

MULTI-MONTH, ULTRA-ENDURANCE BACKPACKING IMPACTS FUEL SELECTION AND AEROBIC CAPACITY: A CASE STUDY



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Rationale and Experimental Design

BACKGROUND:

- The 2,194-mile thru-hike trek along the Appalachian National Scenic Trail (AT) is attempted by about 4,000 people annually with a 20-25% success rate¹.
- This hike takes about 5-7 months, requiring hikers to complete about 10-16 miles daily¹.
- This population undertakes large volumes of consistent, low-to-moderate intensity aerobic activity.
- Self-supported backpacking treks are popular among experienced hikers, yet there is limited research describing the effects of ultra-endurance backpacking on cardiovascular fitness and fuel substrate utilization.
- Challenges of the wilderness and survival coupled with the long duration imposes unique demands on aerobic capacity.
- Current backpacking research has been limited to case studies designed to identify health-related outcomes, such as blood lipid profiles and body composition³.

PURPOSE:

- Observe the effects of a multi-month backpacking event in the wilderness on aerobic capacity.

OVERALL DESIGN:

- An experienced backpacker (30.1yrs; 78.3kg; 179.1cm; 35.2kg SMM) completed the Appalachian National Scenic Trail (AT) northbound thru-hike (Figure 1).
- Maximal aerobic capacity was assessed under standardized conditions at 4 time-points throughout the trek.



FIGURE 1. Map of the Appalachian Trail. Photo Credit: Appalachian Trail Conservancy

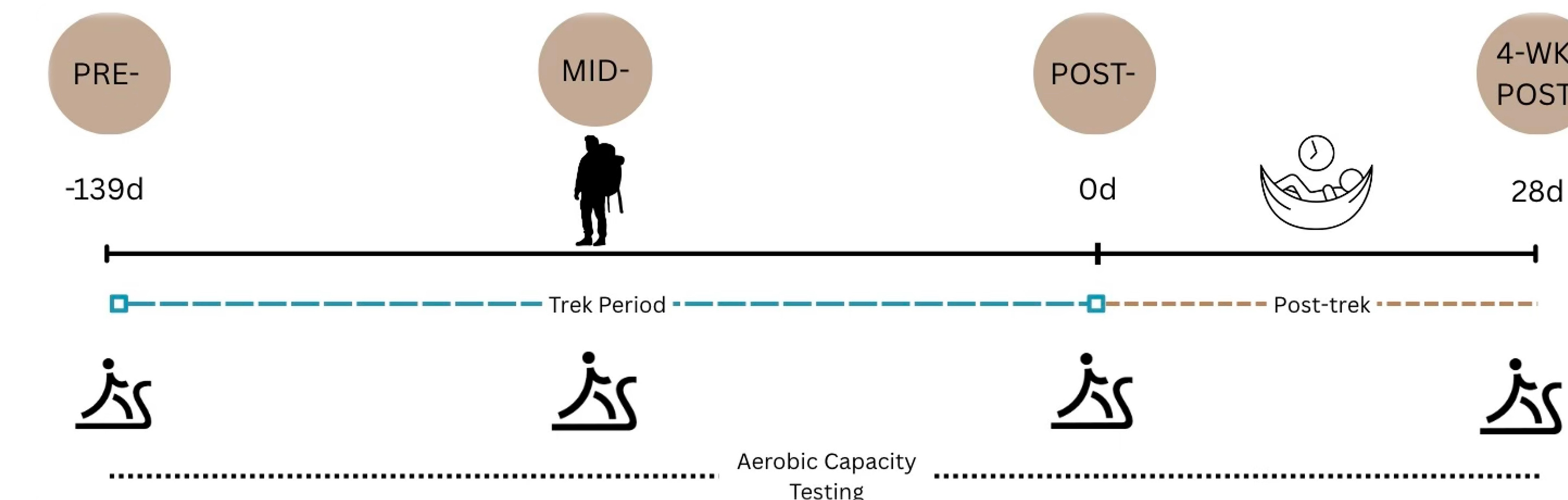


FIGURE 2. Timeline depicting the observational study design. Timepoints reflect progression through the trek, with PRE-, MID-, POST- denoting the first, 70th, and last day on-trail, respectively. 4-WK-POST denotes 28 days post-trek. Trek offset was at -139d, with 0d representing the first day of the post-trek period. Aerobic capacity data was collected PRE-, MID-, POST-, and 4-WK-POST trek.

Methods and Procedures

DATA COLLECTION:

- Over 139-d, the participant hiked 3,462km (2,151mi) and traversed 99,643m (326,322ft) of terrain elevation (accumulated elevation gain).
- Data was collected pre-trek (PRE-), mid-trek (MID-), post-trek (POST-), and 4 weeks post-trek (4-WK-POST)
- Pre-test standardization: void (0.5-h), fasting (8-h), no moderate-vigorous exercise (12-h), no diuretics or caffeine (12-h), no alcohol (48-h), and adequate hydration (48-h).
- Maximal aerobic capacity, reported as absolute and relative VO_2 max, was assessed on a treadmill using indirect calorimetry via metabolic cart (Cosmed Quark CPET) under standardized conditions.
- Fuel substrate utilization during the maximal aerobic capacity protocol was assessed using time and percentage of maximal aerobic capacity at crossover point via metabolic cart software (Cosmed Omnia) analysis.
- VO_2 max determination criteria: respiratory quotient (>1.10), heart rate (within 10bpm of APMHR), Borg rating of perceived exertion (>17), and VO_2 plateau with increasing workload.



FIGURE 3. Treadmill-based maximal aerobic capacity test via indirect calorimetry with metabolic cart.

STATISTICAL ANALYSIS:

- Outcomes were assessed as raw changes and percent changes (%CHG) at MID-, POST-, and 4-WK-POST-trek from pre-trek baseline (PRE).

Results

TABLE 1. Trek Distance on Aerobic Capacity & Fuel Substrate Utilization (%Chg)

Testing Session	Trek Dist. (mi)	Body Weight (kg)	Absolute VO_2 max (L/min)	Relative VO_2 max (L/min)	Time at Crossover (min)	Ex. Inten. at Crossover (% VO_2 max)
Pre-Trek	0.00	78.28	3.960	50.60	3.57	80.60
Mid-Trek	1075.65	78.37 (0.12)	4.037 (1.94)	51.50 (1.78)	2.83 (-20.56)	61.36 (-19.24)
Post-Trek	2151.30	75.60 (-3.42)	4.274 (7.93)	55.90 (10.47)	2.53 (-28.97)	49.91 (-30.69)
4-Wk-Post Trek		79.37 (1.39)	4.060 (2.50)	52.30 (3.35)	3.08 (-13.55)	64.24 (-16.36)

TABLE 1. All % changes (%Chg) calculated from baseline (PRE-).

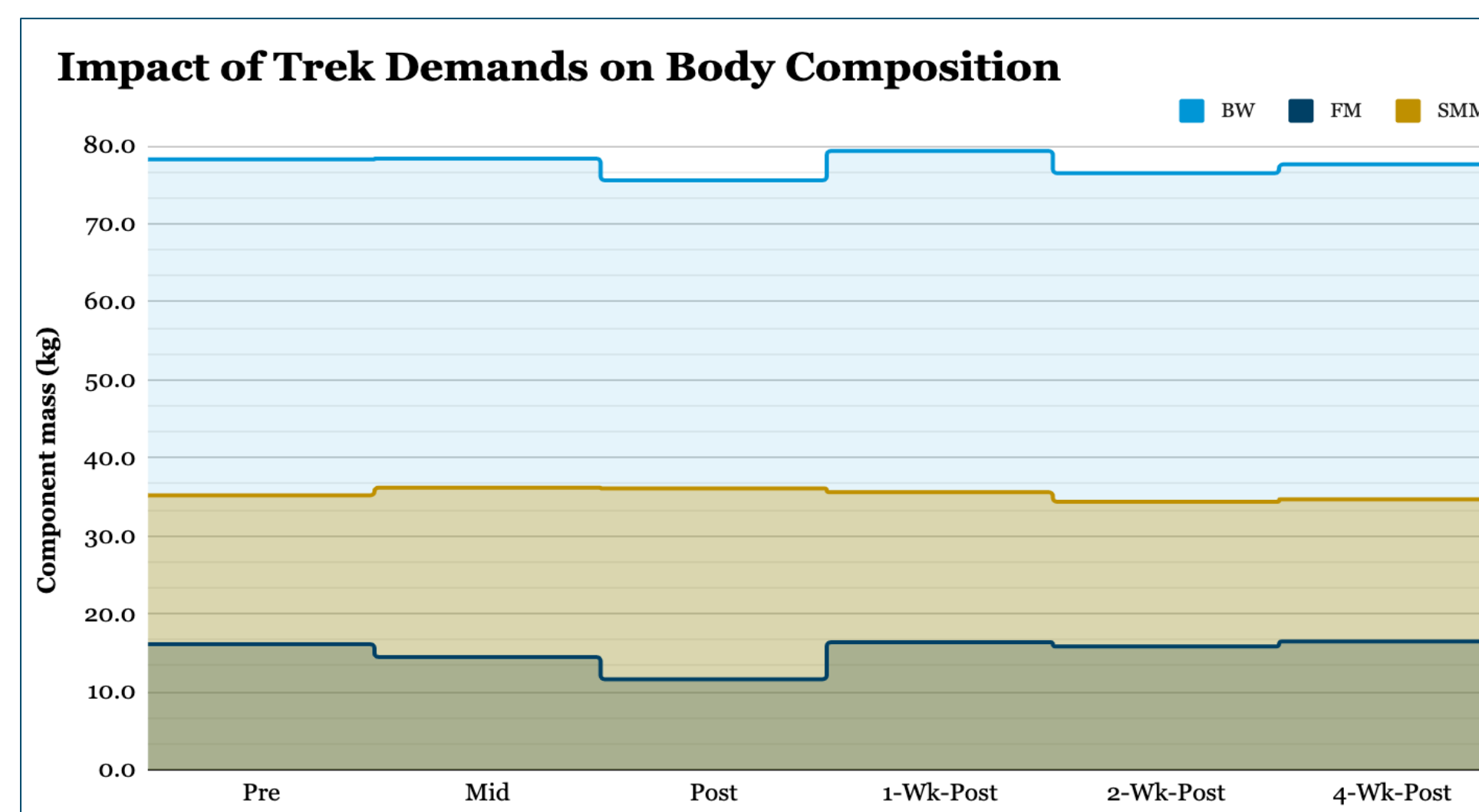


FIGURE 5. Body weight (BW) declined 2.68kg (-3.42%) over the trek (PRE-POST) defined by a 4.5kg (-27.98%) fat mass (FM) loss and a 0.9kg (2.6%) skeletal muscle mass (SMM) gain. 1-Wk-Post trek, BW (1.4%), FM (1.7%), and SMM (1.2%) returned to near-baseline levels (Δ PRE) and were maintained through 4-WK-POST.

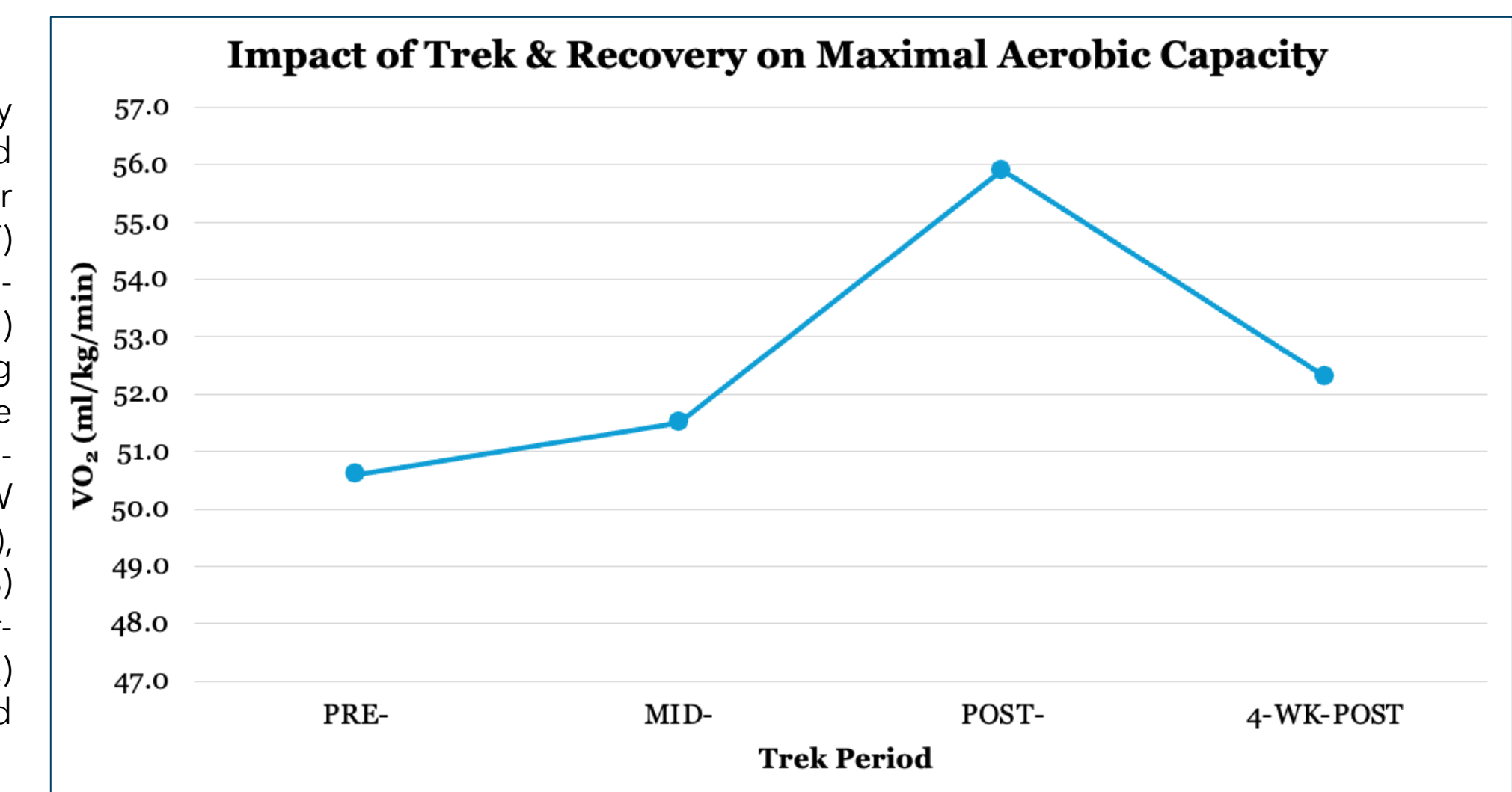


Figure 6. Relative VO_2 max greatly increased MID- to POST- (+8.69%) before returning to near-baseline levels (Δ PRE) 4-WK-POST trek.

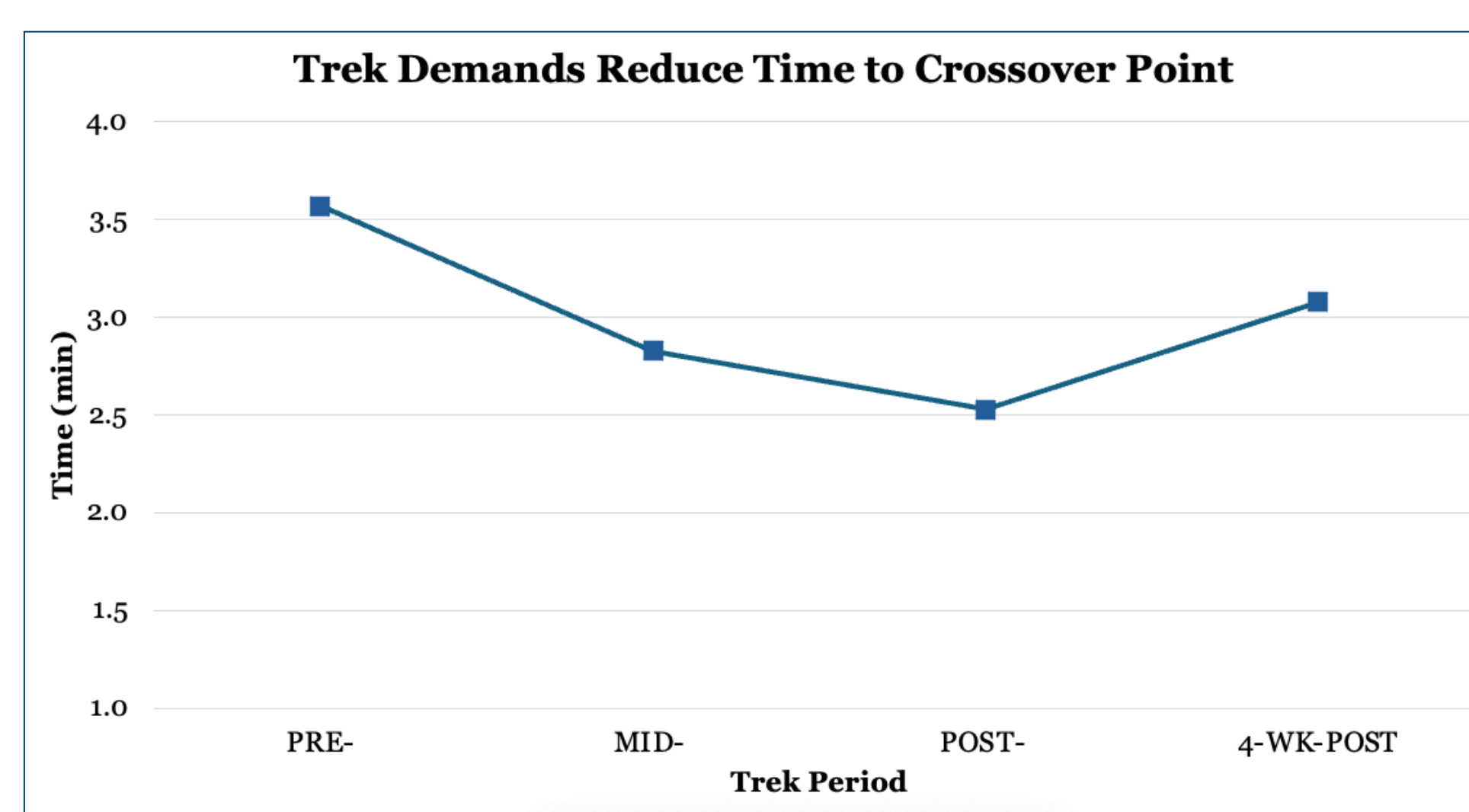


Figure 7. Trek demands elicited sooner reliance on carbohydrates as the predominant fuel source for aerobic activity of increasing intensity throughout the trek (-28.97%), with the lowest Time at Crossover Point immediately post-trek

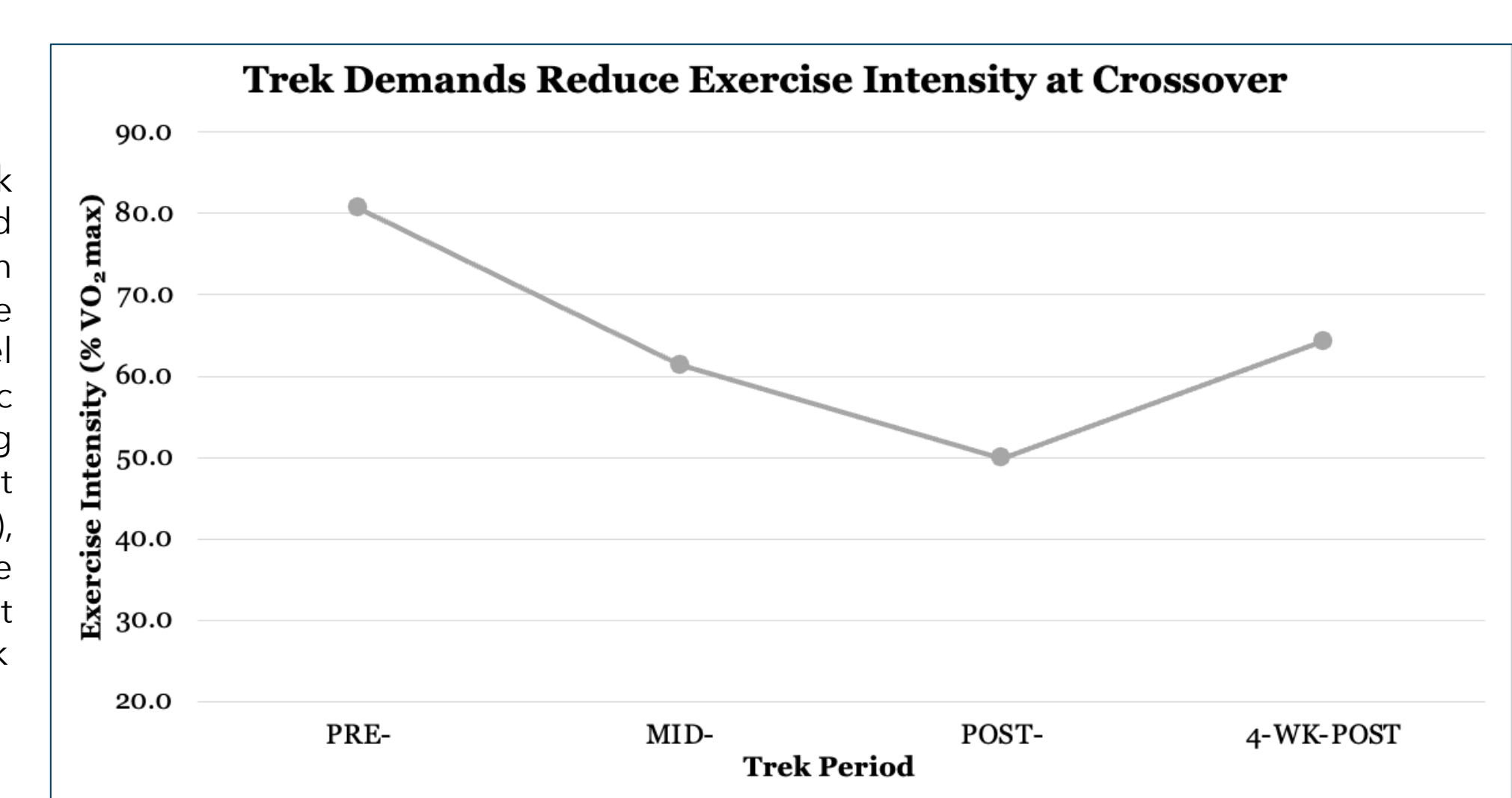


Figure 8. Percent of VO_2 max at Crossover Point decreased throughout the trek (-30.69%) before trending towards baseline levels 4-WK-POST (16.36%)

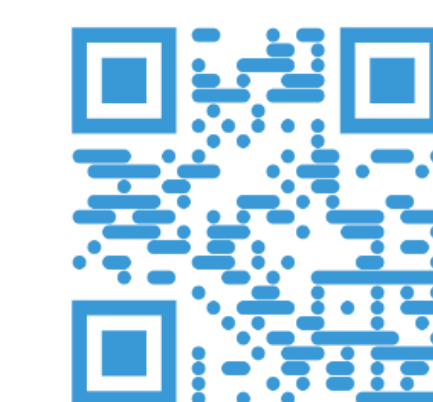
Conclusion and Practical Application

Following the stress of the 139-d trek

- ↑ aerobic capacity in response to ↑ cardiovascular demand, stress, and activity exposure
- Fuel cross over point (Fat → CHO) achieved at lower exercise intensities during maximal aerobic capacity testing
- Cardiovascular system swiftly reverts to pre-trek baseline following cessation of daily, high-volume activity

- Metabolic adaptations demonstrated throughout the trek may guide extended dietary planning
- A post-trek recovery plan that facilitates regular aerobic capacity may be used to:
 - Mitigate a rapid decline in aerobic capacity following a return to a normal daily lifestyle and dietary choices

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