

## Purpose of Intaking Sports Drink

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### ABSTRACT

Sports drinks are beverages commonly consumed to replenish the water and nutrients lost during and after sports, such as baseball and soccer. The sports drinks have been used to prevent heatstroke; however, its efficacy is unclear. Many sports drinks are available in the market; however, whether they are truly suitable for preventing sports led heatstroke or they are suitable for only a specific type of sport remains to be explored. In this study, we considered the consumption of nutrients in the human body during sports and the state of the body during heatstroke. Based on the data of what nutrients are lacking and what ingredients need to be replenished, either quickly or slowly, we evaluated whether sports drinks could meet such requirements.

**KEYWORDS:** Sports drinks, Oral rehydration solution, Heatstroke, Sports intervals

### INTRODUCTION

Currently, many beverages are available in vending machines and supermarkets. Among these, sports drinks seem to be a typical example of something claimed to be effective. Sports drinks are beverages commonly consumed to replenish the water and nutrients lost during or after sports such as baseball or soccer. They have also been used to prevent heatstroke. However, whether they are suitable remains unclear<sup>1</sup>. Because the physical condition of the body during sports is not the same as that during heatstroke, beverages other than sports drinks may be more suitable. Many sports drinks are sold in the market, however, studies on their suitability as a sports drink or whether some are suitable for a specific type of sport remains unclear<sup>2</sup>.

In this study, we considered how nutrients are consumed by the human body during sports and the internal state of the body during onset of heatstroke. Based on the data of what nutrients are lacking and which ingredients should be supplied quickly or slowly, we evaluated whether sports drinks can meet these requirements. Currently, general consumers believe that sports drinks are safe to consume as a daily drink besides their usage as sports drink for preventing and dealing with heatstroke. We considered its suitability for these purposes.

#### *Basic physiological effects in the human body*

The human body is composed of 60% water, followed by protein (about 17%)<sup>3</sup>. Other ingredients present in relatively large amounts include carbohydrates, lipids, and nucleic acids. These ingredients are produced through chemical reactions (metabolism) that break down nutrients present in food, inside cells, in amounts as required by the human body. To replace these ingredients, old ingredients are discarded, excreted, and gradually replaced (so-called renewals). During growth periods and recovery from injuries, production of new cells and regeneration and strengthening of muscles is necessary; therefore, intake of nutrients that serve as substrates for these procedures is essential.

The five major nutrients are proteins, lipids, carbohydrates, vitamins, and minerals, of which the first three are called the three major nutrients and are primarily used to produce ingredients needed by making up the body and produce energy to maintain body temperature and exercise<sup>3</sup>. Among the three major nutrients, lipid metabolism produce a relatively large amount of energy, whereas carbohydrate metabolism produces energy at a higher rate. The remaining two vitamins and minerals are known to regulate various metabolic processes. As these three major nutrients are used as raw materials, they are generally ingested in large amounts in daily life to maintain health and survival. Vitamins and minerals are mainly used for regulation; therefore, they are required in minimal quantity. Metabolism is not properly regulated when the a few amount of nutrient required by the body is not fulfilled, therefore, minimum amount of all five nutrients should be maintained in the body consistently. When the metabolism in the body is active, it causes a heat-generation internally. The tendency of body temperature to rise after a meal is common and is thought to be an example

of this (diet-induced thermogenesis). If people want to suppress fever and lower body temperature in the short term, they should intake sufficient raw materials to trigger the minimum necessary metabolism.

### ***Need and history of sports drinks***

A lot of energy is consumed during sports. As body temperature tends to increase due to internal heat generation, sweating is usually the body's mechanism for lowering body temperature.

Sweat contains many electrolytes (ionizing minerals), such as sodium and potassium, in addition to water, and sweating reduces electrolytes in the body. This implies that drinks that are best consumed during breaks while playing a sport generally contain water, carbohydrates, and electrolytes that can generate energy quickly. Moreover, these compounds should be quickly absorbed. This requires a low osmotic pressure. Osmotic pressure is the water pressure generated by the ingredients dissolved in a solution; if it is the same as that of blood, not only water but also various nutrients will easily move in and out of the blood. If this osmotic pressure is too high, a problem arises in that absorption into the body takes time. When it comes to sports drinks, if they contain a lot of what could be considered active ingredients, even if they have a positive effect on the body, they will be absorbed slowly and lose their immediate effect. After sports, missing nutrients should be replenished slowly. To prioritize recovery from fatigue and the creation of energy ingredients, even if the body temperature rises, it is often stopped physically by icing or other means (Table 1). Icing may be avoided in sports because the muscles may become stiff. Warming before sports is also effective in raising body temperature and loosening muscles.

Many types of sports drinks are currently available on the market in Japan. It is thought to originate from sports drink **G** (Table 2)<sup>2,4</sup>. Sports Drink **G** was developed in 1965 by a medical and physiologist on the University of Florida's American football team. The name was inspired by the name of the football team. The sports drink **G** has the largest market share in the world. This sports drink contains a high concentration of salt (sodium, 48 mg/100 mL), which replenishes the sodium lost when sweating occurs during physical activity. It also contains large amounts of glucose and sucrose, which are the most efficient energy sources for recovery from fatigue. Sports drinks, as the name suggests, are beverages that replenish the water, sodium, and carbohydrates lost during intense exercise. However, no standard amount of alcohol that one should or should not drink is described. Notably, the amount lost during sports varies from person to person; therefore, supplementation of such ingredients could be explored; however, whether the appropriate amount would be consumed is unclear<sup>5</sup>. Even if a new sports drink that provides the essential nutrients is manufactured, the problem of increased osmotic pressure would persist.

In Japan, no clear standards for the ingredients in sports drinks are formulated. They are sold in a free range of variations and advertised as drinks containing ingredients suitable for sports. Salt and carbohydrate concentrations and the types of nutrients varied depending on the product (Table 2). Table 3 shows the purposes for which sports drinks are consumed and the ingredients suitable for these purposes. Because the purpose of their intake varies, they should not be grouped together as sports drinks. To benefit consumers, division of the sports drinks into categories and selling them as drinks that contribute to their health would be a better approach.

### ***Differences from heatstroke prevention/response***

Heatstroke is accompanied by an increase in body temperature due to prolonged exposure to high temperatures for a long time. In the early stages, the rise in body temperature is slightly suppressed by sweating, but as the symptoms worsen, sweating is suppressed and the rise in body temperature becomes more noticeable, causing various symptoms such as chills and dizziness. The treatment for the early stages of sweating can be thought of as similar to that when playing sports. However, once symptoms become severe, different internal changes occur, and different treatments must be considered. Before experiencing a heatstroke, people should try to maintain their overall health without thinking only about the illness. Therefore, maintaining the balance and intake of nutrients through meals is a better approach to ensure that the body functions properly. However, a rapid increase in body temperature is not concerning. When suffering from heatstroke, quick replenishment of lost fluids and electrolytes and intake of vitamins as needed to return the body's functions to normal is necessary. If lowering the body temperature is the first priority, it is best not to consume too much protein, as it will cause heat generation through metabolism (Table 1). People can suffer from heatstroke when playing sports outdoors in the hot sun; therefore, carefully determining the types of nutrients needed depending on the symptoms and taking appropriate action is necessary.

The sports drinks are suitable for rehydration during heatstroke depends on the type of product used (Table 2). When rehydrating in daily life or before contracting heatstroke or other illnesses, tea or water is sufficient without worrying about the absorption rate. The three key factors for effective hydration and dehydration during heat stroke are: high sodium ion concentration, low carbohydrate content, and low osmotic pressure. Surprisingly, few sports drinks satisfy these three key points. Oral rehydration solutions may be more suitable for treating heatstroke than sports drinks<sup>6</sup>. The World Health Organization recommends oral rehydration solutions for dietary dehydration therapy. Sports drinks have high carbohydrate concentrations because their primary

purpose is to replenish energy after sports. When the carbohydrate concentration was high, the rate of movement from the stomach to the small intestine slowed and the drink remained in the stomach. Water is absorbed in the small intestine; therefore, the higher the carbohydrate concentration, the slower is the rate of hydration. If people do not have any symptoms of heatstroke or dehydration and can absorb water slowly, they can rehydrate with sports drinks. In recent years, oral rehydration solutions have become readily available in Japanese pharmacies. It was originally used to smoothly replenish electrolytes and water when symptoms of diarrhea or vomiting appeared due to infectious gastroenteritis. Compared to sports drinks, they contain fewer carbohydrates and amino acids. Salt tablets containing only electrolytes have recently become available for heatstroke<sup>6</sup>. Diluted sports drinks are thought to have lower carbohydrate levels and can be used to treat heatstroke<sup>3,5</sup>.

Sports drinks are beverages that are developed for athletes; therefore, they should not be consumed indiscriminately in daily life, and should only be consumed as beverages to replenish the energy, electrolytes, and nutrients lost during sports. Daily consumption of sports drinks can cause tooth decay and increase blood carbohydrate levels, leading to decreased appetite and food intake. It can also cause the plastic bottle syndrome (acute diabetes)<sup>7</sup>. If possible, refraining from consuming it as a drink may be preferable.

### ***Effects of milk***

Milk, a typical example of a completely nutritional food, replenishes vitamins and minerals lost through sweating while bathing<sup>4</sup>. Milk is rich in calcium, magnesium, protein, and vitamins and it would be best if these minerals and nutrients could be obtained through food; however, body temperature is high after bathing, which often leads to a lack of appetite. Drinking milk after a bath is an efficient way to replenish nutrients in the body. This is because milk provides building blocks for proteins such as albumin in the blood. When albumin and protein levels increase in the blood, blood volume increases. Therefore, it has been recognized as effective in preventing the dehydration associated with heatstroke. People drink milk after bathing even though their body temperature is high because they can maintain their body temperature and avoid getting cold in the bath<sup>4</sup>. Foods high in protein should be avoided after heatstroke because they raise body temperature, increase metabolism, and cause water loss through sweating. Even though milk is said to be effective for prevention, it is recommended to avoid its consumption after suffering a heatstroke or dehydration. Even if milk is cold, the protein (amino acids) in it increases body temperature. Even if people drink beverages that contain many amino acids, their body temperature rises and there is a risk of worsening heatstroke. This is important for determining which beverages to consume during sports and when suffering from a heat stroke.

### **CONCLUSION**

This study clarified the changes that occur in the body and the ingredients that decrease owing to sports or heatstroke. To some extent, it is possible to think systematically about the ingredients that should be ingested, depending on the situation. Ingredients to create energy are needed during and after sports, and depending on the type of sport, ingredients that build or repair muscles may also be effective. If people suffer from heatstroke, they should refrain from consuming sports drinks, and should only consume water and salt, and not carbohydrates. The amount of water and minerals that people need to replenish depends on their health conditions. Regarding ingredients such as minerals, it is difficult to decide in advance where the concentration is good and how much should be taken<sup>3</sup>. Drinks with low osmotic pressure (those that do not contain many nutrients) are quickly absorbed by the body. If people need to quickly replenish the necessary ingredients between sports or if they need prompt treatment when suffering from heatstroke, it is better not to expect to consume too many ingredients. If people do not engage in sports, they may not need to drink sports drinks<sup>4</sup>, as rapid absorption of nutrients is not required. Sports drinks contain relatively large amounts of nutrients, and excessive drinking too much of them can increase the risk of diabetes and obesity<sup>7</sup>.

As there are many types of sports drinks, if we consider the consumer, it would be better to label the containers by category according to when they should be consumed. The nutrients required from the beverage may change depending on the duration of the sport (type of sport), the type and intensity of muscles used, and the place where the sport is performed (outdoors or indoors, under hot sun, or in an air-conditioned place)<sup>5</sup>.

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**Table 1 Conditions and food and drink requirements for each case**

Type of condition	Between sports	After sports	Prevention of heatstroke	During heatstroke
Internal state	Exercise causes excessive sweating. It consumes a lot of energy.	Sports not only reduces fluids but also many nutrients. It is also necessary to cool down the body temperature when it rises.	It is necessary to maintain normal internal functions. If nutritional intake is unbalanced, metabolism will not work properly and people will be more susceptible to heatstroke.	In the early stages, sweating increases, but as the symptoms progress, sweating itself becomes suppressed and body temperature continues to rise.
Nutrient needed	What is lost through sweat (water and electrolytes) and energy needs to be replenished (ingredients that provide energy: carbohydrates, fats, and proteins) quickly. Among the three major nutrients, carbohydrates are easily metabolized quickly, so if people want to recover sports performance in a short time, it is desirable to consume a large amount of carbohydrates.	It is better to replenish fluids and electrolytes quickly, but it is okay to replenish ingredients that provide energy slowly. If people do not exercise afterwards, it is possible to intake various nutrients from many foods and drinks.	It is necessary to consume a variety of nutrients in a well-balanced manner (there is no reason why people necessarily have to get them through drinks). In terms of taking in a balanced amount of nutrients, it is the same as after sports, but if people are not sweating, there is no need to take in a lot of fluids or salt.	Drinking water that has been adjusted for osmotic pressure so that water and salt are quickly absorbed, and that contains minerals (mainly sodium and potassium), is recommended. It is better not to consume too much carbohydrates and protein in order to suppress the rise in body temperature. If the condition worsens, drinking fluids will not be enough and treatment such as intravenous drips will be necessary.
Food suitable for consumption and characteristics	Sports drink	If it is immediately after, sports drinks and easy-to-eat foods such as fruit are recommended. (Also used with icing)	No special drinks required. (Normal drinks and meals are sufficient)	Oral rehydration solution (Diluted sports drink?)
Urgency of consumption	Need to hurry	No need to hurry	No need to hurry	Immediate action required

**Table 2 Types of sports drinks**

Product symbol	<b>G</b>	<b>A</b>	<b>P</b>	<b>E</b>	<b>AV</b>	<b>Z</b>	<b>V</b>
Recommended intake status	Energy supplement during exercise	During exercise	During exercise and non-exercise	Energy supplement during exercise	During exercise and non-exercise (calorie-free)	During exercise	During exercise
Absorption rate of ingredients	○	○	◎	◎	◎	◎	-
Energy (kcal/100mL)	26.0	26.4	27.0	24.6	11.6	11.2	0.0
Protein (g/100 mL)	0.0	0.0	0.0	0.4	0.3	0.1	0.3
Carbohydrate (g/100mL)	6.4	6.0	6.7	5.9	2.6	2.7	0.8
Na (mg/100mL)	48.0	21.8	49.0	52.0	2.4	11.5	24.0
K (mg/100mL)	24.0	17.6	20.0	20.3	-	-	12.0
Ca (mg/100mL)	-	-	2.0	10.4	No additives	No additives	4.6
Mg (mg/100mL)	-	-	0.6	0.6	No additives	No additives	12.0
Display regarding functionality	-	Amino acid, Royal jelly, Citric acid, Plant extracts	-	-	Amino acid	Amino acid, Vitamin C, Vitamin B	Amino acid
Characteristic ingredients	Vitamin B <sub>6</sub> , Vitamin B <sub>12</sub> , Niacin	Vitamin B <sub>6</sub> , Niacin, Arginine, Valine, Isoleucine	No additives	Vitamin C, β-carotene, Vitamin E, Arginine, Citric Acid	Arginine, Valine, Isoleucine, Leucine	Valine, Isoleucine, Leucine	No additives
Sugar/sweetener	Sugar, Glucose, Sweetened glucose syrup	Sugar, Fructose, Honey	Sugar, Glucose	Fructose	Fructose, Aspartame-phenylalanine compound	Glucose, Fructose, Aspartame-phenylalanine compound	Sucralose, Stevia, Trehalose

-: Items not listed on the label

**G** is said to be the world's first sports drink and **P** was the first sports drink to be developed in Japan.

Based on the contents of reference 2).

**Table 3 Purpose of consumption of sports drinks**

Purpose	Countermeasures (improving sports drinks)	Done with oral rehydration solution
Replenish lost energy after (during) sports	Increase carbohydrate content	±
Recover fatigue after (during) sports	Increase vitamins and citric acid	-
	Increase electrolytes	+
Relieve electrolyte loss after (during) sports	Make it easier to absorb water	+
Replenish fluids after (during) sports	Increase amino acids (branched-chain amino acids)	-
Regenerate muscles after sports	Avoid containing too many ingredients other than the targets (lower osmotic pressure)	+
Quickly absorb some ingredients		

Citric acid and amino acids are also useful for replenishing energy.

Based on the contents of reference 4).

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