



Pre-Exercise Sports Drink Durations' Effects on Vo2 Max, Exercise Capacity, Heart Rate, and Oxygen Saturation after a sports workout

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Abstract: In the realm of athletics, there are many chances for athletes to showcase their abilities, gain experience, and enjoy themselves. Everyone from athletes to those in other fields is naturally competitive, so they're constantly trying to outdo themselves. A total of forty-five undergraduates from Indore's Devi Ahilya Vishwavidyalaya's Physical Education department participated in the research. Ages ranged from eighteen to twenty-five for the participants. Three groups of fifteen were formed from this pool of participants using a randomisation process. The three groups were referred to as "Group A," "Group B," and "Control Group C" in that order. The findings suggest that future research should aim for bigger samples, include participants of varying ages and sexes, and include more characteristics.

Keywords: Pre-exercise sports, Effects Drink durations, sports workout

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INTRODUCTION

There are many opportunities for athletes to show off their skills, get experience, and have fun in the athletic world. Nowadays, there is a lot of science and math involved in sporting activities, from biomechanics and physiology to nutrition and sociology to psychology and computer science to growth and development and sports medicine, among several other disciplines. Recognising potential, being fit, and training using scientific techniques are all necessities of international sports. Athletes' exceptional performances are influenced by several factors such as their genetics, physical condition, training, skill level, biomechanics, and psychology. As stated by Conway et al. (2010). A number of nations are sending their best athletes to show the world who's boss. Athletes' strength, stamina, and ability have been tested to their limits as they've been driven to run faster, more nimble, and more flexible by the national spirit.

Because of their inherent competitiveness, athletes from all areas of life are always pushing themselves to set new marks. In addition, there is a constant quest for innovative methods by which coaches may improve their players' performance. Physical education instructors, coaches, fitness experts, and others in the athletic and active professions depend significantly on their knowledge of exercise physiology in their daily job. Modern exercise physiology, biomechanics, and psychological tools are many for researchers to choose from. This may be useful for fitness experts, instructors, and trainers in the field as it allows them to collect and exchange data on people's exercise and physical activity levels. It could be useful for the scientific design and implementation of training and exercise programs for athletes of all types.

Athletes should pay close attention to their pre-exercise diets since they have a significant impact on vital physiological variables including heart rate, exercise capacity, VO₂ max, and oxygen saturation. A lot of people are interested in the dietary approach of drinking a sports drink before exercise. The reasoning behind this is that it will help you utilise energy more efficiently, delay fatigue, and have a better workout overall. Despite ongoing research, there is currently no consensus on how long it is best to wait after drinking a sports drink before engaging in physical performance. Sports drinks, which could include carbohydrates, electrolytes, and other performance-enhancing ingredients, primarily serve to hydrate the user, regulate electrolyte levels, and replace glycogen stores. Important for promoting physical activity over the long term and mitigating performance declines, these factors must be present. Knowing how the body responds to different amounts of fluids before exercise could be very helpful for coaches, athletes, and sports nutritionists.

We want to get a better understanding of the relative benefits of consuming sports drinks at various pre-game intervals from this study. The duration of the advantages of pre-workout beverages is a question that researchers are attempting to answer by examining several aspects. Also, the effects of pre-workout supplements on outcomes will be examined, taking into account factors like training history and individual physiological variances.

The findings of this research have the potential to inform the development of evidence-based nutrition plans that can benefit athletes across different sports. Gaining an advantage and enhancing exercise efficiency in the pursuit of peak athletic performance requires an understanding of the nuances of when to drink before activity.

METHODOLOGY

Selection of subjects

The study's participants were 45 students chosen at random from the Physical Education program at Devi Ahilya Vishwavidyalaya in Indore. The participants' ages varied from eighteen to twenty-five. Using a randomisation procedure, these people were separated into three groups of fifteen each. We called the three sets of participants "Group A," "Group B," and "Control Group C" respectively. Each group received a different beverage in order to study the impact of various fluids on physiological performance measures. As a control, Group C got ordinary filtered water, Group B got freshly squeezed lemon juice, and Group A got Gatorade, a commercially available sports drink.

Experimental Design

A randomized group design was implemented to ensure objective results and minimize bias. Initially, all 45 subjects were randomly allocated into three groups. Sports drinks were also randomly assigned to each group to reduce any influence of selection bias. This design allowed for a comparative analysis of how different types and timings of fluid intake affected exercise performance and physiological response.

Description of Sports Drinks Administered

Gatorade (Group A): Commercially available sports drink (orange flavor), 500 ml per serving.

Fresh Lemon Juice (Group B): Prepared by mixing 500 ml filtered water with 10 ml lemon extract, 30 grams sugar, and 1 gram salt.

Plain Water (Group C): 500 ml of UV-filtered water.

Statistical procedures

We used the right statistical methods to look at the differences within and between the groups. To evaluate differences among groups between the pre- and post-tests, the paired t-test was used. To make sure the treatment effects were accurately interpreted, Analysis of Covariance (ANCOVA) was used to compare the three groups' means, with pre-test scores adjusted for as variables. When it came to examining disparities between groups, one was more suited than the other.

- Dependent t-Test, also known as Paired Sample t-Test
- Step two: analysis of covariance

DATA ANALYSIS AND INTERPRETATION

Analysis of heart rate: pre- and post-test comparisons (1 hour before exercise)

Table 1: Paired Sample t-Test on Heart Rate Measurements Before and After Games Workout When drinks were administered 1 hour prior to exercise

Group	Timing	Test Stage	Mean ± SD	t-value	t-critical
Gatorade	Immediately	Pre-Test	130.6 ± 4.96		
		Post-Test	122.4 ± 4.17	9.50*	1.76
	2 minutes	Pre-Test	105.13 ± 5.96		
		Post-Test	101.6 ± 6.27	10.51*	1.76
	5 minutes	Pre-Test	87.0 ± 6.05		
		Post-Test	81.06 ± 5.33	6.05*	1.76
Lemon Juice	Immediately	Pre-Test	130.73 ± 5.87		
		Post-Test	123.8 ± 3.18	5.62*	1.76
	2 minutes	Pre-Test	105.13 ± 5.96		
		Post-Test	101.6 ± 6.24	3.94*	1.76

	5 minutes	Pre-Test	87.2 ± 4.67		
		Post-Test	80.46 ± 6.12	3.38*	1.76
Water (Control)	Immediately	Pre-Test	131.0 ± 5.56		
		Post-Test	124.53 ± 4.48	8.29*	1.76
	2 minutes	Pre-Test	106.0 ± 5.92		
		Post-Test	102.73 ± 3.28	3.30*	1.76
	5 minutes	Pre-Test	86.86 ± 4.68		
		Post-Test	83.66 ± 4.68	8.41*	1.76

*Significant at 0.05 level

All three groups' heart rates decreased considerably after each recorded period following the games activity, according to the paired t-test results: **Gatorade Group:** Significant reductions were observed immediately after exercise ($t = 9.50$), at 2 minutes post ($t = 10.51$), and at 5 minutes post ($t = 6.05$). These results suggest Gatorade had a consistent effect in supporting heart rate recovery across all time points. **Lemon Juice Group:** The t-values for immediate (5.62), 2 minutes (3.94), and 5 minutes post-exercise (3.38) were also statistically significant, indicating a beneficial effect on heart rate reduction, though the effect size was slightly lower compared to the Gatorade group. **Control Group (Water):** Surprisingly, even plain water led to significant heart rate reductions (t-values = 8.29, 3.30, and 8.41). While effective, the trends suggest a slightly less consistent or sustained impact than Gatorade.



Figure 1: Pre-Test and Post-Test Heart Rate

Comparison of oxygen saturation levels post-workout when drinks were administered one hour prior

in experimental and control groups

Table 2: ANCOVA Analysis of Oxygen Saturation Immediately After a Games Workout When Drinks Were Given One Hour Before Workout in Experimental and Control Groups (Oxygen saturation measured in %)

Test	Gatorade Drink Group	Lemon Juice Group	Control Group	Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F Ratio
Pre-Test								
Mean	93.8	93.67	93.8	Between	0.17	2	0.08	0.05*
SD	1.32	1.23	1.26	Within	68.13	42	1.62	
Post-Test								
Mean	94	93.73	93.73	Between	0.71	2	0.35	0.2*
SD	1.06	1.57	1.33	Within	75.86	42	1.80	
Adjusted Post-Test								
Mean	94	93.72	93.73	Between	0.75	2	0.38	0.21*
				Within	74.9	41	1.83	

***Note:** Low statistical significance ($p < 0.05$). For $df(2,42)$ and $df(2,41)$, the F ratio needed for significance at the 0.05 level is 3.22.

The groups administered the Gatorade drink (93.8 ± 1.32), the lemon juice (93.67 ± 1.23), and the control (93.8 ± 1.26), were given the pre-test oxygen saturation mean and standard deviation, respectively. At 0.05, the estimated F-value fell short of the 3.22 crucial table F-value. This proves that the random assignment of participants worked as there was no discernible variation in oxygen saturation among the three groups before the beverages were given.

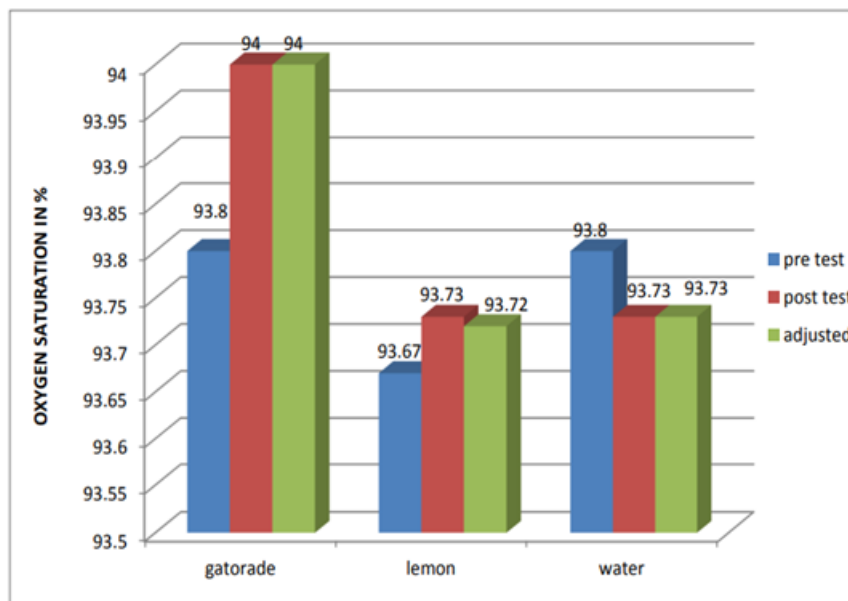


Figure 2: Pre-test, post-test and adjusted Post-test means of oxygen saturation immediately after an games workout when drinks were given 1 hour before workout in experimental groups and control group

Evaluation of heart rate immediately after a games workout in experimental and control groups

Table 3: ANCOVA Analysis of Heart Rate Immediately After a Games Workout (Drinks administered 4 hours before workout; heart rate in beats per minute)

Test	Gatorade Drink Group	Fresh Lemon Juice Group	Control Group	Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F Ratio
Pre-Test								
Mean	130.6	130.73	131	Between	1.24	2	0.62	0.02*
SD	4.96	5.87	5.56	Within	1262.53	42	30.06	
Post-Test								
Mean	123.67	124.53	125.2	Between	17.73	2	8.86	0.31*
SD	5.82	4.34	5.74	Within	1201.46	42	28.60	
Adjusted Post-Test								
Mean	123.67	124.53	125.2	Between	12.41	2	6.21	0.38*

				Within	679.05	41	16.56	
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*Note: Insignificant at the 0.05 level. The F ratio for significance at the 0.05 level for $df(2,42)$ and $df(2,41)$ is 3.22.

Pre-Test Observations

The control group had a heart rate of 131 ± 5.56 beats per minute, the group given Gatorade a heart rate of 130.6 ± 4.96 beats per minute, and the group given fresh lemon juice a heart rate of 130.73 ± 5.87 beats per minute. Compared to the necessary table F value of 3.22, the computed F value of 0.02 was much lower. This result verifies that there were no notable variations in heart rates across the three groups prior to drink delivery, suggesting that individuals were successfully randomised.

Post-Test Observations

Post-test heart rate means and standard deviations were recorded as: Gatorade drink group at 123.67 ± 5.82 , fresh lemon juice group at 124.53 ± 4.34 , and control group at 125.2 ± 5.74 . The computed F value of 0.31 was less than the table F value of 3.22, showing no significant variation. This suggests that consuming Gatorade, fresh lemon juice, or water four hours prior to the workout had no substantial effect on heart rate immediately after the games workout.

Adjusted Post-Test Observations

Following the test, the groups whose heart rates were adjusted showed the following: the control group (125.2), the Gatorade drink group (123.67), and the fresh lemon juice group (124.53). At the 0.05 threshold of significance, the computed F-value of 0.38 was not significant, as it was lower than the table F-value of 3.22. Heart rate after exercise was unaffected by drinking Gatorade, fresh lemon juice, or water four hours before to the exercise, according to the data.

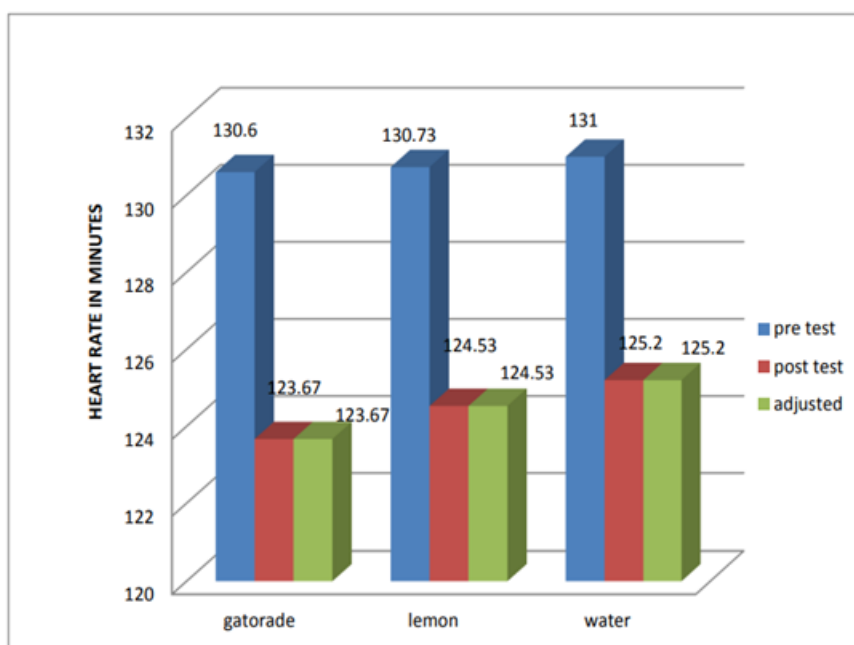


Figure 3: Heart Rate Pre-, Post-, and Adjusted Post-Workout Comparison of Heart Rate Two Minutes After Workout Among Experimental and Control Groups (Following Drink Administration 4 Hours Before Exercise)

To evaluate the impact of pre-workout drinks on heart rate recovery, data were collected from three groups those who consumed Gatorade, fresh lemon juice, and plain water (control) with heart rate recorded two minutes post-exercise. The analysis involved comparing pre-test, post-test, and adjusted post-test means using ANCOVA.

Comparison of oxygen saturation two minutes after exercise among experimental and control groups (Following Beverage Intake 4 Hours Prior to Workout)

Table 4: ANCOVA for Oxygen Saturation (%) Two Minutes After Games Workout (Following Beverage Intake 4 Hours Before Exercise)

Test Stage	Gatorade	Lemon Juice	Water (Control)	Source of Variation	SS	df	MS	F-Ratio
Pre-Test	95.8 ± 0.77	95.73 ± 0.88	95.87 ± 0.74	Between Groups	0.13	2	0.67	0.10
				Within Groups	27.07	42	0.64	
Post-Test	95.87 ± 0.74	95.93 ± 0.96	96 ± 0.92	Between Groups	0.13	2	0.06	0.09
				Within Groups	32.66	42	0.77	
Adjusted Post-Test	95.87	95.97	95.96	Between Groups	0.10	2	0.05	0.10
				Within Groups	23.98	41	0.58	

Note: The critical F-value at the 0.05 level for $df(2,42)$ and $df(2,41)$ is 3.22. All observed F-ratios were below this threshold, indicating statistical insignificance.

Pre-Test Comparison: The pre-test oxygen saturation means for the Gatorade (95.8 ± 0.77), lemon juice (95.73 ± 0.88), and control (95.87 ± 0.74) groups showed no statistically significant differences. The calculated F-value of 0.10 was far below the critical F-value of 3.22. This supports the assumption that participants were randomly and evenly distributed among the groups prior to the intervention.

Post-Test Analysis: Two minutes after the workout, the post-test means recorded were 95.87 ± 0.74

(Gatorade), 95.93 ± 0.96 (lemon juice), and 96 ± 0.92 (control). The F-ratio of 0.09 also fell below the significance threshold, indicating that the consumption of different drinks had no significant impact on post-exercise oxygen saturation at this interval.

Adjusted Post-Test Outcomes: After adjusting for covariates, the oxygen saturation means were 95.87 (Gatorade), 95.97 (lemon juice), and 95.96 (control). The F-ratio remained low at 0.10, confirming the absence of statistically meaningful differences between the groups even after adjustments. Thus, the findings suggest that drinking Gatorade, lemon juice, or water four hours before exercise does not produce a significant effect on oxygen saturation measured two minutes post-workout.

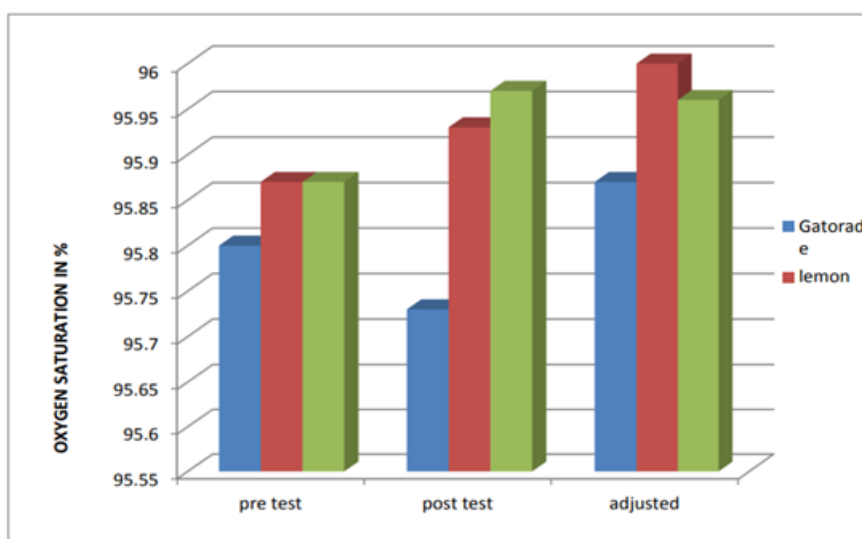


Figure 4: Pre-Test, Post-Test, and Adjusted Post-Test Oxygen Saturation (Two Minutes After Games Workout With Drinks Taken 4 Hours Prior)

Legend

- **Gatorade:** Experimental Group Consuming Gatorade.
- **Lemon:** Experimental Group Consuming Fresh Lemon Juice.
- **Water:** Control Group Consuming Water.

Assessment of exercise capacity at baseline and post-workout in experimental and control groups

Table 5: Paired t-Test Analysis of Exercise Capacity After a Games Workout (Drinks administered 4 hours before workout)

Group	Sampling Stage	Mean ± SD	Calculated t	Tabulated t
Gatorade	Baseline	708.73 ± 43.07	1.28	1.76
	Post-Test	703.53 ± 45.67		
Fresh Lemon	Baseline	706.13 ± 65.80	1.62	1.76

	Post-Test	705.47 ± 65.79		
Water (Control)	Baseline	707.53 ± 53.93	0.06	1.76
	Post-Test	706.8 ± 47.34		

*Note: No significance at the 0.05 level (calculated t below tabulated t of 1.76).

Gatorade Drink Group

For the Gatorade group, the baseline exercise capacity mean and standard deviation were 708.73 ± 43.07, with post-test values at 703.53 ± 45.67. The calculated t-value of 1.28 is below the tabulated t-value of 1.76, indicating no significant difference. This suggests that consuming Gatorade four hours before a games workout had no notable impact on exercise capacity.

Fresh Lemon Juice Group

In the fresh lemon juice group, the baseline mean and standard deviation were 706.13 ± 65.80, and post-test values were 705.47 ± 65.79. The calculated t-value of 1.62 is less than the tabulated t-value of 1.76, showing no significant change. Thus, the administration of fresh lemon juice four hours prior to the workout did not significantly affect exercise capacity.

Water (Control) Group

For the control group (water), the baseline mean and standard deviation were 707.53 ± 53.93, with post-test values at 706.8 ± 47.34. The calculated t-value of 0.06 is well below the tabulated t-value of 1.76, confirming no significant difference. This indicates that water consumption four hours before the workout had no substantial effect on exercise capacity.

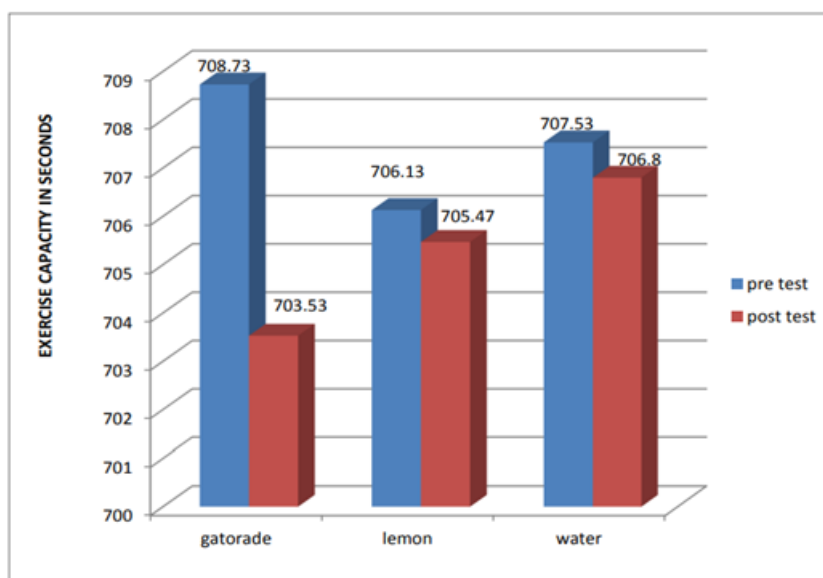


Figure 5: Exercise Capacity Pre- and Post-Workout

Evaluation of vo2 max at baseline and post-workout in experimental and control groups

Table 6: Paired t-Test Analysis of VO2 Max After a Games Workout (Drinks administered 4 hours before workout)

Group	Sampling Stage	Mean ± SD	Calculated t	Tabulated t
Gatorade	Baseline	49.42 ± 2.62	0.20	1.76
	Post-Test	49.58 ± 2.74		
Fresh Lemon	Baseline	49.01 ± 3.72	0.95	1.76
	Post-Test	49.40 ± 3.75		
Water (Control)	Baseline	48.63 ± 2.96	1.74	1.76
	Post-Test	48.83 ± 2.72		

*Note: No significance at the 0.05 level (calculated t below tabulated t of 1.76).

Gatorade Drink Group

In the Gatorade group, the baseline VO2 max mean and standard deviation were 49.42 ± 2.62 , with post-test values at 49.58 ± 2.74 . The calculated t-value of 0.20 is well below the tabulated t-value of 1.76, indicating no significant difference. This suggests that consuming Gatorade four hours before a games workout had no notable impact on VO2 max.

Fresh Lemon Juice Group

For the fresh lemon juice group, the baseline mean and standard deviation were 49.01 ± 3.72 , and post-test values were 49.40 ± 3.75 . The calculated t-value of 0.95 is less than the tabulated t-value of 1.76, showing no significant change. Thus, the administration of fresh lemon juice four hours prior to the workout did not significantly affect VO2 max.

Water (Control) Group

In the control group (water), the baseline mean and standard deviation were 48.63 ± 2.96 , with post-test values at 48.83 ± 2.72 . The calculated t-value of 1.74 is slightly below the tabulated t-value of 1.76, confirming no significant difference. This indicates that water consumption four hours before the workout had no substantial effect on VO2 max.

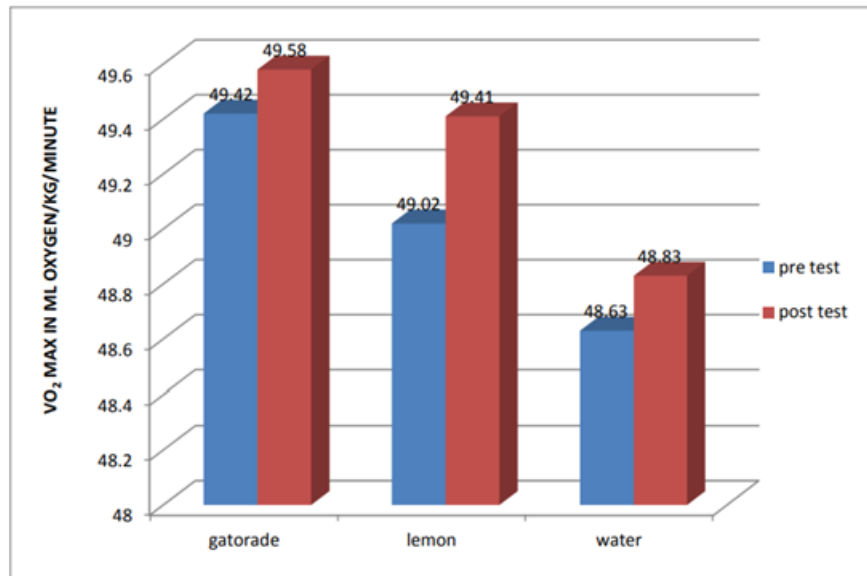


Figure 6: VO₂ Max Pre- and Post-Workout

CONCLUSION

The study revealed that the timing of pre-exercise ingestion of Gatorade, lemon juice, or water did not yield significant differences in performance or oxygen metrics, except for heart rate, which improved across all groups. These outcomes suggest that while heart rate may be sensitive to hydration and rest, neither drink type nor timing had a substantial impact on overall aerobic performance or oxygenation. Based on these results, it is recommended that future studies be conducted with larger sample sizes, across different age groups and sexes, and by incorporating additional variables.

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