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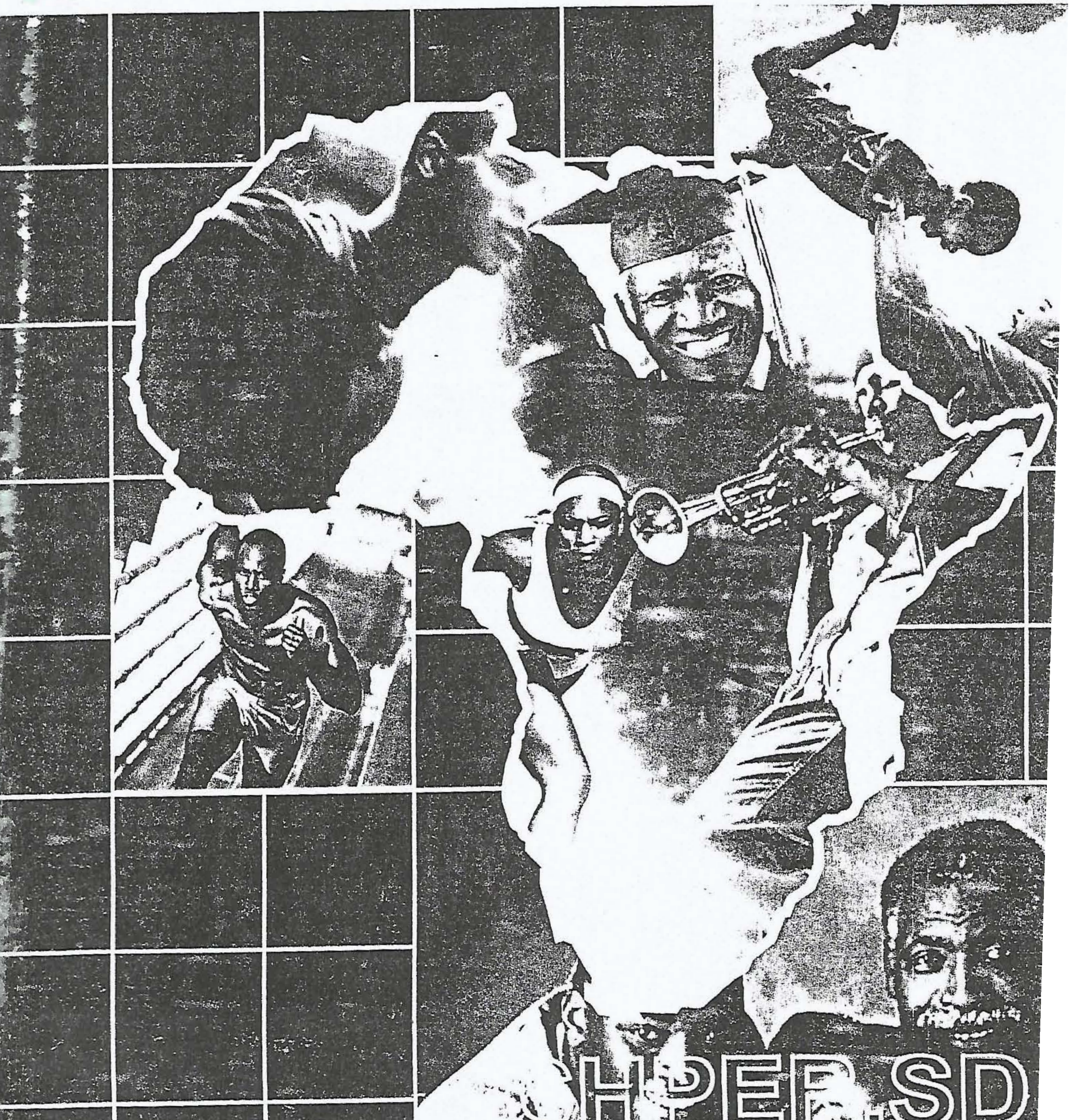

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Contents

Nutritional Supplementation and Elite Sports Performance

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Abstract

This paper attempt to critically review and investigate the role of Nutrition in physical activities and sports performance. The review evaluates the theoretical rationale and potential effects of athletic performance of carbohydrate, protein and micronutrient supplementation. Carbohydrates are the most efficient fuel for energy production. They can also be stored as glycogen in muscle and liver, functioning as a readily available energy for prolonged strenuous exercise. For an elite athlete the total energy requirement is an average of 4500 calories per day. From previous studies, due to the difficulties of evaluating energy output during sports performance, the calories expended were not stated.

Studies on athletes utilizing omega-3 fatty acid and medium – chain tryglycerrides (MCTs) were associated with improvements in metabolic indices. Supplementation with essential vitamins, metabolic intermediates and minerals shows conflicting results, which demands further research. Of the nutrients reviewed, carbohydrates, branched-chain amino acids (BCAA) and creatine appears to have the most nutritional ergogenic potentials for athletes involved in endurance and intense training. All supplements reviewed here need more evaluation for safety and effects on athletic performance.

Keywords: Micronutrient, Glycogen, Calories, Creatine, BCCA, Ergogenic, MCTs.

Introduction

Nutrition is an important feature of any training programme. Ogedengbe (2005) defined nutrition as an aspect of science that deals with the relationship of food to the proper functioning of the body using chemicals for growth and providing energy for day to day living. From earliest times, certain foods were regarded as essential preparation for vigorous exercise. Aside from natural talent and training, nutrition may be the most important influence on athletic performance (American Dietetic Association, 1993). Good feeding can be good fuel for muscular work, energy supplies and ultimately improve performance capacity.

Sports nutrition is the term normally applied to those aspects of nutrition science that relates to the interaction of nutrition and physical activity (Maughan, 2001). [illegible] tremendous demand on the physical condition, vitality, endurance and mental powers of the participants today more than ever before. Since high performance standards are now demanded from athletes, those who are in the finest and fittest conditions can withstand the wear and tear of competitive sports season.

Success in competitive sports, especially at the elite level goes beyond adequate training experience and fitness level of the individual athlete. It involves thorough scientific manipulations or permutations of which nutrition play a very significant role. In an attempt to seek competitive edge, athletes are often susceptible to fat diets or supplements that have not been scientifically validated.

For the purpose of this paper, emphasis would be placed on the contribution of carbohydrate, proteins, fats and micronutrients to elite sports performance. Therefore, the focus of this paper is to examine the specific contribution of selected food supplement to athletic performance at the elite level.

Carbohydrate, Exercise and Sports Performance

Carbohydrate foods have been identified as having the most significant impact on exercise performance especially prolonged, strenuous exercise (Costill and Hargreaves, 1992; Buskirk and Puhl, 1989; Valeriani 1991). Carbohydrates are present to muscles primarily as the monosaccharide glucose. According to Oloyede and Akinsanmi (2005) carbohydrates are composed of carbon hydrogen and oxygen. The combination of these three elements forms either sugars or starches that provide primary source of fuel for the body. Since carbohydrate are the major source of energy at exercise intensities of >70% Vo_2 max, its availability to exercising muscle obviously of paramount importance for maintenance of performance. When muscle glycogen stores are depleted and blood glucose levels are significantly lowered fatigue sets in (Valeriani, 1991).

Carbohydrate status is directly related to dieta[ry] intake rather than other variables. During long-ter[m] exercise lasting more than 2 hours, muscle glycog[en] stores are mobilized first (Friedman, Neufer and Dol[iny] 1991), followed by blood glucose (Miller and Massa[ro] 1989), liver glycogen, gluconeogenesis, and fina[lly] [...] carbohydrate then beco[...]

the chief energy source for exercising muscle (Williams, 1985; Sherman, 1983).

A carbohydrate loading diet is a strategy used by endurance athletes to increase muscle glycogen reserves in order to improve performance. Carbohydrate loading can be accomplished in two stages: the depletion stage (Astrand or classical regimen) and the carbohydrate loading stage (Sherman/Costill method). In the first method the athlete combines exercise with changes in carbohydrate intake. During the carbohydrate loading stage, the diet is switched to a high- carbohydrate intake for the next three days, while training is reduced.

Carbohydrate loading is a pre-event strategy that improves performance for some endurance athletes. Ogedengbe (2005) stated that maximum glycogen storage is very important for athletes like middle distance events, long-distance runners, and long-distance sports like cycling where endurance heightens since glycogen loading is a major source of energy for high intensity and duration.

Protein, Amino acid and Athletic Performance

Amino acids are the building blocks of protein. A considerable amount of research has evaluated dietary protein needs of athletes (Kreider, 1999). Twenty amino acids are needed to build the various protein used in the growth, repair and maintenance of body tissues. According to the Institute of Medicine of the National Academies (2002) the recommended daily allowance (RDA) for protein is 0.8 of kg/d for all healthy adults, with no increase for persons who exercise regularly.

Campbell and Geik (2004) observed that endurance athletes may require 1.2 – 1.4g of kg/d and strength-trained athletes may require as much as 1.6 – 1.7g of kg/d of protein. Although there is some debate, most studies indicate that in order to maintain protein balance during intense resistance, including endurance training, athletes should ingest approximately 1.3 to 1.8g of protein per kg body mass per day (Butterfield, 1991; Lemon, 1998; Kreider, 1999). Proteins (and amino acids) are a minor source of energy for exercising muscles which account for 5 to 10% of energy production during endurance exercise (Lemon and Proctor, 1991; Lemon, 1987; Kaufmann, 1990).

The amino acid, glutamine supplementation raises levels of growth hormone at an intake of 2 grams per day. This helps to stimulate muscle growth according to the findings of Macintyre (1987). However, Nieman and Pedersen (1999) noted that glutamine supplementation has not improved performance or immune status of trained athletes Creatine monohydrate is used in muscle tissue for the production of phosphocreatine (PC), a factor in the formation of ATP (Greenhaff, 1995). In the opinion of Kreider (1999) an increased store of creatine would improve the ability to produce energy during high intensity exercise as well as improve the speed of recovery from high-intensity exercise. However, Mujika and Padilla (1997) did not report any significant improvement. In another study by Balsom, Harridge and Soderlund, Sjodin, and Ekblom (1993) creatine supplementation not only failed to increase endurance performance, it also contributed to weight gain.

According to Kelly (1997) supplemental branched chain amino acids (BCAA) do not result in meaningful changes in body composition or enhanced physical training and exercise performance. BCAAs is a combination of leucine, isoleucine and valine, three of the eleven essential amino acids. Theoretically BCAA supplementation during intense training may help minimize protein degradation and thereby lead to greater gains in fat-free mass (Kreider, 1999).

HMB (beta hydroxy-beta-methylbutyrate) is a metabolite of leucine, one of the essential branched chain amino acids. Kreider (1999) wrote that HMB supplementation has been reported to reduce catabolism and promote greater gains in strength and fat-free in untrained individuals initiating training. However, there are reports of no significant effect of HMB supplementation in well-trained athletes (Kreider, 1999).

There is no convincing evidence that increased dietary protein intake provides a significant ergogenic effect for long-term endurance exercise. However, increased protein intake may be necessary during short-term increases of work load to prevent negative alterations in nitrogen metabolism.

Fats and Ergogenesis

Fats represent the major source for muscular energy at low intensities, and training enhances the ability to metabolize fats for muscular energy during exercise (Williams, 1985). High intakes of dietary fat have experienced almost no beneficial effects on muscular exercise performance and may actually decrease performance relative to high carbohydrate diets (Williams, 1985)

Most fats consist mainly of fatty acids. There are at least 40 different fatty acids. According to King and Burgess (1993) each fatty acid is different because the chains of carbon atoms may be different lengths (long -, medium -, and short – chain fatty acids).

Medium chain triglycerides (MCTs) contains a class of fatty acids found only in very small amounts in the diet, they are more rapidly absorbed and burned as energy than are other fats (Jeukendrup, Saris, Wagenmakers 1994). A controlled study found increased performance when MCTs were added to a 10% carbohydrate solution (Van Zyl, Lambert, Hawley 1996), but another study actually reported decreased performance with this combination, probably, due to gastrointestinal distress, in athletes using MCTs (Jeukendrup Thielen, Wagenmakers 1998).

Omega –3fatty acids are long chain, polyunsaturated fatty acids with a double bond on the third carbon from the end of the molecule. Omega –3 fatty acids manifest biological functions that have profound physiological effects (Nordoy, 1991). Biological effects of omega – 3 fatty acids include amongst other beneficial qualities, reduced plasma cholesterol and triglycerides levels (Simopoulos, 1991).

Micronutrient Supplementation and Ergogenesis

Micronutrients include dietary compounds that are normally found in or required by the body in minor quantities. Essential vitamins, minerals and metabolic intermediates are the most common micronutrients.

Vitamins

In most well-controlled studies, exercise performance has not been shown to benefit from supplementation of Vitamin C, unless a deficiency exists, as might occur in athletes with unhealthy or irrational patterns (Johnston Swan and Corte 1999). Widespread use, availability, and low cost have prompted numerous studies on human performance, with results that are confusing, confounding, contestable, confrontational, contentious, contradictory, and controversial.

Vitamin E has not benefited exercise performance, except possibly at high altitudes (Simon-Schnass and Pabst, 1988; Shephard, 1983; Tiidus and Houston, 1995). Reductions in blood indicators of muscle damage and free radical activity have also been reported for supplementation with 400 to 1,200 IU per day of vitamin E in most studies (McBride Kraemer, Triplett-McBride, 1998; Rokitzki, Logemann, Huber 1994; Meydani, Evans, Handelman 1993).

The B-complex vitamins are important for athletes, because they are needed to produce energy from carbohydrates. Exercises may have slightly increased requirements for some of the B Vitamins, including Vitamin B2, Vitamin B6, and Vitamin B5 (pantothenic acid) (Keith and Alt, 1991); athletic performance can suffer if these slightly increased needs are not met (VanderBeek, VanDokkum, Wedel 1994). However, most athletes obtain enough B Vitamins from their diet without supplementation (VanderBeek, 1991), and supplementation studies have found no effect on performance measures for Vitamin B2, B3 or B6 (Tremblay, Boiland, Breton 1984; Murray Bartoli, Eddy 1995, Manore, 1994).

Metabolic Intermediates and Minerals

The use of alkalinizing agents, such as sodium bicarbonate, sodium citrate, and phosphorous, to enhance athletic performance is designed to neutralize the acids produced during exercise that may interfere with energy production or muscle contraction (Horswill, 1995). L – Carnitine, which is normally manufactured by the human body, has been popular as a potential ergogenic aid because of its role in the conversion of fat to energy (Cerretelli and Marconi, 1990). While some studies have found that L-carnitine improves certain measures of muscle physiology, research on the effects of 2 to 4g of carnitine per day on performance have produced inconsistent results (Heinonen, 1996).

Coenzyme Q_{10} (ubiquinone) is a highly lipophilic compound that occupies a pivotal role in transfer of electrons produced from metabolism of foodstuffs to oxidative phosphorylation (electron transport chain), resulting in aerobic generation of ATP. Strenuous physical activity lowers blood levels of coenzyme Q_{10} (CoQ_{10}). Overvad, Diamant and Holm (1997) observed that the effects of CoQ_{10} on how the healthy body responds to exercise have been inconsistent.

Electrolyte replacement is not as important as water intake in most athletic endeavours. It usually takes several hours of exercise in warm climates before sodium depletion becomes significant and even longer for depletions of potassium, chloride and magnesium to occur (Pivarnik and Palmer, 1994). However, the consumption of dilute aqueous solutions containing electrolytes, simple sugars, and carbohydrates during exercise may enhance performance according to (Brooks, Fahey, White and Baldwin, 2000).

Iron is important for an athlete because it is a component of haemoglobin, which transports oxygen to muscle cells. Some athletes, especially women, do not get enough iron in their diet. However, anaemia in athletes is often not due to iron deficiency and may be a normal adaptation to the stress of exercise (Smith, 1995).

Water is the most abundant substance in the human body and is essential for normal physiological function. Water loss due to sweating during exercise can result in decreased performance and other problems. Fluids should be consumed prior to, during, and after exercise, especially when extreme conditions of climate, exercise intensity, and exercise duration exist (Pivarnik and Palmer, 1994). Favoured sports drinks containing electrolytes are not necessary for fluid replacement during brief periods of exercise, but they may be more effective in encouraging the athlete to drink frequently and in large amounts (Convertino, Armstrong, Lee, 1996).

Athletes Caloric Requirement

Many coaches make dietary recommendations based on their own 'feeling" and past experiences rather than rely on available evidence. This problem is compounded by the fact that athletes often have either inadequate or incorrect information concerning prudent dietary practices as well as the role of specific nutrients in the diet.

Yesufu (1994) observed that to balance the increased output energy as expended by the athlete, a high caloric diet of 4,000 – 6,000 calories per day are needed for footballers, and a lesser amount for hockey, tracks, basketball and handball players. In an earlier write up by Jensen and Fisher (1979), he observed that the total energy requirement for an active athlete may range from 3,000 – 7,000 cal. per day depending upon his size, condition, and the amount of work he performs.

As the athlete work harder in his training, he consumes more calories and must have a proportionate increase in food, if he eats less, he will burn body tissues to make up the deficit, and approach "staleness" more readily. If he consumes more food than he needs, he will add fatty tissue with its accompanying mechanical and endurance disadvantages.

Conclusion

Carbohydrates are the major source of energy for the exercising muscle. Carbohydrate loading is a strategy used by endurance athlete to increase muscle glycogen reserves in order to improve performance.

Dietary supplementation of protein beyond that necessary to maintain nitrogen balance may not provide additional ergogenic benefit. Omega – 3 fatty acids and MCTs, two types of dietary fats possess interesting properties that may benefit exercise performance if manipulated correctly.

Finally, the numerous studies done on the ergogenic effects of essential vitamins, metabolic intermediates and minerals were not conclusive. Although significant advances have been made on the role of nutrition in physical activities and sports, much remains to be learned about their functions and effects. Further research should also evaluate the long-term safety of amino acids, vitamins and mineral supplementation.

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