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MIDDLE DISTANCE RUNNING: MUSCLE METABOLISM PERFORMANCE

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ABSTRACT

In the sport of running, there is a multitude of distances that test an elite athlete's fitness capability to stress a specific muscle metabolic system. Although it is not unheard of for an athlete to excel at more than one distance, versatility is limited to the metabolic demands of a specific distance at which an athlete gears his training towards. This study sought to assess how exertion of a specific muscle metabolic system, in accordance to muscle twitch fiber predominance in a specialized runner, would yield a high deviation for predicted performance of an event that stresses a different metabolic system based on said athlete's volume of oxygen consumption per minute (VDOT). A retrospective survey of 20 collegiate middle-distance runners was carried out in the middle of the 2013 cross-country season. This self-administered survey sought to gather fully automated personal record times for each athlete's respective event as well as other distances shorter (under-racing) and longer (over-racing) then his main event. Data was analyzed in accordance to deviation from predicted values of an athlete's main event based on volume of oxygen consumption per minute (VDOT).

Keywords: Athlete, Metabolism, Muscle, Running, Training

I. INTRODUCTION

Track & Field is both an individual sport as well as a team sport. Although the uncomfortable pain that that a runner endures is one of personal choice, it is towards a greater cause as there are points earned for an athlete's team based upon his performance. The middle-distance runner serves as a powerful asset to his team because of his ability to move up to the longer distances such as 5,000 meters, 10,000 meters, and cross country (over-distance) as well as to move down to the shorter, borderline sprint races, such as the 4x400meter relay (under-distance). As any athlete, the middle-distance runner's training is formulated to strengthen a specific muscle metabolic system that will supply his goals.

With the notion that exercise to exhaustion requiring energy production is time-dependent, being that running in less than 6 to 10 seconds stresses the Phosphate Creatine system and Glycolytic system, above 30 seconds stresses only the Glycolytic system, and after 90 to 120 stresses Oxidative Metabolism [1], it is evident that middle-distance runners require training specific to the glycolytic system and aerobic system in order to excel in over/under distances.

Whereas a sprinter would utilize the phosphagen system for a power surge lasting a few seconds, and a long distance runner would rely predominantly on the aerobic system for prolonged athletic activity, it is the glycogen-lactic acid system [2] that is crucial for the extra power needed in intermediate races such as the 800 meter run and 1500m run (middle-distance). Thus, it is evident that an athlete preparing for the 800 meter run would need to stress the glycogen-lactic acid system as well as the aerobic system [2] in his formulated training.

Training for middle-distance races necessitates an efficient glycogen-lactic acid system because the enzymes that promote rapid release of energy [2] from this system are two to three times as active in fast-twitch fibers as in slow-twitch fibers. This increases the maximal power achievable for a short period of time. This power reserve is useful at the beginning of the race to escape physical contact with other runners that may alter the athlete's momentum as well as allow for a potential energy reserve for the end of the race when any form of reserved energy is beneficial. It is crucial for a runner to formulate his training towards his desired event because the nature of fatigue experienced during training differs along with the metabolic pathways activated by high-intensity interval training of different durations [3].

Middle-distance runners, exhibiting specific and predictable patterns [1] of muscle fiber content and having an equal amount of type I and type II fibers, will excel in the 800 meter and 1500 meter races. However, their performances in races over 1500 meters may not reflect the equivalent caliber of their respective events for the fact that long distance runners have 79-88% type I fibers [1]. Different races call for activation of muscle fibers in a specific pattern. A middle-distance runners high-intensity training will surely build both type I and type II fibers equally [1], but type I fibers will not be recruited to their maximal potential in order for the athlete to excel at longer distances. At the opposite end of the spectrum, type II fibers will not be recruited to their maximum potential in order for the athlete to reach peak sprinting biomechanics. This is the risk to reward ratio that is considered when training a predominantly middle-distance runner. He will be great at the middle distance but will never reach his full potential in the sprints or longer distances due to event-specific training and recruitment of specific physiological energy production system.

Three peripheral adaptations are made with middle distance specific training [3]: 1. The mitochondria, the sites of aerobic metabolism, are increased in size, number, and distribution. 2. Oxidative enzyme activity is increased to accelerate the rate of oxygen delivery and process. 3. Greater perfusion of exercising muscles with blood vessels to enhance blood flow. With these modifications, the cardiopulmonary system can deliver fuel and oxygen and remove carbon dioxide and lactic acid with efficiency. The increased VO2 max that accompanies metabolic adaptations to training is quintessential to the athlete.

II. METHODS

A retrospective survey was conducted on 40 collegiate/post-collegiate runners of which 20 surveys were randomly selected to be analyzed. Data was collected in the middle of the 2013 cross-country season through a web-based survey. The survey included collegiate/post-collegiate athletes of NCAA Division I, II, II, and Junior-College caliber. All athletes were informed about the goals of the study and anonymity of their participation.

The three-part survey consisted of three fundamental features of the study: 1. Aerobic: Anaerobic training specificity ratio to confirm that middle-distance runners and long-distance runners were indeed training under a program formulated for their respective events. 2. Fastest up-to-date Fully Automated Timing for the athlete's respective event performance to rule out biased hand-timed personal records. 3. Fully Automated Timing for over-distances if the athlete was a middle-distance runner and for under-distances if the athlete was a long-distance runner.

Based upon the athlete's record time for his specific event, a correlated rate of oxygen uptake (VDOT) was assigned as per PhD. Exercise physiologist Jack Daniels. With this VDOT as a single number used to assess

fitness, predicted values based upon a runner's VDOT for under/over distance were compared to the assigned VDOT of said runner's actual performance in these events. The net difference between the runner's actual VDOT and theoretical VDOT for the under/over distance was used as a marker to compare performances of the various athletes assessed in the study.

IV. RESULTS

35% (7) of the runners had identical times to their predicted values for a racing distance that was not their main event. 20% (4) of the runners yielded a 1 VDOT deviation from their predicted performance. 15% (3) of the runners yielded a 2 VDOT deviation. Another 20% of the runners yielded a 3 VDOT deviation. 5% (1) of the runners yielded a 5 VDOT deviation. Another 5% (1) of the runners yielded a 6 VDOT deviation.

VDOT Deviations in Athlete Performance

ΔVDOT	Number of Runners
0	7
1	4
2	3
3	4
4	0
5	1
6	1

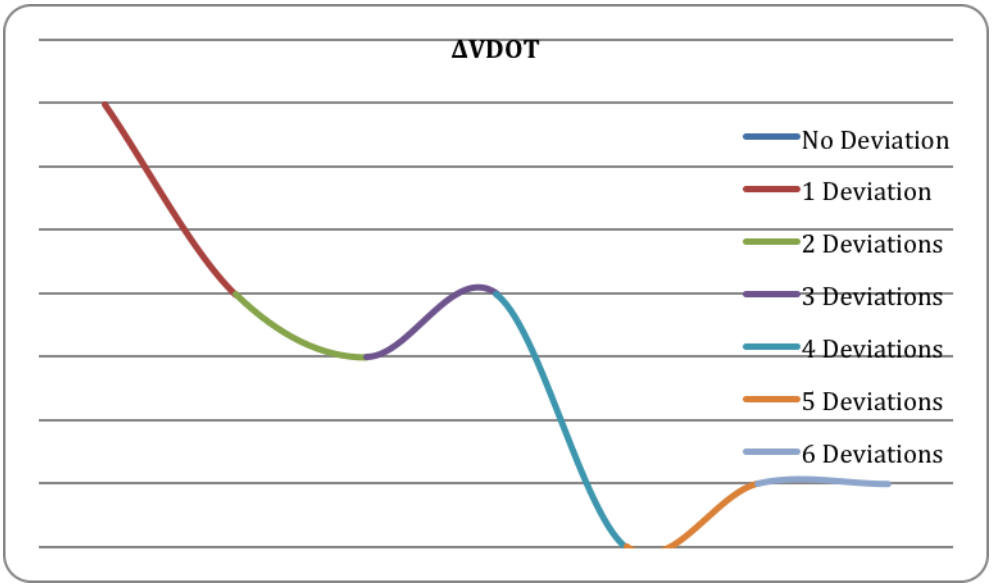

Fig1: Vdot Deviations in Athlete Performance

IV. CONCLUSION

Runners, especially middle-distance runners, stress multiple muscle metabolic systems in their training regimen in order to excel at a specific event. This recruitment of various muscle fibers allows for runners to excel at

events that they do not specifically train for. An 800 meter runner who trains specifically for the 800 with equal development of the aerobic and anaerobic system will be able to compete in the 400 meter race as well as the 1500 meter race to a certain degree. Whether or not that runner will perform in said under/over event in the same caliber as his main event depends on the quality of his training. In this study, 35% of the runners competed with equal caliber in their under/over events in respect to their specific events. The closer the VDOT deviation is to zero, the more successfully the runner has sustained his level of competitiveness in a different event. Only 10% of the runners displayed an extreme VDOT deviation of 4 or higher, suggesting that training is possibly very specific for their main events and that their training regimen lacks recruitment of muscle fibers needed to excel in under/over events.

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