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REVIEW ARTICLE

Effects of ergogenic supplements and dietary supplements on young athletes' performance: A review

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ABSTRACT

The purpose of this review is that physical exercise is becoming more prevalent in today's healthier lifestyle among the stressful condition and makes physically fit. Physical fitness promotes an athlete's different types of development or skills, and it reduces anxiety and stress, also reduces the risk of injury and fracture, improves blood circulation and muscle strength, and develops an immune system. It also treats various types of illnesses. Nowadays, athletes depend upon sports nutrition supplements that are ergogenic supplements and dietary supplements; these supplements fulfil the nutritional requirements, save time, and achieve health goals. Many athletes do not have sufficient knowledge related to the efficacy and safety of using ergogenic supplements. There are various types of ergogenic supplements used by athletes, but excess of these supplements has been linked to major health problems. Dietary supplements are more nutritious and safer than ergogenic supplements. They are not prescription medicine, easily available in the market and help to improve physical performance and to cure or prevent different illnesses of the athletes.
Keywords: Athletic performance, Physical exercise, Physical fitness, Sports nutrition.

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INTRODUCTION

A sport is a two-edged sword in terms of health and the main role of the evolvement of physical fitness is sports competition (Sharma and Sood, 2020). Some people who individual participate in sports have such a stronger level of physical activity. The primary goal of sports is to encourage physical exercise and enhance cognitive skills in order to improve health, efficiency, and social skills (Malm et al., 2019). Physical exercise or sports are becoming more prevalent in today's lifestyle to help people live a longer and healthier lifestyle.

Physical fitness maintains good health must be followed by potentially detrimental effects of free-radicals and bodily protection from mechanical stress, the formation of which is accelerated during physical exercise or sports and can lead to oxidative damage of macromolecules; as well as a significant reduction in many illnesses such as coronary heart disease, stroke, diabetes, hypertension, obesity, osteoporosis, maintained cholesterol levels, several malignancies like colon cancer and metabolic health biomarkers (Abou Elmagd, 2016; Ohuruogu, 2016; Ho et al., 2020; Jovanov et al., 2021); and also treats common musculoskeletal illnesses as lower back pain, shoulders and neck pain. It also helps to improve blood circulation, develop the immune system, keep bones healthy, muscular strength, increases relaxation, reduces stress level, self-esteem, agility and improves sleep and moods (Dumith et al., 2011; Guddal et al., 2019). Physical fitness also promotes an athlete's different development like physiological, psychological, sociological, intellectual, morphological, skills and self-development; increased quality of life; capability through positive lifestyle choices and attitudes related to performance in a particular sport (Baro et al., 2016; Ray et al., 2017).

In society, an athlete or a sportsperson is a healthier person who requires better nourishment. Because sports, health and nutritional status are all intertwined, sports nutrition has evolved as a critical aspect in maximizing athletic performance. Due to their lack of understanding about sports nutrition, Indian athletes have poor dietary and nutritional habits. The athletes' need for nutritionally complete drinks and snacks is increasing these days (Sharma et al., 2021).

SPORTS NUTRITION

Sports nutrition is a relatively recent subject that is a powerful nutritious dietary component and important role for improving athletic performance at all levels of competition and it also maintains energy expenditure, providing a balanced ratio of macro (proteins, carbohydrates and with a small amount of fat) and micronutrients (vitamins and minerals), and normal healthy metabolism (Aljaloud et al., 2020; Ayad et al., 2020; Muñoz et al., 2020). Stabilization, absorption, disposition, metabolism, and excretion have only been investigated on some sports nutrition items. High-level athletes may require additional assistance beyond diet to satisfy the nutritional demands of severe exercise intensities, but this is currently being contested. Sports performance may be measured in a variety of ways, and dietary treatments are frequently seen as necessary when it comes to improving performance (Nieman, 2021).

Athletes who do not follow sports nutrition will be unable to maintain performance throughout the competition and also in training (Khan et al., 2017). The consumption of protein should be between 1.2 and 1.7 g/kg/d, consumption of carbohydrates should be between 3 and 12 g/kg/d according to the time and kind of activity, and consumption of fat should account for 20% to 35% of total energy content, according to sports nutrition recommendation (Sousa et al., 2016). And also, according to sports nutrition standards, athletes in sports-related activities must consume a considerable amount of carbohydrates while training to maintain endurance. The glycaemic index of the most widely viable smoothies, energy drinks and bars are high (Malsagova et al., 2021). Athletes must fuel their bodies by consuming three meals in a day or snacks at

multiple times to meet their energy needs because the right nutrition or well-balanced diet satisfies the energy needs of athletes often pre- and post-training, competition, and practices (Beck et al., 2015; Bingham et al., 2015).

SPORTS SUPPLEMENTS

Sports supplements is that a meal, food component or nutrient that is intentionally eaten in addition to one's regular diet in order to achieve a specific health advantage in all levels or performance of all ages of athletes (Muñoz et al., 2020). Many other terminologies have been proposed for sports supplements, but neither of them is completely suitable. There are various categories of sports supplements like sports foods, medical supplements, ergogenic supplements, dietary supplements, functional foods, superfoods, and other supplements (Garthe and Maughan, 2018; Hurst et al., 2022). But in this review paper, we discuss about only effects of ergogenic supplements and dietary supplements on young athletes' performance.

Ergogenic supplements and dietary supplements are used by athletes to fulfil the specific nutritional requirements before and after exercise; and they must have proper knowledge about validity, safeness, and ethics of supplements before taking them. The supplement usage should be determined by the type of sport and the athletes' performance level (Negro, 2014; Porrini and Del Bo', 2016; Prisukhina and Ermosh, 2020; Krasina et al., 2021). Obesity, malnutrition, diabetes, cardiovascular disease, and other health issues, which are usually caused by dietary errors, can be cured by eating a well-balanced diet. Athletes want and deserve healthy, safe foods that are also handy, portable, and proportional (Sharma and Sood, 2020; Krasina et al., 2021). There are some examples of ergogenic and dietary supplements that are shown in the Table 1.

Table 1. Examples of ergogenic supplements and dietary supplements.

Category	Examples
Ergogenic supplements	Creatine, β-alanine, diuretics, caffeine, nitric oxide, anabolic androgenic steroids.
Dietary supplements	Energy bars (fruits bars, granola bars, protein bars, fibrous bars, etc.), sports drinks, sports juices.

Ergogenic supplements

Ergogenic supplements have been more popular and important for athletes. Any method of training, mechanical equipment, pharmaceutical treatment, or cognitive skill that improves physical strength and endurance or training modifications are considered as an ergogenic aid that is administered orally (Vicente-Salar et al., 2020). The FDA (Food and Drug Administration) does not allow ergogenic supplements to be analysed, so allegations of quality and efficiency of products cannot be validated (Mas et al., 2019). Nutritional and medicinal supplements have preventative measures of nutritional deficiencies, lower body fat, lower anxiety, increased muscle mass, improved cognitive function, improved recovery and stronger immunity, as well as improved performance; and these supplements come in an unusual form of foods or in medicated form like tablets, dropper bottles, pills, powder sachets, capsules or liquid ampoules that contained a healthy diet as well as potentially harmful and extremely poisonous components like hydrogenated oil, lead, mercury, talc, artificial colour, titanium dioxide, therefore, these supplements to be consumed in tiny unit quantities. An athlete or a person says he is obtaining no discernible advantage from taking ergogenic supplements (El Khoury and Antoine-Jonville, 2012; Menal-Puey and Marques-Lopes, 2021; Nagata et al., 2021).

Ergogenic supplements like creatine, β-alanine, diuretics, caffeine, coenzyme Q10, etc. used in large numbers, with an average estimate range is 40-100%, which is illegal substances (i.e., doping) that should

they stop (Hurst et al., 2021). This type of overindulgence has been linked to major health problems such as disorder eating like binge eating, vomiting and nausea to big issues like loss of weight, low self-esteem, nerve injury and a variety of severe illnesses (Nagata et al., 2021). When used incorrectly, certain supplements have been linked to disability and death (Aljaloud and Ibrahim, 2013).

In the past, some athletes to boost their performance have used anabolic steroids and amphetamines, but today's athletes had already led to the creation of anti-doping laws and efficient screening processes to help dissuade their usage. As a result, several athletes now opted for dietary supplements to regain energy balance because maintaining energy balance is a crucial aspect throughout the physical exercise for the athletes (Ray et al., 2017),

Creatine monohydrate

Creatine can either be generated or consumed in the body as creatine monohydrate. Creatine, also known as α-methylguanidino acetic acid, is a nitrogen containing molecule that coexists with phosphocreatine in skeletal muscle. Creatine is among the most widely utilized sports supplements today. A higher dose of this supplement is thought to boost energy potential in anaerobic activity, which is why an increasing number of athletes are utilizing (Apostu, 2014). Creatine is carried out into the muscle and transformed to creatine phosphate by enzymes. In the muscle, phosphocreatine offers a readily accessible energy source able of resynthesizing ATP (Adenosine triphosphate) from ADP (Adenosine diphosphate). This process does not create lactic acid because it occurs in the absence of oxygen (Walpurgis et al., 2020).

Despite this, several studies have shown certain drawbacks of using creatine as shown in Table 2 (Darvishi et al., 2013). Apart from the danger of disrupting the liver's function by continually checking detention, it was revealed that all athletes who ingested the equivalent of 250 kcal carbohydrates before the experiment had better explosive force findings than those who consumed 15 g of monohydrate. At the same time, carbohydrates help the high leap while maintaining bodyweight, but creatine may stimulate weight growth (Apostu, 2014).

β-alanine

β-alanine is a non-essential, non-proteinogenic amino acid present in animal-derived products (beef, poultry, fish) that is produced in the liver, and it is a rate-limiting endogenous intracellular buffer that can improve muscle carnosine content and increase muscle performance. β-alanine forms the dipeptide carnosine with L-histidine. Carnosine is located in muscle tissue and works as a hydrogen protons (H+) buffer during short-duration high-intensity physical workouts and due to which it is used as ergogenic supplements (Bellinger, 2014; Peeling et al., 2018; Murphy et al., 2022). Carnosine cannot be absorbed rapidly from the circulation, and β-alanine quantities in the muscle are low. The supply of β-alanine in the meal may inhibit the production of carnosine in skeletal muscle due to which vegetarian athletes had lower muscle carnosine level than omnivore athletes (Huerta Ojeda et al., 2020).

Early investigations limited the daily intake of β-alanine as shown in Table 2. Because of this greater excretion rates, quick changes in pH and failure to adequately load the muscular supplies that have not been useful for performance results (Trexler et al., 2015; Maughan et al., 2018; Edenfield, 2019). Two research published lately looked into the mechanism of β-alanine induced paraesthesia (Bellinger, 2014).

Diuretics

Hypertension and other cardiovascular problems are commonly treated with diuretics. An athlete can receive a therapeutic use exemption (TUE) permission by proving the circumstances that necessitate the use of

diuretics therapeutically, according to WADA's (World Anti-Doping Agency) international standard for therapeutic use exemptions (ISTUE). TUE is described as the approval of a TUE committee rely on a documented medical file to use drugs on the list of restricted items for therapeutic reasons before use in sports (Evereklioğlu, 2021).

Diuretics are used in sports for the disguising of illicit drugs and were prohibited for the first time in 1988, the WADA has forbidden the diuretics substances are still on the list of both inside and outside of competition. Due to their potential to hide various doping compounds and their capacity to promote rapid abrupt weight reduction, whereas competitors using a forbidden drug will seek to dilute their urine, rendering identification extremely difficult. Loops, thiazides, carbonic anhydrase inhibitors and mineralocorticoid receptor antagonists are the types of diuretics utilized, with loops and thiazides representing for approximately 70% of WADA testing positive. The possible side effects of diuretics are shown in Table 2 (Liddle and Connor, 2013; Favretto et al., 2019).

Caffeine

Caffeine use by athletes has grown after the WADA removed it off the list of prohibited drugs in 2004. Caffeine stimulates lipid catabolism and preserves glycogen levels by increasing plasma levels of free fatty acids (Mielgo-Ayuso et al., 2019). The purine alkaloid presents in a range of beverages and foods as chocolate, colas, tea, coffee, soft drinks, capsules, pills, and a variety of sports supplement that relaxing the skeletal muscles while activates the central nervous system (Mathews, 2018). During exercise and rest, this supplement has a broad range of changes in the nervous system, which include lowering an individual personal rating of perceived effort, boost cognitive function, increases glycolytic activity, raises blood neither epinephrine levels, metabolic, hormonal, muscular, pulmonary, cardiovascular, and renal functions (López-Samanes, 2015; López-González et al., 2018).

Furthermore, too much caffeine or higher dosages can produce diuresis, which can lead to dehydration, and taking the product infrequently might lead to some other possible side effects that shown in Table 2 which would plainly offset any performance benefits (Apostu, 2014; Maughan et al., 2018; Peeling et al., 2018; Elosegui et al., 2020; Stein et al., 2020).

Table 2. Potential adverse side effects of ergogenic supplements.

Ergogenic supplements	Side effects
Creatine monohydrate	Gastrointestinal, liver, and renal damage.
β-alanine	β-alanine doses more than ~800 mg (~10 mg kg^{-1} BM^{-1}); and single big bolus of β-alanine has been demonstrated to generate moderate to severe paraesthesia (pricking or tingling) symptoms and skin rashes. This symptom is caused by acute plasma elevation of β-alanine.
Diuretics	Electrolyte imbalances, tiredness, increased susceptibility to heat sickness and dehydration.
Caffeine	Caffeine levels more than 9 mg/kg BM do not appear to improve performance and are more likely to cause unpleasant side effects such as anxiety, nausea, restlessness, insomnia, headache, irritation, nervousness, gastrointestinal distress, increased urine flow and heart palpitations.

Dietary supplements

A meal, meal component, nutrient, or non-food substance that is purposely eaten in addition to the regularly ingested diet to gain certain health or performance advantages, is a dietary supplement (Shaw et al., 2021). "*A dietary supplement is a food designed for consumption that includes a 'dietary component' intended to give more nutritional content to the diet*", according to the US FDA (Garthe and Maughan, 2018; Borges et al., 2022). When the appropriate procedures are followed, dietary supplements are used to cure or prevent nutritional deficiencies, as a handy source of energy, macro- and micro-nutrients, or even to boost performance in sports. Dietary supplements are safer, not prescription medications, but rather over-the-counter items sold in fitness stores, and as a consequence, they are widely used by elite athletes and they need to eliminate unintended doping (Kioukia-Fougia et al., 2017; Oliveira et al., 2021). A dietary supplement is a widely accessible substance taken in addition to one's regular diet. Athletes' usage of dietary supplements is common, with up to 75% of athletes admitting to consume dietary supplements and expanding quickly in a variety of sports. Athletes utilize supplements to attain a health-related goal or including improved physical performance, increased energy, excess weight loss, tiredness avoidance, overall health, and well-being, and compensating for a poor diet (Deldicque and Francaux, 2016; Baltazar-Martins et al., 2019).

Energy/Power bars

Energy bars are a type of nutritional supplement that athletes and other extremely active persons use to meet their caloric requirements (SILVA et al., 2016). Energy bars are used as a rich and transportable supply of carbohydrates. Energy bars are made composed of cereals as well as other high-energy meals that are designed for those athletes who need immediate energy but don't have time to eat. They vary from energy drinks in that they include caffeine, whereas bars deliver energy from food. Energy bars are devoid of any ergogenic created nutrients. Protein, carbohydrates, and fat included in diets are the three basic sources of energy. A normal energy bar (weighs 45-80 g) has roughly 200-300 kcal (840-1,300 kJ), 3-9 g of fat, 7-15 g of protein, and 20-40 g of carbohydrates (Bhavani et al., 2018; Chandegara et al., 2018; Gill and Meena, 2020; Sharma et al., 2021). The energy bars include healthy and important nutrients in their natural form, they can help to reduce the risk of heart attack, type 2 diabetes, and obesity. Finally, as the name implies, they are a quick source of energy that boosts stamina levels and performance owing to fatty acids, amino acids and monoglycerides (Haider et al., 2021).

Cereal bars are a ubiquitous and accessible snack, making them an appropriate dietary format for delivering phenolic antioxidants and fibre derived from cereals. Oat, wheat, rice, quinoa, and soy appear to be the most widely utilized components in cereal bars, with no preservatives. To keep the dry components together, a supply of agglutinant (honey syrup or sugar syrup) is widely utilized. Fruits, sweets, nuts, and other ingredients can be added to a cereal bar to improve the taste and flavour. Various coating materials, such as caramel or chocolate syrup, are also dipped or coated on some cereal bars (Sharma et al., 2014).

Sports drinks

In recent years, the younger population has been more interested in sports drinks. Sports drinks are designed for sports and fitness to help adult athletes perform better and stay hydrated while competing in endurance and high-intensity sports. Sports drinks have different connotations for different people. Sports drinks are beverages that contain electrolytes (potassium, magnesium, sodium, calcium), carbohydrates, minerals and sometimes vitamins or any other vital nutrients that are typically flavoured and sugar-sweetened with the intention of replenishing energy and fluids produced, recovering from stressful situations and meet biological demands during vigorous activity (Broughton et al., 2016; Cordrey et al., 2018).

However, today's sports drinks are prepared with varying mixtures of nutrients, resulting in a wide range of sports drinks on the market. Sports drinks typically include 5%-8% carbohydrate, 3-5 mmol/L potassium and 10-35 mmol/L sodium (Edenfield, 2019). As a result, consuming sports drinks aids in the maintenance of intracellular and extracellular water balance. Individual energy systems, immune system, joint discomfort, and mental focus are all aided by sports drinks. Carbohydrate, which is a crucial element of sports drinks, helps to increase muscle glycogen storage and inhibit muscle protein breakdown. During the action, it is beneficial for the active muscle to exert consistent effort. Finally, carbohydrate-rich sports drinks aid in the maintenance of the correct nutritional balance (Halder and Daw, 2020). The availability of carbohydrates as a fuel for the working muscle is required to maintain a high level of productive output or athletic performance in the warmth. Ingesting carbohydrates 15-20 minutes before activity increases plasma glucose, performance time, decreases endogenous glucose synthesis and carbohydrate oxidation throughout the exercise (Kalpana et al., 2013).

In one study, pomegranate, cucumber, chia seeds and dextrose juice were used to create sports drinks. A sports drink can refer to carbohydrate concentration, consumption of protein, electrolyte replenishment and a variety of many other drinks that are commercialized to meet the needs of an athlete. This sports drink improves the durability performance of an athlete and restores electrolytes that were lost throughout the exercise session. It also added omega 3 fatty acids, phosphate, calcium, and fibre to the juice without altering its sensory properties (Bhardwaj and Saraswat, 2019).

In another study, pomegranate, kokum, and cumin were used to create a sports drink. A sports drink was created with the need for increased efficiency, the importance of electrolytes and antibacterial properties, all of which led to an improvement in the athletes' performance. The sports drink that was created was isotonic (Vaibhavi and Bhakti, 2014).

CONCLUSION

This review summarizes that sports nutrition is a powerful nutritious dietary component for improving athletic performance and eating balanced, nutritious, healthy, and natural food is the key to maintaining energy expenditure and living a better and healthier life. The dietary supplements are nutrient-dense and offer far more than just needed nutrients; but ergogenic supplements cannot provide nutrients that have yet to be identified, and have been linked to major health illnesses, that is illegal supplements which should they stop. As a result, dietary supplements are the best method to acquire a comprehensive spectrum of all nutrients and can be utilized for a variety of purposes, including to cure different nutritional illnesses, ease and achieve healthier goals.

AUTHOR CONTRIBUTIONS

Ekta Singh Chauhan: Presented the main idea; Mansi Chaudhary: Wrote the whole manuscript; and Ridhima Singh: Review the manuscript.

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