No comparable studies of GHs have been published.

Despite the evolutionary fitness implications of running speed[3], research comparing the locomotor performances of males and females of non-domestic species is similarly limited. Cullum[4] tested both genders of six species of lizard (genus *Cnemidophorus*) for three facets of locomotor performance: burst speed, endurance and maximal exertion capacity. In all six species, Cullum[4] recorded higher average burst speed values for males than females, and this difference was not due to body size. A male speed advantage has been documented in other lizard species, as well[5,6].

The mechanism for gender difference in physical performance has been most thoroughly studied in humans, in whom a male speed advantage is clear. Olympic records for distances from 100 m to 10 km indicate that elite male runners are about 10% faster than elite female runners. At this level of competition, disparities in resources or motivation are unlikely to account for the male performance advantage. Rather, the gender difference in speed is attributable to physiological and morphological differences; in particular, from early adolescence human males have a greater muscle mass and a higher maximum cardiac output for a given body size than do females[7]. These factors have been demonstrated to affect athletic performance either directly[8,9] or through maximal oxygen consumption ($VO_{2max}$)[10–12].

The present study was designed to test the hypothesis that male TB and Standardbred (STB) racehorses and GH dogs are faster than conspecific females. The secondary purpose was to quantify the magnitude of any difference found. Records from formal races were used on the assumption that racing conditions provide reasonable assurance of maximal effort by the animals.

## Methods

For both horses and dogs, the race results were used to calculate the average velocities of victorious male and female animals. All records were publicly available. Two breeds of horse were analysed: TBs and STBs. Horses are represented by three gender categories: males, females and neutered males (geldings). Dogs were either male or female (both un-neutered).

The effects of gender and age were analysed by ANOVA using SPSS software. When a significant gender effect was found, *post hoc* (Scheffe) pairwise comparisons were made. Significance was accepted at the $P < 0.05$ level. Values are reported as means ± standard deviation, unless otherwise specified.

### *Thoroughbred horses (flat racing)*

Data were obtained from the *Daily Racing Form* online and from the *Thoroughbred Times*, a weekly magazine. Results of races run at six tracks in the United States as well as races run in France and Australia were entered into a database. The American races were run on a dirt surface, while races in France and Australia were run on grass. For American races, claiming, allowance and stakes races were used, while races in France and Australia were all stakes. (Stakes races are considered to be the highest calibre, claiming the lowest.) In each case, the distance of the race, the winning time and the winner's gender and age were recorded. The winner's average velocity ($m\,s^{-1}$) was calculated as the distance of the race (m) divided by the winning time (s).

To accommodate the known effect of distance on velocity (longer races are run more slowly), the races were split into two categories prior to analysis: less than or equal to 1 mile ($\leq 1609$ m) and greater than 1 mile ($> 1609$ m). Each dataset was subjected to an ANOVA to test for effects of gender and age on speed. A total of 499 races were analysed: 305 run over distances $\leq 1609$ m and 194 at distances $> 1609$ m.

### *Standardbred horses (harness racing)*

For STBs, track records at eight different North American racetracks were used. Track records are kept separately for trotters and pacers because pacing is known to be slightly faster than trotting, and there is no crossover between trotters and pacers. Records are also kept separately for different genders (intact male, female, gelding) and different ages (2, 3, 4 and $\geqq 5$ yr). All records are for 1 mile (1609 m), the standard distance for harness racing. Average velocity was calculated as 1609 m divided by the record time.

Analyses were done separately for trotters and pacers. The effects of age and gender on velocity were tested *via* ANOVA. A total of 191 records were used: 95 for trotters and 96 for pacers.

### *Greyhound dogs*

Data were obtained from records kept online by Bluffs Run racetrack in Iowa, USA. For each of 169 races, the distance of the race, the winning time and the winner's gender and age were recorded. All races were run over either 5/16th mi. (503 m) or 3/8th mi. (603.5 m). To account for the effect of distance, analyses were done separately for the two race lengths. ANOVA was used to test for effects of gender and age on speed.

## Results

### *Thoroughbred horses*

For races run over distances $\leq 1609$ m, the effect of gender was significant ($P < 0.001$), with intact males recording faster times. Gender accounted for 3.8% of the variance in speed. Age did not have a significant effect on speed. The average (± SD) winning velocities were $17.11 \pm 0.26\,m\,s^{-1}$ ($n = 143$) for intact males, 16.99 ± 0.29 m $s^{-1}$ ($n = 125$) for females and 17.01 ± 0.30 m $s^{-1}$ ($n = 37$) for neutered males (Fig. 1). The difference between intact males and females was 0.7% ($P < 0.01$).

Gender also had a significant effect on speed in races >1609 m ($P < 0.001$), with intact males again recording faster times. Gender accounted for 10.7% of the variance in speed. The effect of age was not significant. The average winning velocities were 16.58 ± 0.26 m $s^{-1}$ ($n = 99$) for intact males, 16.35 ± 0.36 m $s^{-1}$ ($n = 61$) for females and 16.34 ± 0.47 m $s^{-1}$ ($n = 34$) for geldings (Fig. 1). The difference between intact males and females was 1.4%. This difference as well as the difference between intact males and geldings were statistically significant ($P < 0.01$).

### *Standardbred horses*

In pacers, both age and gender had significant effects on speed ($P < 0.001$). Speed increased with age, which accounted for 20.5% of the variance. Gender accounted for 10.1% of the variance in speed, with males recording faster times than females. The average velocity for intact male pacers of all ages was 14.45 ± 0.26 m $s^{-1}$ ($n = 32$), for females it was 14.24 ± 0.23 m $s^{-1}$ ($n = 32$) and the average for neutered males was 14.35 ± 0.28 m $s^{-1}$ ($n = 32$) (Fig. 2). A significant difference of 1.5% was observed between intact males and females ($P < 0.01$).

For trotters, age, but not gender, was a significant predictor of speed ($P < 0.001$). Age accounted for 21.7% of the variance in speed, with older horses recording faster times. The average velocities for trotters of all ages combined were 13.82 ± 0.31 m $s^{-1}$ ($n = 32$) for intact males, 13.81 ± 0.31 m $s^{-1}$ ($n = 31$) for females and 13.83 ± 0.27 m $s^{-1}$ ($n = 32$) for neutered males (Fig. 2). The difference between intact males and females was less than 0.1%.

### *Greyhound dogs*

Gender was not a significant predictor of speed for races run at a distance of 503 m ($n = 146$). The dog's age had a small but significant ($P < 0.05$) effect on speed, accounting for 1.5% of the variance, *via* a modest tendency for faster times in younger dogs. The average winning velocity for male dogs over this distance was 16.43 ± 0.18 m $s^{-1}$ ($n = 90$), and for female dogs it was 16.36 ± 0.21 m $s^{-1}$ ($n = 56$) (Fig. 3), a difference of 0.4%.

For the 23 races run over 305 m, neither an age nor a gender effect was found. The average velocity for male dogs over this distance was 15.24 ± 0.19 m $s^{-1}$ ($n = 10$), and for female dogs it was 15.18 ± 0.22 m $s^{-1}$ ($n = 13$) (Fig. 3), with a difference of 0.3%.

## Discussion

The hypothesis that male TB and STB racehorses and GH dogs are faster than conspecific females was only partially supported; analysis of formal race records revealed a small but significant male speed advantage in TB horses and STB pacers, but not in STB trotters or GH dogs. Quantitatively, the observed speed differences between intact male and female horses and dogs ranged from <0.1 to 1.5% (Fig. 4). The results for TBs and STBs mirrored those found in Quarter

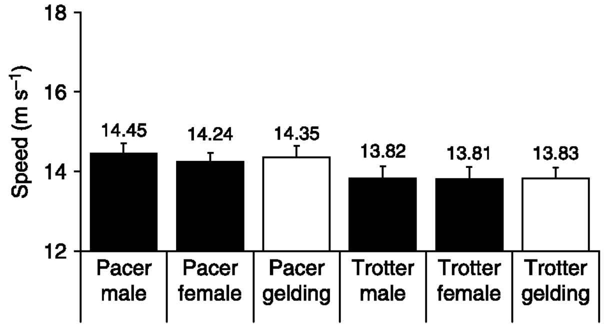


**Fig. 2** Speeds attained by track record-setting intact male, female and neutered male (gelding) STB pacers and trotters. The speed of intact male pacers was significantly ($P < 0.01$) greater than that of females. There were no significant differences by gender in trotters

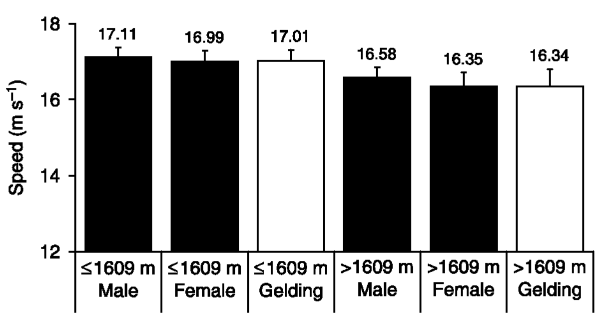


**Fig. 1** Speeds attained by victorious intact male, female and neutered male (gelding) TB racehorses. The speed of intact males was significantly ($P < 0.01$) greater than that of females at distances ≤1609 m and significantly ($P < 0.01$) greater than that of both females and geldings at distances >1609 m

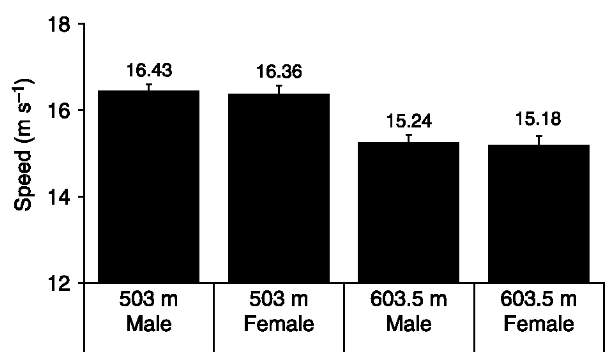


**Fig. 3** Speeds attained by victorious male and female GH dogs. The speeds of males and females were not significantly different at either race distance

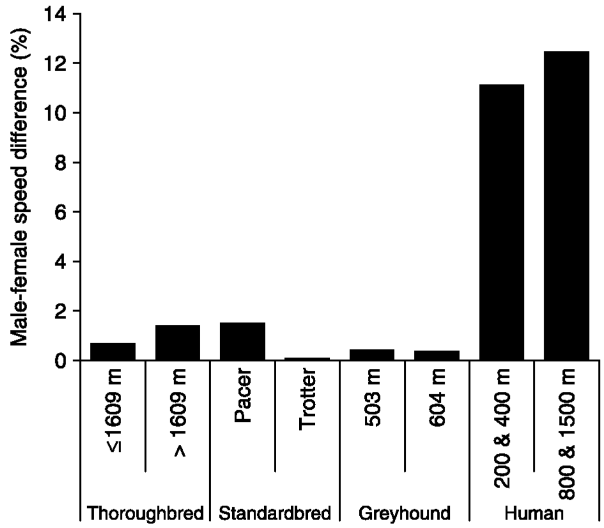


**Fig. 4** Comparison of the percentage difference between intact male and female speed in TBs, STB pacers, STB trotters, GH dogs and humans. Data for humans are calculated from American records as of 2005. The percentage difference observed in humans is tenfold greater than that observed in racehorses and dogs

Horses, among which intact males were 0.3–0.7% faster than females over distances from 210 to 796 m[2]. Neutered male TBs attained speeds essentially equal to those of females, and the average speed of neutered male pacers was intermediate between the genders, suggesting that, when present, the male–female speed difference is ultimately a ramification of differences in testosterone levels rather than of biased management of females.

The tenfold greater male–female speed difference in humans than horses or dogs (Fig. 4) suggests that humans are significantly more sexually dimorphic in the physiological and morphological characteristics underlying running speed. Maximal aerobic capacity ($VO_{2max}$) is one of the physiological measures known to correlate with racing performance in both humans[11–13] and horses[10]. Men have a mass-specific $VO_{2max}$ that is 20–25% greater than that of comparably aged and comparably trained women[14,15]. Factors accounting for this gender difference include the greater percentage of lean body mass and greater maximum cardiac output of men than women[7,16]. A study of similarly conditioned men and women demonstrated that fat-free weight and cardiac size together accounted for 98.7% of the observed gender difference in $VO_{2max}$[17]. Conversely, $VO_{2max}$ does not vary by gender in 5- to 6-year-old children, an age at which body composition is not significantly different between the sexes[18].

The possibility of a gender difference in $VO_{2max}$ of horses or dogs has not been systematically investigated. Sexual dimorphism does occur in both horses and dogs; for example, males are, on average, taller and heavier than females. Limited evidence suggests that body composition also differs between the sexes in these species. Lauten *et al.*[19] found that, at least in some breeds of dog, males have a higher lean body mass. Gee *et al.*[20] reported that the percentage body fat of TB fillies was significantly greater than that of colts at five months of age; however, this finding may not extrapolate to mature animals. Kearns *et al.*[21] reported the opposite trend in a sample of 'elite racing Thoroughbreds', among which the intact males had a higher percentage body fat than the females (11 *vs.* 7.5%). Contrarily, in a study of 14 racing STB horses, Kearns *et al.*[9] found that females had a significantly greater percentage body fat than males of the same age (9.9 ± 0.5% *vs.* 7.4 ± 0.9%), and a correspondingly lower percentage fat-free mass. In addition to uncertainty regarding the directionality of any difference in body composition between male and female horses, the magnitude of that difference (~3%) is one-third of that observed between physically fit men and women (10%)[22].

Heart size is another morphological feature believed to affect running performance in humans, dogs and horses[23,24], due to its correlation with stroke volume and ultimately cardiac output[23]. Male GHs have larger hearts than females; however, standardization of heart weight by body weight eliminates that difference[25]. Using ultrasonic measurements, Young *et al.*[24] found that male TBs have a significantly greater left ventricular mass and diastolic diameter than do similarly aged females, even after accounting for body weight. Although the magnitude of this difference was not reported, a larger heart size implies that male TBs can attain a greater maximum cardiac output than females, in turn suggesting a greater $VO_{2max}$[23]. Indeed, Young *et al.*[26] documented a significant correlation of 0.78 between left ventricular mass and $VO_{2max}$ in TBs. None the less, a causative relationship between the larger left ventricle of males and the male speed advantage is theoretical, not empirical. Gender-based comparisons are lacking for other physiological parameters relevant to $VO_{2max}$ in the horse and dog, including lung diffusing capacity and post-splenic contraction haemoglobin concentration.

The 1.5% or smaller speed difference between male and female racehorses appears to be consistent with the modest degree of sexual dimorphism in the germane parameters that have been measured in both genders. Likewise, the gender parity in speed of GHs is consistent with the lack of difference in body mass-corrected heart size, although other pertinent measures are not available. Given the evolution of the horse as a prey species and the dog as a predatory species, both dependent on running, it is tempting to speculate that natural selection operated on the running ability of both males and females of these species. In contrast, anthropological evidence suggests that human ancestors exhibited sexual division of labour at least as much as 5000 years ago[27], and possibly even 100 000 years ago[28], creating a gender-based disparity in the importance of running speed *per se*. Although such analysis is admittedly speculative, it is clear that humans have selectively bred TBs, STBs and GHs for speed in both genders for at least several hundred years.

In conclusion, although male horses do hold a slight speed advantage over conspecific females, the difference is an order of magnitude smaller than that seen in humans (~1% *vs.* ~10%). However, for TBs and STB pacers, this difference may be functionally, as well as statistically, significant. For example, given the mean speeds found for intact male and female TBs at distances ≤ 1 mile (1609 m), an 'average' male horse will require 82.3 s to complete 7 furlongs (1408 m), while in that time the 'average' female horse will be 9.9 m from the finish, or in the realm of 5 lengths behind. However, it is also notable that male and female means differ by less than one standard deviation, suggesting that indeed some females will be faster than some males. The lack of a significant gender difference in GH running speed is consistent with the practice of racing males and females together.

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