IMPACT OF A MULTI-MONTH ULTRA-ENDURANCE BACKPACKING TREK ON MEASURES OF PHYSIOLOGICAL & PSYCHOLOGICAL RECOVERY & READINESS: A CASE STUDY

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Rationale

BACKGROUND:

- The 2,194-mile thru-hike trek along the Appalachian National Scenic Trail (AT) is attempted by about 4,000 people annually with 20-25% success rate[1].
- This hike takes about 5-7 months, requiring hikers to complete about 10-16 miles daily[1].
- Self-supported backpacking treks are popular among experienced hikers, yet limited intra-event data describes why the conditions lead to a low success rate.
- Challenges of the wilderness and survival coupled with the long duration imposes unique demands on human physiology and psychology.
- Physiologically, fluctuations in RHR and HRV are widely used in active and athletic populations as stress change indicators due to their connection to cardiac parasympathetic activity[2] and stress hormone elevation[3].
- Daily reporting of physiological and psychological changes during a long-term outdoor physical event to evaluate readiness and recovery is limited in the literature.

PURPOSE: Observe how physiological and psychological markers of recovery and readiness adapt to a multi-month self-supported backpacking trek.

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

Experimental Design

RECRUITMENT:

- Inclusion criteria: age (25-45 years), training age (>6 months experience), mobile application compliance, and plans to complete a full Appalachian trail thru-hike.

OVERALL DESIGN:

- An experienced backpacker (30.1yrs; 78.3kg; 179.1cm) completed the Appalachian National Scenic Trail northbound thru-hike.
- A research-validated mobile application was used to collect daily physiological and psychological markers of readiness and recovery throughout the 139-d trek and up to 4-WK post-trek.

Methods and Procedures

DATA COLLECTION:

- Over 139-d, the participant hiked 3,462km (2,151mi) and accumulated 99,643m (326,322ft) of elevation.
- The HRV4Training research-validated mobile application was implemented every morning upon waking to gather data with 95.5% compliance rate over 167-d.
- HRV4Training assessed resting heart rate (RHR) and heart rate variability (HRV) via photoplethysmography (PPG).
- PPG technology requires the subject to use their index finger to cover the phone rear camera lens for the 1-min measurement period.
- HRV4Training also included a daily questionnaire with VAS post PPG measurement to assess sleep duration (SLP-D) and rate sleep quality (SLP-Q), mental energy (ME), muscle soreness (MS), and fatigue (FTG).
- Daily data was compiled using 7-d rolling averages surrounding 6 key time points (BASE, 1/4TK, 1/2TK, 3/4TK, END, and 4-WK-POST).

STATISTICAL ANALYSIS:

- Outcomes were assessed as percent changes (%CHG) from baseline (BASE).

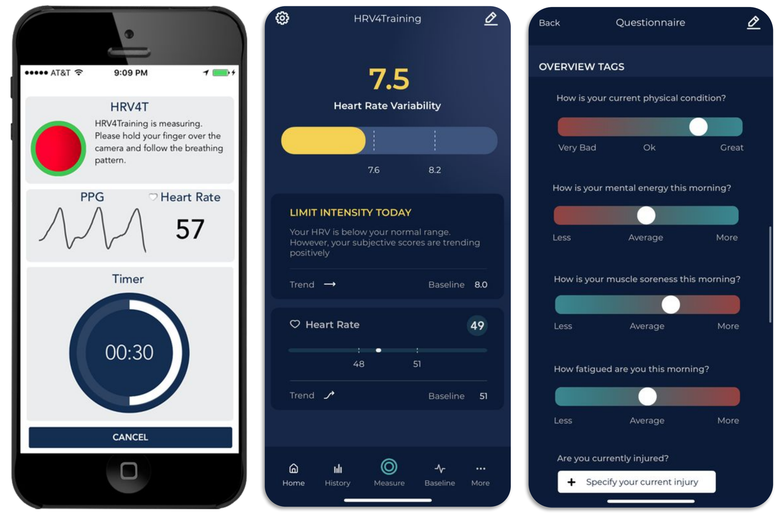

FIGURE 2. HRV4Training mobile application screen shots depicting physiological measurement, survey data collection, and daily reporting. Photo Credit: HRV4Training

FIGURE 3. Observational study design. Critical trek milestones are shown in blue with associated milage where 7-d rolling averages were calculated for daily collected data.

Results

TABLE 1. Trek Distance on Markers of Readiness & Recovery, *mean* (%Chg)

Trek Time Period	Trek Dist. (mi)	RHR (bpm)	HRV_{rMSSD} (ms)	SLP_D (hrs/d)	SLP_Q	MER	MSR	FR
Baseline	0.00	*61.80*	*85.00*	*8.15*	*48.71*	*45.86*	*49.29*	*59.71*
¼ Trek	537.83	*60.87* (-1.50)	*64.81* (-23.75)	*8.40* (3.03)	*44.50* (-8.65)	*43.79* (-4.52)	*56.57* (14.78)	*53.17* (-10.96)
½ Trek	1075.65	*65.19* (5.48)	*56.14* (-33.95)	*7.42* (-9.02)	*43.14* (-11.44)	*47.29* (3.12)	*50.14* (1.74)	*53.57* (-10.29)
¾ Trek	1613.48	*60.43* (-2.22)	*71.00* (-16.47)	*7.41* (-9.09)	*45.86* (-5.87)	*47.57* (3.74)	*52.57* (6.67)	*53.14* (-11.00)
END Trek	2151.30	*63.31* (2.45)	*58.43* (-31.26)	*7.00* (-14.19)	*44.71* (-8.21)	*44.43* (-3.12)	*58.57* (18.84)	*60.86* (1.91)
4WK-Post Trek		*63.89* (3.39)	*49.43* (-41.85)	*5.30* (-35.00)	*51.57* (5.87)	*34.00* (-25.86)	*45.14* (-8.41)	*67.00* (12.20)

TABLE 1. All % changes (%Chg) calculated from baseline (BASE). RHR= resting heart rate; HRV= heart rate variability; rMSSD= root mean square of successive differences between heart beats; SLP_D= sleep duration; SLP_Q=sleep quality rating; MER=mental energy rating; MSR=muscle soreness rating; FR=fatigue rating.

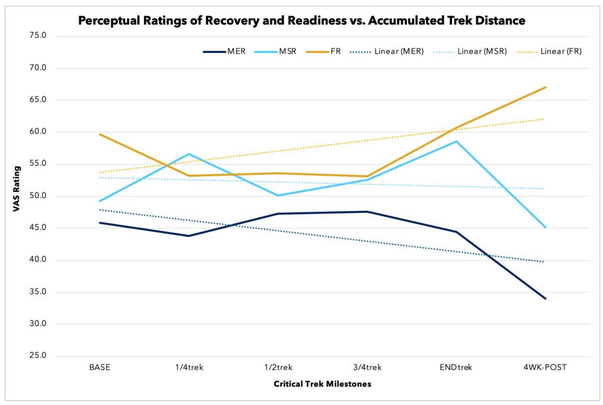

FIGURE 6. After 7-weeks, FTG showed improvement (BASE 59.71, 1/4TK 53.17, Δ -11.0%) while ME declined (BASE 45.86, 1/4TK 43.79, Δ -4.5%). During this time, MS increased substantially (BASE 49.29, 1/4TK 56.57, Δ14.8%). At trek END, MS increased 18.8% from BASE while ME had a 3.1% decrease from BASE. 4-WK-POST trek, MS improved (45.14, Δ -8.4%) thanks to limited activity. Throughout 4-wks recovery, ME sharply decreased (34.00, Δ -25.9%) while FTG continued to increase (67.00, Δ12.2%).

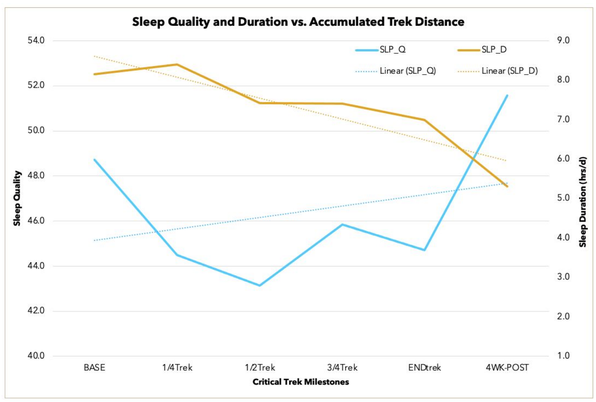

FIGURE 5. Sleep duration generally declined throughout the course of the trek and remained below baseline into recovery (BASE 8.15hrs/d, 4-WK-POST 5.30 hrs/d, Δ -35.0%). Sleep quality declined through the first half of the trek (BASE 48.71, 1/2TK 43.14, Δ−11.4%), improved substantially through the end of the trek (ENDTK 44.71, Δ-8.2%), and continued to improve with extended recovery (4-WK-POST 51.57, Δ5.9%).

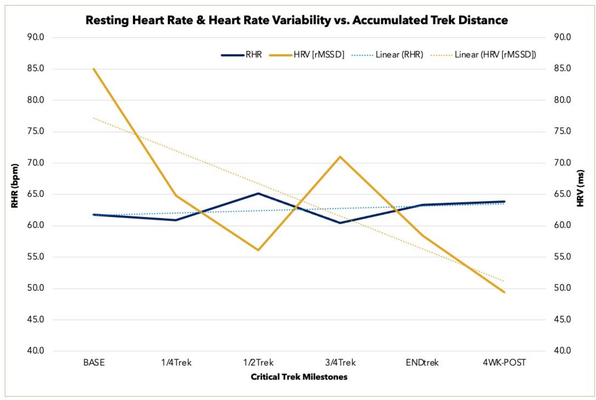

FIGURE 7. After 7-weeks, RHR minimally improved (BASE 61.80bpm, 1/4TK 60.87bpm, Δ -1.5%), and HRV decreased in response to the initial 1/4TRK (BASE 85.0ms, 1/4TK 60.87ms, Δ -23.8%). At trek END, HRV dropped (Δ -31.3%), and continued to decline below BASE (49.43ms, Δ -41.9%), while RHR increased (63.89bpm, Δ 3.4%) over 4-wks of post-trek recovery.

Conclusions

- Physiological and psychological measures of readiness, including sleep, regressed over the course of the trek due to the high amounts of stress.
- The declining readiness measures had no impact on event completion.
- Fatigue accumulated until trek end and did not show improvement despite extensive rest. Other recovery and readiness indicators continued to regress despite relief of survival stress and return to the built environment.

Practical Application

- An extensive post-trek recovery plan is essential to manage stress, fatigue, and injury potential.
- This plan should target both physiological and psychological measures of recovery for optimal re-integration.
- Facilitating greater sleep duration may allow for a more complete recovery and should be prioritized in the post-trek plan.

References

1. 2,000-Milers | Appalachian Trail Conservancy. Appalachian Trail Conservancy |. Published May 11, 2020. https://appalachiantrail.org/explore/hike-the-a-t/thru-hiking/2000-milers/
2. Shaffer F, Ginsberg JP. An Overview of Heart Rate Variability Metrics and Norms. *Front Public Health*. 2017;5:258. doi:10.3389/fpubh.2017.00258
3. Mishica C, Kyröläinen H, Hynynen E, Nummela A, Holmberg HC, Linnamo V. Relationships between Heart Rate Variability, Sleep Duration, Cortisol and Physical Training in Young Athletes. *J Sports Sci Med*. 2021;20(4):778-788. doi:10.52082/jssm.2021.778

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