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EFFECTIVENESS OF ROUND TRAINING IN DEVELOPING SPECIAL ENDURANCE IN BADMINTONISTS

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Annotation. Traditional methods of developing badminton athletes' special endurance (intermittent sprints, multiple draws) provide insufficient growth in anaerobic power and recovery under tournament schedule conditions (3-5 matches per day). Purpose: to assess the effectiveness of the 8-week program of circuit training (CR) alternating with imitation of game actions and short recovery in improving the special endurance of 16-18-year-old players. Solution: CT increased repeat sprinting ability by 14.3% ($p < 0.01$), reduced heart rate recovery time by 22.6%, and increased the number of accurate strikes in the "30-second smash test" test by 18.7% compared to the control group. The program is recommended for the pre-competition mesocycle.

Keywords: badminton, circuit training, special endurance, repeat sprinting ability, heart rate recovery.

ENTRY

Badminton belongs to sports with variable intensity: 45-55% of playing time - high-intensity actions (3-7 m sprints, jumps, strikes), 45-55% - low-intensity movements and pauses of 8-12 s [1]. The top player's tournament day includes 3-5 matches of 35-60 minutes, which requires a high level of repeat sprinting ability (RSA) and quick recovery between games [2].

Classical methods (interval sprints 6×30 m with 30 seconds of rest, multiple wins 10×20 s) provide VO2max growth, but insufficiently develop anaerobic capacity and ATP resynthesis rate under specific techniques [3]. Circuit training (CT) alternating 6-8 stations of game action imitation and 15-20 passes reproduces match structure and allows simultaneous development of strength, speed, and endurance [4].

There are no randomized CT studies of 16-18-year-old badminton players in the literature - the age of maximum sensitivity to anaerobic loads [5].

Purpose of the study: to assess the effectiveness of the 8-week CT program in the development of special endurance in 16-18-year-old badminton players.

Hypothesis: CT surpasses traditional interval training in RSA growth, HR recovery speed, and accuracy of strikes in fatigue conditions.

MATERIALS AND METHODS

32 badminton players (16 men, 16 women) participated in the study. 16-18 years old (average age 17.1 ± 0.7 years), work experience 7.6 ± 1.3 years, national federation ranking 1st category for adults. Inclusion criteria: absence of injuries for 6 months, ≥ 5 training sessions per week. Exception: taking β-blockers, systemic diseases. Participants were randomly divided into experimental (CT, n = 16) and control (traditional, n = 16) groups. Informed consent was obtained, the protocol was approved by the ethics committee of the Sports Research Institute (protocol No. 12/24 dated 15.01.2025).

Randomized controlled trial with pre- and post-testing. Duration - 8 weeks, 3 sessions per week (Tuesday, Thursday, Saturday) for 60 minutes + 2 technical exercises. The total load is the same.

Experimental group (CT): 3 laps with 8 stations (Table. Station work - 30 s, transition - 15 s, rest between circuits - 3 min. Intensity 90-95% of HRmax.

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Table 1. CT stations

No.	Exercise	Simulated action	Major muscles
1.	40 cm Crate Jumping Smesh	Attack	Quadriceps, deltas
2.	5m sprint + return	Movement to the volan	Calcaneal
3.	Shadow drop shot	Deception	Shoulder girdle
4.	Side steps with rubber	Protection	Bringing
5.	180° turn jump	Change of direction	Dorsal
6.	Suspended Volan Strike	Accuracy	Forearm
7.	Shoulder plank	Stabilization	Cortex
8.	Double-turn archer	Coordination	Knee joint

Control group: 6× (6×20 m sprint with 20 s rest) interval training, rest between sets of 4 min + 10 min of impact imitation.

Rating Methods

1. RSA test [6]: 6×30 m sprint with 20 seconds of active rest (walking). Registration of each sprint time (Browing Timing photo sensors). The indicator is % decrement (ideal time = best × 6; % decrement = (real - ideal) /ideal × 100).
2. Heart rate restoration: Polar H10, fixing the heart rate for 60 seconds after the RSA test.
3. 30-second smash test: 30 s with maximum number of smashes on a 50×50 cm target at a height of 2.5 m (Kinovea video analysis).
4. Lactate: Lactate Pro 2 portable analyzer (finger, 3rd minute after the test).
5. RPE: Borg scale CR-10 immediately after training.

Statistical processing

SPSS 28.0. Normality - Shapiro-Wilk test. Intergroup differences - ANCOVA (covariate - pre-test). Intragroup - paired t-criterion. Significance level $p < 0.05$. The magnitude of the effect is $\eta 2$.

RESULTS

The groups did not differ in age, work experience, anthropometry, and tests ($p > 0.05$).

RSA test

Table 2. RSA test % decrement dynamics

Group	Pre-test, %	Posttest, %	Δ, %	p.
CT	8.9 ± 1.4	7.6 ± 1.1	-14.6	<0.001
Counter.	9.1 ± 1.5	8.5 ± 1.3	-6.6	0.012
Intergroup.	-	-	$p = 0.008$, $\eta 2 = 0.28$	

Heart rate recovery

CVD for 60 s: CT - from 52±7 to 64±6 bpm (Δ +23.1%, $p < 0.001$); control - from 51±8 to 55±7 bpm (Δ +7.8%, $p = 0.034$). Intergroup difference $p = 0.002$, $\eta 2 = 0.33$.

30-Second Smesh Test

Figure 1. Number of accurate smashes (average ± SD)

[Histogram: CT pretest 18.3 → posttest 21.7; control 18.1 → 19.2; $p < 0.001$]

Lactate and RPE

Lactate peak after RSA: CT 11.8 → 10.9 mmol/l ($p = 0.041$); control without changes. RPE after training: CT 7.1 ± 0.8, control 7.4 ± 0.9 ($p = 0.31$).

DISCUSSION

CT provided a greater increase in RSA (-14.6% vs. -6.6%) due to alternating multi-directional movements, which activates various muscle fibers and improves buffer capacity [7]. The

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reduction in heart rate recovery time by 23% is associated with an increase in parasympathetic reactivity - an effect previously demonstrated during CT in tennis [8].
Preservation of smash accuracy (+18.7%) during fatigue indicates improved neuromuscular control: stations with target strikes developed proprioception [9].
The decrease in lactate peak at the same intensity confirms the increase in anaerobic capacity [10].
Limitations:
1) absence of long-term follow-up (> 3 months);
2) testing in laboratory conditions (not in a match);
3) age group 16-18 years - the results require verification in adults.

CONCLUSION

An 8-week program of circuit training with imitation of game actions is more effective in developing the special endurance of 16-18-year-old badminton players than traditional interval training. It is recommended to include CT in the pre-competition mesocycle (3 times a week, 8-10 weeks) with a gradual increase in intensity from 85 to 95% of HRmax.

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