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Sex and Age Differences in Trail Half Marathon Running

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ABSTRACT

International Journal of Exercise Science 11(6): 281-289, 2018. Female participation is growing in trail running races. The purpose was to evaluate sex and age differences in top finishers of a trail running half marathon. Velocity differences between males (M) and females (F) were determined for the top 10 finishers of the Moab Trail Half Marathon from 2012 - 2015 across age, and by finishing place. Differences between age category and between sexes were determined through ANOVA with significance accepted at $P < 0.05$. A significant difference for running velocity was present between sexes at each age category (20-29 yr F = 2.9±0.3, M = 3.4±0.4 $m \cdot sec^{-1}$; 30-39 yr F = 2.8±0.3, M = 3.3±0.3; 40-49 yr F = 2.7±0.3, M = 3.0±0.5; 50-59 yr F = 2.3±0.2, M = 2.8±0.3; 60-69 yr F = 1.6±0.3, M = 2.2±0.4; $P < 0.0001$). Sex difference in trail running velocity was consistent (~13%) among all age categories with exception of the oldest group (33%, $P = 0.0001$). There were significantly greater female finishers in every age category (20 - 29 yr F = 107±18, M = 56±1;, 30 - 39 yr F = 150±34, M = 84±21; 40 - 49 yr F = 112±17, M = 64±16; $P < 0.01$) until 50 - 59 yr (F = 48±13, M = 41±14; $P = 0.50$). These data indicate that the widening gap in sex differences observed in road races are ameliorated in a trail running environment that has a larger number of female participants.

KEY WORDS: Endurance event, running velocity, female participation, outdoor environment

INTRODUCTION

There has been some debate surrounding athletic performance differences generally observed between sexes. Regression analyses evaluating the slope of the rate of change in running velocity over time has led some authors to suggest that women and men will have equivalent times in running events from the 100 meter sprint (15) to the marathon (19). Others have taken a more conservative approach in proposing an average sex gap for all running events of 10.7%, providing evidence that sex differences have plateaued and have been stable since 1983 (16).

Physiological differences between men and women have been used to support these contrasting viewpoints. Men typically have greater maximal aerobic capacity, due to larger stroke volumes and greater cardiac output during peak exercise (9), and increased hemoglobin mass (1). Men also generally have lower percent body fat than women (5, 21), and greater relative muscle mass (14). It is possible that these combined attributes allow men to move their body weight over ground at a faster velocity than women. However, females have substrate utilization advantages that appear to spare both lipids (12) and exogenously supplemented carbohydrate during exercise (13). In addition, females are not as prone to oxidative stress produced during muscular work (8), and generally have a higher threshold for pain tolerance and unpleasantness than males (22). Taken together, these attributes may allow women to complete endurance events on par with or faster than their male counterparts.

Recently, Hunter and Stevens analyzed running velocities of the top male and female finishers of the New York City marathon (7). Velocity differences between male and female finishers of this road marathon widened with increasing age, likely due to lower numbers of overall female finishers compared to men (7). It is interesting to note that the popularity of trail running events is on the rise, and that female participation in these trail events is also increasing (6). It is unknown whether this sex gap that exists in the road running literature could be extended to a trail event setting. We hypothesized that due to greater female participation in trail running races, sex differences in running velocity would be reduced to near physiological levels (16). Alternatively, the technical navigation skills required in trail running (20) may counterbalance the need for speed. The purpose was to evaluate sex and age differences in the running velocity of top finishers of a trail running half marathon.

METHODS

Protocol

The institutional review board provided an exemption for the requirement for informed consent for this study (protocol #967302-1) as it involved analysis of publicly available data.

Finishing times of the top 10 male and female finishers in 10-year age categories between 20 and 69 years were analyzed for the Moab Trail Half Marathon from 2012 - 2015 (total n = 400 from 2829 race finishers). Data were retrieved from an online source (http://www.moabtrailmarathon.com) for the years in which it was publicly available. Data are reported in 10-year age groups because this is how it was reported during one of the years included in the analysis (2014). The Moab Trail Half Marathon was chosen because it is a large trail race with an increasing number of finishers each year (2012 = 505, 2013 = 750, 2014 = 737, 2015 = 837) and results were available on their website. Additionally, in 2013 this race was the site of the USA Half Marathon Trail Championships. The race takes place in the desert southwest region of the United States and has an overall elevation change of 1838 feet (560 meters) (see figure 1). Historical environmental data are provided in Table 1.

Table 1. Historical environmental data of the Moab Trail Half Marathon.

	2012	2013	2014	2015
Temperature Range (F)	33.1 - 45.0	36.0 - 45.0	61.0 - 64.9	37.0 - 45.0
Humidity Range (%)	34.0 - 46.0	58.0 - 76.0	43.0 - 48.0	40.0 - 62.0
Wind Speed Range (mph)	0.0 - 0.0	5.8 - 8.1	17.3 - 24.2	5.8 - 12.7

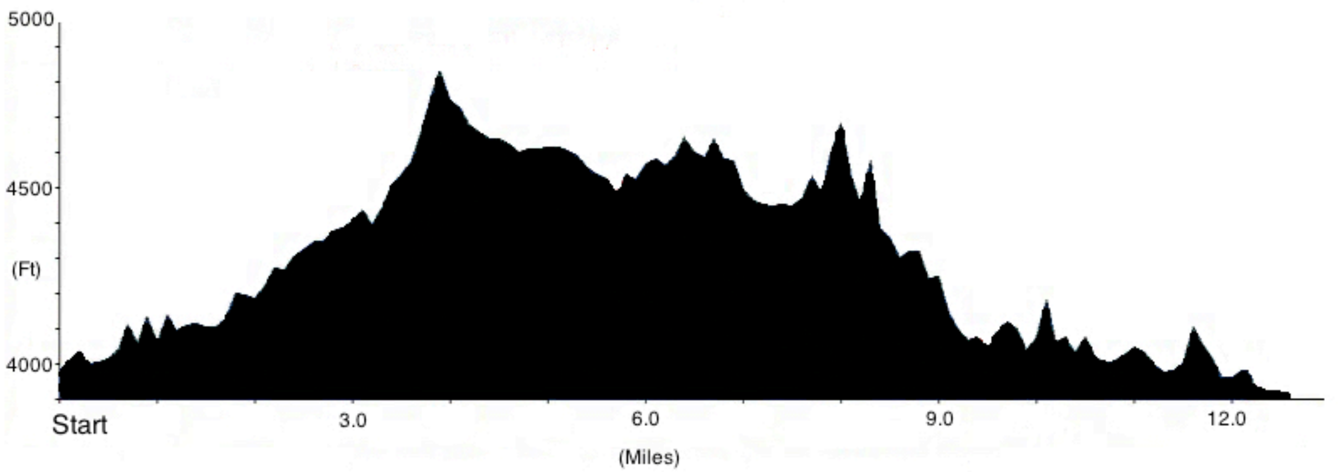

Figure 1. Elevation profile of the Moab Trail Half Marathon.

Running velocity was calculated from the reported finishing time of the trail half marathon for the top ten men and women finishers (see Table 2 for average time and pace). Based on finishing time an average pace per mile was determined, and then expressed as a decimal (i.e. seconds were divided by 60 so that pace was expressed as minute and fraction of a minute). Pace per mile was subsequently converted into meters per second by dividing 26.8224 by per mile pace expressed as a decimal.

Table 2. Mean finishing time and pace across age category.

		20-29 years	30-39 years	40-49 years	50-59 years	60+ years
Top Finish Time (hr:min:sec)	Female	1:48:19	1:51:22	1:50:35	2:15:45	2:47:06
	Male	1:30:48	1:35:18	1:47:45	1:49:47	2:06:18
10th Place Finish Time (hr:min:sec)	Female	2:07:39	2:11:33	2:21:25	2:38:07	4:25:20
	Male	1:51:42	1:56:11	2:08:28	2:13:26	3:16:16
Top Finisher Pace (min:mile)	Female	8:34	8:27	8:53	10:14	14:13
	Male	7:04	7:20	8:09	8:20	9:41
10th Place Finisher Pace (min:mile)	Female	9:56	10:09	10:53	12:26	18:43
	Male	8:43	8:52	9:45	10:43	15:57

The ratio of male to female finishers each year was determined by dividing the yearly number of male finishers by the yearly number of female finishers. Trail running velocity in males and females were determined for the top 10 finishers as a group across age category (20 - 29 years, 30 - 39, years, 40 - 49 years, 50 - 59 years, 60 - 69 years). Although there were finishers who were 19 years and younger, and 70 years and older, there were not 10 finishers in these age categories for all of the years of analysis. Therefore, these age groups (10 - 19 years, 70+ years) were excluded because the lower numbers precluded meaningful analysis. Trail running velocity differences between men and women were matched for place (i.e. 1st through 10th) in each age category and calculated using the formula below:

Sex difference (%) = ((Male place velocity – Female place velocity)/Male place velocity)*100

Statistical Analysis
Data are reported as mean ± standard deviations throughout the text and figures. Data were analyzed using IBM SPSS Statistics (version 21, Chicago, IL). Testing for normality of data was completed via the Shapiro-Wilk test. Sex differences in velocity between age group categories were determined through one-way ANOVA. Post hoc analysis was completed via Tukey's HSD test. Difference in trail running velocity was determined by 2 (sex) x 5 (age category) factorial ANOVA with specific pairwise comparisons performed via independent t-tests when warranted. Differences between the number of male and female finishers in each category, as well as differences by finishing place were determined by the Kruskal-Wallis test. The correlation between trail running velocity and increasing age for each sex was determined using Pearson product moment correlation coefficient. Significance was accepted at $P < 0.05$.

RESULTS

A significant difference for running velocity was present between sexes at each age category (see figure 2). It can also be noted from this data that the fastest female trail running velocity (found in the 20 - 29 year old age group) was statistically similar to males in the 40-49 year old age category ($P = 0.57$, see figure 2). Regardless of sex, velocity of the top ten half marathon trail runners was similar in younger age groups (20 - 29 years, 30 - 39 years) but decreased with age beginning with the 40-49 year old group ($P < 0.001$, see figure 2).

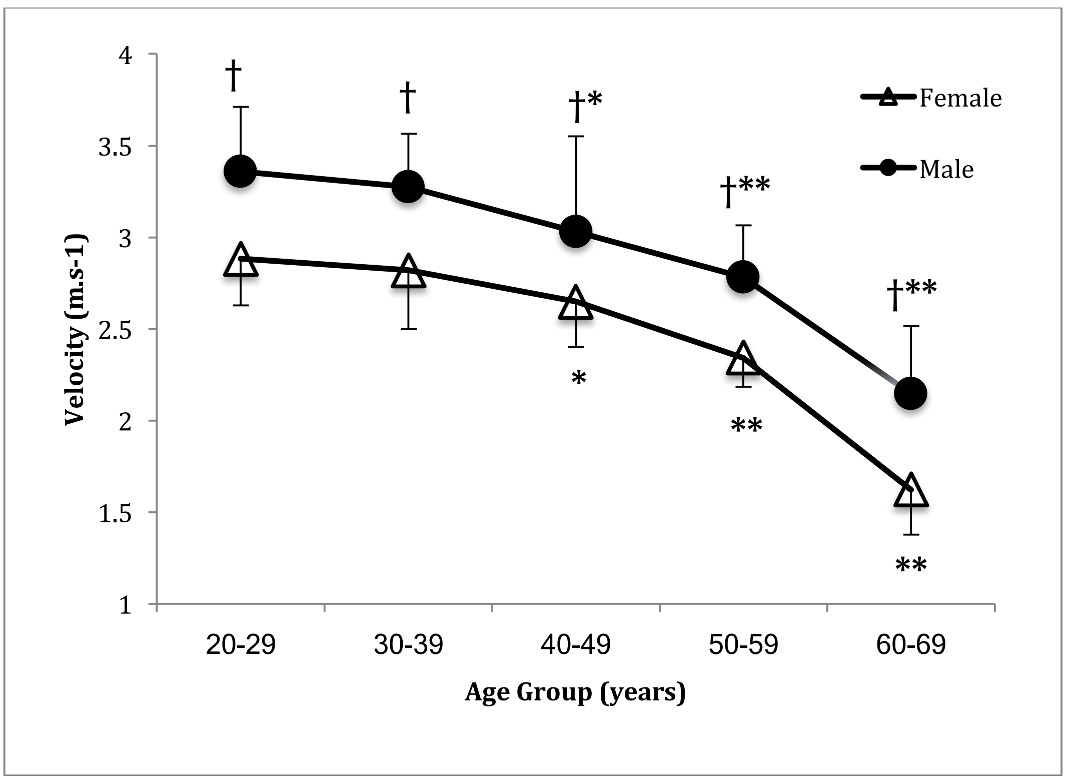

Figure 2. Velocity of top ten finishers of the Moab Trail Half Marathon between 2012 and 2015. † indicates significant differences between males and females (P <0.0001). * indicates significantly different from the 20 - 29 year age group for each sex ($P < 0.001$), ** indicates significantly different from all other age groups for each sex ($P < 0.001$).

When the trail running velocities were correlated with age for all top finishers, significant relationships existed for both males (r = -0.767, P = 0.001, r^2 = 0.588, SEE = 0.353) and females (r = -0.783, P = 0.001, r^2 = 0.614, SEE = 0.248, see figure 3).

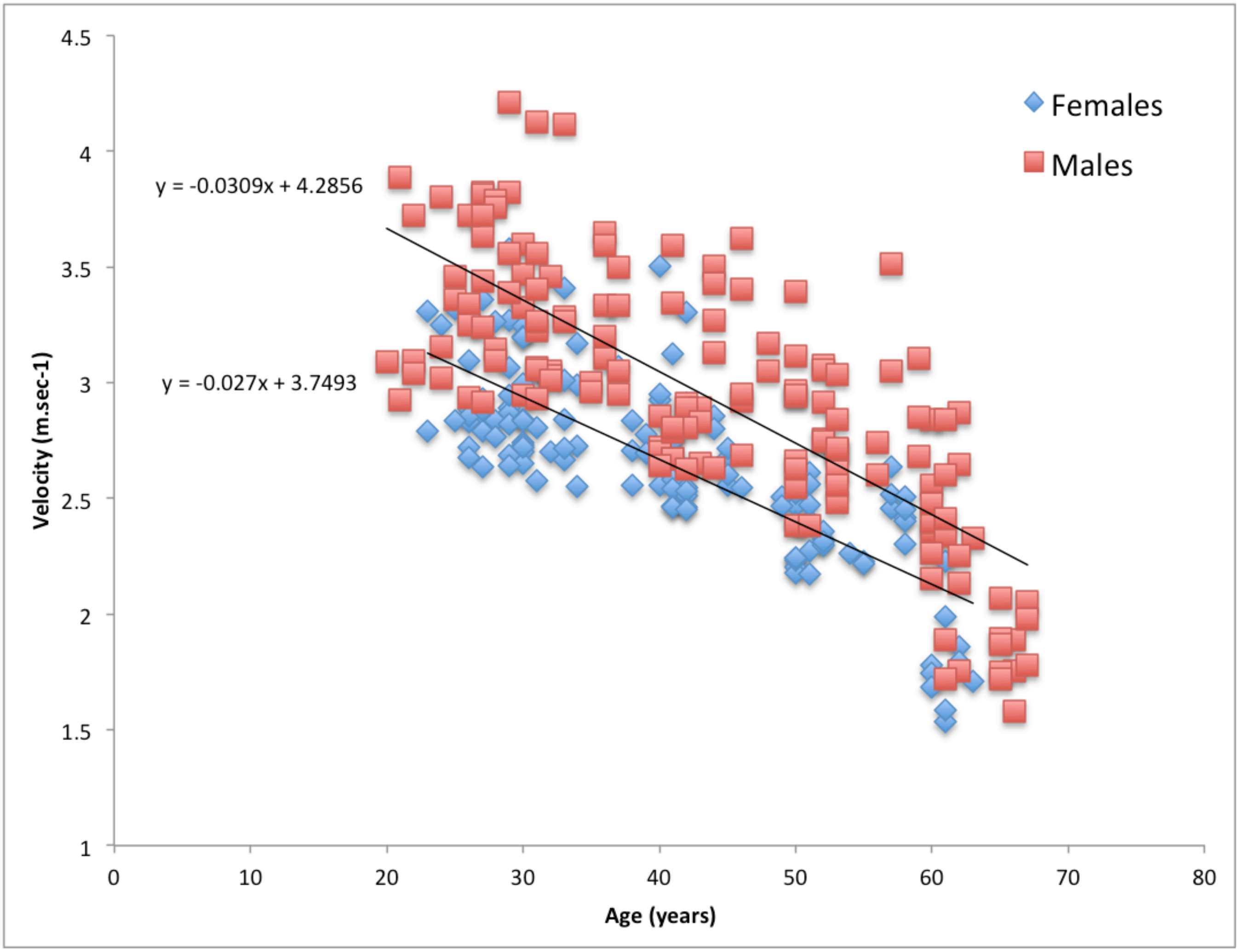

Figure 3. Relationship between trail running velocity and increasing age.

The decline in running velocity with age in males can be predicted using the following equation:

Male trail running velocity ($m \cdot sec^{-1}$) = -0.0309*age + 4.2856.

From a more applied standpoint, top male trail runners can estimate their pace in minutes per mile (expressed as a decimal) over a half marathon distance through the following equation:

Male trail running pace ($min \cdot mile^{-1}$) = 0.1159*age + 4.4544

The decline in running velocity with age in females can be predicted utilizing the equation below:

Female trail running velocity (m·sec-1) = -0.027*age + 3.7493.

Again, from a practical standpoint, top female trail runners can estimate their minute per mile pace (expressed as a decimal) for the half marathon distance by using the following equation:

Female trail running pace (min·mile^{-1}) = 0.1211*age + 5.4559

Overall, there was a greater absolute number and ratio of female finishers in the Moab Trail Half Marathon than men over the years in which data were available (see Table 3). The difference in trail running velocity between top ten finishers of both sexes was similar across age group (see Table 3) until the oldest age category. The difference between male and female top ten finishers in the 60-69 year old age bracket was significantly greater compared to all other age categories ($P = 0.0001$, see Table 3). When sex differences by finishing place were compared, no significant differences were observed (i.e. sex difference of the first place finishers versus the sex difference of the 10th place finishers, $P > 0.05$).

Table 3. Moab trail half marathon finisher data by sex and age category.

		20-29 years	30-39 years	40-49 years	50-59 years	60+ years
Mean Participant *N* per year	Female	107	150	112	48	6
	Male	56	84	64	41	19
	P - value	0.021	0.021	0.021	0.386	0.043
	Effect Size	0.762	0.762	0.762	0.107	0.583
Ratio: Men to Women		0.523	0.562	0.568	0.854	3.040
Sex Difference in Velocity (%)		13.8±4.5	13.9±5.2	11.4±8.2	15.4±4.5	33.3±3.4*

* indicates significantly greater than all other groups

DISCUSSION

The purpose of this investigation was to evaluate sex and age differences in the running velocity of top finishers of a trail half marathon event carried out in the desert southwest. We hypothesized that due to increasing female participation and depth in trail running races, any observed sex differences in running velocity would be reduced to near physiological levels of 10.7%. Our hypothesis was correct for age groups with a significantly greater number of females (20 – 49 years) but widened as the ratio was equal (50 - 59 years) or where a greater number of men participated (60 - 69 years).

We are unaware of any literature on sex differences in trail races over the half marathon distance (13.1 miles or 21 km). In comparison to the limited literature on mountain races, our results are relatively similar. With respect to a European mountain ultra-marathon (78 km), a sex difference of 16% for winners was reported (2). For ages 18-59 years, a sex difference of approximately 7% was reported between male and female finishers of the Jungfrau Marathon, which is the most famous European mountain marathon held in the Swiss Alps (11). In a previous investigation utilizing the same Jungfrau Marathon, the years with the greatest female participation had a reported sex difference of 16.6% in the 35-44 year age group, and 15.9% in the 45-54 year age group (23). Thus, the results of the present investigation over the half marathon distance are in line with reported sex differences in trail races that cover longer distances.

Direct comparisons between trail and road half marathon running are difficult as there is no literature for trail and relatively little literature for road half marathons that report running velocity (10). One recent investigation utilizing half marathons held in Switzerland and limited to flat road races reported that women ran the distance at approximately 2.86 m·sec^{-1}, whereas men ran at an average speed of 2.84 m·sec^{-1} (10). In the current investigation, the fastest trail running velocity occurred in the 20-29 year old age group for both sexes and was 2.88 m·sec^{-1} for women and 3.35 m·sec^{-1} for men. However, a direct comparison between these two investigations is limited because the road half marathon data set includes all individuals who completed a race regardless of finishing place (10). We speculate that top road race finishers of flat half marathons would be able to sustain a much faster overall running velocity compared to the top finishers reported in the current trail races.

Nevertheless, running velocity during trail half marathon running decreased with age (see figure 2), and it is interesting to note that the fastest female running velocity (20-29 year age category) was statistically equivalent to males in the 40-49 year old age category which is similar to what has been shown in a road marathon (7). Hunter and Stevens reported that age related decreases in running velocity for the New York City marathon occurred at a rate of 0.30 m·sec^{-1} every five years (or 0.6 m·sec^{-1} every 10 years) (7); however the decrease in trail running velocity appears to be much less pronounced at a rate of 0.23 m·sec^{-1} over 10 years for men, and 0.32 m·sec^{-1} with each 10 year interval for women (see figure 3b). Finally, pooled sex difference in running velocity across finishing place was substantial for a road marathon (significantly greater in the third through tenth place finishers compared to the age group winners) (7), but sex difference in trail running velocity was not different by finishing place in the current study (see figure 3). It is likely that environmental differences between road and trail events (such as roots and rocks, lower traction due to loose gravel or shale, the presence of wildlife, etc.) contribute to the slower decline in velocity with age observed in the present study, as trail runners must decrease their pace somewhat in order to adapt to their surroundings. It is also possible that in trail running, a premium is placed on navigation skills rather than on endurance speed (20). This could also explain why we did not observe a progressive sex difference in running velocity by finishing place as would be expected from the road running literature.

A relatively small amount of literature describing the current trends in female participation in trail running races exists (2, 6, 11, 23). It has been reported that in ultra-marathons, many of which take place in a trail environment, women represented 10-12% of participants of the Western States 100-mile Endurance Run from 1986 - 1988, and increased to account for 20 - 22% of the participants since 2001 (6). In a European ultra-marathon, female participation was 10% in 1998, and increased to 16% by 2011 (2). To our knowledge, the current investigation is the first to report that female participation is greater than male in a trail running event. These percentages are similar to road running half marathons in the US where 61% of participants were female in 2014 (10). It is possible that this finding relates to social as well as safety reasons. There is evidence to suggest that females enjoy participating in social gatherings to a greater extent than males (3), and this could carry over into training for and participating in trail-based events. On a more sober note, Valentine described how the association of male violence in a given environment has an intense influence on how females use public space (17). Females are subjected to a variety of invasive behavior which ranges from objectification to violent crime (4). One survey-based investigation on female participation in outdoor activities found that women felt significantly more comfortable and safe when recreating in a group (18). It is likely that a combination of social and protective considerations could explain why we observed the large number of female participants over the past few years of the Moab Trail Half Marathon.

These findings indicate that top athletes who compete in trail half marathon races can expect to maintain their running velocity until approximately 40-49 years of age. After this age, significant decreases in trail running velocity can be expected. Additionally, sex differences between the fastest (i.e. top 10 finishers) men and women are to be anticipated with an approximate difference of near 12%. According to our results, female participation in a desert southwest trail half marathon is significantly greater than their male counterparts. These data provide evidence that due to the magnitude of female involvement, sex differences in trail running velocity is reduced to near physiological levels. Thus, the widening gap observed in road races is ameliorated in a trail running environment that has a larger number of female participants.

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