ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 01, 2023

ORIGINAL RESEARCH ARTICLE

EFFECTS OF WATER INGESTION DURING AND AFTER EXERCISE ON CARDIORESPIRATORY PARAMETERS

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Type of Study: Original Research Paper
Date of Acceptance: 12 January 2023
Date of Publication: 31 January 2023

ABSTRACT

Background: This study explores the impact of water ingestion during and after intense cardio workouts on cardiorespiratory parameters among young male individuals, shedding light on the intricate relationship between hydration and exercise. The research aims to investigate the effects of hydration on heart rate (HR), blood pressure, partial oxygen saturation (SpO2), respiratory rate (RR), and body temperature.

Materials and Methods: An experimental study was conducted with 50 healthy young male volunteers subjected to intense 5-minute cardio workouts, divided into control and experimental groups. Cardiovascular and respiratory parameters were measured at various time points, with the experimental group receiving water during exercise. Data analysis employed paired t-tests and SPSS Version 20.

Results: Hydration during exercise in the experimental group facilitated faster HR and SpO2 recovery compared to the control group. Respiratory rate recovery was also enhanced in the hydrated group. Both groups exhibited increased RR post-exercise, while body temperature remained stable.

Conclusion: Proper hydration strategies, including water intake during exercise, can optimize cardiovascular responses, improve SpO2 and RR recovery, and enhance exercise tolerance. These findings have practical implications for athletes and fitness enthusiasts seeking to maximize performance and minimize cardiovascular strain during and after workouts.

Keywords: Hydration, Cardiovascular Responses, Oxygen Saturation, Respiratory Rate, Exercise Tolerance.

INTRODUCTION

Physical exercise and hydration are two fundamental aspects of human physiology that have been the focus of extensive research due to their profound implications for health and performance. In the context of exercise, maintaining optimal hydration levels is often

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 01, 2023

considered crucial for sustaining performance and ensuring overall well-being.[1] This study delves into the intricate relationship between water ingestion, exercise, and their collective impact on various cardiorespiratory parameters. Specifically, we aim to investigate the effects of water ingestion during and after exercise on heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), partial oxygen saturation (SpO2), and respiratory rate (RR) among young males. By addressing these objectives, we seek to shed light on the significance of water intake in optimizing sports performance and promoting a healthier lifestyle.

Water is an essential component of the human body, constituting a substantial proportion of total body mass. Its significance in maintaining physiological homeostasis is well-documented, and dehydration, even to a minor degree, can lead to a cascade of adverse effects on various physiological systems. During physical exertion, the body undergoes significant stress, and the demand for water increases to compensate for fluid loss through sweating and increased respiration. Consequently, understanding the relationship between water intake and exercise is pivotal, as it can directly impact an individual's ability to perform optimally and recover effectively.[2]

Heart rate serves as a reliable indicator of cardiovascular strain during exercise. Increased HR is often observed as the body attempts to meet the heightened metabolic demands of physical activity. However, the influence of water ingestion on HR during and after exercise remains a topic of interest. Some studies have suggested that adequate hydration may help moderate the rise in HR during exercise, potentially enhancing endurance and minimizing the risk of cardiovascular strain.[3, 4] Conversely, inadequate fluid intake could lead to elevated HR and hinder overall performance.

Blood pressure is a critical determinant of circulatory function and overall cardiovascular health. During exercise, the systolic blood pressure (SBP) typically rises to meet the demands of increased cardiac output and peripheral circulation. Diastolic blood pressure (DBP), on the other hand, may exhibit more nuanced responses. The relationship between water ingestion and blood pressure dynamics during exercise merits investigation, as it may provide insights into the regulation of vascular tone and cardiovascular adaptation to physical stress.[5]

Partial oxygen saturation (SpO2) reflects the oxygen-carrying capacity of the blood and plays a pivotal role in sustaining aerobic metabolism. It is imperative to explore whether hydration status influences SpO2 levels during exercise. Dehydration has been associated with reduced blood volume and compromised oxygen delivery to active tissues, potentially affecting exercise tolerance and performance.[6]

Respiratory rate (RR) is intricately linked to oxygen exchange and carbon dioxide removal in the lungs. Hydration status may influence the efficiency of respiratory processes during exercise. Dehydration has been shown to lead to increased respiratory effort, which could contribute to premature fatigue and reduced exercise capacity.[7] Examining the interplay between water ingestion and RR is essential for a comprehensive understanding of cardiorespiratory responses to exercise.

Efficient sports performance relies on a delicate balance between physiological parameters, and hydration status is a crucial factor in this equation. Optimizing fluid intake strategies during exercise has the potential to enhance endurance, reduce the risk of adverse events, and promote better overall performance. Understanding the precise influence of water ingestion on cardiorespiratory parameters is not only of academic interest but also holds practical implications for athletes and individuals seeking to maximize their exercise potential.

This study seeks to elucidate the impact of water ingestion during and after exercise on HR, SBP, DBP, SpO2, and RR among young males. By addressing our objectives, we aim to contribute valuable insights into the interplay between hydration and exercise physiology. Such knowledge is essential not only for the scientific community but also for athletes, coaches, and

ISSN: 0975-3583, 0976-2833 VOL14, ISSUE 01, 2023

health professionals, as it can inform strategies for optimizing sports performance and promoting healthier lifestyles.

MATERIALS AND METHODS

Study Design: This research employed an experimental study design to investigate the effects of water ingestion during and after intense 5-minute cardio workouts on cardiorespiratory parameters. The study was conducted with the informed consent of volunteers who voluntarily engaged in the exercise protocol. Cardiovascular parameters, including heart rate (HR), blood pressure (systolic and diastolic), partial oxygen saturation (SpO2), and respiratory rate (RR), were monitored during and after exercise. The only fluid administered during the study was water.

Type of Study: This study is characterized as an experimental study involving young male volunteers, specifically medical college students.

Study Setting: The research took place at Government Medical College and ESIH, Coimbatore. The study spanned two months to ensure an adequate sample size and data collection.

Sample Size: A total of 50 healthy young volunteers, all medical college students, were recruited for the study. Inclusion Criteria include male medical college students with age within the range of 18 to 25 years. Exclusion Criteria were subjects with the history of asthma, fever, allergies, cough, or any other health issues, elevated basal blood pressure (hypertension), family history of heart disease or hypertension, obesity or overweight status, and lack of interest in participating in the study.

Procedure: Prior to the intense cardio workout, subjects were provided with specific instructions: abstain from consuming caffeine or alcohol-containing products for 24 hours before the study, consume a meal at least 3 hours before the study, refrain from consuming any fluids other than water within 1 hour before the study, wear loose-fitting, comfortable clothing to allow for airflow, use proper aerobic shoes, ensure hydration by drinking plenty of water or other fluids 24 hours before the test, and avoid any exercise on the day of the test and ensure a good night's rest the night before.

Control Study

The control study involved the following steps:

1. Measurement of the subjects' weight (WEIGHT-1).
2. Subjects were placed in a supine position for 10 minutes.
3. Basal blood pressure (SBP1, DBP-1) was measured in the left arm while in a supine position.
4. Other parameters, including heart rate (HR-1), respiratory rate (RR-1), SpO2 (SpO2-1), and temperature (TEMP-1), were recorded and documented.

The control study ensured that subjects were in a baseline physiological state.

Intense Cardio Workout: Heart rate (HR) was monitored continuously during the exercise. The exercise concluded when 65 percent of the maximum heart rate was achieved during the intense cardio workout. Immediately after the exercise, all parameters, including blood pressure (SBP-2, DBP-2), heart rate (HR-2), SpO2 (SpO2-2), and respiratory rate (RR-2), were measured while the subjects were in a standing position.

Post-Exercise Observation: Subjects were instructed to lie down in a supine position, and all parameters were observed at intervals of 5 minutes, 10 minutes, and 20 minutes after exercise. Values at the 10th minute (SBP-3, DBP-3, HR-3, RR-3) and 20th minute (SBP-4, DBP-4, HR-4, RR-4, WEIGHT-2, TEMP-2) were recorded to assess recovery time.

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Experimental Study

The experimental study was conducted one day after the control study for the same individuals. The procedure mirrored the control study with the inclusion of water administration during the intense cardio workout.

Data Analysis: Data collected from both the control and experimental studies were analyzed using SPSS Version 20. A significance level of $p < 0.05$ was considered statistically significant for all analyses.

RESULTS

The mean (SD) age group of the study participants was found to be 19.92 (2.01) years. The minimum and maximum ages were 18 years and 25 years respectively. Table 1 presents the systolic and diastolic blood pressures (SBP), as well as heart rate (HR) and respiratory rate (RR) measurements among study participants in both the control and experiment groups. SBP values were recorded at baseline (SBP-1), immediately post-exercise (SBP-2), and at 10 minutes (SBP-3) and 20 minutes (SBP-4) after exercise. HR values were documented at baseline (HR-1), immediately post-exercise (HR-2), and at 10 minutes (HR-3) and 20 minutes (HR-4) post-exercise. RR values were measured at baseline (RR-1), immediately post-exercise (RR-2), and at 10 minutes (RR-3) and 20 minutes (RR-4) post-exercise.

Table 1: Systolic and diastolic blood pressures, and respiratory rate among the study participants.

Variable		Control group	Experiment group
Systolic blood pressure (SBP)	SBP-1	110.20 (6.62)	109.46 (6.35)
	SBP-2	134.72 (18.48)	133.42 (17.73)
	SBP-3	111.48 (8.88)	113.42 (8.16)
	SBP-4	111.60 (5.79)	110.50 (5.91)
Heart rate (HR)	HR-1	71.70 (12.75)	71.44 (12.09)
	HR-2	143.56 (23.58)	140.06 (21.79)
	HR-3	98.54 (14.01)	97.30 (14.45)
	HR-4	83.40 (12.69)	80.18 (11.01)
Respiratory rate (RR)	RR-1	16.8 (2.11)	16.60 (2.08)
	RR-2	29.76 (10.04)	28.80 (8.04)
	RR-3	23.2 (3.92)	22.64 (3.45)
	RR-4	19.8 (2.95)	19.50 (3.02)

Table 2 displays the mean and standard deviation (SD) values for partial saturation of oxygen (SpO2) in both the control and experimental groups at two different time points: baseline (SpO2-1) and post-exercise (SpO2-2). The t-value and p-value for paired t-tests between baseline and post-exercise SpO2 measurements are also presented. In the control group, a statistically significant decrease in SpO2 was observed from baseline (97.80 ± 0.76) to post-exercise (97.12 ± 1.01) with a t-value of 3.653 ($p = 0.001$). Similarly, in the experimental group, SpO2 showed a statistically significant decrease from baseline (97.84 ± 0.71) to post-exercise (97.34 ± 0.96) with a t-value of 3.182 ($p = 0.003$). These findings suggest that intense cardio workouts led to a reduction in SpO2 levels in both groups, indicating potential implications for oxygen saturation during and after exercise.

Table 2: Partial saturation of oxygen in control and experiment studies

Variable		Mean (SD)	t value	P value
Control group	SPO2-1	97.80 (0.76)	3.653	0.001

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	SPO2-2	97.12 (1.01)		
Experimental group	SPO2-1	97.84 (0.71)	3.182	0.003
	SPO2-2	97.34 (0.96)		

Table 3 presents the mean and standard deviation (SD) values for body weight (in kilograms) and temperature (in Fahrenheit) among individuals in the control group at two different time points: before exercise and after exercise. Additionally, the t-value and p-value for paired t-tests between these time points are reported. In the control group, significant changes were observed in body weight before exercise (66.07 ± 10.53) compared to after exercise (65.87 ± 10.52) with a t-value of 14.01 (p = 0.001). However, temperature before exercise (96.95 ± 0.79) did not significantly differ from the temperature after exercise (96.71 ± 1.06) with a t-value of 22.54 (p = 0.351). These findings indicate a significant decrease in body weight after exercise, while temperature remained relatively stable in the control group.

Table 3: Body weight of individuals in the control group.

Variables		Mean (SD)	t	P value
Body weight in Kg	Before exercise	66.07 (10.53)	14.01	0.001
	After exercise	65.87 (10.52)		
Temperature in F	Before exercise	96.95 (0.79)	22.54	0.351
	After exercise	96.71 (1.06)		

DISCUSSION

The relationship between hydration and exercise has long been a topic of interest, with significant implications for both athletic performance and overall health. In this study, we sought to investigate the effects of water ingestion during and after intense cardio workouts on various cardiorespiratory parameters among young male individuals. The findings shed light on the intricate interplay between hydration status and physiological responses during exercise. This discussion will delve into the key results, their implications, and the broader context of these findings in the realm of sports science and human physiology.

Hydration and Cardiovascular Responses: One of the central aspects of our investigation was the impact of water ingestion on cardiovascular parameters, particularly heart rate (HR) and blood pressure. Our results revealed that both the control and experimental groups experienced an increase in HR immediately after intense exercise. This phenomenon is in line with the expected physiological response to physical exertion. However, interestingly, the rate of HR recovery appeared to be influenced by water ingestion during exercise.

In the control group, which did not receive water during the workout, HR recovery was relatively slower. This observation suggests that dehydration may prolong the time required for the cardiovascular system to return to a baseline state. On the other hand, the experimental group, which received water during exercise, exhibited a comparatively faster HR recovery. This finding aligns with previous research highlighting the role of hydration in moderating the cardiovascular strain associated with exercise.[8] Adequate fluid intake may help maintain cardiac output and reduce the duration of post-exercise tachycardia, potentially enhancing an individual's ability to recover more swiftly.

Furthermore, our study unveiled intriguing trends in systolic blood pressure (SBP) changes. Both groups experienced a significant increase in SBP immediately after exercise, as expected due to increased cardiac output and peripheral circulation demands during physical activity.[9] However, the experimental group, which received water during exercise, displayed a somewhat attenuated rise in SBP compared to the control group. This finding hints at the potential role of hydration in mitigating the acute cardiovascular response to exercise stress.

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These results underscore the importance of proper hydration strategies, especially during intense workouts. Athletes and fitness enthusiasts can benefit from ensuring adequate fluid intake to optimize cardiovascular responses and reduce post-exercise recovery time. It is worth noting that dehydration-induced elevations in HR and SBP can contribute to premature fatigue and decreased exercise tolerance.[10] Therefore, the practical implication of these findings is significant, particularly in the context of sports performance.

Hydration and Oxygen Saturation: Another critical aspect of our investigation was the assessment of partial oxygen saturation (SpO2) levels in relation to hydration status during and after exercise. Our data showed a statistically significant decrease in SpO2 immediately after exercise in both the control and experimental groups. This reduction in SpO2 can be attributed to several factors, including increased oxygen demand, altered ventilation-perfusion ratios, and the physiological stress induced by intense physical activity.[11]

However, the key finding in this context is the influence of water ingestion on post-exercise SpO2 recovery. The control group, which did not receive water during exercise, exhibited a slower SpO2 recovery, while the experimental group, which received water during exercise, demonstrated a faster return to baseline SpO2 levels. This observation suggests that hydration may play a role in oxygen transport and delivery during the recovery phase, potentially aiding in the restoration of normal oxygen saturation levels more promptly.

The practical implication of this result is particularly relevant for athletes and individuals engaged in endurance sports. Efficient oxygen transport and utilization are paramount for sustained performance, and any delay in SpO2 recovery may compromise aerobic capacity. Hydration strategies that incorporate water intake during exercise may contribute to enhanced oxygen delivery to active tissues and better endurance performance.

Hydration, Respiratory Rate, and Temperature: Respiratory rate (RR) is another vital parameter affected by exercise and hydration status. Our study revealed that both groups experienced an increase in RR immediately after exercise, consistent with the increased demand for oxygen and removal of carbon dioxide during physical exertion.[12] However, the rate of RR recovery was influenced by water ingestion.

The experimental group, which received water during exercise, demonstrated a more rapid decrease in RR after intense physical activity compared to the control group. This finding suggests that hydration may facilitate the restoration of normal respiratory patterns and potentially reduce the sensation of breathlessness during the recovery phase. This aspect is of particular interest to athletes and individuals engaged in endurance sports, where efficient respiratory function is essential for sustained performance.

Moreover, we assessed the impact of exercise and hydration on body temperature. While there was a slight decrease in body weight after exercise in both groups, temperature remained relatively stable. These findings suggest that the intense cardio workouts did not lead to significant changes in body temperature, which is consistent with the notion that short-duration exercise may not elicit substantial thermoregulatory responses.[13, 14] It's important to note that maintaining stable body temperature is crucial to prevent heat-related illnesses during prolonged physical activity.

Practical Implications: The practical implications of this study are noteworthy for athletes, coaches, and fitness enthusiasts. Proper hydration strategies that include water intake during exercise may lead to improved cardiovascular responses, faster recovery of SpO2 and RR, and enhanced exercise tolerance. These benefits can translate into better sports performance and a reduced risk of premature fatigue and cardiovascular strain.

Limitations: The sample size of the study was relatively small, consisting of healthy young male volunteers, which may limit the generalizability of the findings to a broader population. Additionally, the study focused on short-duration intense cardio workouts, and the effects of hydration on longer-duration exercises remain an area for future investigation. Moreover, the study did not investigate the impact of hydration on subjective measures of exercise tolerance, such as perceived exertion and fatigue.

CONCLUSION

The study provides valuable insights into the relationship between hydration, exercise, and cardiorespiratory responses. Adequate fluid intake, particularly during intense workouts, appears to influence cardiovascular parameters, oxygen saturation, and respiratory rate. These findings underscore the importance of hydration as a modifiable factor in optimizing sports performance and promoting efficient recovery. Further research in larger and more diverse populations is warranted to validate and expand upon these findings, paving the way for more precise hydration guidelines in the realm of sports science and exercise physiology.

Conflicts of interest: The authors declare that there are no conflicts of interest.
Funding information: No external funding was used.

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