Original Article

Effects of electrolytes on endurance of middle-school girls: a prospective study

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Background: During periods of intense exercise, human body loses a substantial amount of water, in the form of sweat, along with a lot of important electrolytes. Replenishing these electrolytes is not only important to maintain homeostasis, but it helps in sustaining intense exercise for an extended period of time. The aim of the current study was to test whether drinking an electrolyte-laden drink (Gatorade) prior to a short-burst of high-intensity exercise could improve exercise time as compared to water alone.

Methods: This was a prospective cohort study of 12 middle-school girls, between ages of 12–14 years. The study was conducted over a period of 2 days, 1 week apart, where each subject served as a case and their own individual control. Drink 1 consisted of 100 mL of Gatorade and drink 2 consisted of 100 mL of water with 1 drop of Mio original liquid enhancer, which was used to add color and flavor to the water to mimic the Gatorade. Subjects ran for 30 meters after drinking Gatorade on day 1 and flavored water (in a blinded manner) on day 2. Time to distance was recorded.

Results: The mean time taken to run 30 meters was 5.98±0.5 seconds on day 1 and 6.33±0.6 seconds on day 2. On paired t-testing, there was a statistically significant improvement in 30-meter dash time after consuming Gatorade *vs.* Mio enhanced water (5.98±0.5 *vs.* 6.33±0.6 seconds, P=0.004). Nine (75%) subjects had a better running time after consumption of Gatorade.

Conclusions: In a group of middle-school girls, consumption of Gatorade before a short-burst of intense exercise was associated with a significant improvement in running time when compared to Mio enhanced water.

Keywords: Sports drinks; endurance; electrolytes

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Introduction

The primary drivers of human life are oxygen and water. In a physiologic state, approximately 65% of human body is comprised of water and is contained in various tissues, bones and blood. Water exists in many compartments within the body: intracellular (~65% within the cells) and extracellular (~35% outside the cells). An important components of a human body electrolytes. An electrolyte is a substance that ionizes (acquires a positive or negative charge) when dissolved in water. Similar to water and oxygen, electrolytes like sodium, potassium and magnesium are essential for maintaining internal homeostasis (regulation of the internal system to maintain stability), which is crucial for life.

Another crucial element of a healthy human life is exercise (1-3). However, during periods of intense exercise, human body loses a substantial amount of water, in the form of sweat, along with a lot of important electrolytes.

Figure 1 The 2 types of drink products used for the experiment.

Replenishing these electrolytes is not only important to maintain homeostasis, but it helps in sustaining intense exercise for an extended period of time (4). With an increased understanding of sports physiology, there is an increased emphasis on fluid and electrolyte replenishment techniques (5,6). With that in mind, many electrolyte replenishment products have been developed over the last 50 years, with emerging studies and recommendations (7). The first and foremost of such drinks was Gatorade, a unique mixture of water, simple carbohydrates and electrolytes, which was developed by an Assistant Coach at University of Florida, United States. While many other "sports drinks" have emerged in the market since, it remains one of the best known and widely used products of its kind in the world today. It is typically recommended for athletes that indulge in rigorous activity lasting at least 60 minutes, but is still beneficial to the body when intense activity lasts for less than 60 minutes (8,9).

Hypothesis and specific aims

Based on that knowledge, we hypothesized that drinking Gatorade could improve short-term endurance over using water alone. The aim of the current study was to test whether drinking Gatorade prior to a short-burst of high-intensity exercise could improve exercise time as compared to water alone.

Methods

Study population: this was a prospective cohort study of 12 middle-school girls, between ages of 12–14 years, who agreed to participate in the study after providing informed parental consent. The current study was approved by the school ethics committee. The study was conducted over a period of 2 days, 1 week apart, where each subject served as a case and their own individual control.

Study site: a school gymnasium that was more than 30 meters in length.

Materials: 2,400 mL of Strawberry Watermelon flavored Gatorade, 2,400 mL of water, 1 Bottle of Strawberry Flavored Mio Liquid Enhancer and a stopwatch. Drink 1 consisted of 100 mL of Gatorade and drink 2 consisted of 100 mL of water with 1 drop of Mio original liquid enhancer, which was used to add color and flavor to the water to mimic the Gatorade. However, unlike the Gatorade, Mio liquid enhancer does not have the added sugars or the electrolytes). Please refer to *Figure 1* for images of the two products.

Prior to conducting the experiment, a taste-test of the two drinks was carried out on two independent subjects, to confirm that the color and taste of the two drinks was similar.

Experiment on day 1: initially, 100 mL of Gatorade was poured into 12 cups and gave 1 cup to each of the subjects to drink. After drinking, the subjects were told to wait one minute before running to allow for the absorption of the drink. Subsequently, the subjects ran 30 meters while the time was recorded. After a period of rest of 2 minutes, the experiment was repeated once again and we recorded the 30-meter dash time of each subject. So, there were a total of

Table 1 The running times of the subjects for the experiment, recorded on day 1

Subject #	Day 1 time 1 (sec)	Day 1 time 2 (sec)	Average time (sec)
1	7.06	5.30	6.045
2	6.11	5.97	6.04
3	5.37	6.21	5.79
4	5.33	5.07	5.2
5	6.40	6.47	6.435
6	6.04	6.43	6.235
7	6.25	6.25	6.25
8	5.56	5.86	5.71
9	6.64	6.52	6.58
10	5.28	4.85	5.065
11	5.88	6.38	6.13
12	6.09	6.41	6.25

Table 2 The running times of the subjects for the experiment, recorded on day 2

Subject #	Day 2 time 1 (sec)	Day 2 time 2 (sec)	Average (sec)
1	6.03	6.03	6.03
2	5.91	6.02	5.965
3	6.91	5.91	6.41
4	5.56	4.87	5.215
5	7.30	6.85	7.075
6	7.20	6.07	6.635
7	7.24	6.31	6.775
8	7.71	5.32	6.515
9	7.08	6.51	6.795
10	5.75	4.93	5.34
11	6.80	7.13	6.965
12	6.10	6.30	6.2

24 times recordings for day 1.

Experiment on day 2: there was a time gap of 1 week between the 2 experiment days.

The day 2 of the experiment was similar to above, 100 mL of water was poured into 12 cups and added 1 drop of Mio liquid enhancer into each cup, which was then given to each subject to drink. After drinking, the subjects were told to wait one minute before running to allow for the absorption of the drink. Subsequently, the subjects ran 30 meters while the time was recorded. After a period of rest of 2 minutes, the experiment was repeated once again and we recorded the 30-meter dash time of each subject. Similar to above, there were a total of 24 times recordings for day 2.

All study subjects were blinded to the type of drink they were consuming at all times.

Statistics

Continuous variables are reported as mean +/– standard deviation. Categorical variables are reported percentage. Comparison running times on day 1 *vs.* day 2 was performed using paired *t*-testing. A P<0.05 was considered significant.

Results

The average age of the subjects was 13 years (range, 12–14 years). No subject had any physical disabilities that would limit their ability to perform a short-burst of high endurance exercise. The running times of the subjects for the experiment, recorded on day 1 are shown in *Table 1*. The mean time taken to run 30 meters was 5.98±0.5 seconds. Similarly, the running times of the subjects for the experiment, recorded on day 2 are shown in *Table 2*. The mean time taken to run 30 meters was 6.33±0.6 seconds.

On paired t-testing, there was a statistically significant improvement in 30-meter dash time after consuming Gatorade *vs.* Mio enhanced water (5.98±0.5 *vs.* 6.33±0.6 seconds, P=0.004). *Figure 2* demonstrates the change in average running times for each subject after consuming Gatorade and Mio enhanced water. As shown in the figure, 9 (75%) subjects improved their running time after consumption of Gatorade.

Discussion

In this prospective blinded study of middle-school girls, we demonstrate that consumption of Gatorade was associated with a significant improvement in their 30-meter dash time when compared to a similar amount of Mio enhanced water. In fact, 2/3 rs of the subjects demonstrated an improvement in their running times after consumption of Gatorade. No

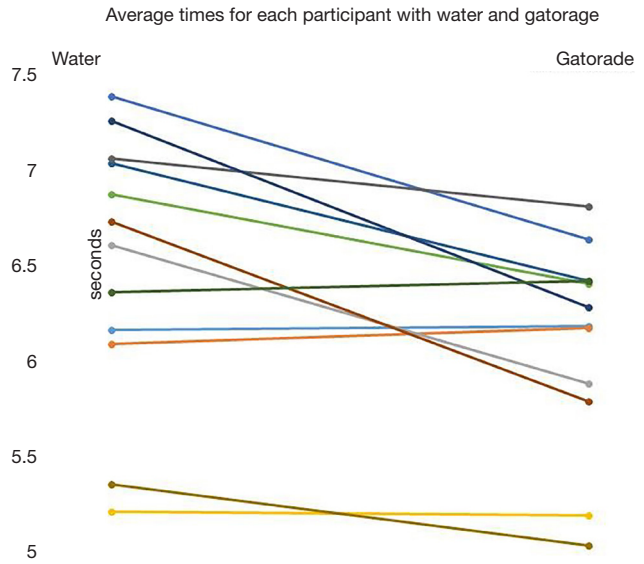

Figure 2 Change in average running times for each subject after consuming Gatorade and Mio enhanced water.

subject had a physical disability which would have impacted the results of the study. In order to avoid a fluke over or under-performance, the subjects were made to run twice per experiment day and average times were recorded. Also, in order to avoid the impact of fatigue on performance, we conducted the experiments with Gatorade and Mio enhanced water on separate days, a week apart.

In order to ensure maintain scientific validity, we ensured that the two "sports drinks" utilized in the study were comparable in color and taste. As a result, we utilized the Mio liquid enhancer to make the water appear and taste similar to the Gatorade. The Mio enhanced liquid was first taste-tested in a blinded fashion by two subjects not related to the current study. The study subjects were blinded to the sports drinks they were consuming.

Exercise is a crucial aspect of a healthy human life-style (1-3). However, during periods of intense exercise, human body loses a substantial amount of water and important electrolytes (5,6). Replenishing water and electrolytes is important to maintain internal homeostasis, along with helping sustain intense exercise for an extended period of time (8,9). This is the primary reason for development and popularity of electrolyte replenishment products like Gatorade over the last five decades (7). While such "sports drinks" are typically recommended for athletes that indulge in rigorous activity lasting at least 60 minutes, there is some evidence that they can be beneficial to the body even when intense activity lasts for less than 60 minutes (8,9). The results of the current study help to reinforce that notion.

Strengths and limitations: a major limitation of the current study is its small sample size. However, this study was performed prospectively in a blinded fashion, where each subject served as their own control and their results were compared to themselves. For the current study, we only included middle-school girls and the results may not be generalizable to boys or adults.

Conclusions

In a group of middle-school girls, consumption of Gatorade before a short-burst of intense exercise was associated with a significant improvement in running time when compared to Mio enhanced water. The findings of this study need further validation in a larger sample of the population.

Acknowledgments

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Footnote

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/jphe.2018.03.02). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The current study was approved by the school ethics committee. Informed consent was taken from their parents.

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