2.4 Testing procedures

2.4.1 Endurance (VO_2 max)

Endurance capacity was assessed using a graded treadmill test to exhaustion with indirect calorimetry (breath-by-breath gas analysis). The protocol involved:

Initial workload: 6 km/h, increasing by 1 km/h every 2 minutes.

Termination: Volitional exhaustion or failure to maintain running speed.

VO_2 max recorded as the highest oxygen consumption averaged over 30 seconds.

2.4.2 Speed (30m Sprint Test)

Sprint performance was measured using a 30-meter sprint test on an indoor track.

Athletes performed 3 maximal sprints with 3-minute recoveries.

Times were recorded with electronic timing gates at the 0m and 30m marks.

Best time of the three attempts was used for analysis.

2.5 Statistical analysis

All statistical analyses were conducted using IBM SPSS Statistics, Version 29 (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was used to determine whether the data distributions were normal. Paired-samples t tests were used to assess within-group differences between pre- and post-intervention values. A two-way repeated-measures analysis of variance (ANOVA) was used to examine the differences between groups over time (HIIT vs. control, pre vs. post), with group serving as the between-subjects factor and time as the within-subjects factor. Post hoc analyses were used to investigate pairwise differences further when significant effects were noted. Cohen's d was used to calculate effect sizes; small, medium, and large effects were denoted by values of 0.2, 0.5, and 0.8, respectively. For every test, the threshold for statistical significance was established at $p<.05$.

3 Result

The effects of the eight-week HIIT program were analyzed for VO_2 max and sprint performance. Results are presented with descriptive statistics, inferential tests, and effect sizes (Figure 1).

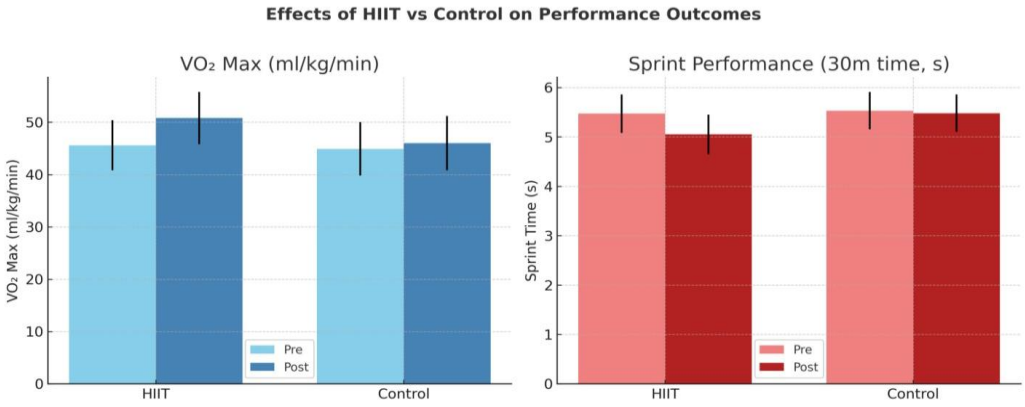

Figure 1 Comparison of VO_2 Max and 30 m Sprint Performance Between HIIT and Control Groups (Pre-and Post-Intervention)

Baseline and post-intervention descriptive statistics for VO_2 max and 30m sprint performance are presented in Table 2. At baseline, the HIIT and Control groups were comparable in VO_2 max ((45.6±4.8) vs. (44.9±5.1) $mL \cdot kg^{-1} \cdot min^{-1}$) and sprint times ((5.47±0.39) vs. (5.53±0.38) s). After the 8-week intervention, the HIIT group showed marked improvements in both VO_2 max ((50.8±5.0) $mL \cdot kg^{-1} \cdot min^{-1}$) and sprint performance ((5.05±0.40) s). The Control group exhibited only minimal changes ((46.0±5.2) $mL \cdot kg^{-1} \cdot min^{-1}$ in VO_2 max; (5.48±0.38) s in sprint times). These findings are consistent with prior reports that HIIT can produce rapid gains in aerobic capacity and speed compared to traditional training (Buchheit and Laursen, 2013; Costigan et al., 2015).