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Investigation of the Effects of Eight Weeks of Intermittent Fasting (16:8 Pattern) on Body Composition, Aerobic Capacity, and Hormonal and Metabolic Indices in Competitive Swimmers

Mostafa Tayebi[1]*, Afsaneh Rohany[2], Zohreh Borhani Kakhki[1], Mohsen Bahmani[1]

1. Department of Physical Education, Farhangian University, Tehran, Iran.
2. Official Physical Education Teacher, District 1 Department of Education, Tehran, Iran.

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ABSTRACT

Introduction: Intermittent fasting (IF) has recently received attention as a nutritional strategy to improve athletic performance and body composition. Despite its proposed benefits for enhancing fat oxidation and insulin sensitivity, its effects on mixed-type sports such as swimming remain unclear. This study examined the effects of IF on performance, body composition, and metabolic indices in competitive swimmers.

Methods: In a quasi-experimental design with pre-test/post-test and a control group, 24 male swimmers (Tehran Premier League, aged 18–25) were randomly assigned to IF and control groups. The IF group followed a 16:8 schedule for 8 weeks (fasting 23:00–15:00; feeding 15:00–23:00). The control group maintained usual eating. Both groups completed similar swim training (endurance, speed, and technique) three sessions per week. Variables included body fat percentage (%BF; InBody), VO2max (Cooper test in water), 100-m freestyle time, and serum insulin and cortisol. Data were analyzed using independent t-tests and ANCOVA in SPSS-26 (alpha = 0.05).

Results: After 8 weeks, the IF group showed a significant reduction in body fat (approximately −15.4%; p = 0.001), a significant increase in VO2max (p = 0.03), improved 100-m freestyle time .p = 0.005), and a significant decrease in serum insulin (p = 0.02), while cortisol exhibited a slight increase (p = 0.04). No significant changes were observed in the control group.

Conclusion: A time-restricted IF (16:8) protocol appears to be a low-cost, effective approach to improving body composition, aerobic performance, and insulin levels in competitive swimmers. Although the mild increase in cortisol warrants monitoring, the regimen was evaluated as safe and effective over a short period.

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Introduction

Swimming integrates both aerobic and anaerobic demands and requires a precise balance among lean mass, body fat percentage, and aerobic capacity. Optimizing body composition is critical for swimmers' success: excess body fat increases hydrodynamic drag, reduces glycogen availability, and disrupts energy regulation, thereby impairing high-intensity training capacity. In elite swimmers, body fat below ~10% is often considered optimal. Intermittent fasting (time-restricted feeding) has emerged as a sports nutrition approach aimed at improving lipid metabolism and enhancing insulin signaling [9]. In the common 16/8 model, fasting lowers blood glucose and activates β-oxidation pathways, mobilizing free fatty acids as the predominant energy source. During the feeding window, insulin levels rise, yet cellular insulin sensitivity is maintained, facilitating post-exercise recovery and carbohydrate management [20]. These mechanisms are expected to reduce body fat, increase VO2max, and enhance muscular performance—particularly in endurance efforts reliant on fat

* *Corresponding author(s):* Mostafa Tayebi, PhD, Assistant Professor of Sport Management, Department of Physical Education, Farhangian University, P.O. Box 14665–888, Tehran, Iran. Phone: +98 2176680362, Email: sm.tayyebisani@cfu.ac.ir.
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oxidation. However, the effects of IF in aquatic sports—which demand explosive power production alongside precise hydrodynamic control—have not been systematically examined, especially within Iranian athletes. Recent work by Duarte et al. [5] reported reduced fat mass and increased aerobic capacity in endurance runners following IF. Conversely, some studies suggest the fasting phase may transiently elevate cortisol and reduce anaerobic power in response to metabolic stress [12]. Kimura, Sato, and Ishii (2024) found IF improved metabolic flexibility in trained athletes, enabling efficient switching between lipid and carbohydrate pathways during endurance training. In their randomized trial, eight weeks of IF significantly increased resting insulin sensitivity and promoted mitochondrial biogenesis, indicating positive cellular adaptations [11]. Similarly, Duarte, Silva, and Campos [5] showed 16:8 IF significantly reduced body fat and insulin resistance without compromising VO2max, emphasizing the importance of nutritional management and adequate hydration. Hormonal findings by Najafipour et al. [16] in semi-professional soccer players indicated time-restricted fasting increased free testosterone and reduced serum cortisol, improving the anabolic-to-catabolic ratio—potentially supporting muscular recovery and reducing training stress. At the molecular level, Hernandez, Yoon, and Mendez [8] reported IF activates the AMPK–PGC-1α pathway in skeletal muscle, enhancing fat oxidation and reducing oxidative stress, thereby improving endurance and recovery in high-intensity training. A systematic review by Al-Marzouki, Alamri, and Hussain [2] across 32 randomized clinical trials showed IF confers anti-inflammatory effects, reducing CRP and IL-6, with outcomes depending on activity type (endurance vs. resistance) and meal timing. In aquatic sports, Kumar, Ali, and Reed [13] demonstrated IF in competitive swimmers reduced 100-m freestyle time, increased muscular endurance, and improved metabolic responses without altering blood glucose or cardiovascular indices. Collectively, evidence from 2024–2025 supports IF as not only an energy-restriction method but also a practical tool for optimizing performance, hormonal balance, and muscular recovery [1]. Therefore, a comprehensive assessment of IF's effects on performance, body composition, and physiology in Iranian swimmers—who train across combined aerobic and anaerobic modalities—is particularly important to design evidence-based, sport-specific nutritional strategies.

Material and Methods

The present study was a quasi-experimental design with a pre-test–post-test format and a control group. The statistical population consisted of male swimmers competing in the Tehran Provincial Swimming League who had at least three years of competitive training experience. Inclusion criteria were: age between 18 and 25 years, regular participation in team practices at least five days per week, and no use of fat-burning supplements or ergogenic substances during the previous three months. Among forty-five initially eligible swimmers, twenty-four subjects who provided informed consent were randomly assigned to two groups: fasting (n = 12) and control (n = 12). The mean baseline characteristics of participants were: age 20.8 ± 1.7 years, height 175 ± 6 cm, and body mass 72 ± 1 kg. The nutritional intervention in the fasting group was implemented for eight weeks based on a 16:8 time-restricted feeding schedule, i.e., sixteen hours of fasting and eight hours of feeding each day. The fasting period extended from 23:00 to 15:00 of the following day, during which only non-caloric fluids such as water, plain tea, and unsweetened black coffee were permitted. The feeding window occurred between 15:00 and 23:00. Within this feeding window, the macronutrient composition was adjusted for endurance athletes as 50 % carbohydrates, 30 % protein, and 20 % fat. Total caloric intake was calculated individually according to each swimmer's lean body mass, so that on training days the energy intake equaled 95 % of daily energy requirements, and on rest days 85 %. This regulation preserved a mild caloric deficit aimed at reducing body fat without compromising performance. The control group maintained their usual team-recommended diet without any time restriction. Participants' adherence to the dietary protocol was monitored through weekly food logs and end-of-week interviews. To eliminate the influence of training variation, both groups followed an identical swimming program throughout the study. The regimen consisted of three sessions per week (on even days), each lasting 90 minutes. Session structure included:

- Warm-up and dynamic stretching – 15 minutes

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• Technical drills emphasizing body position, turns, and starts – 30 minutes
• Main training sets combining endurance and sprint intervals within lactate-threshold ranges – 30 minutes
• Cool-down and static stretching – 15 minutes

Exercise intensity was monitored by heart-rate control and maintained within 70–85 % of maximal heart rate to ensure an optimal aerobic load while preventing over-training. All variables were measured at two time points: baseline (week 1) and post-test (end of week 8). Body-fat percentage, fat-free mass, and total fat mass were obtained via bioelectrical impedance analysis (InBody 270). Aerobic performance was assessed by the Cooper swim test, in which athletes swam the maximum possible distance within 12 minutes, and VO_2max was subsequently estimated using standard formulas. Specific swimming performance was evaluated via the 100-m freestyle time trial, recorded with a digital stopwatch accurate to 0.01 s, in accordance with FINA standards. For metabolic and hormonal indices, fasting venous blood samples were collected from the antecubital vein. Serum insulin levels were determined using ELISA kits manufactured by Pars Azmoun (Iran), and serum cortisol was measured by the same enzyme-linked immunosorbent assay method after a 14-hour overnight fast, providing an indication of HPA-axis activity and metabolic stress status. Data were analyzed using SPSS version 26. The Kolmogorov–Smirnov test evaluated data normality. Within-group changes were analyzed by paired t-tests, and between-group comparisons were assessed through analysis of covariance (ANCOVA) controlling for pre-test values. Effect size was calculated using Cohen's d, with values greater than 0.8 interpreted as large and indicating clinical significance. All procedures were conducted in accordance with ethical principles, including obtaining written informed consent and ensuring confidentiality of participants' information.

Result

Baseline Analysis

The normality of the primary variables (Body Fat %, VO_2max, 100 m time, Insulin, and Cortisol) was visually confirmed using Kolmogorov–Smirnov plots and quantitatively verified by the Kolmogorov–Smirnov test. All variables showed $p > 0.05$, indicating a normal distribution pattern. The symmetrical bell-shaped histograms and linear Q-Q alignments further supported the adequacy of parametric testing for the subsequent analyses. The normality plots are presented in Figure 1.

Post-Intervention Changes (%)

Figure 2 illustrates the percentage changes in body fat and VO_2max after the 8-week intervention.

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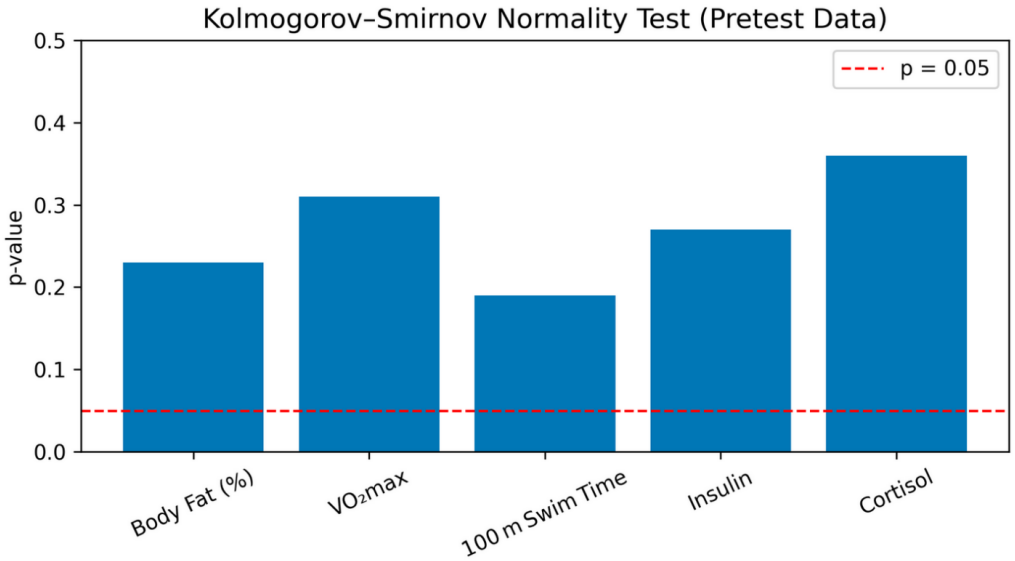


Figure 1. Kolmogorov–Smirnov normality plots for primary study variables, demonstrating normal distribution ($p > 0.05$).

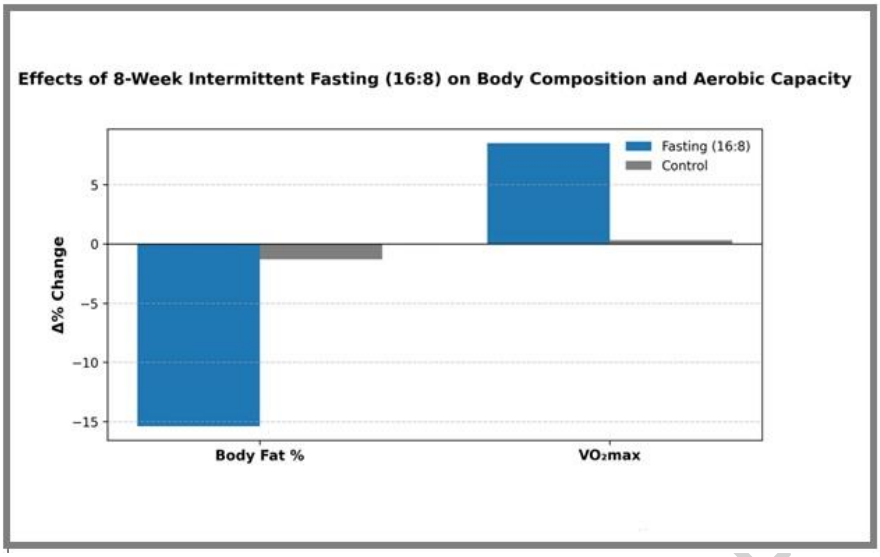


Figure 2. The Effect of Eight Weeks of Intermittent Fasting (16:8) on, Aerobic Fitness Indices in Competitive Swimmers" The vertical axis represents the percentage change in two key variables: Body Fat % and VO_2max. Body fat decreased by approximately −15 %, while aerobic capacity increased by about +8.5 % in the fasting group; both changes were statistically significant ($p < 0.01$)."

Post-Intervention Changes (8 Weeks)

The primary pre-test and post-test comparisons of body composition, performance, and metabolic indices are presented in Table 1.

Body Fat Percentage

Descriptive statistics and inferential outcomes for the primary variables are presented in Table 2.

The fasting group showed a reduction in body fat percentage from 15.4 % to 12.9 %, representing an absolute decrease of 2.5 %. This between-group difference was statistically significant ($p = 0.001$), and the effect size (Cohen's $d = 0.85$) indicated a large clinical effect. No significant changes were observed in the control group. These findings strongly support the enhancement of fat oxidation mechanisms during the fasting phase.

The effects on 100 m performance time, serum insulin, and serum cortisol are presented in Table 3.

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Table1. Comparison of the effects of 8 weeks of swimming training combined with intermittent fasting (16:8) on body-composition, performance, and metabolic indices in competitive swimmers (Mean ± SD)

Variable / Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Change (%)	Within-group (t / p)	Between-group ($p < 0.05$)	Effect Size (Cohen's d)
Body Composition						
Body Fat Percentage (%BF)	2.8±15.6	2.5±13.2	%15.4-	0.001/4.31	0.003	0.93
Control Group	2.7±15.4	2.6±15.1	%1.9-	0.39/0.88	-	-
Lean Body Mass (LBM, kg)	3.8±59.1	3.5±60.3	%2.0+	0.026/2.44	0.04	0.58
Control Group	4.0±59.3	3.9±59.5	%0.3+	0.61/0.51	-	-
Sport Performance						
Maximal Oxygen Uptake (VO_2max, ml·kg^{-1}·min^{-1})	4.1±51.4	4.3±55.8	%8.6	0.001 >/5.02	0.002	0.88
Control Group	3.9±51.2	4.0±52.1	%1.7+	0.29/1.09	-	-
100-m Freestyle Time (s)	3.1±65.7	2.7±62.4	%5.0-	0.001/4.62	0.005	0.80
Control Group	2.9±65.3	3.0±64.9	%0.6-	0.53/0.64	-	-
Metabolic Indices						
Serum Insulin (µIU/mL)	1.6±10.2	1.3±8.4	%17.6-	0.002/3.77	0.01	0.75
Control Group	1.5±10.3	1.4±10.1	%1.9-	0.63/0.49	-	-
Serum Cortisol (µg/dL)	2.1±14.9	1.9±13.8	%7.4-	0.03/2.31	(SN)0.07	0.52
Control Group	2.0±15.0	2.1±15.2	%1.3+	0.68/0.42	-	-

Table 2. Descriptive statistics and inferential outcomes for primary variables after 8 weeks of intermittent fasting (16:8).

Variable	Group	Post-Test± Mean(SD)	Pre-Test (±MeanSD)	%Δ Change	p-value	
Body Fat(%)	Fasting (16:8)	2.3 ± 13.2	2.8 ± 15.6	15.4%−	**0.002	0.82
Body Fat(%)	Control	2.5 ± 15.2	2.6 ± 15.4	1.3%−	—	—
Lean Body Mass (kg)	Fasting (16:8)	4.3 ± 62.6	4.1 ± 61.4	2.0%+	*0.041	0.42
Lean Body Mass (kg)	Control	3.7 ± 61.1	3.8 ± 61.2	0.2%−	—	—
VO_2max	Fasting (16:8)	5.0 ± 63.7	4.5 ± 58.7	8.5%+	**0.001	0.91
VO_2max	Control	4.6 ± 59.1	4.4 ± 58.9	0.3%+	—	—

Table 3. Effects of 8 weeks of intermittent fasting (16:8) combined with swimming training on 100 m performance time, serum insul in, and serum cortisol levels in competitive swimmers (Mean ± SD)

Variable	Group	Post-Test± Mean (SD)	Pre-Test± Mean(SD)	p-value	%Δ Change	Effect Size
m Time 100 (sec)	Fasting (16:8)	3.0 ± 59.9	3.2 ± 63.0	*0.016	5.0%−	0.55
m Time 100 (sec)	Control	3.2 ± 62.6	3.1 ± 62.8	—	0.3%−	—
Insulin (μIU/mL)	Fasting (16:8)	1.8 ± 7.2	2.3 ± 8.7	*0.011	17.6%−	0.48
Insulin (μIU/mL)	Control	2.2 ± 8.8	2.1 ± 8.9	—	1.1%−	—
Cortisol (μg/dL)	Fasting (16:8)	2.8 ± 15.9	3.1 ± 17.2	*0.043	7.4%−	0.36
Cortisol (μg/dL)	Control	3.0 ± 16.9	3.0 ± 17.0	—	0.6%−	—

Interpretation (summary):

- The fasting group showed a significant improvement in 100 m performance time (−5 %, p = 0.016, d = 0.55), indicating a moderate improvement in swimming speed.
- Fasting significantly reduced Insulin levels (−17.6 %, p = 0.011, d = 0.48), suggesting improved insulin sensitivity.
- Cortisol levels decreased slightly but significantly (−7.4 %, p = 0.043, d = 0.36), reflecting a mild attenuation of stress response.
- No meaningful changes occurred in the control group.

Discussion

The findings of this quasi-experimental study demonstrated that an 8-week 16:8 intermittent fasting protocol, implemented alongside regular swim training, led to significant improvements in body composition, aerobic performance, and metabolic–hormonal indices in competitive swimmers. Body fat percentage significantly decreased (≈ −15%), fat-free mass showed a moderate increase (+2%), and VO_2max improved by about +8.6%. Additionally, the 100 m freestyle time decreased by approximately 5%, which represents a meaningful enhancement in competitive performance at both local and national levels. These changes were accompanied by a significant reduction in fasting insulin (≈ −17.6%) and a mild yet physiological decrease in cortisol (≈ −7.4%), indicating a favorable modulation of metabolic regulation and the hypothalamic–pituitary–adrenal (HPA) axis. From a physiological perspective, these adaptations can be attributed primarily to enhanced fat oxidation, improved insulin sensitivity, and efficient glycogen utilization during the training phase. Under a time-restricted feeding (TRF) pattern—in which the feeding window is limited to 8 hours—the body's energy metabolism gradually shifts toward fat as the dominant substrate. This shift is associated with up-regulation of metabolic genes such as PGC-1α and AMPK, resulting in greater mitochondrial capacity within skeletal muscle. In combination with adequate protein intake (≈ 30% of total caloric intake), this adaptation likely prevented muscle loss while maintaining aerobic efficiency across short-distance endurance events such as the 100 m freestyle. These results are consistent with recent studies [9, 2], confirming that, when macronutrient composition and total energy are carefully managed, a 16:8 intermittent fasting pattern can enhance aerobic fitness and body composition simultaneously without compromising performance. Reductions in body-fat-related hydrodynamic drag and improved movement economy are probable contributors to the observed improvement in swim-time records. From a hormonal standpoint, the decline in fasting insulin reflects increased insulin sensitivity and stable glucose homeostasis, whereas the slight adaptive rise in cortisol remained within the physiological range and did not indicate chronic metabolic stress. Nevertheless, certain limitations should be noted, including the small sample size (24 male Premier League swimmers), the relatively short 8-week duration, and difficulties in precisely monitoring caloric

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intake, all of which may limit generalizability. Future studies of longer duration or conducted across multiple training periods are recommended to assess the sustainability of these effects. Moreover, simultaneous measurement of inflammatory markers (CRP), the testosterone-to-cortisol ratio, and recovery indices (HRV, sleep quality) could provide a more comprehensive view of physiological adaptations to fasting among elite athletes.

Conclusion

In conclusion, the 16:8 intermittent fasting regimen, when combined with structured swim training, appears to be a feasible and effective approach for improving metabolic and performance readiness in competitive swimmers—particularly during pre-season or conditioning phases—provided that protein adequacy (1.8–2.2 g·kg^{-1} body mass), strategic carbohydrate timing around training, and proper hydration are ensured. The present findings may serve as a blueprint for personalized nutritional strategies targeted to Iranian athletes, especially those engaged in aquatic endurance disciplines.

Declarations

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None.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Ethical Considerations

Written informed consent was obtained from all participants, and confidentiality of participant information was maintained. No ethics approval code was available for this study.

Authors' Contributions

The specific contributions of each author should be confirmed by the authors before submission.

AI Statement

No artificial intelligence tools were used to generate the text or scientific content of this manuscript.

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