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The effect of the carbohydrate loading method on improving the performance of amateur runners

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Abstract

Many runners experience decreased performance and premature fatigue, influenced by various factors, including nutrition. The results of the observations show a high level of fatigue and a need for more performance among runners who are members of the running community in Makassar, especially beginner runners. This research aims to examine the effect of the carbohydrate loading method on improving the performance of the amateur runner community in Makassar. This research used an experimental design involving 60 runners from the amateur runner community in Makassar. Subjects were divided into two groups: an experimental group that applied the carbohydrate loading method and a control group that followed a normal eating pattern. Training to measure runner performance The multistage fitness test (MFT) is the instrument to measure runner performance. Data analysis techniques with t-test (paired sample t-test) to see differences using spss version 20. Data analysis showed significant improvements in performance improvement with the carbohydrate application method. The average performance value increased in the experimental group to 46.18 compared to the control group to 37.21. This increase can be seen from the calculated t-value of 13.75. So, the carbohydrate loading method influences performance. The carbohydrate loading method is an effective strategy for improving the performance of running athletes, especially in the Makassar runner community. With proper application, this method can help runners achieve peak performance, reduce fatigue, and increase efficiency during training and competition.

Keywords: Performance, carbohydrate loading, runner.

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INTRODUCTION

In the world of sports, especially long-distance running, many factors, including nutrition, greatly influence an athlete's performance

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(Hughes & Holscher, 2021). One nutritional method that is often used to improve performance is the carbohydrate loading method or what is usually called Carbohydrate Loading (Burke, 2021). Carbohydrate loading is a nutritional strategy that aims to increase glycogen stores in the muscles and liver Wilson, (2022), which can be used as an energy source during long-term, high-intensity exercise (Lawler & Cialdella-Kam, 2020).

Carbohydrate loading can improve performance in sports that lasts more than 90 minutes and extend the time to exhaustion (Quinn et al., 2024). Increasing performance using the Carbohydrate Loading method has become popular among athletes, especially long-distance runners (Sepriadi, 2019) because it has been proven to increase performance and endurance during the competition (Hartoto et al., 2023). This process is usually carried out by increasing carbohydrate consumption (8-12 grams per kilogram of body weight) for 3-4 days before engaging in intense physical activity (Kelly et al., 2021). Although much research has been conducted on the effect of carbohydrate loading on athlete performance (Shandi et al., 2021), most of this research has focused on elite or professional athletes (Fadhiil et al., 2023).

Runners who apply carbohydrate loading before a competition show a significant increase in performance compared to runners who do not apply it (King et al., 2022; Michalczyk et al., 2019). This increase in performance is characterized by faster running times and reduced levels of fatigue (Shiose et al., 2022). increasing glycogen reserves through carbohydrate loading can also help reduce muscle fatigue during training and competition (Furber et al., 2022). Research conducted by (Hidayatulloh & Widodo, 2020) on the runner community found that the carbohydrate loading method can be implemented effectively with the right guidance. The running community in Makassar is growing very rapidly, with many participants competing in various events ranging from marathons (Feely et al., 2023; Wigati et al., 2022). There is potential to increase runners' performance through the application of the carbohydrate loading method (Podlogar & Wallis, 2022), in line with the increasing public

interest in running sports, but more attention should be paid to strategies for increasing performance through carbohydrate loading.

Carbohydrate loading is a technique used by athletes to increase the amount of energy stored in the muscles to improve the athlete's sports performance, especially in long-duration sports (Millah, 2019). Makassar, one of the largest cities in Indonesia, has many amateur runner communities. The running community participates in activities large and small. By understanding the Carbohydrate Loading method on the performance of Makassar runners, researchers hope to provide practical guidelines for improving the performance of multisport runners and opportunities for developing sports education in Indonesia. This research observes and analyzes the runner community in Makassar using the pre-run Carbohydrate Loading technique. The parameters measured increase runners' performance, one of which is using Vo2 max or endurance (Marsuna et al., 2024).

Further explained by (Dorans et al., 2021; Iwayama et al., 2023), the strategy of implementing carbohydrate loading can optimize energy utilization during endurance training. This research aims to determine the effect of the Carbohydrate Loading method on improving running performance in the running community in Makassar. Thus, the results of this research can provide practical and scientific guidance for runners to improve their performance safely and effectively, help them achieve their best performance, and support the development of the running community in Makassar in particular.

METHOD

The research design uses experimental methods and an RCT (Randomized Controlled Trials) approach, namely a control group pretest-posttest design. The sample was divided into 2 (two) groups randomly by dividing by age. The sample was divided into two groups. Group 1 is the experimental group (Carbohydrate Loading method), and group 2 is the control group (no treatment). They were used in this research.

The subjects of this research were 60 amateur runners, with samples taken using purposive sampling. In this study, runners who were male, aged 20-22, and who were willing to be research subjects were used. The subjects were then divided into 2 groups: an experimental group of 30 people and a control group (without treatment) of 30 people. Group division was carried out randomly based on age.

Table 1. Control group pretest-posttest design

Pre-test	Treatment	Post-test
O1 (Experimental class)	X	O2 (Experimental class)
O3 (Control class)		O4 (Control class)

The multistage fitness test (MFT) instrument is used to measure runner performance (Lockie et al., 2021). This test involves running back and forth between two lines 20 meters apart, with the speed gradually increasing according to the beep signal heard. In the control group, it can be increased for matches of more than 90 minutes by eating a regular balanced diet (50-60% carbohydrates), with vigorous physical exercise on the fifth and fourth days before the match, followed by a high carbohydrate diet (approx. 70% - 80%) and a gradual decrease in training intensity during the last three days before the match (Damayati, 2015). Increased glycogen capacity can be achieved by loading carbohydrates a few days before the competition to prevent the appearance of fatigue too early. Carbohydrate loading will lead to an increase in the level of energy formation and even increase the performance capacity of the athlete's body during the race. For amateur athletes of Makassar City, carbohydrate loading is applied 3 to 5 days before the race, including the depletion and loading stages.

Research Procedure

Carbohydrate loading given to the high carbohydrate experimental group was 70-80% of total energy requirements (protein and fat were given with normal percentages of 5-15% for protein and 10-20% for fat). High carbohydrate food intake was given with three large meals and two snacks. The total energy and carbohydrate intake given for seven days is 1) Day 1 intake of 4000 calories with 710 grams of carbohydrate (71%); 2)

Day 2 intake of 4010 calories with 722 grams of carbohydrate (72%); 3) Day 3 intake of 4015 calories with 733 grams of carbohydrate (73%); 4) Day 4 intake of 4020 calories with 744 grams of carbohydrate (74%); 5) Day 5 intake of 4025 calories with 755 grams of carbohydrate (75%) 6) Day 6 intake of 4030 calories with 766 grams of carbohydrate (76%); and 7) Day 6 intake of 4402 calories with 766 grams of carbohydrate (75%). Day 7 intake of 4040 calories with 778 grams of carbohydrate (77%).

The data analysis technique uses descriptive statistical tests, then proceeds with prerequisite tests, namely normality test analysis and the t-test, using SPSS Version 20.

RESULT

Researchers present descriptive data on the variable carbohydrate loading's effect on performance improvement in amateur runners by obtaining minimum, maximum, performance improvement, and standard deviation values. Table 2 presents the various types of analysis.

Table 2. Description of the application of the control and experimental groups to improve performance

Data statistics	Experimental group	Control group
Number of samples	30	30
Minimum	40.50	31
Maximum	49.60	42.70
Performance improvements	46.18	37.21
Standard Deviation	2,59	2,45

Based on the results of statistical analysis of performance improvement with multistage fitness test (MFT) training, there is an increase in performance that can be seen from the data obtained in the experimental group, which has a minimum result of 40.50, a maximum result of 49.60, with an increase in performance of 46.18 and a standard deviation of 2.59. The performance improvement of this study's experimental group was more optimal than the control group. Based on these findings, carbohydrate loading needs to be applied to long-distance running athletes.

The statistical analysis results of performance improvement in the control group had a minimum result of 31, a maximum result of 42.70, a

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performance increase of 37.21, and a standard deviation of 2.45. Descriptive data is depicted in the following diagram, figure 1:

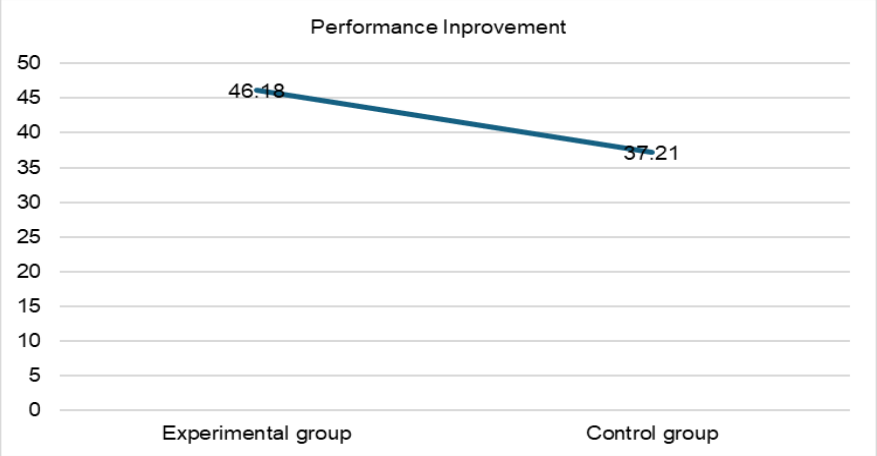

Figure 1. The difference in performance improvement between the experimental group

The results of data analysis can be integrated into a frequency distribution table, where the results obtained in the experimental and control groups are presented in a form that is easier for readers to understand and analyze. This frequency distribution is used to understand how data is distributed and to identify patterns or trends (Haryono et al., 2023). The results of data analysis can be integrated into a frequency distribution table, where the results obtained in the experimental and control groups are presented in a form that is easier for readers to understand and analyze. This frequency distribution is used to understand how the data is distributed and to identify patterns or trends (Haryono et al., 2023). Based on the results of data analysis, it was found that the experimental group with carbohydrate loading was more dominant, with a value of 48.18, while the control group was 37.21. The frequency distribution can be seen in the following table:

Table 3. Frequency distribution results improved performance through MFT training

Performance Improvement Experiment Results			Improved Performance of Control Results		
Intervals	**Frequency**	**Percentage**	**Intervals**	**Frequency**	**Percentage**
40.50-41.44	1	3%	31.00-34.64	1	3
41.45-42.09	1	3%	34.65-36.04	4	13
42.10-44.19	1	3%	36.05-38.84	12	40
44.20-44.64	1	3%	38.85-40.79	10	33
44.65-45.54	4	13%	40.80-42.09	1	3
45.55-49.58	13	43%	42.10-42.58	1	3
49.59 -49.60	9	30%	42.59 -42.70	1	3
Total	**30**	**100%**	**Total**	**30**	**100**

Based on the application of the results of the frequency distribution of performance improvement after applying the carbohydrate loading method, data was obtained, namely: as many as 4 people with a percentage of 3% each who had MFT (multistage fitness test) results of 40.50-44.64. A total of 4 people with a percentage of 13% had MFT test results of 44.65-45.54. A total of 13 people, with a percentage of 43%, had MFT test results of 45.55-49.58. Furthermore, as many as 9 people, with a percentage of 30%, had MFT test results of 49.59-49.60. Meanwhile, the data obtained by increasing performance by not applying the carbohydrate loading method were: 1 person with a percentage of 3% who had MFT (multistage fitness test) results of 31.00-34.64. A total of 4 people with a percentage of 13% had MFT test results of 34.65-36.05. A total of 12 people, with a percentage of 40%, had MFT test results of 36.05-38.84. A total of 10 people, with a percentage of 33%, had MFT test results of 38.85-40.79. Furthermore, as many as 3 people, with a percentage of 3% each, had MFT test results of 40.80-42.70. The results of the data normality test in this study aim to determine whether the data that has been obtained follows a normal distribution between groups or treatments in an experiment that are the same or comparable. The results of the data normality test can be seen in the following table:

Table 4. Results of data normality test implementation

	statistic	Significance
Implementation Experiment	0.901	0.179
Control Implementation	0.837	0.090

Based on the data normality test table, the experimental group obtained a significance value of 0.179 > 0.05, and the control group obtained a significance value of 0.090 > 0.05, where both groups had normally distributed data. Next, a t-test was carried out on each group to determine the effect of the carbohydrate loading method on improving the performance of the Makassar runner community.

Table 5. Results of Implementation of t-Test Data Analysis

Variable	t	df	Mean Difference	Significance
Experiment and Control Implementation Data Analysis Results	13.75	58	8.97	0.000

Based on the results of the t-test data analysis in the experimental and control groups, it is known that the calculated t-value is 13.75> 0.05, so it can be concluded that the carbohydrate loading method influences the performance of the Makassar runner community. Based on the percentage increase in performance through MFT (multistage fitness test) training, it is 8.97% of the results obtained from the experimental and control groups.

DISCUSSION

This study's results show a significant increase in performance in the amateur runner community who use the carbohydrate loading method. This is done by increasing carbohydrate intake before aerobic activity or during heavy aerobic exercise (Hulton et al., 2020; König et al., 2019). In essence, glucose is needed when exercising as an energy source (Boisseau & Isacco, 2022). Therefore, runners need available glucose to be broken down from glycogen stores in the liver and muscles to help the runner's performance when entering a high-intensity period (Hargreaves & Spriet, 2020). During exercise, an athlete's energy fuel is used because of glycogen availability in the muscles and central nervous system (Alghannam et al., 2021).

Endurance lasting more than 90 minutes aims to quickly increase glycogen synthesis with slightly more branching points than usual so as to

delay fatigue and improve runner performance (Husnul, 2024). Physical fitness can be improved through correct, measurable, and sustainable training and the implementation of regular measurements (Bauhaus et al., 2023; Xianglin et al., 2020). Carbohydrate intake is one of the main considerations in a runner's diet; various studies show that carbohydrates can fill muscles with glycogen, which is very important for optimizing runners' stamina (Hulett et al., 2022; Muscella et al., 2020). This optimization can be achieved by maintaining carbohydrate intake in both types and amounts when exercising. Fulfillment This aims to carry out cardio loading, namely adjusting the carbohydrate diet so that muscle glycogen can be formed and stored seven days in advance (Moreno-Cabañas & Gonzalez, 2023; Soo et al., 2023). Some running competitions involve heavy training for three days to use up glycogen reserves, where a runner's stamina is a determining component of a runner's success in achieving achievements. Without excellent fitness, runners will not be able to achieve results even though they have good technical and tactical abilities.

This research has many limitations, such as the characteristics of the sample, which still needs to be narrower, namely only involving amateur runners aged 20-22 years, even though the population of the runner community in Makassar is still large over that age. Therefore, this reduces the strength of the results to be limited. In addition, according to (D'Souza et al., 2023), various factors such as age, gender, and type of exercise appear to have a subtle but potentially important influence on continuous glucose monitoring (CGM) measurements during exercise in healthy individuals. However, this research is difficult to generalize to the amateur runner community in Makassar. Although this research shows the influence of the carbohydrate loading method on runner performance, it does not assume the possibility that other unexpected variables influence the performance, as explained by (Granero-Gallegos et al., 2020). Other alternative interpretations that influence the response to Structured aerobic exercise can vary significantly from individual to individual. Furthermore,

research conducted by (Parmar et al., 2021) explains that variations in training duration and intensity of aerobic training used in this study can have a significant effect on performance because the training is structured, so it is difficult to generalize it to the population of the runner community in Makassar so that It is possible that there are other factors involved in improving the runner's performance.

Food and nutrition research shows that consuming sufficient carbohydrates before training or competition can improve runners' endurance and performance. In this study, a carbohydrate intake of between 70-80% was applied to the experimental group and it was found that the results were better than the control group. In addition, adequate hydration is also very important to maintain performance and prevent fatigue. Well-structured training and adequate recovery time are key to maintaining runner performance. Therefore, carbohydrate loading is recommended for long-distance running athletes.

Similar research conducted by (Hulton et al., 2022) based on factors such as muscle glycogen depletion and hypoglycemia is discussed. This study of the energy requirements of soccer highlights key nutritional strategies to support the preparation and recovery of male soccer players to improve performance or at least enable players to perform adequately. Thus, Carbohydrate loading is a nutritional strategy that aims to increase muscle glycogen stores before high-intensity physical activity or competition. Several studies show that this method can significantly improve athlete performance, especially in endurance sports. Future research can evaluate the long-term effects of the structured carbohydrate loading method on improving the performance of amateur runners. This will provide a better understanding of the sustainability of results and the factors that influence performance improvements.

CONCLUSION

The carbohydrate loading method succeeded in increasing muscle glycogen stores in amateur runners in Makassar. This increase allows runners to have greater energy reserves during training or competition.

Runners who apply carbohydrate loading show a significant increase in performance compared to those who do not. They are able to run at higher intensities and for longer durations without experiencing excessive fatigue. The average running time of runners over various running distances decreased after implementing the carbohydrate loading method. This shows that this method is effective in increasing running efficiency and speed. Runners report decreased fatigue levels during and after training or competition. With greater energy stores, they can maintain optimal performance for longer. The success of the carbohydrate loading method is highly dependent on the runner's adherence to established nutritional protocols, including consuming the right amount of carbohydrates at the right time. Runners and coaches need to plan their nutritional strategies well before important competitions or training. Adopting a carbohydrate loading method can be an integral part of competition preparation. Educating runners about the importance of carbohydrate loading and how to do it correctly is very important. Assistance by a nutritionist or trainer can also help ensure runners follow the protocol correctly. Although the carbohydrate loading method is generally effective, each individual's response can be different. Therefore, it is important to take an approach that is tailored to the needs and conditions of each runner.

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