GROUND CONTACT TIME AND RUNNING SPEED IN ELITE CHAMPIONSHIP DISTANCE RACES

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INTRODUCTION

The goal in distance running is to find a balance between maximum sustainable speed and energy production. This balance plays a vital role in distance running. Throughout the years, athletes have sought for ways to improve performance in this event by balancing the distance of the race with speed.

One way to understand the proper balance of distance and speed is to measure running economy at a given speed. Improvements in running economy increase performance in any distance running event [1].

As a runner increases in speed, changes in movement patterns and forces occur. Specifically, the amount of time the runner spends on the ground decreases [2,3,4]. Faster athletes are able to apply greater ground forces leading to a shorter ground contact time and greater maximum running speeds [2]. While it is known that as running speed increases, ground contact time decreases, there may also be factors other than speed increases that relate to ground contact time. We hypothesized that ground contact time normalized by speed would be correlated with average running speed during an elite 10 km race on the track.

METHODS

A digital camera running at 200 Hz was placed perpendicular to the backstretch of the track at the 2009 USA Track and Field Nationals for the men's 10,000 m final. An 8 m section of the track was visible within the camera view. A 4-m horizontal scaling was completed with adjustments being made according to which lane the runners came through.

The top 13 runners in the race were analyzed. Ground time was determined by initial contact of the left foot until toe-off. Horizontal velocity of the left hip was calculated over the course of one stride from foot contact to the next foot contact of the same foot using Dartfish ProSuite 4.5 (Dartfish Corp, Alpharetta, GA). Lap times were obtained from official meet results.

Ground contact time was normalized by horizontal velocity during the stride of ground time measurement. A simple linear regression using SPSS 18.0 determined the correlation between ground contact time divided by horizontal velocity and average lap speed.

RESULTS AND DISCUSSION

Ground contact time divided by running speed during the measured stride is correlated with average lap running speed for men (Average Race Speed = -58.4 x (GroundTime/Speed) - 0.7, R^2 = 0.545, F= 11.978, p=0.006, Figure 1). One of the runners, Abdi Abdirahmen, was removed from the analysis due to being an outlier (marked in red in Figure 1). The current analysis does not explain why he did not follow the trend of the other athletes, but this runner was well outside the trend

of the other athletes. His leg length relative to body height and, visually, his technique is very unique. In addition to leg length and height, other musculoskeletal structure differences may also be related to his unexpected result.

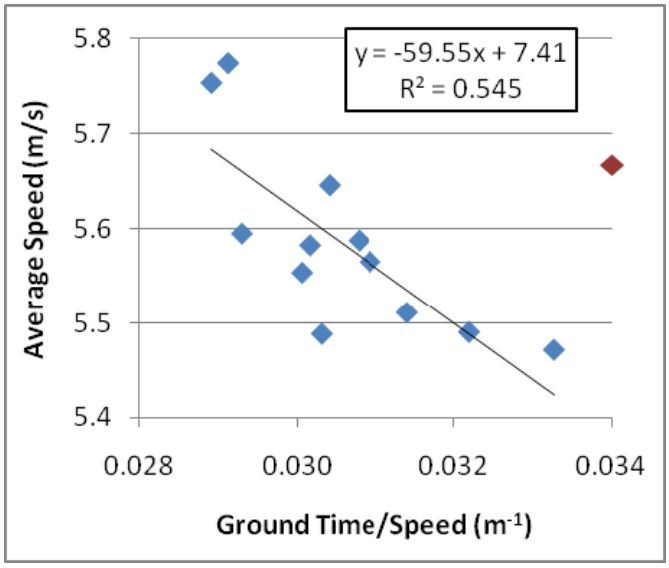

Figure 1: Average speed versus ground time normalized by running speed for the men's 10000 m final at the 2009 US Nationals.

Maximizing running economy during the majority of a 10,000 m race and maximizing running speed during the final stage of the race is critical for maximum performance. There are many runners that can be with the leaders for nearly the entire race, but fall well behind during the last couple of laps. Many authors have considered how ground time is related to maximum sprinting speed which relates nicely to an athlete's ability to finish a race effectively [2, 3, 4]. However, studies are only beginning to focus on the importance of ground time related to running economy.

Over the past few years, improvements in running economy and performance in long distance races have been found through completing plyometric exercises [6, 7]. There may be a connection between plyometric training and leg stiffness through muscular changes that can connect why ground time varies due to factors other than running speed. However, there is much to be learned through further research to determine whether this is true or not.

During distance races it is important to balance running economy with speed. Most laps of a 10,000 m race are run at sub-maximal effort. As the race progresses, the athlete will adjust speeds according to competition and strategy. Often, on the final lap the runner focuses on maximizing effort placing less emphasis on running economy. The plyometric training that is connected with improved running economy may also help in improving final lap finishing speed.

SUMMARY/CONCLUSIONS

This study adds to our knowledge of how ground time is related to running economy. While there is much more to understand, there appears to be something other than running speed that is related to ground time. This other factor or factors may have a connection with running economy. Further laboratory studies will investigate how running economy and ground time are related to factors such as leg stiffness and leg power. As endurance athletes prepare for performances, they should consider training that affects ground time such as plyometrics in ways previously reported [6,7].

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