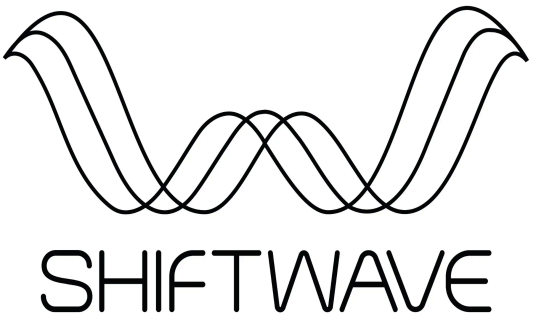

Effects of Shiftwave Sessions on Pain, Stress, Anxiety, and Sleep in Volunteer Firefighters: A Real-World Evidence Study

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Shiftwave

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Executive Summary

Purpose: This real-world evidence study examined whether Shiftwave sessions affect pain, stress, anxiety, restedness, and sleep quality among volunteer firefighters, a high-stress occupational group.

Design: This was a single-arm study conducted at Woodmere Fire Department, a volunteer department in Long Island, New York. Twelve firefighters and EMS personnel completed twice-weekly Shiftwave sessions (10–20 minutes each) over 28 days. Participants completed surveys immediately before and after each session assessing pain, stress, anxiety, and restedness on 0–10 scales. Validated instruments for sleep quality (PSQI), trait anxiety (STAI-T), and well-being (WHO-5) were administered at intake and exit. Ten participants completed the full protocol, contributing 67 matched session observations.

Acute session effects: Participants demonstrated large, statistically significant pre-to-post improvements on all four state outcomes (all $p < .0001$). On 0–10 scales, stress decreased from 3.7 to 1.9 (−18% of scale; $d = 0.95$), anxiety from 3.5 to 2.0 (−15% of scale; $d = 0.79$), and pain from 1.8 to 1.1 (−7% of scale; $d = 0.63$). Restedness increased from 4.6 to 6.8 (+22% of scale; $d = 0.74$).

Trait-level outcomes: No statistically significant changes were detected, though all measures trended toward improvement. PSQI decreased from 5.9 to 4.7 ($p = .051$), moving below the commonly used clinical threshold of 5, though not quite reaching statistical significance. STAI-T decreased from 34.2 to 31.7 ($p = .20$) and WHO-5 increased from 66.8 to 72.0 ($p = .23$). The study was underpowered for effects of this magnitude.

Qualitative findings: Participants consistently described immediate relaxation and stress reduction (9 of 10 respondents). When asked about effect duration, most (6 of 10) reported benefits lasted "a few hours."

Acceptability: Ninety percent (9/10) would recommend Shiftwave to other first responders; 70% (7/10) would continue using it if available; and 70% (7/10) agreed it could be valuable for their department's health strategy.

Limitations: The single-arm design precludes causal inference; observed improvements cannot be distinguished from rest, expectancy, or non-specific factors. The modest sample size limited power for trait analyses.

Implications: Findings suggest Shiftwave may function as an acute recovery tool, producing immediate, user-valued benefits. The pattern of significant acute effects without detected trait-level changes suggests benefits may be session-specific. Controlled studies with larger samples are needed to establish causation and generalizability.

Introduction

First Responder Wellness Context

Firefighters face a demanding occupational environment characterized by exposure to traumatic events, physical exertion, and irregular schedules. Research consistently documents elevated rates of sleep disturbance, anxiety, post-traumatic stress symptoms, and chronic musculoskeletal pain in firefighter populations compared to the general public [1–4]. These challenges affect both career and volunteer firefighters, though the specific stressor profiles may differ — volunteer firefighters often balance fire service responsibilities with separate primary employment, potentially compounding time pressures and recovery demands.

The need for accessible, practical wellness interventions in fire service settings has prompted interest in non-pharmacological approaches—including mindfulness-based interventions that have shown promise in first responder populations [9, 10]— that can be integrated into station routines. Effective interventions must accommodate the unpredictable nature of fire service work while providing meaningful benefit within realistic time constraints.

The Shiftwave Intervention

Shiftwave is a wellness platform that delivers synchronized vibrotactile stimulation and audio content while users recline in a zero-gravity position. The system applies programmed vibration patterns along the posterior body surface, with intensity varying across location and time, coordinated with audio elements including guided breathing, body awareness cues, music, and ambient soundscapes. Narrative content varies across protocols and may include visualization guidance, mindset coaching, or relaxation instruction. Sessions range from 5–60 minutes depending on application (typically 10–20 minutes in this study) and are designed to guide users through structured audio-tactile experiences aimed at shifting mental and physical state.

The platform has been deployed in various first responder settings, with informal survey data suggesting positive user experiences. However, these prior deployments have been largely cross-sectional, often conducted under active crisis conditions (such as with Los Angeles firefighters during the 2025 fires), and have used less structured data collection methods. While valuable for initial feasibility assessment, such data are limited in their ability to inform systematic adoption and implementation decisions for routine station-based wellness programs.

Study Rationale

This study was designed to address gaps in the existing evidence base by:

- Tracking the same participants across multiple sessions over approximately four weeks, enabling examination of both acute session effects and potential longer-term changes

- Deploying in a routine volunteer firehouse setting rather than during active crisis response
- Using validated psychometric instruments with standardized pre- and post-session measurement
- Examining trait-level outcomes (sleep quality, trait anxiety, well-being) in addition to acute state changes
- Collecting structured qualitative feedback to understand participant experience

The goal was to generate more rigorous preliminary evidence relevant to Shiftwave adoption and implementation as an ongoing wellness resource within fire departments.

Research Questions

This study examined four primary questions:

1. Do participants demonstrate acute improvements in pain, stress, anxiety, and restedness from pre- to post-session?
2. Do participants demonstrate changes in sleep quality, trait anxiety, or well-being from study intake to exit?
3. How do participants describe their subjective experience with Shiftwave?
4. Is Shiftwave acceptable to first responders as a wellness tool?

Methods

Study Design

This was a prospective, single-arm, within-subject study examining both acute (within-session) effects and longitudinal (intake-to-exit) changes over approximately four weeks. The study employed a real-world evidence (RWE) design, prioritizing ecological validity and participant convenience within the operational constraints of a volunteer fire department.

Setting and Participants

The study was conducted at Woodmere Fire Department, a volunteer fire department serving a suburban community on Long Island, New York. Participants were active volunteer firefighters and emergency medical services (EMS) personnel. Recruitment was open to all active members of the department via an invitation distributed by department leadership. No monetary compensation was provided.

Inclusion criteria were: (1) active member of Woodmere Fire Department, (2) age 18 or older, and (3) able to provide informed consent. Exclusion criteria included medical conditions contraindicating use of vibrotactile stimulation (e.g., epilepsy, unstable cardiac conditions, pregnancy, implanted medical devices) as determined through screening by the principal investigator.

Intervention

Hardware configuration. Participants interfaced with the Shiftwave platform, which delivers synchronized vibrotactile and audio stimulation via 18 bilateral transducers distributed along the posterior body surface from occiput to calf. Transducers interface through a suspended fabric surface. Users are positioned in a zero-gravity recline configuration with visual occlusion via eye mask and audio delivered via headphones. User-adjustable intensity (0–100% scale) introduces variability in absolute vibrotactile dose; participants were instructed to begin at 60% and adjust to the maximum comfortable level.

Protocol content. Protocols included instrumental music, ambient soundscapes, and spoken narrative content. Narrative elements varied across protocols and could include breath guidance, body awareness cues, visualization guidance, and relaxation instruction. Vibration intensity patterns were choreographed with audio content, with breath-synchronized vibration as a primary design feature (rising intensity aligned with inhalation cues, falling intensity with exhalation).

Session parameters. Sessions lasted approximately 10–20 minutes. Multiple protocols were used across the study period based on participant preference and availability, reflecting typical use conditions; therefore, effects are attributable to the platform experience as implemented rather than any single standardized protocol. Session duration ranged from 9–18 minutes (median: 10 minutes); see Appendix B for protocol details.

Outcome Measures

Acute (session-level) outcomes were assessed immediately before and after each session:

- **Pain** (NRS-11): "On a scale from 0 to 10, please rate your current level of pain" (0 = no pain, 10 = worst possible pain)
- **Stress** (VAS 0–10): "Right now, how stressed do you feel?" (0 = not at all, 10 = extremely)
- **Anxiety** (VAS 0–10): "Right now, how anxious or tense do you feel?" (0 = not at all, 10 = extremely)
- **Restedness (VAS 0–10):** "Right now, how rested or rested do you feel?" (0 = not at all, 10 = extremely)

Trait-level outcomes were assessed at study intake and exit using validated instruments:

- **Pittsburgh Sleep Quality Index (PSQI)** [5]: Global score ranging from 0–21, with higher scores indicating worse sleep quality. Scores >5 indicate clinically significant sleep disturbance.
- **State-Trait Anxiety Inventory — Trait subscale (STAI-T)** [6]: 20 items assessing trait anxiety, with total scores ranging from 20–80. Higher scores indicate greater trait anxiety.
- **WHO-5 Well-Being Index** [7]: 5 items assessing subjective well-being over the past two weeks, converted to a 0–100 percentage scale. Higher scores indicate better well-being; scores ≤50 suggest risk for depression.

Qualitative data were collected through free-text response fields in post-session surveys ("Is there anything you'd like to share about your experience during or after this session?") and in exit surveys (questions about surprises, a general description, and additional feedback).

Acceptability was assessed at exit through three items: (1) "Would you personally want to continue using the Shiftwave chair if it were available?" (Yes/No), (2) "Would you recommend Shiftwave sessions to other first responders?" (Yes/No), and (3) "Do you feel that wellness tools like Shiftwave could be valuable in your department's long-term health strategy?" (5-point Likert scale).

Procedures

Participants were screened by the Principal Investigator for contraindications (e.g., epilepsy, unstable cardiac conditions, pregnancy, implanted medical devices) prior to enrollment. Those cleared for participation completed an intake survey including demographic information, job characteristics, chronic pain status, current medications, wellness practices, and baseline administration of the PSQI, STAI-T, and WHO-5.

Sessions were scheduled twice weekly over approximately four weeks, with a target of eight sessions per participant. At each session, participants completed the pre-session survey, underwent the Shiftwave session (10–20 minutes), and then completed the post-session survey. The principal investigator supervised all sessions.

At study conclusion, participants completed an exit survey including the PSQI, STAI-T, and WHO-5 (repeat administration), global change ratings, acceptability items, and qualitative feedback questions.

Statistical Analysis

Acute effects. Linear mixed-effects models (LMM) were used to test pre-to-post session changes while accounting for repeated measures within participants. Models were estimated using restricted maximum likelihood (REML) with time coded as 0 (pre) and 1 (post) and a random intercept for participant. Session number was included as a covariate to assess whether effects changed across sessions. Effect sizes (Cohen's d) were calculated from raw change scores (d = mean change / SD of change).

Secondary session-level analyses examined: (1) session number effects, testing whether the magnitude of acute benefit changed across sessions (habituation or sensitization); and (2) baseline trends, testing whether pre-session scores improved across sessions (cumulative carryover effects).

Trait-level outcomes. Paired t-tests compared intake and exit scores for PSQI, STAI-T, and WHO-5. Effect sizes (Cohen's d for paired data) and 95% confidence intervals were calculated.

Multiple comparisons. The four acute outcomes and three primary trait outcomes each assess distinct constructs and were not corrected for multiple comparisons. False discovery rate (FDR) correction using the Benjamini-Hochberg procedure was applied to the PSQI component analysis, where seven related sleep dimensions were examined.

Qualitative analysis. Free-text responses were analyzed using a hybrid thematic approach. Initial open coding identified recurring concepts, which were grouped into themes through iterative refinement. Themes were validated through comprehensive quote assignment with attention to disconfirming evidence.

This was an exploratory study; all outcomes were of equal a priori interest and no primary outcome was pre-specified. Statistical analyses were conducted in Python using statsmodels and scipy. Significance was set at $\alpha = .05$ (two-tailed).

Ethical Considerations

The study was conducted as a practice-based wellness evaluation. Informed consent was obtained from all participants prior to enrollment. Participation was voluntary with no monetary compensation and no impact on employment status. Data were collected using de-identified participant codes via password-protected online forms; only the study team had access to identifiable information. No institutional review board oversight was obtained.

Results

Participant Characteristics

Twelve participants enrolled and completed the intake survey. Ten participants completed the exit survey and contributed data for trait-level analyses. Two participants (P11, P12) completed only one session each and did not complete exit assessments.

All participants were male. Ages ranged from 22 to 67 years (M = 43.3, SD = 13.4). Job titles included Firefighter (n = 6), EMT (n = 4), Lieutenant (n = 1), and Ex-Captain (n = 1). Years of service ranged from 1 to 40+ years.

At baseline, three participants reported chronic pain conditions. Four participants reported current use of medications for pain, anxiety, or sleep. Six participants reported engaging in regular wellness practices such as exercise, meditation, or massage.

Session Completion

Participants completed a total of 67 matched pre-post session pairs across the study period (August 19 – September 16, 2025). One pre-session survey could not be matched to a post-session survey and was excluded; missingness appeared unrelated to participant characteristics or session timing. Sessions per participant ranged from 1 to 8 (M = 5.6, Median = 6). Ten participants completed 4 or more sessions.

Acute Session Effects

Primary analysis. Linear mixed-effects models revealed significant pre-to-post improvements for all four acute outcomes (Table 1). Pre-session scores showed considerable variability (see Table 1 for means and standard deviations); notably, baseline pain was low (M = 1.76 on 0–10 scale), while stress and anxiety were in the mild-to-moderate range. Participants demonstrated significant improvements across all four outcomes: Stress decreased from 3.67 to 1.94 ($\Delta = -1.73$, 17% of scale; $d = 0.95$, $p < .0001$). Anxiety decreased from 3.46 to 1.96 ($\Delta = -1.51$, 15% of scale; $d = 0.79$, $p < .0001$). Restedness increased from 4.63 to 6.75 ($\Delta = +2.12$, 21% of scale; $d = 0.74$, $p < .0001$). Pain decreased from 1.76 to 1.10 ($\Delta = -0.66$, 7% of scale; $d = 0.63$, $p < .0001$).

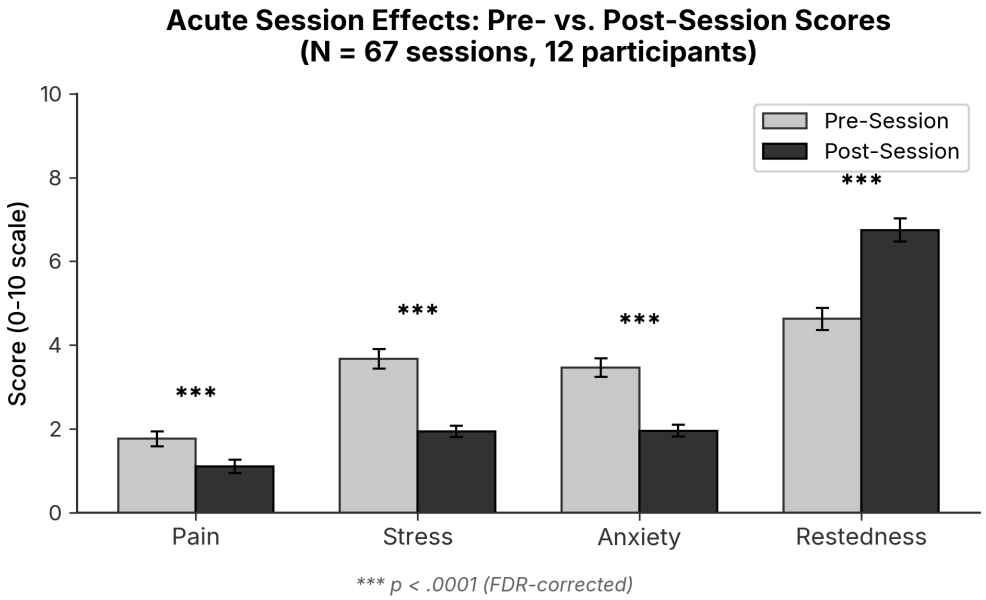

Figure 1. Acute Session Effects: Pre- vs. Post-Session Scores. Mean scores on pain, stress, anxiety, and restedness immediately before and after Shiftwave sessions (N = 67 sessions, 12 participants). Error bars represent ±1 standard error. All pre-to-post differences were statistically significant (p < .0001).

Table 1. Acute Session Effects: Linear Mixed Model Results
Note: CI = confidence interval for mean change (Δ).

Outcome	Pre M (SD)	Post M (SD)	Δ	Cohen's d	p
Pain	1.76 (1.47)	1.10 (1.35)	−0.66	−0.63	<.0001
Stress	3.67 (1.89)	1.94 (1.09)	−1.73	−0.95	<.0001
Anxiety	3.46 (1.85)	1.96 (1.15)	−1.51	−0.79	<.0001
Restedness	4.63 (2.18)	6.75 (2.25)	+2.12	+0.74	<.0001

Note: N = 67 sessions from 12 participants. Negative β indicates decrease (improvement for pain, stress, anxiety); positive β indicates increase (improvement for restedness).

Secondary analyses: Session number effects. No significant effect of session number was detected for any outcome (all p > .50). The magnitude of acute benefit did not systematically increase or decrease across sessions, suggesting neither habituation nor sensitization occurred over the study period.

Secondary analyses: Baseline trends. To assess whether pre-session scores improved across sessions (suggesting cumulative or carryover effects), separate models examined pre-session scores as a function of session number. No significant baseline trends were detected for any outcome (all p > .50). Participants did not arrive at later sessions in systematically better baseline states, suggesting that observed benefits were session-specific rather than accumulating over the study period.

Trait-Level Outcomes

Table 2 presents intake-to-exit changes on the three trait instruments. No statistically significant changes were detected, though all changes were in the direction of improvement and PSQI was close to the pre-specified α = .05 threshold (p = .051).

Table 2. Trait Outcome Changes: Intake to Exit (N = 10)
Note: CI = confidence interval for Cohen's d.

Instrument	Intake M (SD)	Exit M (SD)	p	Cohen's d	95% CI d
PSQI	5.9 (3.1)	4.7 (3.0)	.051	−0.71	[−1.41, −0.02]
STAI-T	34.2 (10.6)	31.7 (7.2)	.203	−0.43	[−1.08, 0.21]
WHO-5	66.8 (13.5)	72.0 (16.6)	.226	+0.41	[−0.23, 1.06]

Note: PSQI and STAI-T: lower scores indicate improvement. WHO-5: higher scores indicate improvement.

PSQI global score decreased from 5.9 to 4.7 (Δ = -1.2, d = -0.71, p = .051), crossing below the clinical threshold of 5 which conventionally distinguishes good from poor sleepers. Component analysis suggested this improvement was primarily driven by reduced sleep latency (time to fall asleep; d = -0.86), though this did not survive correction for multiple comparisons within the PSQI subscales. Whether this reflects a true intervention effect or regression to the mean cannot be determined without a control group. This study was not adequately powered to detect small-to-medium trait effects; the non-significant findings should be interpreted as "not detected" rather than "absent."

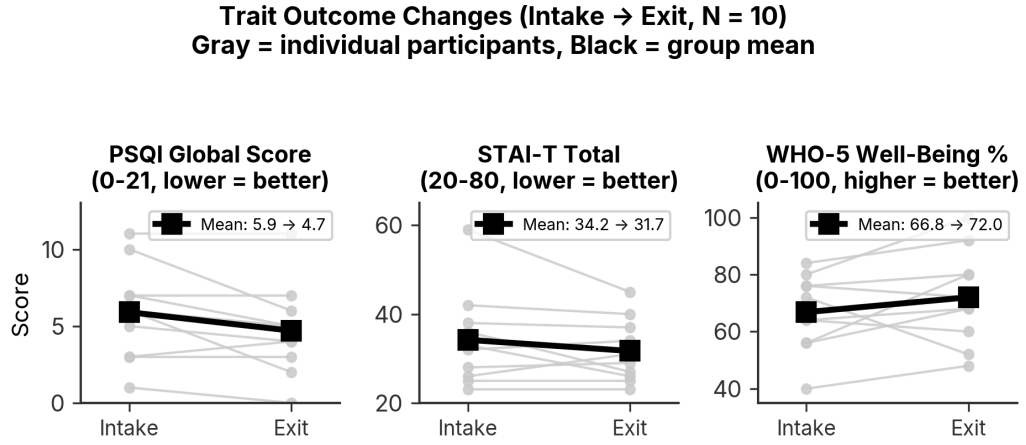

Figure 2. Trait Outcome Changes: Individual Trajectories from Intake to Exit (N = 10). Gray lines represent individual participants; black lines with markers represent group means. PSQI and STAI-T: lower scores indicate improvement. WHO-5: higher scores indicate improvement. No changes reached statistical significance .

Qualitative Findings

Thematic analysis of 35 substantive post-session comments and 10 exit survey responses identified six themes.

Theme 1: Immediate psychophysiological benefits. Nine of ten exit respondents described acute relaxation, stress reduction, or improved mental state. Representative quotes included: "Excellent tool to relax and re-center oneself" (P06), "At times it was almost euphoric" (P04), and "Surprised how much of an impact the waves had on not just my physical body but my mental state" (P02).

Theme 2: Physical symptom relief. Four participants specifically reported reduced pain or tension. Two participants who reported pre-session pain concerns (P09: "Lower back pain"; P12: "my back legs and ankles are very tense from work") described relief post-session (P09: "Back pain not noticeable at the moment"; P12: "back and neck pain is gone").

Theme 3: Novelty and unexpected effectiveness. Six of ten exit respondents expressed surprise at the experience or noted it was unlike conventional interventions. P04 described it as "a very unique intervention" that "can't exactly be likened to anything conventional."

Theme 4: Perceived effect duration. When asked how long effects lasted, participants provided estimates of their subjective experience. Six participants reported "a few hours," two reported "most of the day," one reported "less than one hour," and one reported "no noticeable effects." Several participants commented on this directly:

- "Only after the chair, no long lasting effects" (P03)
- "Even though I did not notice long term benefits, the time in the chair was very relaxing and calming" (P04)

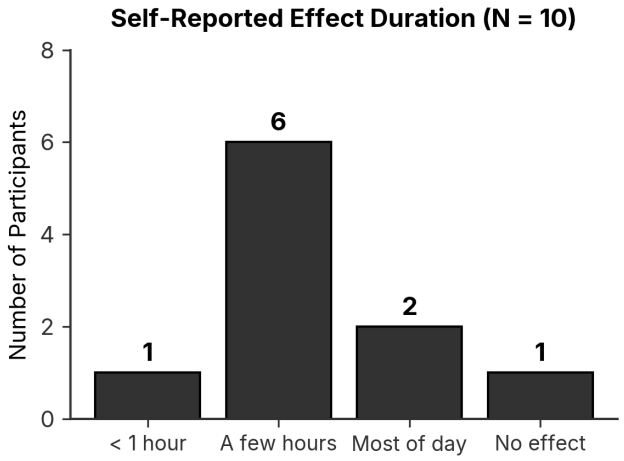

Figure 3. Self-Reported Effect Duration (N = 10). Distribution of participant responses when asked how long the effects from each session seemed to last.

This descriptive finding provides useful context for understanding user experience and may inform practical implementation decisions (e.g., timing of sessions relative to shifts).

Theme 5: Protocol and equipment preferences. Five participants commented on specific aspects of audio content or equipment. Preferences varied: P01 "preferred the sessions with less talking," while others appreciated the guidance. P07 noted that "headphones not noise canceling enough" interfered with relaxation in the firehouse environment.

Theme 6: Implementation context. Four exit respondents commented on environmental or logistical factors. The single clearly negative case (P07) attributed their experience primarily to implementation factors: "the environment of the study was not a relaxing environment" and scheduling was "a hassle." In contrast, P06 praised the clinician as "excellent, very reassuring and patient."

Acceptability

Exit survey responses indicated high acceptability:

- 90% (9/10) would recommend Shiftwave to other first responders
- 70% (7/10) would continue using Shiftwave if available at the station
- 70% (7/10) agreed or strongly agreed that wellness tools like Shiftwave could be valuable in their department's long-term health strategy

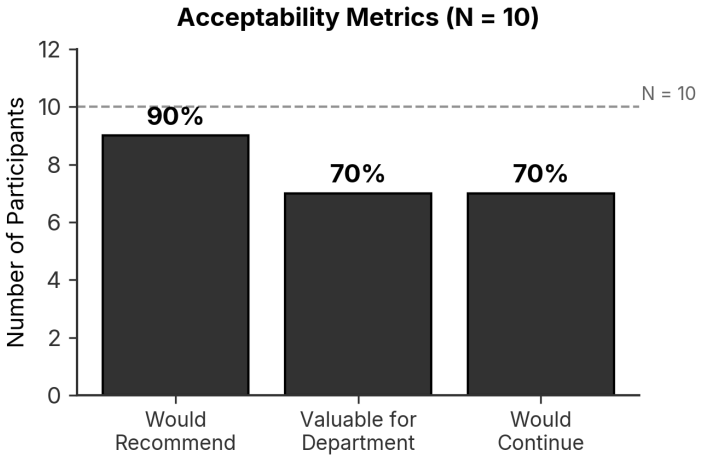

Figure 4. Acceptability Metrics (N = 10). Percentage of participants endorsing each acceptability item at exit.

The three participants who indicated they would not continue using (P02, P07, P08) showed divergent patterns: P07 had a clearly negative experience related to implementation factors, while P02 and P08 both indicated they would still recommend it to others and agreed it was valuable for the department — suggesting personal preference or practical constraints rather than negative evaluation of the intervention itself.

Discussion

Summary of Findings

This study examined the effects of Shiftwave sessions among volunteer firefighters over approximately four weeks. Three key findings emerged:

First, participants demonstrated statistically significant and meaningful improvements in pain, stress, anxiety, and restedness from immediately before to immediately after each session. Effect sizes ranged from medium (pain, d = 0.63) to large (stress, d = 0.95), and these effects were consistent across the study period , with no evidence of habituation or sensitization.

Second, no statistically significant changes were detected in trait-level outcomes (sleep quality, trait anxiety, well-being) from intake to exit, though all changes were in the direction of improvement and effect sizes were in the small-to-medium range. The study was not adequately powered to detect effects of this magnitude, so these findings should be interpreted as "not detected" rather than "absent." Pre-session baseline scores also showed no cumulative improvement across sessions.

Third, participants reported high acceptability: 90% would recommend Shiftwave to other first responders, and 70% would continue using it if available. Qualitative data revealed that participants valued the acute experience even when noting that benefits did not persist long-term.

Acute Effects

The acute session effects observed in this study are notable for their consistency and magnitude. All four outcomes showed statistically significant improvement with medium-to-large effect sizes (d = 0.63–0.95), with stress reduction showing the largest effect.

These findings align with qualitative reports: 9 of 10 participants described immediate relaxation or stress reduction, and several expressed surprise at the effectiveness. The consistency of effects across sessions (no habituation) suggests that repeated use does not diminish acute benefits within the timeframe studied.

However, the single-arm design limits interpretation. The observed improvements could reflect Shiftwave-specific effects, but alternative explanations cannot be ruled out, including rest and recumbency (lying in a zero-gravity position), expectancy effects, regression to the mean, or the Hawthorne effect.

Trait-Level Outcomes

The non-significant trait-level findings can be interpreted in multiple ways. First, true effects may exist but the study was underpowered to detect them — effect sizes of d = 0.41–0.71 would require substantially larger samples to detect reliably (the 95% confidence interval for PSQI, for example, ranged from −1.41 to −0.02). Second, the intervention dose (twice-weekly sessions over four weeks) may have been insufficient

to produce measurable trait-level change. Third, Shiftwave may primarily produce acute state changes without influencing underlying trait levels regardless of dose.

Pre-session baseline scores showed no cumulative improvement across sessions, which is consistent with either insufficient dose or a genuinely state-specific mechanism — but does not distinguish between these possibilities. The qualitative finding that participants perceived effects as lasting "a few hours" provides user-experience context but cannot inform mechanistic conclusions.

Acceptability and User Experience

The high acceptability rates are notable given participants' recognition that benefits were acute rather than lasting. This suggests that the immediate experience itself is valued, independent of expectations for long-term change. From a practical standpoint, a tool that reliably produces acute stress relief and relaxation may have substantial value in high-stress occupational settings, even if it does not produce cumulative therapeutic effects.

The negative case (P07) provides actionable insight: implementation factors (environment, scheduling, equipment) can substantially affect user experience. This participant's concerns were primarily contextual rather than reflecting fundamental dissatisfaction with the intervention concept.

Use-Case Implications

The significant acute effects on stress relief and relaxation suggests Shiftwave may function primarily as an acute recovery and relaxation tool. This is consistent with:

- Shift-based decompression (use between or after calls)
- In-the-moment stress relief
- Session-specific pain and tension relief

Integration of Quantitative and Qualitative Findings

The quantitative and qualitative findings converge meaningfully. Participants' descriptions of immediate relaxation and stress reduction align with the significant acute effects observed statistically. The qualitative theme regarding perceived effect duration — with most participants reporting benefits lasting "a few hours" — provides user-experience context, though the relationship between subjective perception of effect duration and underlying physiological or psychological mechanisms remains unclear and would require different study designs to investigate.

Limitations

Several limitations warrant emphasis:

Design limitations. The single-arm design without a control group is the most significant limitation. Without a comparison condition, observed improvements cannot be causally attributed to Shiftwave. Alternative explanations include:

- Rest and recumbency effects: Participants spent 10–20 minutes lying in a zero-gravity position in a designated space away from active duties (though environmental conditions varied). This context alone may produce relaxation benefits independent of vibrotactile stimulation.
- Expectancy and placebo effects: Participants volunteered for a wellness study and may have expected benefit, which can produce real subjective improvements independent of specific intervention effects.
- Regression to the mean: Participants may have been more likely to schedule sessions when experiencing elevated stress or discomfort, with subsequent measurements reflecting natural return toward baseline.
- Hawthorne effect: The experience of participating in a study and receiving attention from a healthcare provider may itself produce benefits.
- Demand characteristics: Participants may have reported improvements they believed researchers expected to find.

Measurement limitations. All outcomes were self-reported. While validated instruments were used for trait outcomes, acute measures were single-item scales. No objective physiological measures (e.g., heart rate variability, cortisol) were collected. Self-report measures are susceptible to response bias and cannot distinguish between genuine subjective improvement and reporting bias.

Sample limitations. The sample of 12 participants (10 completers) from a single volunteer fire department limits statistical power and generalizability. All participants were male. The sample was self-selected, potentially overrepresenting individuals predisposed to wellness interventions. Results may not generalize to career firefighters, other first responder populations, or other demographics.

Dose-response relationships could not be meaningfully assessed; session completion was relatively uniform across participants (range: 5–8 sessions among completers). Exploratory analysis found no significant correlation between total sessions completed and magnitude of trait-level change, though statistical power for this analysis was limited.

Other limitations. Protocol variability across sessions, while reflecting real-world implementation, prevents conclusions about specific protocol effects. The qualitative data, while informative, were limited to brief free-text survey responses rather than in-depth interviews. The study did not have IRB oversight.

Future Research Directions

Several directions would strengthen the evidence base:

- Controlled designs: Randomized trials comparing Shiftwave to appropriate control conditions (e.g., recumbent rest without vibrotactile stimulation, sham vibration, or active comparators).
- Larger samples: Studies powered to detect small-to-medium effects on trait outcomes (likely requiring N = 30–50 or more per group).
- Objective measures: Incorporation of physiological measures (HRV, cortisol, actigraphy for sleep) to complement self-report.
- Structured assessment of effect duration: Systematic measurement at multiple post-session timepoints.
- Longer duration and higher dose: Studies examining whether more frequent sessions or longer study periods produce cumulative effects.
- Diverse populations: Replication in career firefighters, female first responders, and other occupational groups.

Conclusions

This preliminary study provides initial evidence that Shiftwave sessions are associated with significant acute improvements in stress, anxiety, pain, and restedness among volunteer firefighters, with high user acceptability. The pattern of findings is consistent with Shiftwave functioning as an acute recovery and relaxation tool. No statistically significant trait-level changes were detected, though the study was underpowered for these outcomes and the intervention dose may have been insufficient to produce trait-level change. Controlled studies with larger samples and objective outcome measures are needed to establish whether observed effects are attributable to Shiftwave specifically, to clarify whether cumulative benefits might emerge with different protocols or longer durations, and to determine generalizability to other populations and settings.

Disclosures

Wyatt Rodgers is employed by Shiftwave. Dr. David S. Rosenthal owns a Shiftwave system and is enrolled in Shiftwave's ambassador program. Study design, survey instruments, and data analysis support were provided by Shiftwave. Data analysis was conducted with AI assistance (Claude, Anthropic; ChatGPT, OpenAI). The study was not externally funded.

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Appendix A: PSQI Component Analysis

Table A1. PSQI Component Analysis (N = 10)

Component	Intake	Exit	Δ	SD Δ	p	d	p (FDR)
C1: Subjective Quality	1.10	1.10	0.00	0.47	1.000	0.00	1.000
C2: Sleep Latency	1.20	0.60	−0.60	0.70	.024	−0.86	.167
C3: Sleep Duration	0.70	0.80	+0.10	0.57	.591	+0.18	1.000
C4: Sleep Efficiency	0.50	0.25	−0.25	0.72	.299	−0.35	1.000
C5: Sleep Disturbances	1.30	1.10	−0.20	0.42	.168	−0.47	.392
C6: Sleep Medication	0.40	0.40	0.00	0.00	—	0.00	1.000
C7: Daytime Dysfunction	0.80	0.50	−0.30	0.48	.081	−0.62	.284

Note: Each component scored 0–3; higher scores indicate worse sleep. FDR correction applied across all seven components. Sleep latency (C2) showed the largest effect (d = −0.86) but did not survive correction.

Appendix B: Shiftwave Protocols Used

Table B1. Protocol Usage Summary

Protocol	Duration	Sessions
This is Shiftwave	10 min	11
SS Meditate Express	15 min	11
Disco Nap Express	10 min	10
Rapid Relief	10 min	10
Sensorial	15 min	9
Stay Cool	18 min	6
NeuroBoost	9 min	5
Get In The Zone	10 min	3
Brake Time	10 min	1
Chill Activate 15	15 min	1

Note: Protocol selection varied based on participant preference and clinician judgment; not experimentally controlled. Duration range: 9–18 minutes. Most common duration: 10 minutes (35 sessions).

Appendix C: Extended Participant Quotes

This appendix provides additional participant quotes beyond those cited in the main text, organized thematically. Participant IDs are anonymized codes.

First Responder Relevance

Participants were asked whether they would recommend Shiftwave to other first responders and why:

"GREAT EXPERIENCE, especially for first responders." — P03, Exit Survey

"First responders have a lot of stress." — P03, Exit Survey

"Helps to reduce the stresses of the job and helps to prepare you for dealing with stressful situations." — P06, Exit Survey

"I think this could be very helpful, especially to first responders." — P09, Exit Survey

"Not first responders per se. But a good destressing for anyone." — P10, Exit Survey

Session-by-Session Feedback

Post-session comments illustrating consistency of acute experience across multiple sessions:

P01 (8 sessions):

Session 1: "It was great"

Session 2: "Continues to be very cool and refreshing"

Session 7: "Feel great"

Session 8: "Great — very relaxing"

P04 (6 sessions):

Session 2: "Felt great"

Session 3: "Very relaxing"

Session 4: "Really relaxing"

Session 5: "Very relaxing"

Protocol and Equipment Preferences

"The background track was really helpful." — P01, Session 5

"Music was corny during this session, but the other prompts were good." — P01, Session 6

"I preferred the sessions with less talking." — P01, Exit Survey

"Enjoyed the music." — P10, Session 5

"I did not like the drumming consistently." — P07, Session 3

Minority and Disconfirming Experiences

"Feels like a mall back massage chair." — P11, Session 1

"Every time I finish my heart rate seems elevated." — P05, Session 8

"I actually felt it took me a little longer than usual to fall asleep." — P10, Exit Survey

"I wasn't able to relax during it." — P07, Exit Survey

Appendix D: Supplementary Figures

Figure A1. Baseline Trends Across Sessions

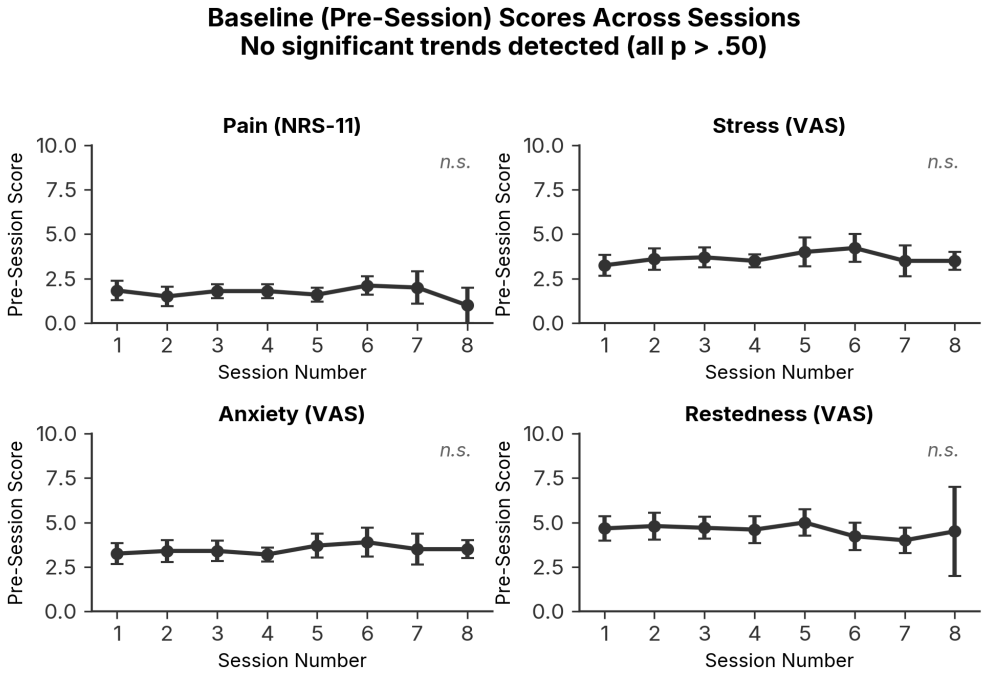

Figure A1. Baseline (Pre-Session) Scores Across Sessions. Mean pre-session scores for each outcome plotted by session number. Error bars represent ±1 standard error. No significant trends were detected (all p > .50), indicating that participants did not arrive at later sessions in systematically better or worse baseline states. This suggests observed session benefits were acute rather than cumulative over the study period.

Figure A2. Individual Participant Acute Response Patterns

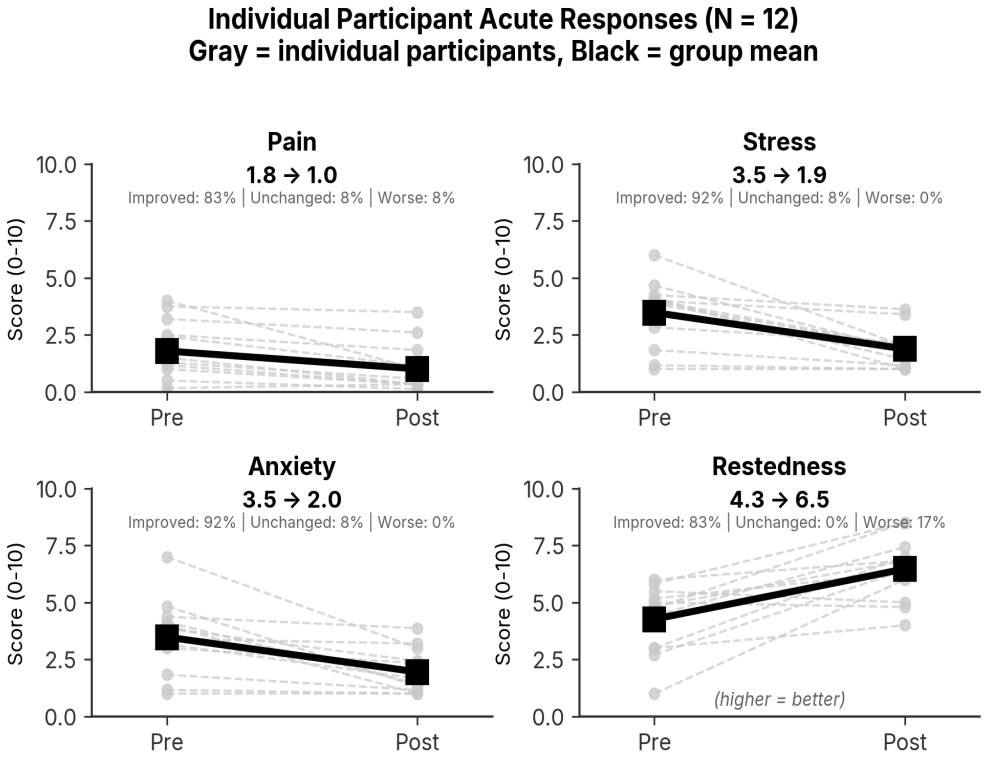

Figure A2. Individual Participant Acute Response Patterns (N = 12). Gray dashed lines represent each participant's mean pre- and post-session scores averaged across all their sessions (range: 1–8 sessions per participant; M = 5.6). Black lines with square markers indicate the group mean. For Pain, Stress, and Anxiety, lower scores indicate improvement; for Restedness, higher scores indicate improvement. The majority of participants showed improvement on all four outcomes. Individual trajectories illustrate that acute session effects were consistent across participants and not driven by outliers.