Research Square

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Adapting brief behavioral therapy for insomnia for Team USA athletes: Development and pilot implementation of “REST USA”

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Abstract

Background

While sleep is essential for elite athletes, poor sleep is a common issue in this population. Brief Behavioral Therapy for Insomnia (BBTI) is a 4-session adaptation of Cognitive Behavioral Therapy for Insomnia (CBT-I) that has been feasibly delivered to retired athletes. Whether BBTI is feasible and acceptable for actively competing elite athletes with subthreshold insomnia symptoms remains unclear.

Methods

This mixed-methods study comprised two phases: (1) focus group informed by the COM-B and Theoretical Domains Framework to guide BBTI adaptation, and (2) prospective, non-randomized pilot study of the adapted protocol (REST USA: Recovery and Elite Sleep Training for Team USA), evaluating a priori feasibility benchmarks and preliminary self-report and objective sleep outcomes via linear mixed models.

Results

Twenty-two senior winter national team athletes with subthreshold insomnia symptoms were enrolled. Retention and clinician fidelity were excellent. Benchmarks for recruitment, sleep diary completion, and actigraphy compliance were unmet, with assessment burden and device usability identified as primary barriers. Linear mixed models (modified intent-to-treat; n = 20) revealed preliminary signals of improvement at post-intervention in sleep difficulty (ASSQ: β=-0.69, SE = 0.29, p=.023), sleep behaviors (ASBQ: β=-0.84, SE = 0.25, p=.002), dysfunctional sleep beliefs (DBAS: β=-0.69, SE = 0.26, p=.013), training distress (TDS: β=-0.54, SE = 0.25, p=.036), and anxiety (GAD-7: β=-0.53, SE = 0.25, p=.044). Improvements in sleep beliefs and training distress were sustained at 2-month follow-up. The proportion of athletes flagging for clinically significant sleep disturbance decreased from 46% to 19%.

Conclusion

REST USA demonstrated strong acceptability and preliminary target engagement, with clear and addressable pathways for refining feasibility in subsequent trials.

Introduction

Sleep is essential for optimal athletic performance, recovery, and mental health.[1–3] Yet, elite athletes frequently experience sleep disturbances due to training, travel, and other sport demands.[4,5] Sleep hygiene and general sleep education can help,[6,7] but are not sufficient for more complex or chronic sleep disturbances[8–10] and rarely include athlete-specific content. Cognitive behavioral therapy for insomnia (CBT-I) is a gold-standard, first-line treatment[11] that yields sustained reductions in clinical[12] and subthreshold insomnia.[13] However, standard CBT-I (6-8 sessions) is not optimized for the unique sleep challenges incurred by elite athletes with intense travel, competition schedules, and life pressures.

Brief Behavioral Therapy for Insomnia (BBTI) – a 4-session, behaviorally focused adaptation of CBT-I – may offer a more practical alternative.[14] Originally developed for older adults and military veterans, research suggests that BBTI is efficacious,[14] non-inferior to CBT-I,[15] and adaptable to in-person or virtual formats (via phone[16]). Research on BBTI in athletic populations remains limited, with one notable study examining its implementation with former NFL players with insomnia and chronic pain,[17] which provided preliminary evidence of feasibility and efficacy. Another study tested a 2-session version of BBTI with professional esport athletes,[18] but findings suggested this dose may have been too small. It remains unclear whether a full BBTI protocol can be successfully implemented in a population of active elite athletes facing ongoing competition, travel, and physical training demands.

To address this gap, we evaluated the feasibility of an adapted BBTI protocol (Recovery and Elite Sleep Training for Team USA [REST USA]) among national team winter sport athletes. Specifically, we aimed to: (1) identify barriers and facilitators to BBTI implementation, (2) adapt BBTI for actively competing Team USA athletes, (3) examine feasibility, and 4) explore preliminary effects on subjective and objective sleep outcomes. We hypothesized that the REST USA program would be feasible for athletes and produce significant and sustained improvements in sleep behaviors.

Methods

Design

This mixed-methods study comprised two sequential phases: (1) a qualitative focus group to inform BBTI adaptation, and (2) a prospective, non-randomized pilot study of the adapted intervention (REST USA) evaluating a priori feasibility benchmarks and preliminary outcome signals. The study was approved by the University of Utah IRB (protocol #00189602). Figure 1 provides an overview of the study protocol timeline.

Phase 1: Focus Group: Adapting BBTI for Elite Athletes

Participants and Procedures. In July 2025, six senior national team athletes (66.7% women; *M* age = 27.3, SD = 6.6) completed a 60-minute focus group via Zoom (see Table 1 for participant characteristics for the full sample). Eligibility required age ≥ 18 years, English fluency, and active roster status for the 2025/2026 season. Focus group goals were to: (1) assess sleep education and intervention needs and preferences; (2) outline BBTI; (3) identify barriers and facilitators for implementation; and (4) introduce proposed adaptations for athlete feedback.

Table 1
Participant characteristics for the Phase 2 Pilot Intervention.

Variable	n	%
Gender		
Female	10	45.5
Male	12	54.5
Race / Ethnicity		
Asian	6	27.3
Black or African American	1	4.5
Multiracial / Multiethnic	2	9.1
White	13	59.1
Sex Assigned at Birth		
Female	10	45.5
Male	12	54.5
Sleep Aid Use		
No	14	63.6
Yes	8	36.4
Self-Reported Sleep Disorder Diagnosis		
No	21	95.5
Yes	1	4.5
Previous or Current Wearable Sleep Tracker Use		
No	14	63.6
Yes	8	36.4
Sleep Aid Use = “Do you regularly use sleep aids (e.g. melatonin, medications)?”		

The Theoretical Domains Framework (TDF) and Capability, Opportunity, Motivation-Behavior model (COM-B)[19] guided focus group questions and discussions. JD facilitated the focus group, while EP and LP took notes. The study clinicians (EC, MC) observed the focus group and participated in subsequent intervention adaptation discussions. See **S.1** in **Supplemental Materials** for the full focus group script and questions.

Measures. Participants completed the Feasibility of Implementation Measure (FIM), Acceptability of Intervention Measure (AIM), and Intervention Appropriateness Measure (IAM) – each of which are four-item measures rated on 5-point ordinal scales. A mean score ≥ 15 on each was used as the implementation threshold, consistent with prior research.

Data Analysis. TDF domains were mapped onto the COM-B model. Two researchers (AT, LA) independently coded a focus group transcript subset in NVivo (v.15),[20] then met to reconcile interpretations. Full transcript coding proceeded iteratively with an audit trail maintained throughout.

Phase 2: Pilot Study of REST USA

Clinician Training. Two licensed psychologists and certified mental performance consultants from the USOPC Psychological Services team with prior CBT-I training were trained by JD via two 60-minute synchronous Zoom sessions covering intervention materials and protocol delivery. Clinicians attended weekly team meetings throughout the intervention for consultation.

Recruitment, Baseline Assessment, and Sleep Disorder Screening. Twenty-two participants were recruited via direct electronic communication. Eligibility criteria were identical to Phase 1. Following informed consent, participants completed a baseline assessment (Week 0). In addition to other sleep-related measures, participants completed the following self-report instruments that are questionnaires included within the Sport Mental Health Assessment Tool-1 [SMHAT-1])[21], Patient Health Questionnaire (PHQ-9), the General Anxiety Disorder survey (GAD-7), and the Athlete Sleep Screening Questionnaire (ASSQ). For safety, clinical follow-up was initiated for any athlete flagging per SMHAT-1 guidelines (PHQ-9 ≥ 10; GAD-7 ≥ 10; ASSQ ≥ 8). Assessments were repeated at post-intervention (Week 6) and 2-month follow-up (Week 14).

Participants were then provided with a wrist-worn actigraphy device, and were instructed to wear it continuously for 6 weeks. Participants also completed a daily Consensus Sleep Diary[22] and actigraphy wear log via Qualtrics during the 2-week pre-intervention window. At Week 1, clinicians conducted individual intake sessions using the Structured Clinical Interview for DSM-5 Sleep Disorders-Revised (SCISD-R[23]) to screen for contraindicated sleep disorders.

Intervention Adaptation and Delivery. Adaptations to BBTI were informed by focus group findings, recent systematic reviews and consensus statements on elite athlete sleep,[5] and the authors' experiences adapting CBT-I skills for Team USA athletes and other elite athlete populations (JD, EC, MC).

REST USA sessions were delivered virtually via a secure videoconferencing platform (Zoom). All participants received group sleep psychoeducation during Sessions 1 and 2. Consistent with BBTI, Session 1 included education on healthy sleep practices, the two-process model of sleep regulation, and the "Four Rules for Sleep" (derived from core components of CBT-I) plus new content on what constitutes "healthy sleep," how sleep impacts sport performance, and building "healthy sleep mindsets" for athletes.

We adapted Session 2 as an additional psychoeducational session to include more athlete-relevant content. Because athletes revealed unhelpful attitudes or beliefs about sleep during the focus group, we included education on cognitive restructuring techniques to shift these beliefs (original BBTI excludes cognitive components from CBT-I). Given that national team athletes regularly travel internationally, we also included expert-consensus recommendations on mitigating jetlag and travel fatigue.[24]

After Session 2, we introduced a "Sleep Game Plan" – a worksheet to help athletes adapt the psychoeducational content to their specific goals and challenges. The Game Plan also reminded athletes when and how to apply skills and knowledge in their daily lives (see **S.2** in **Supplemental Materials**).

Consistent with a stepped-care approach, athletes could opt out of Sessions 3 and 4 if they denied significant sleep concerns or believed they would not receive added benefit. As with BBTI,[14] Sessions 3 and 4 focused on tailoring sleep behavior change recommendations to the individual, monitoring progress, and addressing barriers. Session 4 emphasized relapse prevention during the season. All sessions were audio recorded. Clinicians completed post-session fidelity checklists. See **S.3** in **Supplemental Materials** for a full outline of REST USA content and adaptations.

Outcome Measures

Outcome measures included six subjective self-reported measures and one objective measurement of sleep and activity patterns.

The *Athlete Sleep Screening Questionnaire (*ASSQ[25]) is a 16-item sport-specific screening self-report measure classifying athletes as good, suboptimal, or problematic sleepers. In a study of Canadian national team athletes, the ASSQ demonstrated acceptable internal consistency (α = .74) and good test-retest reliability (r = .86), with strong agreement with expert clinical assessment (κ = .84; sensitivity = 81%, specificity = 93%).[26]

The *Athlete Sleep Behavior Questionnaire* (ASBQ[27]) is an 18-item self-report measure assessing maladaptive sleep practices common among elite athletes. The ASBQ demonstrated acceptable convergent validity with established sleep questionnaires (r = .32–.69) and discriminated between athlete and non-athlete samples.[27] Meta-analytic findings show acceptable internal consistency (α = .73) and test-retest reliability (ICC = .88).[28]

The *Dysfunctional Beliefs and Attitudes about Sleep-16* (DBAS-16[29]) is a 16-item self-report measure assessing maladaptive sleep-related cognitions across five domains: Sleep expectations, perceived consequences of insomnia, worry and helplessness, and medication. In a study of 283 people with insomnia, the DBAS-16 demonstrated good internal consistency (α = 0.77 for clinical and 0.79 for research samples), temporal stability (r = 0.83), and convergent validity with established measures of insomnia severity, anxiety, and depression.[29]

The *Patient Health Questionnaire-9* (PHQ-9[30]) is a 9-item self-report measure assessing depressive symptom severity over the past two weeks. The PHQ-9 has demonstrated strong internal consistency (α = .86–.89), good test-retest reliability (r = .84), and excellent criterion validity against structured clinical interview, with a total score ≥ 10 yielding 88% sensitivity and 88% specificity for major depressive disorder.[30]

The *Generalized Anxiety Disorder-7* (GAD-7[31]) is a 7-item self-report measure assessing the frequency of anxiety symptoms over the past two weeks. The GAD-7 has demonstrated excellent internal consistency (α = .92), strong criterion validity against structured clinical interview (sensitivity = 89%, specificity = 82% at a cutoff of ≥ 10 for generalized anxiety disorder), and good convergent validity with established anxiety measures.[31]

The *Training Distress Scale* (TDS[32]) is a 19-item self-report measure assessing training-related distress symptoms over the past 48 hours, including fatigue, emotionality, concentration difficulties, physical discomfort, sleep disturbance, and appetite changes. The TDS has demonstrated good internal consistency (α = .80–.88) and criterion validity based on positive associations with objective performance decrements in laboratory and field settings.[32]

The wrist-worn *ActiGraph LEAP*[33] is the upgraded version of the ActiGraph GT9X Link. The LEAP performs similarly to the GT9X,[34] providing valid estimates of sleep-wake patterns. Specific objective measures of interest were total sleep time, sleep efficiency, sleep onset latency, and wake after sleep onset.[35]

Feasibility benchmarks

Several benchmarks quantitatively evaluated feasibility of recruitment, retention, the REST USA intervention (intervention completion, clinician fidelity), and the study assessments (sleep diary completion, outcome measure completion, actigraphy compliance). The specific cut-offs are similar to those used in other feasibility trials for behavior change interventions (Table 2).[36,37] Qualitative self-report feasibility data were also collected via a brief exit survey within the 2-month follow-up assessment.

Table 2

Phase 2 mixed-methods feasibility results for the REST USA pilot study (n = 21), including benchmark definitions, quantitative outcomes, and representative participant quotes

Benchmark	Definition	Result	Threshold (good/excellent)	Met?	Representative participant quotes
Recruitment	Percentage of eligible senior national team athletes who consented to participate.	58% (22/38) overall; 100% of those directly approached	≥ 70% / ≥80%	No (overall)	*"…clearly showing consideration for athletes and their time constraints."*
Retention	Percentage of enrolled participants who completed the 2-month follow-up assessment (i.e., did not drop out or become lost to follow-up).	96% (21/22)	≥ 70% / ≥80%	Yes (excellent)	*"A really great resource and the [researchers] running it were really helpful and available to answer questions and provide good suggestions."*
Intervention completion	Percentage of participants who completed all assigned REST USA sessions.	77% (17/22) overall; 75.0% of those who opted in for all 4 sessions (15/20)	≥ 80% / ≥90%	No	*"The 1:1s were fantastic!"* *"The progression of information from meeting to meeting was really helpful and insightful."* *"I felt like I could feel a difference."* *"Group education especially went beyond surface level sleep info that most athletes already know."*
Clinician fidelity - recording	Percentage of REST USA sessions for which clinicians completed an audio recording and progress note.	97% (1 session missed due to technical issue)	≥ 75% / 100%	Yes (good)	—
Clinician fidelity - protocol adherence	Percentage of sessions in which clinicians delivered 100% of core REST USA content, based on	100%	≥ 75% / 100%	Yes (excellent)	—

REST USA=Recovery and Elite Sleep Training for Team USA; BBTI=Brief Behavioral Therapy for Insomnia.

Feasibility thresholds adapted from Mace et al. (2022; 2023). Qualitative data were collected via open-ended exit survey items administered at 2-month follow-up and integrated with quantitative benchmark data to provide a more comprehensive assessment of feasibility.

Benchmark	Definition	Result	Threshold (good/excellent)	Met?	Representative participant quotes
	independent adherence checks of audio recordings and session checklists.				
Sleep diary completion	Percentage of athletes who completed ≥ 10 out of 14 daily sleep diaries during the pre-intervention window.	64% (14/22)	≥ 70% / ≥80%	No	*"A bit of a hassle to answer the questions."* *"Surveys were a little much to keep up with."* *"I think it definitely helped me to track my sleep schedule and be more mindful of it."*
Outcome measure completion	Percentage of participants who provided outcome measure data at all three time points (baseline, post-intervention, 2-month follow-up).	64% (14/22)	≥ 70% / ≥80%	No	*"Asking a lot if we weren't getting intermittent feedback."* *"I thought all of the info that you guys wanted from us was reasonable and worth what I learned."*
Actigraphy compliance	Percentage of participants with valid accelerometer data for ≥ 10 hours/day across Weeks 0–6.	68% wore device > 5 nights; 18% did not wear device at all	≥ 70% / ≥80%	No	*"Wearable was glitchy and uploading was very slow."* *"The watch died so quickly."* *"Watch syncing process could be improved."* *"Would be better if we were able to see some data."*

REST USA=Recovery and Elite Sleep Training for Team USA; BBTI=Brief Behavioral Therapy for Insomnia.

Feasibility thresholds adapted from Mace et al. (2022; 2023). Qualitative data were collected via open-ended exit survey items administered at 2-month follow-up and integrated with quantitative benchmark data to provide a more comprehensive assessment of feasibility.

Data Analysis

Feasibility benchmarks were computed as percentages. Feedback on study feasibility was analyzed qualitatively (inductive) and mapped onto relevant feasibility benchmarks. We examined item-level missing data on self-report

measures during data cleaning. Total scores were computed for cases with complete data only.[38] Preliminary outcomes measures were analyzed using linear mixed models, where the dependent variables were outcome measures (six subjective survey measures, actigraphy metrics) and the independent variable was time (baseline, week 6, month 2 post-completion). All variables were standardized as z scores prior to analysis. An a priori value of 0.05 was established as significant for statistical tests.

Results

Phase 1

Barriers and Facilitators to Sleep Behavior Change. Analysis guided by COM-B/TDF identified multiple barriers and facilitators to sleep behavior change. Key barriers included competing time demands (e.g., outside employment, training schedules), environmental and biological factors impacting sleep (e.g., travel, altitude), and unhelpful attitudes and beliefs about sleep (e.g., perceived lack of control). Facilitators included prior self-directed sleep experimentation (e.g., supplements, wind-down routines) and engagement with wearable sleep data. Athletes responded favorably to REST USA, reporting that CBT-I-based strategies were new to them and they were open to learning more (see **Supplemental Table S4**).

Focus group participants rated REST USA highly on all implementation outcome measures (Acceptability: AIM; Appropriateness: IAM; Feasibility: FIM). All measures exceeded the ≥ 15 implementation threshold, with specific sum scores (M, SD, and range) as follows: AIM: M = 18.6 (SD = 1.7, range: 16–20); IAM: M = 18.2 (SD = 2.4, range: 14–20); FIM: M = 19.0 (SD = 1.5, range: 16–20).

Phase 2

Baseline Surveys. At baseline, athletes demonstrated moderate sleep difficulty (ASSQ-SDS: M = 6.64, SD = 2.68), with 45.5% (10/22) exceeding the SMHAT-1 clinical threshold (≥ 8). Table 3 provides descriptive statistics for all self-reported measures across timepoints.

Table 3
Descriptive statistics across all study timepoints.

Variable	Possible Range	T0 (n)	Mean (SD) / Flag	Min-Max	T1 (n)	Mean (SD) / Flag	Min-Max	T2 (n)	Mean (SD) / Flag	Min-Max
ASSQ-SDS Sum	0–17	22	6.64 (2.68)	3–11	14	4.57 (1.91)	1–8	21	5.38 (3.07)	2–13
ASSQ-SDS Flag (≥ 8)	N/A	22	10/22		14	1/14		21	4/21	
Anxiety Sum (GAD-7)	0–21	22	4.95 (5.83)	0–18	14	1.79 (2.42)	0–7	21	4.95 (5.71)	0–21
Depression Sum (PHQ-9)	0–27	22	4.14 (4.11)	0–15	14	2.21 (3.31)	0–11	21	3.67 (6.09)	0–27
ASBQ Mean	1–5	22	2.28 (0.37)	1.56–3.11	14	1.95 (0.29)	1.39–2.44	21	2.14 (0.37)	1.22–2.67
DBAS Total Mean	0–10	21	3.16 (1.09)	1.75–5.88	12	2.56 (1.29)	0.69–5.12	19	2.52 (1.26)	0-5.12
DBAS: Expectations	0–10	21	6.23 (2.15)	3–10	12	5.43 (1.86)	2–8	19	5.19 (2.14)	0-8.50
DBAS: Consequences	0–10	21	3.55 (1.22)	1.40-6.00	12	2.92 (1.60)	1.00-5.40	19	2.82 (1.35)	0-5.20
DBAS: Worry/Helplessness	0–10	21	2.61 (1.85)	0-6.67	12	1.90 (1.52)	0-5.33	19	1.74 (1.44)	0–5.00
DBAS: Medication	0–10	21	1.70 (1.16)	0-3.33	12	1.69 (1.11)	0-3.33	19	1.86 (1.60)	0–5.00
TDS Sum	0–76	22	18.45 (12.84)	4–45	14	13.50 (10.11)	3–36	21	12.05 (9.32)	0–38

Higher scores indicate more severe symptoms. ASSQ-SDS = Athlete Sleep Screening Questionnaire-Sleep Difficulty Score. Flag indicates SDS ≥ 8 (consistent with the Sport Mental Health Assessment Tool-1). T0 = Baseline. T1 = Post-Intervention. T2 = 2-Month Follow-Up. ASBQ = Athlete Sleep Behavior Questionnaire. DBAS = Dysfunctional Beliefs and Attitudes about Sleep. TDS = Training Distress Scale.

Attrition. Of the 22 participants enrolled at baseline, one dropped out after Session 2, citing challenges with time commitment. Consistent with our flexible, stepped-care delivery model, two participants opted out of Sessions 3 & 4, citing minimal sleep difficulties. Diagnostics identified five instances of incomplete item-level data on the DBAS-16: one at baseline, two at post-intervention, and two at 2-month follow-up. These cases were excluded from descriptive statistics and linear mixed models. Only 14 participants completed the post-intervention assessment. The team's high-performance director cited sport-related scheduling conflicts as the primary barrier to athletes' participation. All participants enrolled at the time of the 2-month follow-up (n = 21) completed this assessment.

Feasibility of the Intervention and Benchmarks. Retention and clinician fidelity met a priori benchmarks. Intervention completion approached (but did not meet) benchmarks, due to primary barriers of shifting training

schedules and other time demands. Benchmarks for sleep diary completion, session completion, outcome measure completion, and actigraphy compliance were not met. Qualitative data pointed to assessment burden and device usability as the principal drivers of these shortfalls. While the recruitment benchmark was not met, all athletes who were approached about the study consented to participate. Qualitative feedback on REST USA revealed its practical, individualized nature; participants reported learning sleep strategies that surpassed standard sports sleep hygiene education (Table 2).

Preliminary Signals of Improvement. Linear mixed models with participants opting in for all four sessions (n = 20) revealed preliminary signals of improvement at post-intervention across sleep difficulty (ASSQ), sleep behavior (ASBQ), dysfunctional sleep beliefs (DBAS Total), training distress (TDS), and anxiety (GAD-7) (Table 4). These outcomes demonstrated moderate-to-large effect sizes, with the most robust improvements observed in sleep behaviors and sleep difficulty. DBAS improvements were sustained at 2-month follow-up across the total score and subscales assessing perceived consequences of poor sleep and worry/helplessness about sleep, all maintaining moderate effect sizes. Training distress improvement was sustained at follow-up, and this effect increased over time. Initial improvements in sleep difficulty and sleep behavior were attenuated at follow-up. Anxiety improvements at post-intervention were not sustained and depression showed no significant change at either timepoint, consistently yielding small effect sizes.

Table 4

Linear Mixed Model Results for Primary Outcomes Across Timepoints: mITT (n = 20) and Sensitivity Analysis (n = 22)

Outcome	β (T1 – T0)	β (T2 – T0)	SE (T1 – T0)	SE (T2 – T0)	df (T1 – T0)	df (T2 – T0)	p (T1 – T0)	p (T2 – T0)	d (T1 – T0)	d (T2 – T0)
Modified Intent-to-Treat Analysis (mITT; n = 20)										
ASSQ	-0.69	-0.48	0.29	0.26	31.5	29.4	.023*	.071	-0.707	-0.499
ASBQ	-0.84	-0.45	0.25	0.22	33.7	32.3	.002*	.050*	-0.877	-0.476
DBAS Total	-0.69	-0.62	0.26	0.23	29.6	28.4	.013*	.012*	-0.705	-0.631
DBAS Expectations	-0.52	-0.38	0.24	0.21	27.4	26.6	.040*	.085	-0.508	-0.371
DBAS Consequences	-0.73	-0.63	0.29	0.26	30.9	29.2	.017*	.022*	-0.773	-0.657
DBAS Worry/Helplessness	-0.54	-0.66	0.29	0.26	29.0	27.2	.076	.018*	-0.563	-0.683
DBAS Medication	-0.17	0.14	0.26	0.23	28.8	27.8	.534	.544	-0.161	0.139
TDS	-0.54	-0.70	0.25	0.22	33.5	32.2	.036*	.004*	-0.557	-0.719
GAD-7	-0.53	-0.10	0.25	0.23	32.3	31.0	.044*	.652	-0.518	-0.102
PHQ-9	-0.23	-0.09	0.29	0.26	32.1	30.4	.424	.725	-0.220	-0.086
Sensitivity Analysis — Full Sample (n = 22)										
ASSQ	-0.64	-0.48	0.28	0.24	34.3	31.6	.026*	.054	-0.657	-0.490
ASBQ	-0.81	-0.39	0.24	0.21	36.3	34.4	.002*	.070	-0.851	-0.409
DBAS Total	-0.64	-0.56	0.26	0.22	32.1	30.5	.019*	.016*	-0.652	-0.566
DBAS Expectations	-0.50	-0.32	0.24	0.20	29.8	28.6	.048*	.124	-0.485	-0.314
DBAS Consequences	-0.67	-0.54	0.29	0.25	33.6	31.2	.026*	.037*	-0.689	-0.550
DBAS Worry/Helplessness	-0.48	-0.60	0.29	0.24	31.5	29.2	.106	.021*	-0.488	-0.610
DBAS Medication	-0.18	0.07	0.26	0.21	31.1	29.7	.490	.754	-0.172	0.066
TDS	-0.48	-0.56	0.25	0.22	36.7	34.7	.068	.016*	-0.488	-0.571
GAD-7	-0.48	0.00	0.25	0.22	35.1	33.1	.066	.985	-0.486	0.004

Note. Modified Intent-to-Treat (mITT) analysis excluded two participants who, per study protocol, opted out of REST USA sessions 3 and 4 if they felt they did not have significant sleep concerns requiring further consultation. Sensitivity analysis includes all enrolled participants (n = 22). All variables were standardized as z-scores prior to analysis. β and SE reported to two decimal places; df to one decimal place; p-values to three decimal places; Cohen's d to three decimal places. T1 − T0 = Change from baseline to post-intervention; T2 − T0 = Change from baseline to two-month follow-up. β = standardized regression coefficient; SE = standard error; df = degrees of freedom; d = Cohen's d (calculated as fixed effect estimate divided by square root of total model variance). * p < .05. T0 = Baseline; T1 = Post-Intervention; T2 = 2-Month Follow-

Outcome	β (T1 – T0)	β (T2 – T0)	SE (T1 – T0)	SE (T2 – T0)	df (T1 – T0)	df (T2 – T0)	p (T1 – T0)	p (T2 – T0)	d (T1 – T0)	d (T2 – T0)
Modified Intent-to-Treat Analysis (mITT; n = 20)										
PHQ-9	-0.24	-0.10	0.28	0.24	35.1	32.7	.384	.670	-0.236	-0.100

Note. Modified Intent-to-Treat (mITT) analysis excluded two participants who, per study protocol, opted out of REST USA sessions 3 and 4 if they felt they did not have significant sleep concerns requiring further consultation. Sensitivity analysis includes all enrolled participants (n = 22). All variables were standardized as z-scores prior to analysis. β and SE reported to two decimal places; df to one decimal place; p-values to three decimal places; Cohen's d to three decimal places. T1 − T0 = Change from baseline to post-intervention; T2 − T0 = Change from baseline to two-month follow-up. β = standardized regression coefficient; SE = standard error; df = degrees of freedom; d = Cohen's d (calculated as fixed effect estimate divided by square root of total model variance). * p < .05. T0 = Baseline; T1 = Post-Intervention; T2 = 2-Month Follow-

Post-hoc sensitivity analyses including all participants (N = 22) yielded largely consistent findings, with significant post-intervention improvements observed for sleep difficulty, sleep behaviors, and dysfunctional sleep beliefs. Change in anxiety at post-intervention was not statistically significant in the full sample, nor were changes in training distress, both showing attenuated signals compared to the completer group. However, training distress improved significantly at follow-up with a moderate effect size (Table 4). Residual diagnostics on these linear mixed models indicated non-normal residuals for the ASSQ, DBAS Worry/Helplessness, GAD-7, and PHQ-9. Bootstrapped CIs confirmed that substantive conclusions were unchanged from these four models. The non-significant GAD-7 post-intervention effect observed in the sensitivity analysis was further attenuated under bootstrapping (CI: −0.93 to + 0.03). While not part of the linear mixed models, the proportion of athletes flagging for clinically significant sleep disturbance was reduced from 45.5% at baseline to 19% at 2-month follow-up.

Discussion

We adapted and piloted REST USA, a sport-specific BBTI protocol, with actively competing elite athletes reporting subthreshold insomnia symptoms. We found strong participant motivation and openness to the intervention, excellent retention and clinician adherence. Preliminary signals of improvement across sleep-, mood-, and training- self-report outcomes were detected. Benchmarks for recruitment, sleep diary completion, and actigraphy compliance were not met. Qualitative data pointed to assessment burden and actigraphy device usability as the primary drivers. BBTI can be adapted for elite athletes with strong acceptability and satisfaction, although clear and addressable protocol refinements are required to enhance feasibility. Overall, our hypotheses were partially supported by these findings.

BBTI has been implemented primarily with more accessible patient populations with higher comorbidity, including older military veterans[14] and retired NFL players with insomnia and chronic pain.[17] While important, these findings do not translate directly to actively competing athletes, including those with subthreshold insomnia symptoms. To our knowledge, only one study adapting BBTI for active elite athletes has been published – a two-session protocol over two weeks with daily biofeedback for professional esport athletes,[18] which yielded modest short-term sleep improvements but no sustained improvements in mood or performance. The authors hypothesized that a more intensive stepped-care approach might help sustain benefits. REST USA provides such a stepped-care model, with the option to complete two sessions or all four. Our preliminary signals of

improvement, while not indicative of efficacy, are consistent with evidence that CBT-I reduces sleep disturbance in group formats,[39] via virtual delivery,[40] and for individuals with subthreshold symptoms.[13] Our protocol, which screens athletes via the ASSQ and allows for calibrating intervention dose accordingly, aligns with consensus best-practices for enhancing elite athlete sleep at a systems level.[5]

Three feasibility challenges emerged concerning data collection, and we are adjusting the next trial accordingly. First, qualitative feedback on the actigraphy device was nearly unanimously negative, revealing significant technical and usability barriers that resulted in very poor adherence. To honor participant feedback and reduce further burden, we ultimately informed participants that they were no longer required to wear the device for the study. We will switch to a commercially available health tracking ring for subsequent research, as evidence now suggests that Oura Rings demonstrate sleep staging accuracy comparable to polysomnography.[41] Sleep diary adherence was also poor. Because data suggest that one week is the minimum necessary assessment window for reliable results,[42] we will shorten the sleep diary window accordingly for the next trial. Third, completion of study self-report assessments was inconsistent. The post-intervention survey was administered during a tightly scheduled performance camp without protected time. In subsequent trials, we will ensure team time is protected within a group meeting for completing all study assessments.

This study had several strengths. The development and evaluation of REST USA was guided by the NIH Stage Model[43] – specifically Stages 1a and 1b – reflecting current best practices for behavioral intervention development. Qualitative data collection and analysis were grounded in established implementation science frameworks,[19] enabling a more precise understanding of our population's needs and preferences. Gaining entry to the study population was facilitated by prior delivery of sleep psychoeducation to the team, inclusion of the team's sport psychologist as a study clinician, and active engagement from the team’s high-performance director. This study also has several limitations. The single-arm, non-randomized design, along with a small sample, precludes attribution of change in sleep-related outcomes to REST USA specifically. Study of national team athletes from a single winter Olympic sport also limits generalizability. Missing outcome data and issues with actigraphy data collection constrained our interpretation of preliminary signals of improvement and prevented us from understanding potential associations between REST USA participation and objective sleep parameters. Future research will evaluate a refined protocol in both elite able-bodied and para-athlete populations, with potential for widespread rollout consistent with consensus recommendations for improving sleep across the athlete lifecycle.[5]

Conclusion

This work extends the science of behavioral sleep intervention in elite sport beyond standard biological and sleep hygiene approaches that predominate. REST USA shows promise as a feasible, acceptable, and athlete-centered behavioral sleep intervention for actively competing elite athletes.

Declarations

Ethics approval and consent to participate:

This study was approved by the University of Utah Institutional Review Board (Protocol #00189602). All participants provided written informed consent prior to enrollment.

Consent for publication:

All participants provided consent for publication of study findings.

Competing interests:

None.

Funding:

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Author Contribution

JD conceptualized the study, led the adaptation of the sleep intervention (REST USA), co-coordinated data collection, analyzed the data, and led the preparation of the manuscript. AT led actigraphy data collection and analysis, analyzed qualitative data, and co-coordinated the collection of other-study data. EP co-coordinated data collection, analyzed qualitative and quantitative data (on feasibility), and co-created the study protocol. LA co-coordinated data collection and analyzed qualitative data. EC and MC assisted in the adaptation of the sleep intervention and co-delivered the intervention. HV, JB, AD, and JF supervised study execution, provided input on the study protocol, and edited the manuscript. All authors reviewed and approved the final manuscript.

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Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

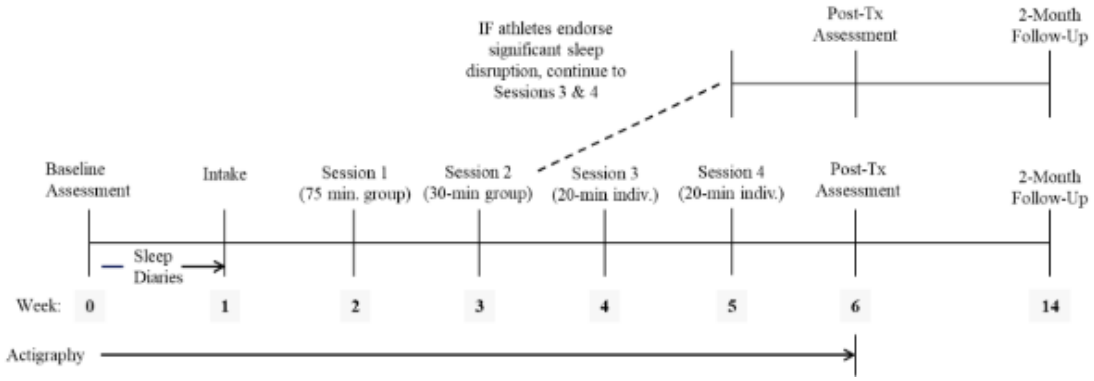


Figure 1

Overview of study timeline and procedures.

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