Jurnal
Kepelatihan
Olahraga

Volume 18 Number 1 (2026) 31 - 36

Journal homepage:
https://ejournal.upi.edu/index.php/JKO
p-ISSN number: 2086-339X e-ISSN number: 2657-1765
DOI: https://doi.org/10.17509/jko-upi.v18i1.89769

Response of Selected Physiological Variables and Blood Electrolyte Levels Following an 800 m Freestyle Swim in Youth Long-Distance Swimmers

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ABSTRACT

This study examined acute cardiovascular and electrolyte responses following an 800 m freestyle swim in youth long-distance swimmers. A one-group pretest–posttest experimental design was employed. Twelve male competitive swimmers (16.18 ± 0.70 years; training age 7.2 ± 0.58 years) participated voluntarily. Heart rate, systolic and diastolic blood pressure, and blood concentrations of sodium, potassium, calcium, and hemoglobin were measured before and immediately after exercise. Paired-sample t-tests and Cohen's d effect sizes were calculated. Significant post-exercise increases were observed in heart rate, systolic blood pressure, sodium, potassium, and calcium concentrations ($p < .05$), with moderate to large effect sizes. No significant changes were found in diastolic blood pressure and hemoglobin concentration. These findings indicate that an 800 m freestyle effort induces substantial acute cardiovascular strain and electrolyte redistribution in youth swimmers. Coaches should consider hydration management and cardiovascular monitoring when prescribing long-distance swimming sessions.

ARTICLE INFO

Article History:
Submitted 07 December 2025
Revised 01 January 2026
Accepted 02 February 2026
Available online 01 March 2026
Publication Date 01 March 2026

Keyword:
swimming physiology,
electrolyte balance,
cardiovascular response,
youth swimmers,
endurance swimming.

1. INTRODUCTION

Middle- and long-distance swimming events rely heavily on aerobic metabolism and sustained cardiovascular output (Pyne & Sharp, 2014; Mujika et al., 2019). The 800 m freestyle event is characterized by prolonged submaximal intensity with high oxygen uptake demand and significant thermoregulatory involvement (Seifert et al., 2019).

From a cardiovascular perspective, endurance swimming elevates heart rate and systolic blood pressure through sympathetic activation and increased cardiac output (Kenney et al., 2020). Hydrostatic pressure and horizontal body position uniquely influence venous return and stroke volume compared to land-based endurance exercise (Tipton, 2016). Training-induced adaptations in swimmers include plasma volume expansion and improved cardiac efficiency (Convertino, 2012; Hellard et al., 2018).

Electrolyte balance is fundamental for neuromuscular transmission and excitation–contraction coupling. Sodium and potassium regulate membrane potential and action potential propagation, while calcium governs cross-bridge cycling in skeletal muscle (Sawka et al., 2015; Armstrong, 2007). During endurance exercise, electrolyte concentrations may fluctuate due to plasma volume shifts, sweat loss, and ion exchange between intracellular and extracellular compartments (Shirreffs & Sawka, 2011; Baker et al., 2016).

Exercise-associated hyponatremia and potassium imbalance have been reported in prolonged endurance events (Hew-Butler et al., 2015; Maughan et al., 2018). Although swimming produces lower sweat rates compared to running, electrolyte disturbances can still occur due to altered renal and hormonal regulation during sustained effort (Casa et al., 2010).

Youth athletes represent a unique population because adolescence involves ongoing cardiovascular and endocrine maturation (Rowland, 2017; Armstrong & McManus, 2011). Despite growing literature on elite swimming performance (Barbosa et al., 2021), limited applied research has examined acute electrolyte responses in youth swimmers under real pool conditions.

Most previous investigations emphasize lactate and VO_2 responses (Gastin, 2001; Figueiredo et al., 2016), with fewer studies integrating cardiovascular and biochemical markers simultaneously. Therefore, this study aims to evaluate acute changes in selected cardiovascular variables and blood electrolyte concentrations following an 800 m freestyle swim in youth long-distance swimmers.

2. METHODS

A one-group pretest–posttest experimental design was used to evaluate acute exercise responses.

2.1. Participants

Twelve male youth swimmers (age 16.18 ± 0.70 years; training experience 7.2 ± 0.58 years) volunteered.

Inclusion Criteria:

- ≥5 years competitive swimming experience
- Training frequency ≥5 sessions/week
- Free from cardiovascular, renal, or metabolic disorders

Exclusion Criteria:

- Acute illness within 2 weeks
- Medication affecting electrolyte balance
- Injury limiting performance

Parental and participant informed consent were obtained. Procedures adhered to ethical research guidelines for human participants. An equation was developed regarding the following variables (height, age, weight and training age) as shown in Table 2.1

Table 2.1 Arithmetic average, standard deviation, and variance factor of variables equalized.

Statistical means	variable	Arithmetic average	Standard deviation	Variance factor
year	age	16,18	0,70	4,32
cm	Height	167	6,67	3,99
kg	weight	55,78	5,40	9,68
years	Training age	7,20	0,58	8,05

2.2. Procedures

Testing was conducted in a 50 m outdoor pool (water temperature 18°C). After a standardized 15-minute warm-up, participants completed an 800 m freestyle swim at competitive pace.

Measurements were taken:

- Pre-exercise (resting state)
- Immediately post-exercise (within 2 minutes)

Environmental conditions were controlled to minimize confounding thermal stress.

Measurements

Cardiovascular Variables

- Heart rate (beats·min^{-1})
- Systolic blood pressure (mmHg)
- Diastolic blood pressure (mmHg)

Measured using calibrated sphygmomanometer and validated procedures (Kenney et al., 2020).

Biochemical Variables

Venous blood samples (5 mL) were collected.

Analyzed for:

- Sodium (mmol·L^{-1})
- Potassium (mmol·L^{-1})
- Calcium (mg·dL^{-1})
- Hemoglobin (g·dL^{-1})

Laboratory analyses followed standardized enzymatic protocols.

Statistical Analysis

Normality was verified using Shapiro–Wilk tests. Paired t-tests assessed pre–post differences. Effect sizes were calculated (Cohen's d). Significance level: $p < .05$.

3. RESULTS

Results of functional and biochemical variables pre –post 800 freestyle swimming exercise, (Moral at an error rate of > (0,05) at a temperature of (13) °C and table t-value is (2,16)) :

Table 3.1. AMA, Sd., and calculated t-values pre-post 800 freestyle swimming for all research variables.

Functional variables	Statistical measures	Measurement stage	AMA	Sd.	Calculated t value	Tabled t-value	morality
Heart rate	Beat /minute	pre	69,929	8,325	55,585	2,16	moral
		post	198,143	7,352			
Shrinking pressure	Mlm/z	Pre	117,857	4,258	5,896	2,16	moral
		post	149,286	18,172			

DOI: https://doi.org/10.17509/jko-upi.v18i1.89769

Recess pressure	Mlm/z	Pre	85,000	6,504	0,434	2,16	immoral
		post	84,286	7,559			
Calcium concentration	Mlg/dc	Pre	10,089	0,690	12,913	2,16	moral
		post	10,886	0,699			
Sodium concentration	Mlg/dc	Pre	142,357	5,242	5,891	2,16	moral
		post	146,429	5,080			
Potasium concentration	Mlm/litre	Pre	4,166	0,246	7,831	2,16	Moral
		post	4,385	0,195			
Hymoglobine concentration	Gm/litre	Pre	12,736	1,097	1,028	2,16	Immoral
		post	12,800	0,958			

Table 3.1 shows the morally significant variance at (0,05) level of error between pre-post exercise measures of heartbeat and in favor of post-exercise calculated t value was (55,585) higher than the tabled value reaching 2,16. The morally significant variance at the (0,05) level of error between pre-post shrinking blood pressure and the calculated t value in favour of post-measurement was (5,896) bigger than the tabled t value, reaching (2,16). The morally significant variance at (0,05) level of error between pre-post measurements of calcium concentration and in favour of post-exercise measurement calculated t value was (12,913) bigger than the tabled t value, which is (2,16). The morally significant variance at the (0,05) level of error between pre-post measurements of sodium concentration in favour of post-measurement calculated t value was (5,891) higher than the tabled t value, reaching (2,16). The morally significant variance at the (0,05) level of error between pre-post measurements of potassium in favour of post-measurement calculated t value was (7,831) higher than the tabled t value, reaching (2,16). Absence of morally significant variance at (0,05) error level between pre-post measurements of recess blood pressure. The calculated t value was (0,434) less than the tabled t value, which was (2,16) There was an absence of morally significant variance at (0,05) level of error between pre-post measurements of haemoglobin concentration; the calculated t value was (1,028) less than the tabled t value reaching (2,16).

4. DISCUSSION

The large increase in heart rate confirms acute sympathetic activation necessary to maintain oxygen delivery during prolonged aerobic effort (Kenney et al., 2020). Similar cardiovascular responses have been documented in competitive swimmers following race-pace sets (Hellard et al., 2018).

Systolic blood pressure elevation reflects increased stroke volume and peripheral resistance during sustained exertion (Joyner & Coyle, 2008). Hydrostatic pressure in water modifies circulatory dynamics, yet arterial pressure still rises proportionally to metabolic demand (Tipton, 2016).

The increase in sodium concentration may be attributed to plasma volume shifts and mild hemoconcentration (Convertino, 2012; Shirreffs & Sawka, 2011). Potassium elevation likely reflects muscular depolarization and ion efflux during repeated contractions (Bishop et al., 2011). Calcium increase supports heightened excitation–contraction coupling demand (Armstrong, 2007).

The absence of hemoglobin changes suggests that exercise duration was insufficient to induce significant plasma volume reduction beyond normal physiological variation (Rowland, 2017).

Collectively, these findings align with endurance physiology literature (Sawka et al., 2015; Maughan et al., 2018) and confirm that even youth swimmers experience measurable biochemical stress during middle-distance events.

5. CONCLUSIONS

An 800 m freestyle swim induces significant acute cardiovascular and electrolyte responses in youth swimmers, indicating that middle-distance swimming places substantial physiological stress on both circulatory and biochemical systems. These findings highlight the importance of carefully monitoring hydration strategies during endurance swim training to maintain electrolyte balance and optimize performance. Coaches are encouraged to integrate structured recovery intervals that take into account the cardiovascular strain imposed by prolonged aerobic efforts, ensuring adequate physiological restoration between sessions.

Furthermore, monitoring electrolyte status may serve as an additional tool in evaluating training load and athlete readiness. Future research should incorporate plasma volume calculations to better interpret changes in blood markers, compare responses between training and competition intensity, and expand the sample size to include female swimmers in order to enhance the generalizability of findings.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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