

## **Comparative Analysis of Isotonic Drinks and Water Consumption After Exercise: *A Study on Teenagers' Metabolic Response and Health Implications***

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*A Case Study of Biology: Metabolism,*

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*“Finally, brothers and sisters, whatever is true, whatever is noble,  
whatever is right, whatever is pure, whatever is lovely, whatever is  
admirable—if anything is excellent or praiseworthy—  
think about such things.”  
– Philippians 4:8 (NIV)*

### **ABSTRACT**

This study aims to show a comparison of the effects of consuming isotonic drinks and water after exercising. Many believe that isotonic drinks will help restore stamina and strength when exercising. It is for this reason that athletes consume it, and many recommend it. However, this study will find out and prove whether this hypothesis is true for all groups, especially teenagers. To prove it, several students from *Makarios Christian School*, samples of students of grade 10 to 12 were taken, while doing exercise with the same intensity. The data were taken by using the theory of *Blood Glucose Testing* by Brown, et. al. (2019) and Sandercock and Brodie, (2006) as the secondary theory of heart rate variability to assess the effect of isotonic drink and pH on metabolism and autonomic control during exercise. The categories that drank water and isotonic drinks were separated and the data was collected. As a result: **1)** This study showed the effects of drinks consumed on the body's metabolism, especially pulse rate, blood sugar and blood pressure. **2)** It was found that consuming isotonic drinks will provide electrolytes so that those excreted through sweat can be returned back, so that the body does not lack electrolytes or ions. On the other hand, even though water does not contain electrolytes, this also means there are no carbohydrates or sugar. **3)** The pH level of water was also neutral, so the body was helped to return its level back to neutral, whereas isotonic drinks had a pH with an acidic level. This study serves as a valuable resource for athletes, health enthusiasts, and educators, providing evidence-based insights into the nuanced effects of isotonic drinks and water on the body post-exercise, particularly among the adolescent demographic.

**Keyword:** *metabolism, isotonic drink, mineral water, blood glucose, blood pressure, pH level, electrolytes, carbohydrates*

### **INTRODUCTION**

Isotonic drinks are known and believed to have benefits in replenishing the human body after exercising. These drinks contain electrolytes and fluids. Athletes are known to frequently consume these beverages. During exercise, sweat is released through the pores of the skin. Sweat not only releases water but also electrolytes, fluids, and substances needed by the body; such as carbohydrates, proteins, minerals,

and important ions. Although these beneficial contents are still present in the body, they can have an impact, no matter how small. By consuming isotonic drinks, it is hoped that these fluids can be replenished back into the body. And indeed, this is beneficial and helpful for athletes. However, there is one thing to consider. The glucose content in isotonic drinks is also high. Cell Respiration needs glucose to be converted into energy so that it can be carried out in daily lives. Fortunately, athletes have high metabolism. This means their bodies can easily and quickly convert and process glucose into energy. Regardless of how long an athlete exercises, if their intake is sufficient, no matter how much is ingested into their body, their body will still be able to process quickly and convert glucose into energy.

Consuming isotonic drinks by teenagers with low metabolism can have negative effects. Most teenagers do not exercise frequently for long periods, unlike athletes who have trained their bodies intensely and rigorously. It's no wonder that teenagers have low metabolism. This means that teenagers cannot quickly convert glucose into energy. And because isotonic drinks are known for their high glucose content, the question now is; where does all the glucose go if the body cannot process it well? Researchers indicate that regular excessive consumption of isotonic drinks after exercising can lead to overweight or obesity, type 2 diabetes mellitus, high blood pressure, and other diseases (*alodokter, 2020*). On the other hand, beverages like plain water do not contain as many electrolytes as isotonic drinks. However, this means that drinking plain water will not increase glucose in the body, which is a good thing. It can aid in dieting, reduce excess fat, and prevent diseases or dehydration. But does this mean that plain water is the best drink? This study aims to compare the pros and cons of consuming isotonic drinks and plain water after exercising. Data will be collected from the teenagers themselves, and the best drink between the two will be determined. Observable factors include body glucose levels, heart rate, and blood pressure. Therefore, it is expected that the study will fulfill the curiosity if teenagers drink isotonic drinks after exercising will be the same, if the drink will have the same positive impact as it does for athletes, or if something else will happen, and what the other potential outcomes are.

## **METHOD**

The study entitled "*Comparative Analysis of Isotonic Drinks and Water Consumption After Exercise: A Study on Teenagers' Metabolic Response and Health Implications*" was conducted at Makarios Christian School for 4 months. The data was collected from students in grades 10, 11, and 12. This research was conducted as part of the requirements for 12th-grade High School. The following are the required data that have been collected for this study:

| Grade 10   | Grade 11  | Grade 12   |
|--|---|--|
| Collected for:<br>- Isotonic drink examination in normal metabolism without exercise<br><br>Data collected:<br>- Blood glucose before and after isotonic drink consumption<br>- Heart rate before and after isotonic drink consumption | Collected for:<br>- Isotonic drink examination<br><br>Data collected:<br>- Blood glucose before and after exercise.<br>- Heart rate before and after exercise.<br>- Blood pressure before and after exercise. | Collected for:<br>- Mineral water examination<br><br>Data collected:<br>- Blood glucose before and after exercise.<br>- Heart rate before and after exercise.<br>- Blood pressure before and after exercise. |

*Table 1: Data Collecting*

This study used a qualitative method to collect, analyze, and draw the conclusion for this research. According to (Shava, 2021) from the National University of Science and Technology, Zimbabwe, quoted that *“Qualitative data analysis requires some creativity in organizing a pile of raw data and can be a daunting task for educational researchers”*. With that, the procedure of data collection are as follows: gathering the students and categorizing them based on the data was needed; mineral water and isotonic drink, reviewing the important notes for the samples, undergoing the procedure of exercise, collecting the data samples, contrasting the data using the theory used, determining the conclusion from the data collected

During the data collection, the writers collected the blood samples using the instructions in theory of Brown, et. al. (2019) and Sandercock and Brodie, (2006) as the secondary theory of heart rate variability to assess autonomic control during exercise. *“Traditional Blood Glucose Monitoring Methods”* refers to the conventional techniques used to measure and monitor blood glucose levels in individuals, particularly those with diabetes. These methods have been in use for several decades and are still widely utilized today. The primary traditional blood glucose monitoring method was *“Fingerstick Blood Glucose Testing” (Self-Monitoring Blood Glucose, SMBG)*.

The study overall steps were: Reading the related books, *“Metabolism”* & *“Metabolic Rate Measurement”* many times, categorizing and making indicators of the analysis, analyzing the data, describing, interpreting the data and findings in accordance with the theory used.

# DISCUSSION

## 1. Result

|  |           |  |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
|--|-----------|--|--------------------|-----------|-----|-----------------|--|--|---------------------|--|----|---------------------|--|----|-------------------------------|--|----|------------------|--|--|---------------------------|--|-----|-------------------|--|--|--------------|--|----|----------------|--|----|---------------|--|----|----------------|--|----|
| <p>Pocari Sweat effectively replenishes the body with essential water and electrolytes that are lost during sweating. This hydration drink is absorbed easily and quickly and matches the natural fluid balance of electrolytes in the body. Ideal for providing rehydration in countless situations including during and after sports, workouts, following a hot bath, to refresh you at work and even to hydrate you first thing in the morning. Convenient and handy for anyone, anywhere. Pocari Sweat packets come in powder form which is simple to store and easy to carry.</p> <p><b>Preparation:</b><br/>Stir thoroughly 1 packet of Pocari Sweat in 1 liter (33.8 ounces) of water.</p> <p><b>Important Storage Recommendations:</b><br/>Store Pocari Sweat powder away from direct sunlight. After mixed with water keep the drink refrigerated in a non-metal container. Use this product immediately upon opening as your Pocari Sweat powder instantly absorbs moisture.</p> <p><small>Developed by Otsuka Pharmaceutical Co., Ltd., Japan</small></p> |           | <h3>Nutrition Facts</h3> <p>About 15 servings per box<br/> <b>Serving Size 1 2/3 tbs (22g) makes 12 fl oz</b></p> <table border="1"> <tr> <td>Amount per serving</td> <td><b>80</b></td> <td>%DV</td> </tr> <tr> <td><b>Calories</b></td> <td></td> <td></td> </tr> <tr> <td><b>Total Fat</b> 0g</td> <td></td> <td>0%</td> </tr> <tr> <td><b>Sodium</b> 170mg</td> <td></td> <td>7%</td> </tr> <tr> <td><b>Total Carbohydrate</b> 20g</td> <td></td> <td>7%</td> </tr> <tr> <td>  Total Sugars 20g</td> <td></td> <td></td> </tr> <tr> <td>    Includes 16g Added Sugars</td> <td></td> <td>32%</td> </tr> <tr> <td><b>Protein</b> 0g</td> <td></td> <td></td> </tr> <tr> <td>Calcium 10mg</td> <td></td> <td>0%</td> </tr> <tr> <td>Potassium 70mg</td> <td></td> <td>2%</td> </tr> <tr> <td>Magnesium 2mg</td> <td></td> <td>0%</td> </tr> <tr> <td>Chloride 200mg</td> <td></td> <td>8%</td> </tr> </table> <p><small>Not a significant source of saturated fat, trans fat, cholesterol, dietary fiber, vitamin D and iron.<br/> *The % Daily Value tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000calories a day is used for general nutrition advice.</small></p> <p><b>INGREDIENTS:</b>CANE SUGAR, GLUCOSE, CITRIC ACID, GRAPEFRUIT POWDER, NATURAL AND ARTIFICIAL FLAVOR, SODIUM CITRATE, SALT, LESS THAN 1% OF ASCORBIC ACID (TO PROTECT FLAVOR), POTASSIUM CHLORIDE, CALCIUM LACTATE, MAGNESIUM CARBONATE.</p> <p><small>DISTRIBUTED BY CRYSTAL GEYSER WATER CO. 1-888-424-1977<br/> CALISTOBA, CALIFORNIA, USA<br/> PRODUCT OF SOUTH KOREA<br/> www.trypocari.com</small></p> | Amount per serving | <b>80</b> | %DV | <b>Calories</b> |  |  | <b>Total Fat</b> 0g |  | 0% | <b>Sodium</b> 170mg |  | 7% | <b>Total Carbohydrate</b> 20g |  | 7% | Total Sugars 20g |  |  | Includes 16g Added Sugars |  | 32% | <b>Protein</b> 0g |  |  | Calcium 10mg |  | 0% | Potassium 70mg |  | 2% | Magnesium 2mg |  | 0% | Chloride 200mg |  | 8% |
| Amount per serving   | <b>80</b> | %DV  |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| <b>Calories</b>  |           |  |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| <b>Total Fat</b> 0g  |           | 0%   |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| <b>Sodium</b> 170mg  |           | 7%   |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| <b>Total Carbohydrate</b> 20g  |           | 7%   |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| Total Sugars 20g   |           |  |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| Includes 16g Added Sugars  |           | 32%  |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| <b>Protein</b> 0g  |           |  |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| Calcium 10mg   |           | 0%   |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| Potassium 70mg   |           | 2%   |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| Magnesium 2mg  |           | 0%   |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |
| Chloride 200mg   |           | 8%   |                    |           |     |                 |  |  |                     |  |    |                     |  |    |                               |  |    |                  |  |  |                           |  |     |                   |  |  |              |  |    |                |  |    |               |  |    |                |  |    |

Table 1: Nutrient facts of Pocari

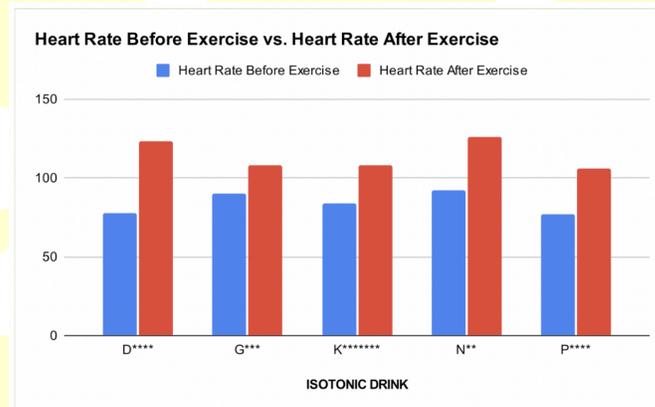


Chart 1: Heart Rate Before and After Isotonic Drink Exercise

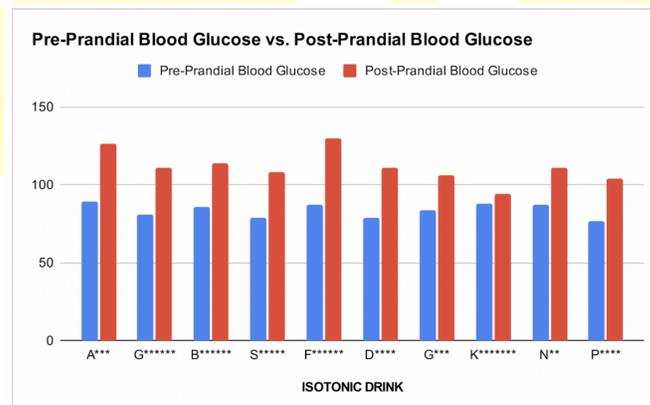


Chart 2: Pre-Prandial Blood Glucose and Post-Prandial Blood Glucose for Isotonic Drink

Chart Note : The first 5 students are 10th Grade students, and the last 5 students are 11th Grade students.

| Name   | Blood Pressure Before Exercise (mmHg) | Blood Pressure After Exercise (mmHg) |
|--------|---------------------------------------|--------------------------------------|
| D****  | 115/74                                | 134/68                               |
| G***   | 109/76                                | 137/79                               |
| K***** | 108/63                                | 138/54                               |
| N**    | 93/58                                 | 115/70                               |
| P****  | 110/67                                | 126/80                               |

Table 2: Blood Pressure Before and After Isotonic Drink Exercise

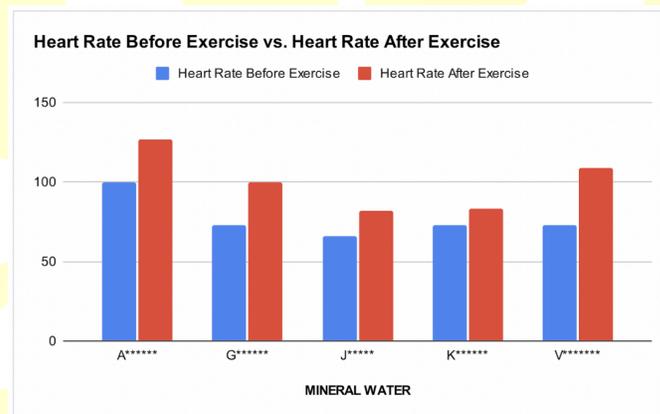


Chart 3: Heart Rate Before and After Mineral Water Exercise

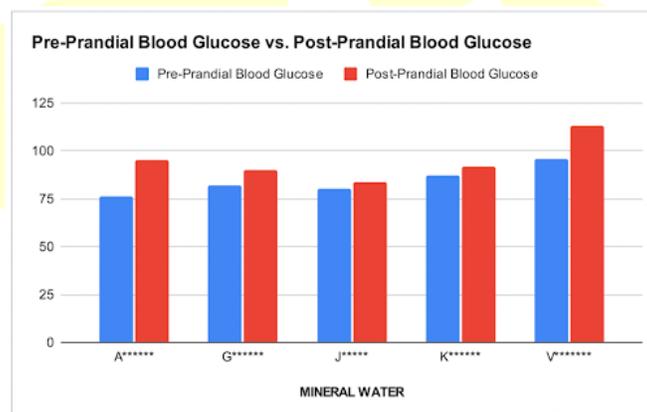


Chart 4: Pre-Prandial Blood Glucose and Post-Prandial Blood Glucose for Mineral Water

| Name   | Blood Pressure Before Exercise (mmHg) | Blood Pressure After Exercise (mmHg) |
|--------|---------------------------------------|--------------------------------------|
| A***** | 129/64                                | 132/78                               |
| G***** | 133/66                                | 135/62                               |
| J***** | 121/64                                | 136/58                               |
| K***** | 104/56                                | 124/68                               |
| V***** | 112/55                                | 117/66                               |

*Table 3: Blood Pressure Before and After Mineral Water Exercise*

## 2. Interpretation

Quoting Gugup Prasetyo et al (2021), isotonic drinks are known for their ion content, such as sodium, chloride and potassium, which function as replacements for ions lost through sweat during physical activity. Prasetyo emphasized the importance of these ions, and stated that isotonic drinks maintain balance like body fluids and even contain vitamins. These fluids, like ions and electrolytes, help the body not to dehydrate. As a result, during exercise-induced loss of electrolytes through sweat, isotonic drinks can replenish important components for a better body performance. However, with all these ions coming inside the body, it might cause a risk. This aspect also relates to the observation of an increase in blood pressure as seen in Chart 1 and Chart 2. Consuming isotonic drinks introduces electrolytes into the body, causing the heart to pump more blood to facilitate the transport of oxygen, hormones, nutrients and ions (*detikedu, 2021*). As a result, blood pressure increases as the heart works harder to meet these needs; causing the heart rate to increase significantly. During exercise, the heart faces increased demands as it transports electrolytes, ions, and oxygen throughout the body. This increased workload is as seen in Chart 1, which depicts a great increase in students' heart rates, exceeding 100 beats per minute, compared to their resting rates of under 100 beats per minute. The blood pressure increased as well, which can be seen in Table 1. Whilst a good drink should ease down the heart rate and neutralize the body. Additionally, the experiment revealed a significant spike in blood sugar levels. Isotonic drinks, rich in beneficial ions including carbohydrates, such as those found in Pocari Sweat, can also significantly increase blood glucose levels. For example, Pocari in a 330 mL portion contains 80 kcal of energy and 20 grams of carbohydrates (*Klikindomaret.com*). These blood sugar spikes pose risks, especially for teenagers with slow metabolism, because the body has difficulty converting glucose into energy efficiently. In addition, excess carbohydrates can accumulate as unhealthy fat deposits. Thus causing chances of getting overweight or obesity, type 2 diabetes mellitus, high blood pressure, and other diseases.

On the other hand, even though mineral water lacks ions, electrolytes, or vitamins to replace fluids lost from the body, mineral water offers its own benefits. The absence of this content means the heart does not have to work as hard, so the heart rate is more controlled and breathing patterns become normal. It helps the body neutralize. As shown in Table 2, students who consumed air while exercising experienced only a slight increase in blood pressure, with Chart 3 showing that their heart rates remained relatively stable. This supports the hypothesis that mineral water does not inhibit breathing during physical activity. Apart from that, the absence of electrolytes in mineral water also means a lack of carbohydrates (*cnnindonesia.com, 2023*), so it has minimal impact on blood sugar levels, as seen in Chart 4. Students' blood sugar levels remain in the normal range below 100 mg/dL after consuming mineral water, making it a suitable choice for those watching their diet. Drinking water before or after exercise has a positive effect on the body, aiding hydration, digestion, and without introducing additional glucose into the system.

Furthermore, isotonic drinks usually have acidic pH levels. In this research, students consumed Pocari Sweat which has a very acidic pH level of 3.47 (*Widya Wirandika, 2013*). During vigorous exercise, cellular respiration transitions from aerobic to anaerobic due to insufficient oxygen levels. This anaerobic respiration produces lactic acid, a metabolic byproduct produced by muscles and red blood cells (*Halodoc.com, 2021*). The combination of acids from isotonic drinks, especially Pocari Sweat which is famous for its high acidity level, with lactic acid produced during exercise can cause various discomforts such as cramps, muscle aches, headaches and increased heart rate. Excess acid can disrupt muscle function, inhibit fat oxidation and reduce nutritional quality.

Ideally, after exercise, the body should return to a neutral state with normal breathing patterns. Furthermore, isotonic drinks disrupt this balance because the body's optimal pH ranges from 7.35 to 7.45 (*Dr. Soeradji Tirtonegoro Klaten, 2022*). In contrast, mineral water has a pH range of 6.5 to 8.5, which is conducive to maintaining healthy hydration and restoring the body to a neutral state (*sehataqua.co.id, 2023*). Although mineral water may not completely replace lost electrolytes, it can effectively restore the body's pH balance to normal without side effects.

However, there is another option, and is said to be the best option. For those concerned about electrolyte depletion, but still want to avoid risks of increased heart rate and blood pressure, consuming alkaline water during exercise is recommended for all age groups. Alkaline water contains electrolytes to replace electrolytes lost during physical activity, without introducing excessive carbohydrates. Additionally, alkaline water usually has a pH level of 8 or higher, which means it helps neutralize the lactic acid the body produces during exercise, improving balance and overall well-being.

## CONCLUSION

Isotonic drinks are popular for their ability to improve muscle performance among athletes and fitness enthusiasts. Its content is full of electrolytes along with ions which are able to nourish the body, restore stamina and strength to athletes. However, apart from the high electrolyte and ion content, the glucose is also high. It will also benefit individuals such as professional athletes who are known to have fast metabolisms. However, the average human does not exercise as intensely as they do. Especially teenagers. For those who do not engage in regular exercise sessions, frequent consumption of isotonic drinks can pose serious health risks. Excessive glucose that cannot be converted into energy will only accumulate as fat. This will result in increased body weight and excess fat, and cause diabetes and blood pressure.

Comparing the consumption of isotonic drinks and water before exercising involves various factors, both positive and negative. To reiterate, isotonic drinks replenish important electrolytes lost during physical activity through sweat, thereby preventing circulation problems and ion deficiency. However, because the large number of substances entering the body can cause the heart to pump blood faster and harder, resulting in an increase in blood pressure and pulse rate, resulting in a faster heart rate and resulting in a longer recovery time. This can cause blood pressure problems, even strokes for those who don't exercise enough. This will cause shock. In addition, its high carbohydrate content can contribute to fat gain if consumed after exercise. and with excessive glucose in the body, this increases the risk of an unhealthy body, increased weight gain, and glucose disease.

On the other hand, drinking water does not have as many electrolytes as isotonic drinks, although it contains enough sodium and calcium to support the body's metabolic functions. But this might be a good thing. Because no additional substances are entering the body, the heart does not need to pump excessively and hard. So, pulse rate and blood pressure do not need to increase drastically; it reduces the risk of heart disease. Plus, there's not much glucose. So there is no excess fat, it doesn't need to be converted into energy, and this can actually help burn fat in the body. Making this a safe option before and after exercise, making it suitable for individuals with a low metabolism or those following a diet plan.

Another point can be seen from the pH content of the two drinks. Isotonic drinks tend to have acidic pH levels, which can cause muscle-related problems when combined with the lactic acid produced during intense exercise. This causes muscle cramps and the body is not neutral. On the other hand, water with a neutral pH helps restore balance to the body, because its pH is neutral. However, the safest choice is alkaline water, which is highly recommended for individuals of all ages. It effectively replaces lost electrolytes without excessive carbohydrate intake and has an alkaline pH. So when the body exercises intensely and produces lactic acid which makes the body acidic, alkaline water can respond with its alkaline pH, making the body neutral again.

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