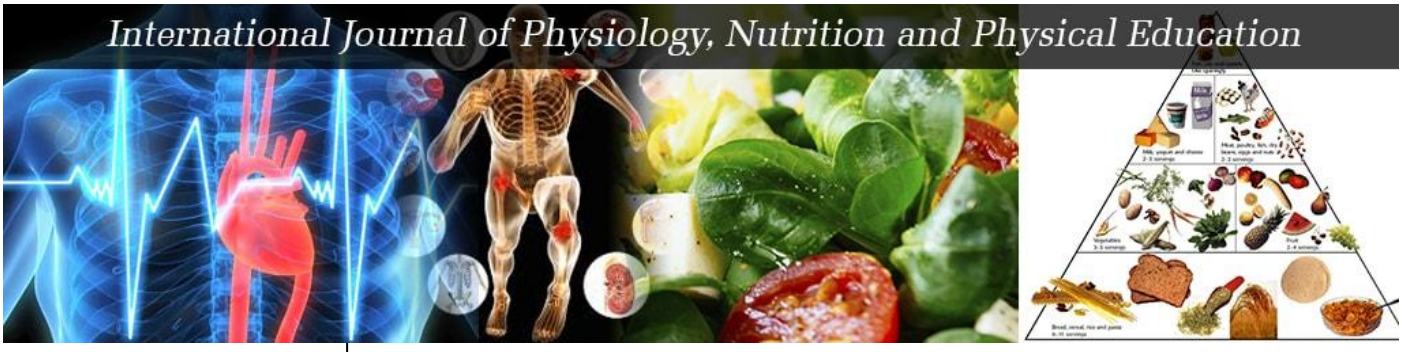

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Role of nutrients and sports drinks on sports performance: A review

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Abstract
Sportsperson required a proper balanced diet to full fill the daily need of nutrients. Absence of nutrients and their presence in lesser amounts in the sportsperson diet affects the performance of sportsperson. Many researchers found that the diet rich in nutrients and intake of sports drinks enhance the sportsperson performance. Sports drinks are to prompt fast fluid absorption and speed up rehydration and promote recovery after the exercise. Macronutrients plays an important role in our diet, carbohydrates gives energy supply for cell functions, fat also providing energy for workout, and principle elements of cell membranes and facilitation of the absorption of fat-soluble vitamins. Protein helps rebuild and repair muscle after exercise and also a source of energy during exercise, particularly when carbohydrate reserves are very low.

Keywords: Athlete**,** carbohydrates, nutrition, sports drinks

1. Introduction
Sports nutrition is a part of nutrition in which study of nutrients and their role in sports person diet and the study of the human body and exercise science (Congeni and Miller, 2002) [19]. Sports Nutrition is also defined as the application of nutrition knowledge to a practical daily eating plan providing the fuel for physical activity, facilitating the repair and building process following hard physical work and achieve athletic performance in various competitive events, while also promoting overall health and wellness (Prochaska and Velicer, 1997) [31]. Sports Nutrition applies nutrition principles to sport with the intent of maximizing performance. Success in sports depends on three factors - genetic endowments, the state of training and nutrition. Genetic make-up cannot be changed. Specialized exercise training is the major means to improve athletic performance and proper nutrition is an important component of the total training program. Athletes and fitness enthusiasts need the same essential nutrients that non-active people need with varied increases in their caloric needs as well as some increase in macro and micronutrients. Therefore, it is essential to explore and assess these increased nutritional needs of athletes before, during, and after event for achieving optimal sports performance.

The human body obtains nutrients from the digestion and absorption of food, and they are needed for virtually all bodily functions. Macronutrient (i.e., carbohydrates, fats and proteins) provide energy, the micronutrients (i.e., vitamins and minerals) are required for a number of specific metabolic functions. A balanced diet must supply all nutrients to fulfill the requirements for energy and the other elements that support metabolism, including water. The individual requirement for each nutrient differ and it depends on age, gender, presence of medical conditions and level of physical activity (NRC, 2002) [26]. The information about the nutrition playing an important role in sports performance. Many aspects can impact the performance of a sports person during championship which may be related to different domains. The most frequently encountered nutritional related problem among sports person is their failure to eat up sufficient total of food energy. Food is composed of six basic substances: minerals, fats, vitamins, proteins carbohydrates and water. Each one of these has specific function in providing nourishment for the body. The body requires these nutrients to function properly however the body is unable to endogenously manufacture them in the quantities needed on a daily basis (Weber, 2004) [38].

It is of critical importance for sportsperson to recognize what each does to his body under the physical, mental and emotional strains of competition. The duration and the intensity of the exercise involved in a given sports will determine the principal source of energy used in meeting the work demands of that particular sports. The certain nutrition and dietary approaches an enhance the sports performance and also nutrition is essential for an athlete's good performance. The athlete's diet should be high in carbohydrates, moderate in proteins and low in fat. Researchers found that in his studies the proper nutrition for young athletes is critical not only to their athletic success, but more importantly to their growth, development and overall health (Nancy, 2008) [5]. Poor nutrition can lead to fatigue, poor recovery and injury, all three of which can hinder as to how efficiently an athlete performs (Costill, 1980) [6].

2. Role of nutrients

2.1 Carbohydrates

There is a great range of carbohydrate recommendations for an athlete, which depend largely upon intensity and duration of exercise. The most important role played by carbohydrates (CHO) is a supply of energy for cell functions. CHO act as energy substrates and can be either oxidized via aerobic metabolism (i.e., glycolytic pathway coupled with Krebs cycle and respiratory chain) or converted into lactate via anaerobic metabolism (i.e., anaerobic glycolysis). In both process, energy is transferred and ATP is synthesized. Whereas the aerobic metabolism is more efficient (i.e., more ATP is synthesized) and the energy transferred is less readily available (i.e., the rate of ATP synthesis is lower), the anaerobic metabolism produces lower amounts of ATP per glucose molecule, but at very high rates, which is crucial for high-intensity exercises. In the context of sports nutrition, the energetic role of carbohydrates is even more evident because they will give energy for muscle contraction and for sustaining the exercise. Various studies have shown that the acute ingestion of high-glycemic index CHO is beneficial for performance in high-intensity intermittent exercises (Foskett *et al*., 2008) [8]. According to some authors, approximately 40-60 g of high-glycemic index CHO should be consumed every hour during a continuous exercise (Jeukendrup, 2004) [15]. Blood glucose and muscle glycogen are the main sources of energy for contracting muscles. An optimal dietary carbohydrate intake increases recovery and optimizes glycogen stores for the next training session. The habitual dietary requirement for carbohydrates vary according to the amount and intensity of training and should focus on including more complex carbohydrates of low-moderate glycaemic index (Rosenbloom and Colemen, 2012) [34]. However, concentrated, nutrient-dense sources of carbohydrates can be included during difficult and intense training and when it is a challenge to reach high carbohydrate requirements because of the high bulk and fibre content of complex carbohydrates. Low-risk supplements can also be added to achieve the daily requirements if required. Carbohydrate intake is mainly liable for increasing glycogen stores. Available information shows that ideal levels of carbohydrate intake optimize muscle glycogen resynthesize. Immediate refueling is particularly important when there is less than 8 h of recovery time between events or training sessions (Burke *et al*., 2011) [3]. CHO intake before and during may prolong time to exhaustion by increasing muscle glycogen concentration, sparing muscle and liver glycogen, and causing a delay in gluconeogenesis which would delay the onset of hypoglycemia (Jacobs *et al*., 1982) [13]. Saltin (1973) [35] found that in his study soccer players with low glycogen levels covered 25% less distance in a game. A critical cause which affect performance was the decrease in running speed. Players with low initial stores walked 50% of the total distance and ran 15% at top 14 speed compared to 27% walking and 27% sprinting for players with high muscle glycogen levels at the start of the game. Kirkendall *et al*, (1993) [17] studied that players who consumed a glucose polymer solution covered 25% greater distance with 40% at speed.

2.2 Proteins

The main function of protein in repair and rebuild muscle after exercise and can also be used during exercise as an energy source, particularly when carbohydrate reserves are very low. Protein needs of most athletes can be met by a proper balanced diet. Dietary protein requirements are elevated with strength, speed or endurance training. Energy intake, exercise intensity and duration ambient temperature, and gender and age also influence protein requirements (Kreider *et al*., 2010) [20]. Dietary protein intake should consist of high quality protein. You should consume a wide variety of high-quality protein foods such as chicken, turkey, beef, lamb, pork, fish, eggs, dairy foods, nuts and seeds. Some athletes, such as strength trained or endurance athletes often need more protein, with requirements of 1.2-1.6 g per kilogram of body mass per day. The optimal timing of protein intake should also be considered when determining and prescribing protein requirements, as this can lead to faster recovery times and improved adaptation after training (Phillips *et al*., 2011) [29]. A considerable amount of research has evaluated dietary protein needs of athletes. Although there is some debate, most studies indicate that in order to maintain protein balance during intense resistance and/or endurance training, athletes should take approximately 1.3 to 1.8 g protein per kg body mass per day (Butterfield, 1991; Kreider *et al*., 1993; Kreider, 1999) [4, 18, 21]. Athletes training at high-altitude may need as much as 2.2g protein per kg per day in order to maintain protein balance (Butterfield, 1991) [4]. This protein intake is about 1.5 to 2 times the recommended dietary allowance (RDA) for the normal adult.

2.3 Fat

Fat is a necessary component of a healthy diet, providing energy, essential elements of cell membranes and facilitation of the absorption of fat-soluble vitamins. Fat intake by sportpersons should be in accordance with public health guidelines and should be based on training level and body composition goals (Rosenbloom and Colemen, 2012) [34]. The dietary recommendations of fat intake for athletes are same or slightly more than those recommended for non-athletes in order to promote health. Maintenance of energy balance, replenishment of intramuscular triacylglycerol stores and adequate consumption of essential fatty acids are of greater importance among athletes and allow for somewhat increased intake (Venkatraman *et al*., 2000) [37]. This depends on the athlete's training state and goals. For example, higher-fat diets appear to maintain circulating testosterone concentrations better than low-fat diets (Reed *et al*., 1987; Hamalainen *et al*., 1983; Dorgan *et al*., 1996) [32, 11, 7]. This has relevance to the documented testosterone suppression which can occur during volume-type overtraining (Fry *et al*., 1998) [9]. Normally, it is recommended that athletes consume a sufficient amount of fat (approximately 30% of their daily caloric intake), while

increases up to 50% of kcal can be safely ingested by athletes during regular high volume training (Venkatraman *et al*., 2000) [37]. Average macronutrient requirements for athletes are represented in Table 1.

2.4 Vitamin and Minerals

Vitamins are required by body to perform many functions and operations which helps to sustain the body healthy and disease free. The function of minerals is for structural development of tissues as well as the regulation of bodily process.

2.5 Water

The human body can survive for a long duration without any of the macro and micro nutrient but not without water. The body is made of 55-60% water, representing a nearly ubiquitous presence in bodily tissues and fluids. In athletics, water is important for temperature regulation, lubrication of joints and the transport of the nutrients to active tissues. It regulates the body's temperature, cushion and protects vital organs, aids the digestive system, acts within each cell to transport nutrients and dispel waste (Nancy, 2008) [5].

Table 1: Average macronutrient requirements for athletes

	Endurance athletes	Strength athletes
Carbohydrates	6-10 g kg^{-1} day^{-1}	3.9-8.0 g kg^{-1} day^{-1}
Protein	1.2-1.4 g kg^{-1} day^{-1}	1.2-1.7 g kg^{-1} day^{-1}
Fat	20-30% of total energy intake (10% saturated, 10% polyunsaturated, 10% monounsaturated)	20-30% of total energy intake (10% saturated, 10% polyunsaturated, 10% monounsaturated

Adapted from Genton *et al*., (2010) [10].
The Institute of Medicine Guidelines, 2005 (Rodriguez, 2009) [33]

3. Sports drinks

Scientists have extensively researched the best fluid to drink during exercise and there is now a different variety of beverages available that are marketed with reference to sport or performance (Sports Dietitians, Australia). Sports drinks are made to deliver a right amount of carbohydrate and fluid to allow an athlete to simultaneously rehydrate and refuel after and during the exercise. Sports drinks are defined as a liquid mainly consist of water, with other nutrients and substances dissolved within, to create an ergogenic aid. Sports drinks are made to provide the right balance of carbohydrate and fluid to the body, to ensure that they are quickly emptied from the stomach and are rapidly absorbed from the small intestine. However, a sports drink can contain a variety of nutrients and other substances. Therefore consumption of a sports drink will provide a large amount of water in addition to other components which could otherwise be obtained from food. The formulation of sports drinks is related to that of oral rehydration solutions designed for the treatment of diarrhoea, in which water, carbohydrate and sodium are the key ingredients. The majority of main stream sports drinks have a carbohydrate content close to 6% weight/ volume and contain small amounts of electrolytes, the main one being sodium. Sports drinks are used by mostly all types of athletes all over the world. They are consumed in association with sport to provide the edge over other competitors; at a professional level this is very important. The most important function of sports drinks are to stimulate fast fluid absorption, supply carbohydrate and other nutrients as substrates in exercise, reduce physiological stress, speed up rehydration and promotes recovery after the exercise. Some sports drinks products are available in powdered form and need to be diluted with water. These are normally cheaper than ready-to-drink products. It is important that consumers using powdered drinks follow the manufacturer's instructions to ensure that the carbohydrate and electrolyte balance is optimal for gut absorption, fluid balance and fuel delivery. Incorrect preparation of drink may lead to gastrointestinal discomfort and a negative impact on athlete performance (Sports dietitians, Australia).

3.1 Types of sports drinks

Now a day's various types of sport drinks are available in market for sportspersons but the mainly three types of sports drinks containing distinct concentrations of electrolytes, fluids and carbohydrates. The rationale is that different athletes competing in different types of sports events have different needs before, during and after the exercise; and therefore sports drinks are tailored to match exact specifications. Nutritional value of different types of sports drinks are represented in Table 2.

3.1.1 Isotonic

Isotonic drinks containing same concentrations of salt and sugar as in the human body. This type of drinks replenishment of fluids lost through sweating and supplies a boost carbohydrate. Isotonic drinks are the preferred choice for the vast majority of athletes, including middle and long-distance runners and those involved in team sports. These are the most commercially available of sports drinks.

3.1.2 Hypertonic

Hypertonic drinks contain a higher concentration of salt and sugar than the human body and are normally consumed post-workout to supplement daily carbohydrate intake and top-up muscle glycogen stores. They are occasionally used in ultra-distance events to meet the high energy demands but most are used with isotonic drinks to replace lost fluids.

3.1.3 Hypotonic

Hypotonic drinks contain a lower concentration of salt and sugar than the human body, quickly replacing fluids lost through sweating. These drinks are suitable for athletes who require hydration without a carbohydrate boost, such as gymnasts.

Table 2: Nutritional value of popular sports drinks

Sports drinks	Calories (kCal/25ml	Sodium (mg/250ml)	Potassium (mg/250ml)	Chloride (mg/250ml)	Total CHO (g/250ml)	CHO conc. (%)	Sugars (g/250ml) (w/v)	CHO source
Gatorade	63	103	30	1	15	6.0	14	Sucrose (38%) /glucose (34%) / fructose (28%) / maltodextrins (8%)
Powerade	70	70	30	NS	17	7.6	15	High-fructose corn syrup/ maltodextrins (%)
Allsport	80	80	55	NS	21	8.4	10	High-fructose corn syrup (56%) / glucose (43%)/ maltodextrins (1%)
Hydrafuel	66	25	30	NS	17	6.8	NS	Maltodextrins/glucose/fructose (% ns)
Isostar	70	110	45	8	17	6.8	NS	Ns
Exceed	70	50	45	80	17	6.8	NS	Maltodextrins/fructose (%)
10K	60	55	30	NS	15	6.0	NS	High fructose corn syrup (% ns)
Gatorade (Europe)	50	110	30	8	14	5.6	14	Sucrose (38%) /glucose (34%) / fructose (28%) / maltodextrins (8%)
Endura	62	80	160	NS	16	6.4	NS	NS
Xcel	62	47	70	NS	15	6.0	NS	NS
Sponser	NS	69	110	11	16	6.4	NS	NS
Rivella marathon	NS	24	136	4	12	4.8	Ns	NS
Sport plus	72	91	54	NS	18	7.2	18	Sucrose (71%) /glucose (29%)
Isosport	42	103	29	NS	17	7.2	15	Sucrose (43%) /glucose (24%) / fructose (19%) /glucose polymers (14%)
Staminade	51	58	49	NS	13	5.2	13	Glucose (100%)

NS- not stated, Adapted from: Jeff S. Coombes (2005) [14]. Sports drink and dental. American Journal of Dentistry. 2005;18: 101-104.

3.2 Sports drinks intake time

3.2.1 Before exercise

Sports drinks may be used by athletes before an event to fine tune their fluid and fuel intake. The carbohydrate tops up muscle glycogen fuel levels, while the added sodium may reduce urine losses before exercise begins (Sports Dietitians, Australia).

3.2.2 During exercise

Sports drinks are mainly designed for use during exercise, for optimal fluid and fuel delivery. They will allow the athlete to perform for longer and more effectively in training and competition (Sports Dietitians, Australia).

3.2.3 Recovery - after exercise

Sports drinks are made to meet individual athletes' nutrition recovery goals by replacing fluids lost in sweat during the event and also assist with refueling targets to replenish glycogen stores. When quick re-hydration strategies are required, drinks with higher amount of sodium content may be more useful. To meet all recovery goals, the drinking of sports drinks should be substituted with other liquid foods and fluids that provide additional carbohydrate, protein, and other nutrients required for recovery (Sports Dietitians, Australia).

3.3 Role of sports drinks on athlete performance

Researchers found that the prolonged exercise greater than one hour can be increased through the consumption of CHO electrolyte drink is commonly accepted and demonstrated by many studies (Khanna and Manna, 2005; Maughan *et al*., 1996) [16, 23]. Studies conducted by Palmer *et al*. (1998) [28] and Powers *et al*. (1990) [30] indicates that ingesting a drink containing 7% CHO had no effect on high intensity exercise lasting 30 min. Sports drinks production companies mainly included CHO a glucose, however many sports drinks include maltodextrin, a polymer of several glucose molecules. Maltodextrin is useful for endurance athletes as it produces a greater CHO concentration (10-20g per 100ml) yet maintains a low osmolarity giving fast absorption, allowing slower breakdown (Bean, 2010) [1]. On the other hand, limited studies have investigated the effect of CHO electrolyte sports drinks on exercise performance of lasting less than 30 min. One study researcher found that supplementing 52 undergraduate subjects with 24 ounces of Gatorade before a leg raising endurance activity, helped participants to keep their leg raised for longer (187s) compared to a water control (Hornsby, 2011) [12]. Bonetti and Hopkins (2010) [2] compared the effects of three available sports drinks against a water control, consumed throughout a 2 h fixed intensity cycle followed by a peak power test of sixteen subjects. The isotonic drinks compared to the hypotonic had the greatest effect on performance. Hornsby, (2011) [12] found that in his study the carbohydrate-electrolyte sports drinks on performance and physiological function during an 8 km cycle time trial and found that the performance and physiological function during a maximal cycling exercise lasting approximately 10 min (8 km) is not improved or limited by endogenous substrate availability prior and during the event.

4. Conclusions

Overall review of this paper concluded that the nutrients has most important role in our daily diet as well as to enhanced the sportsperson performance. Single nutrient is not important but the combination of micro and macro nutrient is also important. Combination of carbohydrate, protein and fats provide energy for workout and also repair and made new tissues in body. Similarly the sports drinks also play an important role in sportsperson daily dietary requirement.

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