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Arts and Science of Athletic Performance

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ABSTRACT

Athletes utilize numerous strategies to reduce body weight or body fat and to increase stamina prior to competition. Personalized nutrition in athletic populations aims to optimize health, body composition, and exercise performance by targeting dietary recommendations to an individual's genetic profile. Additionally, athletes' nutritional requirements may vary widely depending on sport, position, timing of season, and training vs rest day. Bodily hydration during sporting activity is one of the best indicators of health in athletes and can be a limiting factor for sport performance. Treatment for athletes is primarily to increase energy availability and often requires a team approach including a sport physician, sports dietitian, physiologist, and psychologist. Maximizing athletic performance is a passion that athletes, coaches, athlete support professionals, and sports scientists share. A thorough understanding of the basics of all aspects of human physiology and the ability of the body to adapt to the environmental stress of exercise training is the foundation we use to explain the incredible athletic and sport performances that are commonplace in today's world.

Keywords: performance, endurance, stamina, caloric restriction, altering body composition, lower-body heavy strength training; low energy availability; anabolic steroids

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By definition, “Stamina” is the ability of an individual’s sustainability to some physical and mental effort. Fatigue or laxity can be mental or physical, due to lack of motivation, vigor or energy and underlying injury [4]. All these terms are very much related to athletic performance where pretty much energy (calorie breakdown) is to be spend at a time compared to energy spend by common people in daily activities. During one hour of hard training an athlete may expend 30% of his or her total 24-hour energy output [5]. These high-power outputs have important implications for energy substrate and water requirements. Surprisingly, a recent study by Jäger et.al, 2019 reveals reduction in caloric intake by 30% may increase their energy expenditure by 10% [6]. According to Pons et.al, 2018 caloric restriction (CR) improves athletes’ performance and energy efficiency but should be implemented with micronutrient supplementation during CR programs [7]. Altering body composition in such a manner may be advantageous to the athlete for various biomechanical, aesthetic, and locomotive reasons, thereby increasing the likelihood of competitive success in a target weight-class (e.g., com bat sports, weight lifting), weight-sensitive sports (e.g., endurance events, ski jumping), or aesthetically judged sports (e.g., gymnastics and bodybuilding) [8]. Training is the predominant demand in the athletic lifestyle. Optimum adaptation to training requires the careful balancing of stress and recovery [9]. Buckner et.al, 2018 concluded that resistance exercise may indirectly impact sports performance through injury prevention, as opposed to directly improving sport related abilities [10]. Schoenfeld et.al, 2018 demonstrates that a marked increase in strength and endurance can be attained by resistance-trained individuals with just three 13-min weekly sessions over an 8-wk period [11]. Lower-body heavy strength training performed in addition to endurance-cycling training can improve both short- and long-term endurance performance [12,13]. Bigger muscles don't mean stronger muscles-- research has shown that while bodybuilders' muscles may look big, after a certain point, the strength of a muscle doesn't increase with size [14,15]. Greater muscular strength allows an individual to potentiate earlier and to a greater extent, but also decreases the risk of injury [16]. Bodyweight exercise, isolation exercises, plyometric exercise, unilateral exercise, and kettlebell training may be limited in their potential to improve maximal strength but are still relevant to strength development by challenging time-limited force expression and differentially challenging motor demands [17]. Cardiovascular training can be used to enhance fat loss [18]. Squat training with low/moderate loads combined with light-load sled towing (LST) may be an effective stimulus for improving leg strength, jump ability, COD, and sprint performance. Success in sports such as bodybuilding is dependent on obtaining maximal levels of muscle mass while carrying minimal fat mass [19]. The International Association of Athletics Federations (IAAF) has long recognized the role of diet and nutrition strategies in helping the athlete to achieve these goals. CR enhance the performance of sustained exercise conducted at intensities below the so-called anaerobic threshold [20]. Sleep is recognized as an essential component of physiological and psychological recovery from, and preparation for, high-intensity training in athletes [21]. Also, mental fatigue on endurance performance is the most important factor responsible that gives a negative impact [22,23]. Negative impact is primarily mediated by the greater perception of effort experienced by participants [24]. Combat sports represent around 25% of all Olympic medals disputed, and the success in these sports are determined by technical-tactical excellence and supported by physiological and psychological development [25]. Regardless of sex and wrestling styles, an optimal level of cardiorespiratory fitness is important to help sustaining effort throughout the duration of the match and to stimulate the recovery process between periods [26]. In

general, aerobic exercise induces greater improvements in cardiorespiratory fitness and cardio-metabolic variables, whereas resistance exercise mainly effects muscular strength and has positive effects on body composition, such as muscle mass and bone density [27]. The reported prevalence of low energy availability (LEA) in female and male track and field athletes is between 18% and 58% with the highest prevalence among athletes in endurance and jump events [28]. Performance variables associated with LEA included decreased training response, impaired judgement, decreased coordination, decreased concentration, irritability, depression and decreased endurance performance [29]. During dieting phases many athletes may substantially increase their protein intake, as this practice has been shown to be beneficial to maintain lean mass whilst reducing body-fat [30]. Carbohydrates (CHO) and fat are the main sources of fuel oxidized in muscles during exercise [31]. In contrast to fat, endogenous stores of CHO are limited. The storage form of carbohydrate, glycogen, is found almost exclusively in muscle and liver and represents only ~ 8000 kJ (about 1911 kcal) in untrained individuals and about 20–50% higher in trained men and women. However, there is a vast quantity of fat stored even in the leanest of athletes (approximately 600,000 kJ) [32]. Physical performance (mainly endurance) and exercise ability can be limited when endogenous CHO are the dominant fuel [33]. Females athletes are 5 to 10 times more likely than male athletes to have an eating disorder. The prevalence of clinical eating disorders, such as anorexia nervosa or bulimia nervosa, among female elite athletes ranges from 16% to 47% [34,35]. However, in addition to daily meal planning, a sports nutritionist pays special attention to the needs of athletes before, during and following training sessions and competitions [36]. Murtaza et.al, 2019 suggests that a low-carbohydrate, high-fat ketogenic diet influences the relative abundances of some key bacterial taxa, with an increase of Bacteriodes that paradoxically correlates with fat oxidation [37]. Omega 3 fatty acids play a fundamental role in reducing physiological inflammation through resolvins, and its utility for muscle damage and recovery in sports has been widely demonstrated [38]. Approximately 50% of athletes have reported consuming some form of micronutrient supplement; however, there is limited data confirming their efficacy for improving performance [39]. Mohiuddin, 2019 reported myocardial infarction, myocardial hypertrophy, hypertension, mood disorders, aggressive behavior, dependence syndrome, or cognitive effects with anabolic steroids. Caffeine is perhaps the most common pre-workout stimulant consumed by athletes, which primarily affects the cardiovascular system and leads to sleep disorders [40]. However, caffeine doses of 1 and 5 mg/kg ameliorated loss of skill performance in elite rugby players following sleep restriction [41]. Review from Ramezani et.al, 2019, Chang et.al, 2019 and Coqueiro et.al, 2019 reported that glutamine (one of the most abundant amino acids in many human tissues) supplementation has no effect on athletics immune system, aerobic performance, body composition but promotes weight reduction, provides host energy reserves and prevent fatigue through production of ammonia during exercise [42-44]. Davani-Davari et.al, 2019 recommended optimal daily dose and intake duration of common supplemental amino acids like L-Carnitine, L-Arginine, and Glutamine in athletes and bodybuilders [45]. $NaHCO_3$ has been proposed as a performance enhancing aid by reducing acidosis during exercise but to which extent, remains unclear due to the inconsistencies in the study results of Hadzic et.al, 2019 [46]. However, Wang et.al, 2019 reported that supplementation of HCO_3^- at the level of 0.2 g/kg body mass before HIIT training enhances the effect of HIIT on anaerobic performance [47]. Potential disadvantages of supplement use include expense, false expectancy, and the risk of ingesting banned substances sometimes present as contaminants

[48]. Several studies have shown the important role of gene polymorphisms in aerobic performance. Mitochondrial DNA encodes some proteins of the oxidative phosphorylation enzymatic complex, playing an important role in aerobic ATP production; therefore, it can contribute to the ability to respond to endurance exercise training [49]. Both Maciejewska-Skrendo and Cao et.al, 2019 suggested that Peroxisome proliferator-activated receptor delta (PPARD) gene is associated with dynamic balance performance of human being [50,51]. Iron and Magnesium supplementation have the best quality evidence for improvements to markers and outcomes related to exercise capacity and athletic performance [39], [52,53]. The use of creatine supplementation is still controversial. It is pertinent for sports foods and nutritional supplements to be considered only where a strong evidence base supports their use as safe, legal, and effective and that such supplements are trialed thoroughly by the individual before committing to use in a competition setting. Pre-exercise nutrition should consider a multitude of factors including nutrient composition, digestibility, potential untoward effects and suitability.

Figure. Stamina and endurance: The secret behind athletic performance [1-3]. Men may possess more physical strength than women, but the ladies are far superior when it comes to muscle endurance and stamina. Unlike stamina, endurance is concerned with capacity, time or duration is what matters. “Improved stamina and endurance give your body the ability to put your muscles through more time under tension, while an improved pain threshold allows the individual to put their body and mind through more rigorous workouts,”- David Wiener, training and nutrition specialist.

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Abbreviations

high-intensity interval training (HIIT); sodium bicarbonate (NaHCO3); low energy availability (LEA); caloric restriction (CR); International Association of Athletics Federations (IAAF); Peroxisome proliferator-activated receptor delta (PPARD); light-load sled towing (LST); change of direction (COD); Carbohydrates (CHO)

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