

RECHARGING THE BATTERY: MONITORING DAILY RECOVERY AND READINESS PERCEPTIONS FOLLOWING A MULTI-MONTH WILDERNESS BACKPACKING TREK: A CASE STUDY



Eleanor U. Flacke, Kyle S. Levers, Andrew M. Stranieri, Eden Glick, Trevor Gardner, David Kim, Michael Esmeralda, Jade Esmeralda, Alison Ragusa, Amy Liebman, Jared Whitaker

Metabolism & Exercise Testing Laboratory, Department of Exercise and Nutrition Science, The George Washington University, Washington, DC, USA

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 trek takes 5-7 months, requiring completion of 10-16 mi/d¹.
- Most ultra-endurance events emphasize physiological capacities and race performance², but thru-hiking adds layers of durability, extended recovery, and survival unaccounted for in the available literature.
- Fluctuations in resting heart rate and heart-rate variability are widely used to indicate parasympathetic activity and monitor levels of physiologic stress³.
- Sleep quality and duration, fatigue, and mental energy collectively represent the hiker's perceived level of recovery and readiness, mirroring markers suited to monitor recovery from shorter-duration ultra-endurance events⁴.
- Current backpacking research has been limited to case studies designed to identify health-related outcomes, such as blood lipid profiles and body composition^{5,6}.

PURPOSE:

- Evaluate factors best suited to capture daily recovery and readiness fluctuations after a multi-month, self-supported backpacking wilderness trek.

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).
- Markers of acute recovery and readiness were collected daily on-trail and through the post-trek period using a research-validated mobile application.

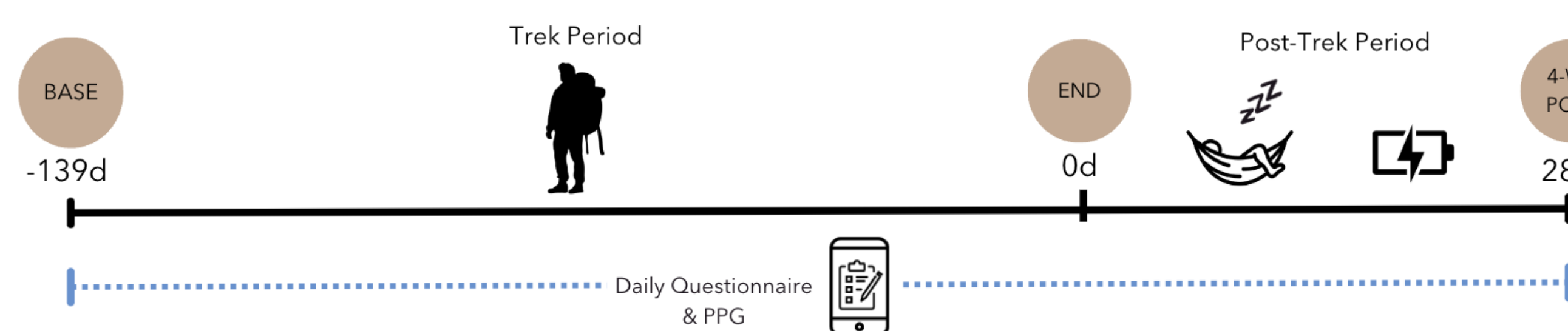


FIGURE 3. Timeline depicting the observational study design. Timepoints reflect progression through the trek, with BASE and END denoting the first and last days on-trail, respectively, and 4-WK-POST denoting 28 days post-trek. To best capture trends over time, BASE is an average of the first day on-trail with the two days immediately preceding it. END is an average of the final three days on-trail, and 4-WK-POST is an average of days 25-28 post-trek. Trek offset was at -139d, with 0d representing the first day of the post-trek period.



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



FIGURE 2. Picture of the participant hiking the White Mountains in New Hampshire, along the AT. Photo Credit: DB

Methods and Procedures

DATA COLLECTION:

- HRV4Training Mobile Application**
 - Markers of recovery measured daily during the 139-d trek and 28-d post-trek period each morning, upon waking.
 - Questionnaire utilized visual analog scale for ratings.
 - Photoplethysmography (PPG) technology used to assess RHR and HRV using mobile phone camera.
 - Compliance rate of 95.5% for the 167-d research period.
- Perceived Recovery & Readiness Measures**
 - Fatigue Rating (FR), Mental Energy Rating (MER), Sleep Quality (SQ), Sleep Duration (SD)
- Autonomic Function Measures**
 - Resting Heart Rate (RHR), Heart Rate Variability (HRV)

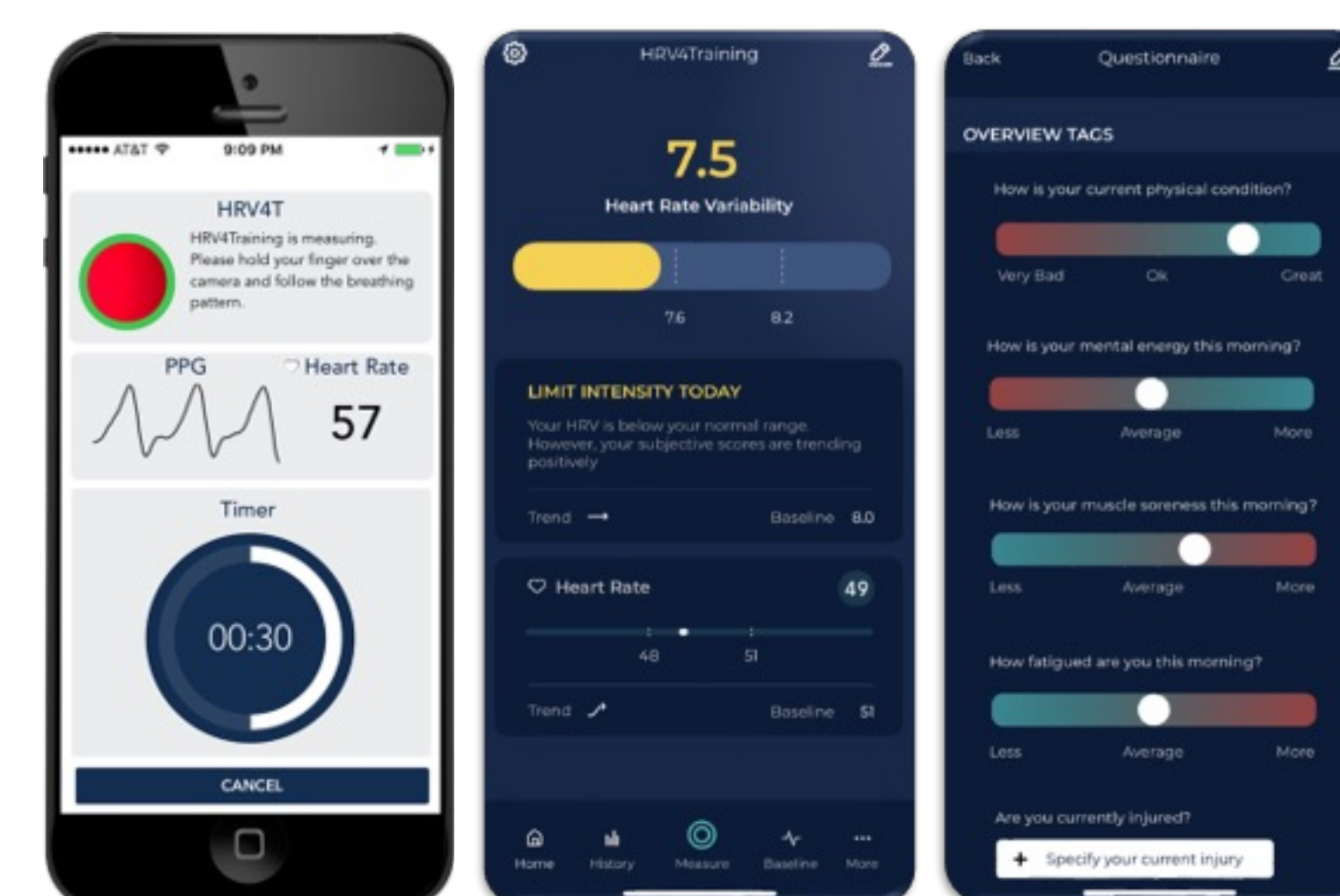


FIGURE 4. HRV4Training mobile app and associated questionnaire, RHR, and HRV measurements

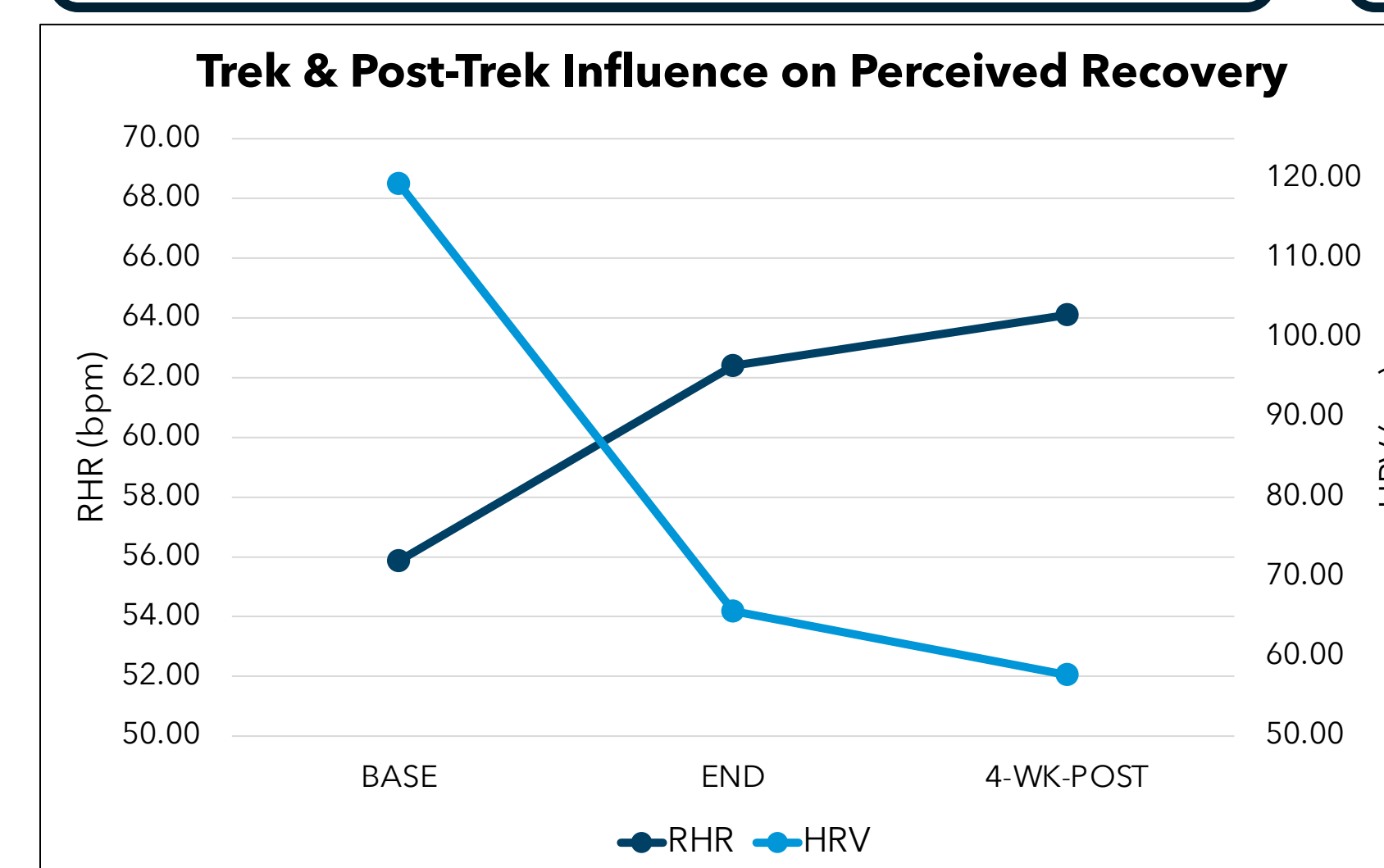
STATISTICAL ANALYSIS:

- Percent Change from Baseline**
 - 3-d averages surrounding trek outset (BASE), the final days of the trek (END), and 4-weeks post-trek (4-WK-POST) were calculated to reflect changes in autonomic and perceived markers from baseline.
- Pearson Correlations**
 - Evaluated daily association between all autonomic and perceived variables from trek END through 4-WK-POST.
- Cross-Correlation Time Series Analysis**
 - Established strength of correlational relationships and existence of relational time lag.

TABLE 1. All % changes (%Chg) calculated from baseline (BASE). SQ = sleep quality; SD = sleep duration; FR = fatigue rating; MER = mental energy rating; HRV_{MSSD} = heart rate variability; rMSSD = the root mean square of successive differences between normal heart beats; RHR = resting heart rate. Participant hiked 3,531 km (2,151 mi) with an accumulated elevation gain of 99,643 m (325,913 ft) over 139 days. The post-trek period was 28-d from END.

Trek Influence on Markers of Recovery (%Chg)			
	BASE	END	4-WK-POST
Trek Dist. (mi)	0.00	2151.3	-
SQ (VAS)	43.00	28.00 (-34.88)	55.67 (29.46)
SD (hrs)	10.15	6.01 (-40.84)	5.25 (-48.26)
FR (VAS)	60.00	70.00 (16.67)	67.67 (12.78)
MER (VAS)	50.00	26.00 (-48.00)	32.67 (-34.67)
HRV _{MSSD} (ms)	119.33	65.67 (-44.97)	57.67 (-51.68)
RHR (bpm)	55.87	62.40 (11.69)	64.10 (14.74)

FIGURE 5. Effect of the trek and post-trek period on perceived variables as reflected by 3-d averages surrounding BASE, END, and 4-WK-POST. MER, FR, and SQ are visualized using the y-axis on the left, with SD shown using the one to the right. Both MER and FR worsened through the trek and improved by 4-WK-POST but didn't recover to BASE. SD worsened at each timepoint. SQ diminished over the course of the trek and recovered, above baseline, by 4-WK-POST.



Results

Correlation Between Autonomic & Perceived Variables						
	SQ (VAS)	SD (hrs)	FR (VAS)	MER (VAS)	HRV _{MSSD} (ms)	RHR (bpm)
SQ (VAS)		R = 0.08 p = 0.66	R = -0.64 p < 0.01	R = 0.61 p < 0.01	R = -0.14 p = 0.46	R = -0.16 p = 0.39
SD (hrs)	R = 0.08 p = 0.66		R = -0.24 p = 0.18	R = 0.35 p = 0.049	R = -0.044 p = 0.81	R = 0.10 p = 0.59
FR (VAS)	R = -0.64 p < 0.01	R = -0.24 p = 0.18		R = -0.63 p < 0.01	R = 0.076 p = 0.68	R = -0.006 p = 0.97
MER (VAS)	R = 0.61 p < 0.01	R = 0.35 p = 0.049	R = -0.63 p < 0.01		R = -0.08 p = 0.66	R = 0.065 p = 0.72
HRV _{MSSD} (ms)	R = -0.14 p = 0.46	R = -0.044 p = 0.81	R = 0.076 p = 0.68	R = -0.08 p = 0.66		R = -0.72 p < 0.01
RHR (bpm)	R = -0.16 p = 0.39	R = 0.10 p = 0.59	R = -0.006 p = 0.97	R = 0.065 p = 0.72	R = -0.72 p < 0.01	

TABLE 2. Pearson product correlations between the perceived and autonomic variables through the 4-week post-trek period. The significant findings are outlined in blue. Both significant correlations were between perceived sleep quality (SQ) and other perceived markers of recovery (FR and MER).

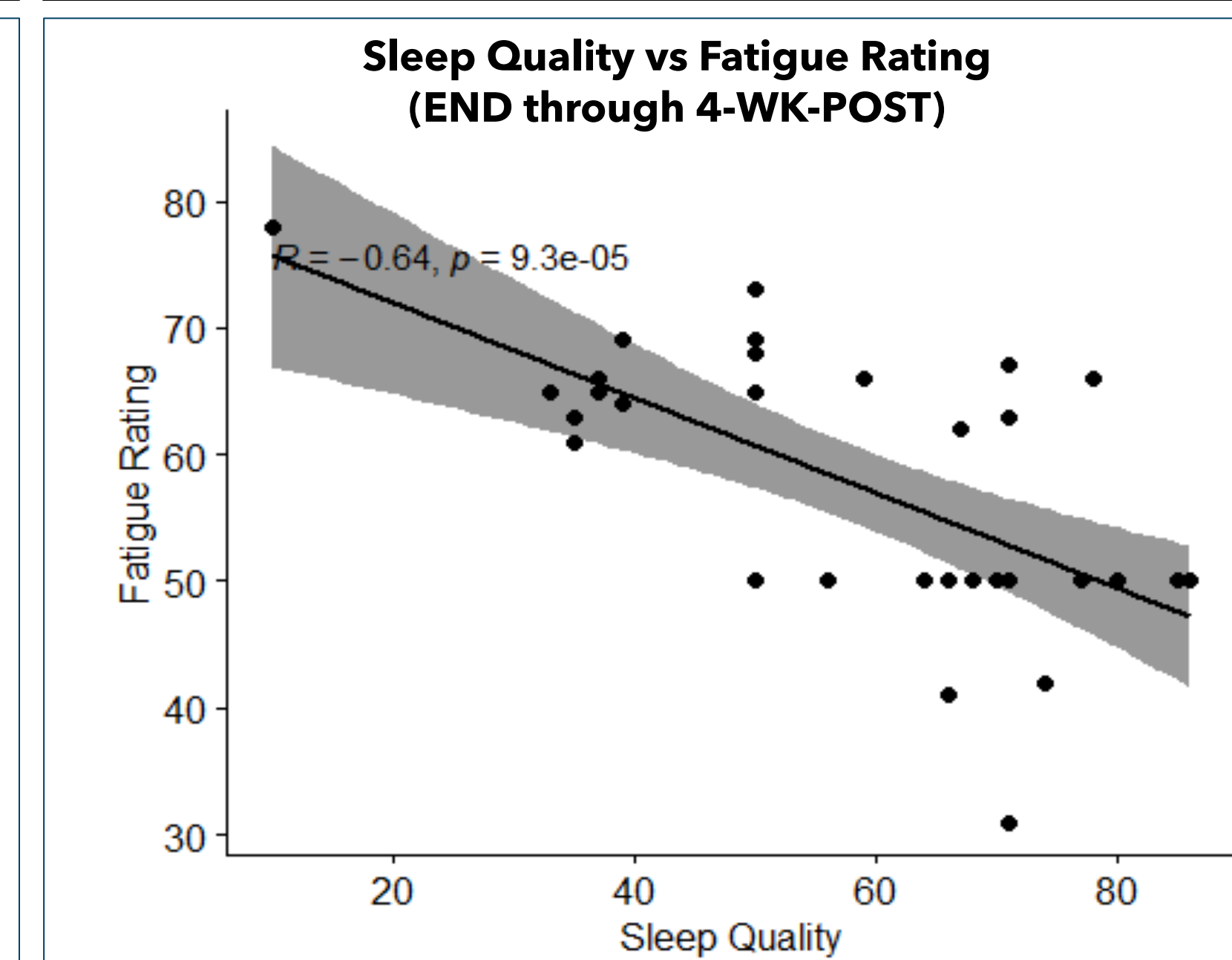
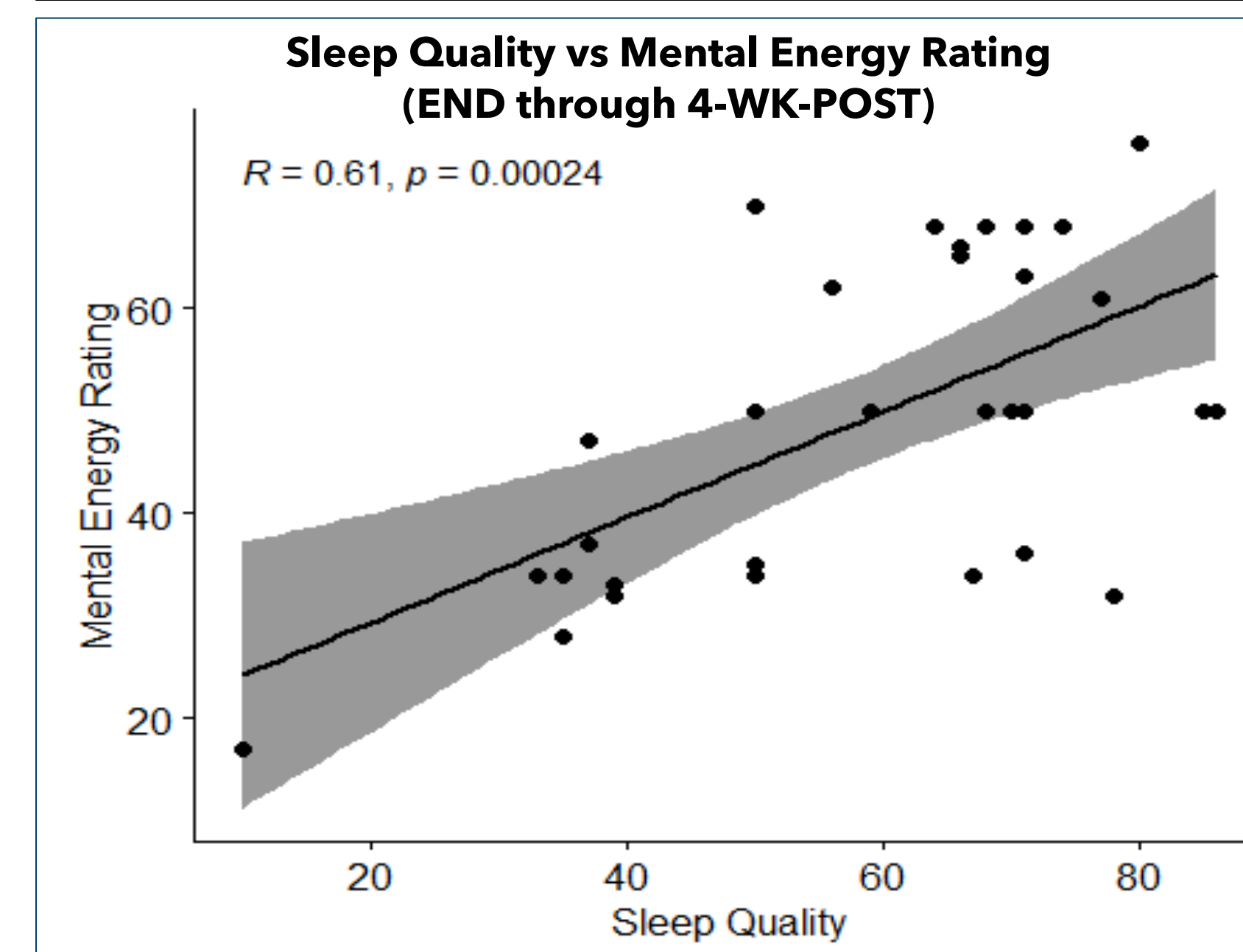


FIGURE 6. Effect of the trek and post-trek period on autonomic variables as reflected by 3-d averages surrounding BASE, END, and 4-WK-POST. RHR is visualized using the y-axis on the left, with HRV shown using the one to the right. Both RHR and HRV worsened throughout the trek and continued to deteriorate through 4-WK-POST.

FIGURE 8. Self-reported SQ exhibited a strong, negatively correlated linear relationship with perceived fatigue over the 4-WK-POST trek period, when comparing daily ratings. This relationship was strongest on the same day of rating, indicating that there was no lag/effect of time on the relation.

Conclusion and Practical Application

Following the stress of the 139-d trek:

- ↑ SQ
- Autonomic function and other perceived recovery markers failed to return to BASE
- Higher post-trek SQ → elevated perception of acute recovery *DESPITE* continued ↓ ↓ SD & autonomic markers
- SQ seems to be better suited to capture daily fluctuations in acute recovery & readiness vs. autonomic markers

- Ratings of SQ may be used to monitor acute perceived recovery post-ultra-endurance event
- High quality sleep should be a post-event priority to:
 - Expedite perceived recovery and readiness for successive events

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