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Evaluating the Effectiveness of Endurance Development Exercises for Male Swimmers Aged 14–15 In Dong Nai City

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Abstract

Using fundamental scientific research methods in physical education and sports, this study selected 22 exercises aimed at developing physical endurance for male athletes of the Dong Nai City swimming team aged 14–15 over one training macrocycle, thereby contributing to enhancing training efficiency and competitive performance.

Keyword: Swimming, Experiment, Athletes, Exercises, Endurance

1. Introduction

Endurance training is designed to improve aerobic capacity, enabling swimmers to swim faster without relying heavily on anaerobic metabolism. Consequently, lactic acid accumulates at a slower rate, and the onset of acidosis is delayed. Endurance-trained athletes can maintain a faster average swimming speed during the first three-quarters of most competitive distances while preserving sufficient energy for a strong finish in the final stage. Endurance training is of critical importance for all swimmers competing in distances of 100m and above. At the age of 14–15, the nervous system undergoes rapid development characterized by high excitability of the central nervous system, weak internal inhibition, and limited attention span. To investigate this issue, the present study is entitled: *"Evaluating the effectiveness of endurance development exercises for male swimmers aged 14–15 in Dong Nai City"*.

- **Objective of the Study:** To select and apply aerobic-anaerobic endurance development exercises to improve training efficiency and competitive performance for male athletes of the Dong Nai City swimming team aged 14–15.
- **Research Methods:** The study employed the following methods: literature review and synthesis, expert interviews, pre- and post-experiment pedagogical testing, pedagogical experimentation on the selected sample of athletes, and statistical mathematics.
- **Participants:** The study involved 14 male swimmers aged 14–15 from the Dong Nai City swimming team, divided equally into two groups: an experimental group and a control group. Both groups demonstrated homogeneous baseline performance levels. The control group ($n = 7$) followed the traditional aerobic-anaerobic endurance training program prescribed by the coaching staff, whereas the experimental group ($n = 7$) trained using the newly proposed aerobic-anaerobic endurance exercises according to the study's experimental plan.

2. Results and Discussion

2.1. Baseline Assessment of Aerobic-Anaerobic Endurance of Male Swimmers Aged 14–15 in Dong Nai City

The study utilized 10 tests to examine and collect baseline data from the athletes prior to implementing the experimental program. Statistical comparisons were conducted to verify the initial equivalence between the experimental and control groups. The results are presented in Table 1.

Table 1: Comparison of baseline endurance between the experimental and control groups of male swimmers aged 14–15 in Dong Nai City prior to the experiment

TT	Test			Experimental Group ($n = 7$)	Control Group ($n = 7$)	So sánh	
				$(\bar{X} \pm \sigma)$	$(\bar{X} \pm \sigma)$	t	P
1	Specific Endurance	200m Individual Medley (s)		192 ± 4.07	192 ± 3.95	1.37	>0.05
2		400m Freestyle (s)		355 ± 8.32	354 ± 7.84	0.95	>0.05
3		800m Freestyle (s)		766 ±11.11	765 ± 11.11	0.71	>0.05
4		1500m Freestyle (s)		1476 ± 13.21	1474 ± 13.88	0.87	>0.05
5		$4\ x\ 50m$ Freestyle (s)		169 ± 3.95	168 ± 3.95	0.76	>0.05
6		50m Breaststroke Pull (s)		52.08 ± 0.25	52.07 ± 0.25	1.51	>0.05
7		Breath-holding Time (s)		48 ± 5.66	49 ± 4.65	0.49	>0.05
8	Functional Indices	Cardiac Function Index (HW)		9.3 ± 0.74	9.6 ± 0.99	0.85	>0.05
9		Vital Capacity (L)		3.37 ± 0.21	3.3 ± 0.18	0.67	>0.05
10		VO_2 max (beep test)		39.7 ± 2.29	39.66 ± 2.32	0.03	>0.05
11		Wingate test	Peak Power Output (W)	475.71 ± 32.12	474 ± 31.18	1.25	>0.05
			Relative Peak Power Output (W/kg)	6.96 ± 0.91	6.56 ± 0.85	1.81	>0.05
			Anaerobic Fatigue (%)	24.4 ± 5.33	25.1 ± 4.19	1.67	>0.05

Note: $n = 7$ per group; $df = n_a + n_b - 2 = 12 \Rightarrow t_{0.05} = 2.179$.

As shown in Table 1, the baseline endurance levels of both groups were statistically equivalent, with no significant differences observed ($P > 0.05$).

2.2. Selection and Application of Endurance Development Exercises for Male Swimmers Aged 14–15 in Dong Nai City Over One Training Cycle

2.2.1. Selection of Endurance Development Exercises

Based on the predefined selection criterion (exercises achieving $> 70\%$ consensus across both rounds of expert interviews), 22 exercises were deemed qualified for inclusion in the experimental program. The selected aerobic-anaerobic endurance exercises include:

- **Exercise 1:** 5000m run (moderate intensity).
- **Exercise 2:** 1500m run (moderate intensity).
- **Exercise 3:** 400m run.
- **Exercise 4:** Fartlek/Interval run: 200m fast, 200m slow.
- **Exercise 5:** Cycle ergometer pedaling for 30–45 minutes at moderate intensity.
- **Exercise 6:** Stair sprint (20–30 steps), 4 repetitions.
- **Exercise 7:** 4×10m shuttle run.
- **Exercise 8:** Jump rope: 6–8 sets × 15s.
- **Exercise 9:** Wheelbarrow walk for 30m.
- **Exercise 10:** Leapfrog jumps for 2 minutes.
- **Exercise 11:** Dry-land freestyle arm pull with resistance: 3–5 sets × 15s/set.
- **Exercise 12:** Dry-land backstroke arm pull with resistance: 3–5 sets × 15s/set.
- **Exercise 13:** Push-off swim 16×25m arm pull, interval $p = 45$s.
- **Exercise 14:** Push-off swim 16×25m kick, interval $p = 1$ min.
- **Exercise 15:** Push-off swim 8×50m arm pull.
- **Exercise 16:** Push-off swim 8×50m kick.
- **Exercise 17:** Swim $8 - 10 \times 200$m, rest $r = 40$s, target heart rate 160–180 bpm.
- **Exercise 18:** Swim $5 - 10 \times 150$m, rest $r = 40$s, target heart rate 160–180 bpm.
- **Exercise 19:** 2000m swim (moderate intensity).
- **Exercise 20:** 4000m swim (moderate intensity).
- **Exercise 21:** Interval swim: 100m fast, 100m slow × 3 sets.
- **Exercise 22:** Interval swim: 200m fast, 200m slow × 3 sets.

2.2.2. Application of Endurance Development Exercises

To maximize training effectiveness, established principles and methods of sports training were integrated into the 6-month (1 macrocycle) experimental intervention. The selection of exercises and progression planning were aligned with the 6-month training schedule stipulated in the 2025–2026 annual training plan (from August 2025 to January 2026).

The mandatory training frequency for both groups was 3 sessions per week, totaling 72 lesson plans across the experimental period. Out of the 24-week macrocycle, the remaining 2 weeks served as reserve weeks. The exercise progression strictly adhered to the principle of progressive overload, tailored to the athletes' age, gender, and training status, ensuring no adverse interference with their participation in the 2026 National Youth and Age-Group Swimming Championships during aerobic-anaerobic endurance training.

2.3. Evaluation of the Effectiveness of Endurance Development Exercises After One Training Cycle

Following the 1-cycle application of the selected exercises according to the experimental training plan, post-intervention assessments of aerobic-anaerobic endurance were conducted for both the experimental and control groups, as detailed in Table 2.

Table 2: Post-experiment comparison of endurance between the two athlete groups

TT	Test			Experimental Group ($n = 7$) ($\bar{X} \pm \sigma$)	Control Group ($n = 7$) ($\bar{X} \pm \sigma$)	t	P
1	Specific Endurance	200m Individual Medley (s)		182 ± 2.88	184 ± 3.59	3.27	<0.02
2		400m Freestyle (s)		334 ± 5.27	338 ± 2.44	3.34	<0.02
3		800m Freestyle (s)		722 ± 7.65	735 ± 6.33	3.15	<0.02
4		1500m Freestyle (s)		1359 ± 3.35	1364 ± 4.27	2.69	<0.05
5		$4 \times 50m$ Freestyle (s)		160 ± 1.92	166 ± 3.99	2.94	<0.05
6		50m Breaststroke Pull (s)		50.75 ± 0.32	51.5 ± 0.3	2.46	<0.05
7		Breath-holding Time (s)		64 ± 3.9	49 ± 4.65	6.42	<0.001
8	Functional Indices	Cardiac Function Index (HW)		7.18 ± 0.69	8.4 ± 0.61	3.73	<0.01
9		Vital Capacity (L)		3.88 ± 0.16	3.4 ± 0.19	4.11	<0.01
10		VO_2 max (beep test)		44.02 ± 2.92	40.9 ± 2.38	2.33	>0.05
11		Wingate test	Peak Power Output (W)	491.29 ± 30.07	479 ± 31.39	1.78	>0.05
			Relative Peak Power Output (W/kg)	7.5 ± 0.97	6.9 ± 0.81	1.04	>0.05
			Anaerobic Fatigue (%)	29.73 ± 4.57	27.2 ± 3.73	5.70	<0.01

Note: $n = 7$; $t_{0.05} = 2.447$; $t_{0.02} = 3.143$; $t_{0.01} = 3.707$; $t_{0.001} = 5.959$.

As indicated in Table 2, $t_{calculated} > t_{critical}$ at significance levels ranging from $P < 0.05$ to $P < 0.001$, demonstrating statistically significant differences between the experimental and control groups across 10 out of 13 test parameters in favor of the experimental group ($P < 0.05$), with the exception of three parameters: VO_2max (Beep test), Peak Power Output (W), and Relative Peak Power Output (W/kg). These post-experiment comparisons are further illustrated in Figure 1.

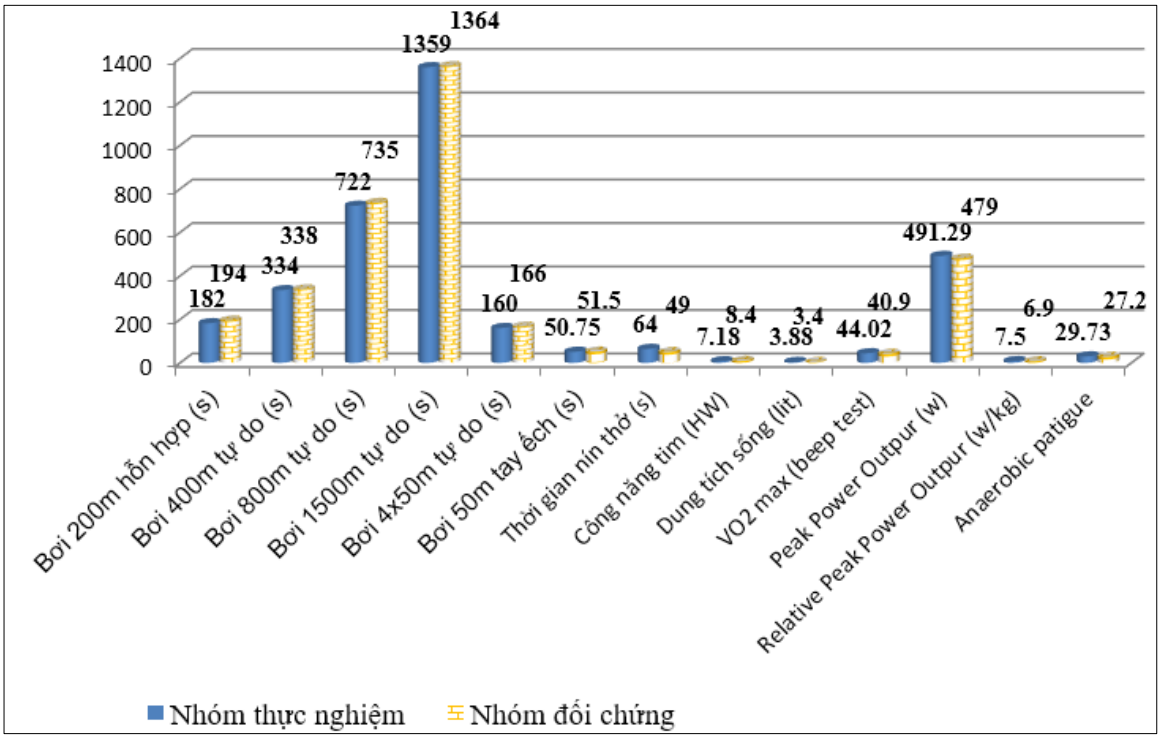


Fig 1: Post-experiment comparison of endurance performance between the two groups (Legend: Blue bar = Experimental Group; Patterned bar = Control Group)

3. Conclusion

The study successfully selected 22 exercises aimed at developing aerobic-anaerobic endurance for male swimmers aged 14–15 on the Dong Nai City team and established a 6-month training progression within one annual competitive macrocycle comprising 72 lesson plans over 24 weeks.

Experimental implementation of the selected exercises revealed superior improvements in aerobic-anaerobic endurance in the experimental group compared to the control group. Post-intervention comparisons showed that the experimental group outperformed the control group across all 13 test items, with statistically significant differences observed in 10 out of 13 parameters ($P < 0.05$ to $P < 0.001$). These empirical findings confirm that the proposed exercises are well-suited for male swimmers aged 14–15.

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