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Outcomes from the Transdiagnostic Sleep and Circadian Intervention (TranS-C) for midlife and older adults with serious mental illness and sleep and circadian dysfunction

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Abstract

The present study tested outcomes of the Transdiagnostic Sleep and Circadian Intervention (TranS-C) among midlife and older adults with serious mental illness (SMI). Further, we tested predictors–credibility, expectancy, usefulness, and utilization—that may affect TranS-C outcomes. Midlife and older participants from a community setting (>49 years; 62.3% female, 37.7% African American or Black) with sleep and circadian problems and SMI were randomized to receive TranS-C plus usual care (TranS-C+UC, n=27) or usual care followed by Delayed Treatment with TranS-C (UC-DT, n=26). Immediate and delayed TranS-C data were combined to increase power (combined n=52). Outcomes were assessed at pre-treatment, post-treatment, and 6-month follow-up. Credibility and expectancy were assessed during the second session. Usefulness and utilization of TranS-C skills were assessed at post-treatment and 6-month follow-up. TranS-C+UC, relative to UC-DT, was associated with improvements in depression symptoms, sleep disturbance, overall sleep health, and select sleep/wake outcomes, though not all improvements were sustained at 6-month follow-up. Lower usefulness of TranS-C skills predicted more severe sleep disturbance at post-treatment and daytime sleep-related impairment at post-treatment and 6-month follow-up. Lower utilization predicted more severe psychiatric symptoms at post-treatment, sleep disturbance at post-treatment and 6-month follow-up, and overall impairment and daytime sleep-related impairment at 6-month follow-up. Higher credibility and expectancy predicted greater usefulness of TranS-C skills at post-treatment and 6-month follow-up and greater utilization at 6-month follow-up. Together, findings highlight benefits of TranS-C for midlife and older adults with SMI. However, boosting credibility, expectancy, utilization, and usefulness may meaningfully improve TranS-C outcomes.

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Keywords

Sleep and circadian; transdiagnostic; midlife and older; community mental health; serious mental illness

Introduction

Sleep and circadian problems are prominent in serious mental illness (SMI). Poor sleep prospectively predicts and is a key diagnostic criterion of several SMI (American Psychological Association, 2013; Hertenstein et al., 2019). SMI can be operationalized as the presence, for 12 months or more, of at least one mental illness that leads to substantial interference with one or more major life activities (American Psychiatric Association, 2013; Public Law 102–321; Wang et al., 2002). However, a limitation of prior work is that little research has tested sleep and circadian problems among *midlife and older* adults with SMI. This limitation is notable, because sleep and circadian problems can be exacerbated as we age. Indeed, healthy aging is associated with circadian rhythm disturbances (particularly advanced sleep timing), shorter sleep duration, more fragile sleep, longer sleep onset latency, and more frequent nighttime awakenings (Mander et al., 2017). In turn, given that poor sleep predicts psychopathology, these worsening sleep problems are likely to exacerbate existing SMI (Alvaro et al., 2013; Hertenstein et al., 2019).

A consequence of the limited research in this area is that few treatments have been tested for sleep and circadian problems among midlife to older adults with comorbid SMI. When treatment studies for sleep and circadian problems among midlife and older adults do include individuals with psychiatric disorders, they commonly exclude participants with a) more than one sleep diagnosis, or b) severe SMI symptoms, both of which can impair sleep and circadian functioning (e.g., Sarfan et al., 2021a; Talbot et al., 2012). For example, past studies have excluded participants with severe, unstable, or untreated psychiatric disorders (Dzierzewski et al., 2019; Germain et al., 2006; Lovato et al., 2014); bipolar and psychotic disorders (Karlin et al., 2014; Sadler et al., 2014); and a primary medical/psychiatric diagnosis other than a sleep disorder (Espie et al., 2001). These exclusion criteria may limit applicability of existing research to “real-world” practice settings, where clients often have varied, comorbid sleep and circadian problems and SMI diagnoses (Hombali et al., 2019; Reeve et al., 2019; Sarfan et al., 2021b). To address these limitations, the present sample consistent of treatment-seekers in a “real-world” practice setting—a community mental health center—and the exclusion criteria were minimal.

The present study, drawn from a parent randomized controlled trial (Harvey et al., 2021; NCT02469233), focused on midlife and older adults who received the Transdiagnostic Sleep and Circadian Intervention (TranS-C) (Harvey & Buysse, 2017). Transdiagnostic treatments—including TranS-C—that concurrently target processes common to different mental illness may ease provider burden and improve care in routine practice settings, such as community mental health centers (McHugh et al., 2009). Specifically, providers can be trained in one treatment that is helpful across patient groups versus learning and choosing between various disorder-specific treatments. TranS-C is “transdiagnostic” is two

ways: it addresses a range of sleep and circadian problems across a range of SMI. The approach is grounded in the Sleep Health Framework (Buysse, 2014) and is associated with reductions in sleep and circadian problems, overall functional impairment, and psychiatric symptoms, when controlling for age (Harvey et al., 2021). Interestingly, a previous study found that age moderated the effects of TranS-C for self-reported sleep disturbance, such that older age was associated with less improvement after treatment (Armstrong et al., 2021). Age did not moderate daytime sleep-related impairment, general psychiatric symptoms, or overall functional impairment. However, outcomes for midlife and older adults were not directly assessed in these moderation analyses, meaning that the benefits of TranS-C for this population are still unclear. For instance, midlife and older adults might experience *less* improvement in sleep disturbance, but do they experience any benefits in sleep disturbance following TranS-C? Moreover, in this prior study, sleep/wake variables (e.g., sleep efficiency, bedtime/waketime, etc.), overall sleep health, and specific psychiatric outcomes (e.g., depression symptoms) were not included (Armstrong et al., 2021). Together, critical questions remain, including: 1) What are the sleep/wake, psychiatric, and overall functioning outcomes of TranS-C for midlife and older adults with comorbid sleep and circadian problems and SMI? And 2) What factors impact TranS-C outcomes for these individuals?

The present study tested these questions with midlife and older adults, age 50 years and older. This age cutoff was used to stratify the parent study sample at randomization and was selected for a few key reasons. First, sleep and circadian problems tend to increase with age (e.g., Mander et al., 2017). Second, among men, slow-wave sleep decreases from early adulthood to age 50 (Van Cauter et al., 2000), likely contributing to increased sleep complaints among men aged 50 and older. Third, among women, the average age of menopause is 51.4 years (Santoro, 2005), and menopause is frequently accompanied by sleep problems (Ameratunga et al., 2012). Aim 1 was to test TranS-C outcomes for midlife to older adults immediately post-treatment and at 6-month follow-up (i.e., six months after the final session). We hypothesized that TranS-C, relative to a delayed treatment control, among midlife and older adults would be associated with improvements in sleep and circadian problems, overall functional impairment, and psychiatric symptoms (Armstrong et al., 2021; Harvey et al., 2021). Aim 2 tested predictors that may impact TranS-C's effects for this population. Specifically, Aim 2a tested whether participant ratings of usefulness and utilization of the skills learned in TranS-C predicted primary outcomes at post-treatment and 6-month follow-up. Prior evidence suggests that, among midlife and older adults, ratings of treatment usefulness and utilization are associated with treatment outcomes (e.g., Gallagher-Thompson et al., 2008; Powers et al., 2008). Thus, we hypothesized that lower ratings of usefulness and utilization of TranS-C skills would predict poorer treatment outcomes, including poorer overall functioning, psychiatric symptoms, and self-reported sleep disturbance and daytime sleep-related impairment. Aim 2b focused on participants' ratings of treatment credibility and expectancy. Although evidence generally suggests that treatment credibility and expectancy predict treatment outcomes (Constantino et al., 2018a), there are some discrepant findings among midlife to older adults (e.g., Constantino et al., 2018b; Jones et al., 2016). Aim 2b tested one potential path by which credibility and expectancy may influence outcomes; namely, by predicting ratings of TranS-C usefulness

and utilization. We hypothesized that higher participant ratings of treatment credibility and expectancy at the start of treatment would predict higher ratings of TranS-C usefulness and utilization at post-treatment and 6-month follow-up.

To summarize, the present study sought to offer two novel contributions to the prior literature. First, this study reports TranS-C outcomes for midlife and older adults with sleep and circadian problems and comorbid SMI. Given the limited research on treatments for this population, these findings could (1) expand this evidence-base and (2) help clinicians determine whether TranS-C might be an appropriate treatment for their midlife and older patients with sleep and circadian problems and SMI. Second, this study evaluates novel predictors that may affect TranS-C outcomes—credibility, expectancy, usefulness, and utilization—with the goal of isolating targets for researchers and clinicians to boost TranS-C effectiveness for this population.

Method

Participants and Procedures

Participants included in this study were drawn from a randomized controlled trial funded by the National Institute of Mental Health (Harvey et al., 2021; R01MH105513). Participants who endorsed sleep and circadian problems and met criteria for SMI were recruited from Alameda County Behavioral Health Care Services, the community mental health center for Alameda County, California. SMI was operationalized according to Public Law 102–321 and previous research (Wang et al., 2002) as the presence, for 12 months or more, of at least one Diagnostic and Statistical Manual–5 (DSM-5) mental illness that leads to substantial interference with one or more major life activities (American Psychiatric Association, 2013).

Inclusion and exclusion criteria of the parent study were kept to a minimum. The inclusion criteria included: 1) Age 18+ years; 2) English language fluency; 3) presence of at least one DSM-5 mental disorder for 12 months; 4) having a guaranteed bed to sleep in for 3 months; 5) receiving care for SMI at Alameda County Behavioral Health Care Services; 6) consenting to regular communications between research team and psychiatrist and/or case manager; and 7) experiencing one or more sleep or circadian problems for at least 3 months assessed with the Sleep and Circadian Problems Interview (Morin, 1993).

The exclusion criteria included: 1) presence of an active and progressive physical illness or neurological degenerative disease and/or substance use making participation in the study infeasible; 2) current serious suicide or homicide risk; 3) night shift work >2 nights per week in the past 3 months; 4) pregnancy or breast-feeding; 5) not able/willing to complete the pre-treatment assessments. Hence, these individuals were included in this study. As participants' SMI medications often need to be changed, excluding on this basis is neither feasible nor representative of clinical practice. Medication use and changes were recorded.

Participants were included in the present analyses if ≥ 50 years. They were randomly allocated to TranS-C plus Usual Care (TranS-C+UC, $n = 27$) or 6-months of Usual Care followed by Delayed Treatment with TranS-C (UC-DT, $n = 26$). Randomization was stratified by age (0 = 49 years and under, 1 = 50+ years) and psychosis (0 = no, 1 =

yes). Assessments were completed at pre-treatment, post-treatment, and 6-month follow-up. Assessors were blind to treatment allocation. Although flexibility was necessary to improve retention given the complexity of the setting and population, participants were asked to complete assessments within 2 weeks for post-treatment (i.e., immediately after treatment; M (*SD*) days between final session and post-treatment = 19.4 (*17.3*)) and 6-month follow-up (i.e., six months after final session; M (*SD*) days between final session and 6-month follow-up = 201.0 (*52.5*)).

To maximize power, TranS-C data were analyzed from both the TranS-C+UC and UC-DT groups (combined TranS-C $n = 52$; one participant passed away, see Supplement Figure 1 for CONSORT figure). For the TranS-C outcomes of the UC-DT group, UC-DT 6-month follow-up was used for pre-treatment assessment. The combined groups did not differ with respect to number of sessions or baseline clinical/demographic characteristics (Supplement Tables 1 and 2). Study procedures are further detailed in the Supplement (see also Harvey et al., 2021). The study was approved by the Committee for the Protection of Human Subjects.

Treatment Conditions

TranS-C—TranS-C administration is driven by case conceptualization. It includes four cross-cutting interventions used in every session; four core modules that apply to most participants; and seven optional modules used less commonly, depending on the presentation. The average number of 50-minute sessions attended was 7.14 (*SD* = 2.51), with additional sessions offered as needed. See Supplement for details about TranS-C and Supplement Table 3 for treatment summary.

UC-DT—In the UC-DT condition, a case manager coordinated care within Alameda County Behavioral Health Care Services and referred each participant for a medication review and to various programs (e.g., health care, housing, vocational services, groups). After eight weeks in UC-DT, participants received TranS-C.

Measures Included from Pre-Treatment Only

Sleep and Circadian Diagnoses—To determine whether participants met criteria for sleep and circadian diagnoses, the DUKE Structured Interview for Sleep Disorders (Edinger et al., 2004) was administered at pre-treatment. This measure is a clinical semi-structured interview designed to detect the presence of sleep and circadian disorders according to both the International Classification of Sleep Disorders and DSM-5 criteria. It has demonstrated discriminant validity and high reliability (kappa range: .71 to .86; Edinger et al., 2009). Diagnoses were clarified via self-report daily sleep diaries collected for the week preceding pre-treatment assessment.

Stratification and Mental Illness Diagnoses—Age was collected using a demographics form. Current and past presence of SMI diagnoses was assessed using the Mini-International Neuropsychiatric Interview (DSM-5, Version 7.0.0). This measure has demonstrated good test retest reliability (kappa > .88) and validity (Lecrubier et al., 1997; Sheehan et al., 1998). For the present study, each participants' principal diagnosis was also

identified using a widely accepted severity rating scale that captures distress and interference (DiNardo, Moras, Barlow, & Rapee, 1993).

Measures Collected at All Assessments

Outcome measures generally mirrored Harvey et al. (2021) and clinicaltrials.gov (NCT02469233). See footnote for exceptions and Supplement Table 5 for internal consistency.

Primary Outcomes—The Sheehan Disability Scale (SDS) assessed functional impairment (Sheehan et al., 1996). The first three items on the SDS assess impairment in work/school, social life, and home/family responsibilities on a scale from 0–10 (‘not at all’ to ‘extremely’). These items are summed and range from 0–30, with higher scores indicating greater impairment. The SDS has demonstrated adequate reliability and validity (Leon et al., 1997; Sheehan et al., 1996).

The DSM-5 Cross-Cutting Measure assessed general psychiatric symptoms (Narrow et al., 2013). Across 13 mental health domains, participants rate how bothered they were by a list of psychiatric symptoms from 0–4 (‘not at all’ to ‘nearly every day’). Total scores range from 0–52, with higher scores indicating greater psychiatric severity. The measure has demonstrated good test-retest reliability and clinical utility (Clarke & Kuhl, 2014; Narrow et al., 2013).

The 8-item PROMIS - Sleep Disturbance (PROMIS-SD) assessed sleep disturbance (e.g., restlessness, sleep quality) over the past week on a scale from 1–5 (‘not at all’ to ‘very much’; Yu et al., 2011). Scores range from 8–40. Higher scores indicate increased disturbance. This questionnaire has demonstrated adequate reliability and validity (Yu et al., 2011).

The 16-item PROMIS - Sleep Related Impairment (PROMIS-SRI) assessed sleep-related impairment during waking hours over the past week on a scale from 1–5 (‘not at all’ to ‘very much’). The PROMIS-SRI measures perceptions of alertness, sleepiness, and tiredness (Buysse et al., 2010). Raw scores range from 16–80. Higher scores indicate increased impairment. This measure has demonstrated adequate validity (Buysse et al., 2010; Yu et al., 2011). A discussion of PROMIS T-scores can be found in the Supplement and Harvey et al. (2021).

Secondary Measures—Functional impairment was further assessed by the World Health Organization Disability Assessment Schedule (WHODAS) 2.0 and the Centers for Disease Control and Prevention’s ‘Healthy Days’ core module. The WHODAS 2.0 is a 36-item measure that assesses disability across six domains on a scale from 1–5 (‘none’ to ‘extreme or cannot do’) during the past 30 days (World Health Organization, 2012). The WHODAS 2.0 possesses strong psychometric properties (Konecky et al., 2014). The ‘Healthy Days’ core module assesses physical and mental health. Following Harvey et al. (2021), the present study focused on self-reported overall health on a scale from 1–5 (‘excellent’ to ‘poor’), where higher scores indicate poorer health. This measure has demonstrated good validity (Moriarty et al., 2003).

The 16-item Quick Inventory of Depressive Symptoms (QIDS) assessed depressive symptoms (Rush et al., 2013). Each item is rated on a four-point scale from 0–3, with higher scores indicating greater symptom severity. The measure has demonstrated good reliability and validity (Rush et al., 2003). The Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST) assessed substance use and related impairment (Group, 2002). Frequency of use, substance dependence, and related problems are rated on a 5-point scale ('never' to 'daily or almost daily'), as they pertain to specific substances. Failed attempts to cut down or quit are measured on a 3-point scale ('no, never', 'yes, in the past 3 months', 'yes, but not in the past 3 months'). ASSIST has good reliability and clinical feasibility (Group, 2002).[1]

Lastly, sleep and circadian functioning were more specifically assessed. Daily sleep diaries and actigraphy (GT9X, Actigraph) were collected for seven days at each assessment point. The sleep diary outcomes were mean and variability in sleep efficiency (total sleep time/time in bed × 100), total sleep time, total time in bed[2], total wake time, bedtime, and morning waketime. Outcomes analyzed from actigraphy include the mean and variability for total sleep time and total wake time (corroborated with sleep diary in-bed and out-of-bed parameters), as well as daytime activity count. For all sleep/wake parameters, variability was operationalized as intra-individual variability and calculated using the estimated within-subject standard deviations for each parameter at each timepoint (Buysse et al., 2010).
To capture the complexity of the sleep problems in SMI, we calculated the Sleep Health Composite score, defined as the sum of scores on 6 sleep health dimensions: Regularity, Satisfaction, Alertness, Timing, Efficiency, and Duration (Dong et al., 2019). The score for each dimension is dichotomized (0 = poor; 1 = good). Total scores range from 0–6, with higher scores indicating better sleep health. See Supplement Table 4 for details about how each dimension is scored. This measure is proposed to capture the complexity of the sleep problems covered by TranS-C. Initial validity of this measure has been established (Dong et al., 2019).

Behavioral and Process Measures

To assess participant ratings of usefulness and utilization of the skills learned in TranS-C, the Usefulness Scale and Utilization Scale (adapted from Gumport et al., 2019) were administered at post-treatment and 6-month follow-up. Each scale consists of 17 TranS-C elements rated on a 5-point Likert scale (0 = 'not at all useful/I never use it' to 4 = 'extremely useful/I always use it'). The mean of each scale was calculated for post-treatment and 6-month follow-up. Higher scores indicate more perceived usefulness and utilization of TranS-C skills. Variations of these scales have demonstrated convergent validity (Gumport et al., 2019).

To assess participants' ratings of TranS-C credibility and expectancy, five questions were adapted from the Credibility/Expectancy Questionnaire (CEQ; Devilly & Borkovec, 2000)

[1]In Harvey et al. (2020) and clinicaltrials.gov, subject hallucinations and delusions were also assessed via the Psychotic Symptoms Rating Scales (Haddock et al., 1999). However, this measure was only administered to those experiencing active psychotic symptoms, resulting in a sample size that was not amenable to the present analyses (for midlife to older adults: *n* UC-DT = 9, *n* TranS-C = 3).
[2]In Harvey et al. (2020) and clinicaltrials.gov, time in bed was not reported. Time in bed was reported in the present study, due to relevance for midlife and older adults (e.g., Chan et al., 2017).

and administered at Session 2. These questions assess how logical and acceptable TranS-C seemed, how much participants felt TranS-C would reduce symptoms, confidence in recommending TranS-C to a friend, and expected improvement. All questions are rated on a scale from 0 (‘not at all’) to 9 (‘very’), except for expected improvement, which is rated as a percentage from 0–100%. Scores from all questions were converted to standardized *z*-scores. Three outcomes were derived from the standardized items: 1) Total CEQ (all five items summed), 2) Credibility (sum of the two items assessing TranS-C logic and acceptability), and 3) Expectancy (sum of the two items assessing expected improvement and TranS-C’s expected impact on symptoms).

Note that these measures (Usefulness and Utilization Scales and Credibility/Expectancy Questionnaire) were only administered to participants in TranS-C+UC and TranS-C UC-DT, not UC-DT. As a result, for these measures, treatment and control conditions were not compared.

Data Analysis

All analyses were conducted in Stata/IC 16.1. The Benjamini-Hochberg procedure (Benjamini & Hochberg, 1995) was used to correct for multiple testing, with a .10 false discovery rate for Aim 1, given the limited prior treatment evidence for this population and conservative nature of this correction (Ferreira & Zwinderman, 2006), and a .05 rate for Aims 2a and 2b. Almost all *p* values remained significant compared to the corresponding Benjamini-Hochberg critical values. Exceptions are noted in Results below. See Supplement for information on missing data, missingness patterns, and missingness assumptions for Aims 1 and 2.

Aim 1—Random intercept multilevel models were used to compare TranS-C+UC relative to UC-DT. Data were assumed to be missing at random and estimated with maximum likelihood estimation and robust standard errors. All available data were used. The random component of the model consisted of a random intercept for participants and a level-1 (i.e., occasion) error term. The fixed component of the model consisted of two dummy-coded variables for time (0 = pre-treatment, 1 = post-treatment, 2 = 6-month follow-up), one dummy-coded variable for treatment condition (0 = UC-DT, 1 = TranS-C+UC), and two time-by-treatment interactions. Time-by-treatment interactions can be interpreted as the difference between TranS-C+UC relative to UC-DT in mean change from pre-treatment to post-treatment and from pre-treatment to 6-month follow-up. For effect size, a variation on Cohen’s *d* was used for independent-groups, pretest-posttest designs, which was calculated using the mean change scores and pre-treatment raw standard deviation from each treatment condition (Feingold, 2009; Equation 5). This can be interpreted as 0.20 = small, 0.50 = medium, and 0.80 = large (Cohen, 1988).

Aim 2—For Hypothesis 2a, multiple linear regression was used to test whether TranS-C usefulness and utilization predicted primary outcomes at post-treatment and 6-month follow-up. Each model controlled for baseline levels of the corresponding primary outcome. Partial eta^2 is reported as an effect size and can be interpreted as the proportion of variance explained by each predictor (Richardson, 2011). For Hypothesis 2b, linear regression was

used to test whether participants' ratings of credibility and expectancy predicted their ratings of TranS-C usefulness and utilization at post-treatment and 6FU. R^2 is reported as an effect size and can be interpreted as the proportion of variance explained by the regression model (Rao, 1973). For all Aim 2 analyses, unstandardized coefficient values are reported, and listwise deletion was used.

Results

Participants' clinical and demographic characteristics can be found in Supplement Table 2. Baseline variables did not significantly differ between treatment conditions (all *p*s>.05). See Table 1 for pre-treatment means of self-report psychosocial and sleep and circadian functioning as well as sleep/wake parameters assessed by sleep diary and actigraphy.

Aim 1

Table 1 includes means and standard deviations of outcome variables at each timepoint and effect sizes (Feingold, 2009). Multilevel modeling results are presented in Table 2. As seen in Table 2, there were no differences between TranS-C+UC and UC-DT on any of the outcome variables at pre-treatment (all *p*s>.05).

Participants in TranS-C+UC, relative to UC-DT, demonstrated a significant reduction in sleep disturbance from pre-treatment to post-treatment and depression symptoms from pre-treatment to 6-month follow-up. For sleep diary outcomes, TranS-C+UC was associated with significant improvements in sleep efficiency from pre-treatment to post-treatment and 6-month follow-up, relative to UC-DT. Relative to UC-DT, participants in TranS-C+UC had significantly reduced time in bed, total waketime, waketime variability, and total waketime variability from pre-treatment to post-treatment, as well as significantly reduced total waketime variability and bedtime variability from pre-treatment to 6-month follow-up. On the Sleep Health Composite, participants in TranS-C+UC, relative to UC-DT, had significantly improved sleep health from pre-treatment to post-treatment and 6-month follow-up.

Aim 2

Multiple linear regression results for Aim 2a are presented in Table 3. Consistent with hypotheses, lower Utilization of TranS-C skills at post-treatment predicted more severe psychiatric symptoms and more severe sleep disturbance at post-treatment. Lower Utilization at 6-month follow-up predicted more severe overall impairment, sleep disturbance, and sleep-related impairment at 6-month follow-up. Lower Usefulness of TranS-C skills at post-treatment predicted more severe sleep disturbance at post-treatment. Lower Usefulness at 6-month follow-up predicted more severe sleep disturbance and sleep-related impairment at 6-month follow-up.

Linear regression results for Aim 2b are in Table 4. Consistent with hypotheses, higher participant ratings of Total Credibility/Expectancy at Session 2 predicted higher ratings of Usefulness at post-treatment and 6-month follow-up and higher Utilization at 6-month follow-up. Similarly, higher ratings of Credibility at Session 2 predicted higher ratings of Usefulness at post-treatment (though this effect was no longer significant with the

Benjamini-Hochberg correction) and 6-month follow-up and higher Utilization at 6-month follow-up. Finally, higher ratings of Expectancy at Session 2 predicted higher rating of Usefulness at post-treatment and Utilization at 6-month follow-up.

Discussion

Little research has tested treatments for midlife and older adults with sleep and circadian problems and comorbid SMI. This is of concern, as sleep and circadian problems can be exacerbated as we age, and in turn, these exacerbated sleep problems may worsen SMI symptoms (Hertenstein et al., 2019; Mander et al., 2017). The present study tested outcomes of TranS-C among midlife and older adults with SMI. We also tested predictors that may impact outcomes for this population: credibility, expectancy, usefulness, and utilization of TranS-C.

At the outset, it is worth commenting on the sleep/wake characteristics of this sample, given that little research has investigated sleep and circadian problems in midlife and older adults with SMI. Relative to healthy midlife and older adults, as well as midlife and older adults with insomnia (i.e., the most common sleep and circadian diagnosis in the present sample), adults in the present sample had lower sleep efficiency, greater total wake time, and spent more time in bed (Boulos et al., 2019; Buysse et al., 2010; Evans et al., 2021). Surprisingly, participants in the present study appeared to sleep longer than their healthy and insomnia-diagnosed peers. However, this may be attributable to the wide inclusion gates of the present study (e.g., 18.8% had hypersomnia). Together, these findings expand the limited knowledgebase on the sleep/wake characteristics of midlife and older adults with sleep and circadian problems and comorbid SMI. Additionally, they hint at the possibility that the compounded impact of SMI and age may contribute to worse sleep/wake characteristics, although this merits more rigorous investigation.

Results from the first aim indicated that TranS-C, compared to UC-DT, was associated with select improvements in sleep and circadian functioning at post-treatment and 6-month follow-up. Perhaps most notably, overall sleep health—which is thought to better assess transdiagnostic sleep/wake functioning compared to individual parameters (Dong et al., 2019)—improved at post-treatment and 6-month follow-up. Further, the following sleep/wake parameters improved, as assessed by the sleep diary: mean sleep efficiency and total waketime variability at post-treatment and 6-month follow-up, as well as bedtime variability at 6-month follow-up. Additional sleep/wake improvements were observed via sleep diary at post-treatment but not sustained to 6-month follow-up: mean time in bed, morning wake time variability, and mean total wake time. Similarly, TranS-C was associated with lower self-reported sleep disturbance at post-treatment, though effects were not sustained at 6-month follow-up. However, even though these outcomes were not sustained to 6-month follow-up at the level of statistical significance, the effect sizes for each of these outcomes at 6-month follow-up were small to medium in the hypothesized direction ($d$pre-6FU = −0.23 to −0.67). Interestingly, a very similar pattern of non-sustained benefits at 6-month follow-up was observed in parent trial (Harvey et al., 2021), but in contrast, the effect sizes in the parent trial were substantially smaller than the present effect sizes or even in the opposite direction at 6-month follow-up. Two interesting possibilities emerge from these

findings, which should be empirically tested in future research with a larger sample of midlife and older adults. The first possibility is that TranS-C is associated with sustained improvements in sleep and circadian functioning for midlife and older adults, but the present sample was underpowered to detect statistical significance at 6-month follow-up. The second possibility is that TranS-C is associated with improvements in sleep/wake functioning, but adjustments to TranS-C may be needed to sustain these improvements. Regardless of which explanation bears out in future research, findings from the first aim of the present study support TranS-C's utility for improving select sleep and circadian outcomes in midlife and older adults with SMI in "real world" practice settings.

Contrary to hypotheses, no significant findings emerged for actigraphy. These surprising findings may be due to the relatively small sample size in the present study. In other words, meaningful changes may have occurred but were undetectable due to limited power. For example, looking at the effect sizes in Table 1, although not statistically significant, TranS-C was associated with small decreases in total sleep time variability and mean daytime activity count from pre-treatment to post-treatment as well as in mean total sleep time from pre-treatment to post-treatment and 6-month follow-up. Interestingly, these effects are not necessarily in the anticipated direction. Replication with a larger sample would help clarify whether the effects observed in the present study do indeed represent meaningful changes in actigraphy-measured sleep/wake parameters. In addition, actigraphy findings may partly be explained by use of the GT9X Link Actigraph, which does not have an "event marker" to indicate when a participant goes to bed and gets out of bed. Although we were able to assess these in-bed and out-of-bed behaviors with the sleep diary, experts recommend using multi-modal assessment methods, including sleep diary, validated questionnaires, and actigraphy, to assess sleep and circadian problems (Buysse et al., 2006). Thus, our ability to fully assess in-bed and out-of-bed behaviors, as well as related sleep/wake parameters (e.g., total sleep time), via *actigraphy* was limited by the actigraphy model used. This issue may have been particularly relevant for our sample, because older individuals with SMI tend to engage in long periods of inactivity during the day (e.g., Vancampfort et al., 2016). Put another way, the actigraphs may not have accurately differentiated between inactivity and sleep, contributing to the surprising pattern of nonsignificant findings observed in the present study.

With respect to psychosocial outcomes, TranS-C was associated with improvements in depression symptoms at 6-month follow-up but not in general psychiatric symptoms, substance use, or overall impairment. These findings differ from the primary outcomes of parent trial, which tested TranS-C controlling for age and found that general psychiatric symptoms and overall impairment, as assessed by the DSM-5 Cross-Cutting Measure and Sheehan Disability Scale respectively, improved from pre-treatment to post-treatment and to 6-month follow-up (Harvey et al., 2021). However, upon inspection, means and effect sizes in the present study were generally small to medium in the anticipated direction for both these outcomes at post-treatment ($d$pre-post: DSM-5 = −0.53, Sheehan Disability Scale = −0.29) and for overall impairment at 6-month follow-up ($d$pre-6FU: DSM-5 = −0.10, Sheehan Disability Scale = −0.18). Similar to the sleep and circadian outcomes discussed above, the small effect sizes for the present study relative to the parent trial may be due to limited power and small sample size. Alternatively, TranS-C may improve

depression symptoms, general psychiatric symptoms, and overall functioning among midlife and older adults, but not at the level of statistical significance for the latter two outcomes. Future research with larger samples of midlife to older adults is needed to evaluate these competing explanations. Depending on which explanation is empirically supported, additional treatment modules to address the psychiatric and functional needs of this age group may be warranted, such as those focusing on sleep and menopause (Tal et al., 2015) or nocturia (Yoshimura, 2012).

The pattern of effect sizes for the other secondary outcomes (i.e., substance use and overall impairment assessed by CDC Healthy Days and WHODAS) was more complex. Effects sizes were negligible for substance use at post-treatment (*d*pre-post: −0.11) and 6-month follow-up (*d*pre-6FU: 0.09). Overall impairment, as assessed by CDC Healthy Days, improved at post-treatment (*d*pre-post: 0.27) but not at 6-month follow-up (*d*pre-6FU: −0.04). Overall impairment, as assessed by the WHODAS, improved slightly at post-treatment (*d*pre-post: −0.16) and worsened at 6-month follow-up (*d*pre-6FU: 0.26). In the parent trial, these effects similarly did not reach statistical significance, but effect sizes were all in the anticipated direction and generally larger than those in the present study. Together, these findings corroborate the possibility described above that changes to TranS-C may be warranted to improve psychiatric symptoms and overall impairment for midlife to older adults.

Results from Aim 2a may highlight another way to help account for nonsignificant outcomes observed in the present study: utilization and usefulness of TranS-C skills. Specifically, the *less* that midlife and older adults utilized treatment skills or perceived skills as useful, the *more* severe their overall functioning, psychiatric symptoms, sleep disturbance, and sleep-related impairment at post-treatment and 6-month follow-up (though to varying degrees at different timepoints). This is consistent with past research showing that treatment usefulness and utilization are associated with outcomes among midlife and older adults (e.g., Gallagher-Thompson et al., 2008; Powers et al., 2008). Thus, an obvious next question is: how do we boost usefulness and utilization of TranS-C skills among midlife and older adults with SMI?

Findings from Aim 2b highlight one route toward increased usefulness and utilization. Specifically, higher TranS-C total credibility and expectancy at the start of treatment predicted more usefulness at post-treatment and six-month follow-up and more utilization of TranS-C skills at six-month follow-up. This makes sense in light of evidence that credibility is associated with improved adherence to psychosocial treatments among midlife to older adults, though evidence is somewhat mixed for expectancy (Hundt et al., 2013; Williams et al., 2005). Taking the findings from Aims 1 and 2 together, boosting usefulness and utilization of treatment skills via credibility and expectancy at the start of treatment may be one route to improve TranS-C outcomes for midlife and older adults with sleep problems and SMI. In their meta-analyses on treatment credibility/expectancy and outcomes, Constantino et al. (2018a, 2018b) identified several strategies to enhance credibility and expectancy, such as assessing patients' treatment expectancies and beliefs about therapist credibility. Exciting next steps would be to test whether these strategies increase TranS-C

credibility and expectancy among midlife and older adults, and whether such increases lead to more usefulness and utilization and better treatment outcomes.

This study had several limitations. First, the sample herein consisted of treatment-seeking participants at a community mental health center, and it is unclear whether the findings generalize to other populations. Second, the sample size was relatively small. We used the Benjamini-Hochberg procedure to account for multiple testing and included effect sizes. However, as discussed above, future research with larger samples of midlife and older adults is needed to draw definitive conclusions about the effects of TranS-C for this population. Third, 6-month follow-up was used as the baseline assessment for participants in the UC-DT TranS-C group. Thus, not all baseline sessions for the combined TranS-C group were equivalent in terms of timing. Fourth, for Aim 1, the data were assumed to be Missing at Random. However, to our knowledge, there are no widely-accepted statistical methods to directly test this assumption (e.g., van Buuren et al., 2018). Although our theoretically-based approaches supported the Missing at Random assumption, some uncertainty remains about whether this assumption was met. Fifth, for Aim 2, results of Little's MCAR were nonsignificant (see Supplement), indicating that the data were Missing Completely at Random and that listwise deletion was appropriate for missing data (van Buuren et al., 2018). However, listwise deletion may have limited our ability to detect significant effects in Aim 2 by reducing sample size. The nonsignificant results from Aim 2 should be interpreted with this caveat, as well as with careful consideration of the effect sizes.

Notwithstanding these limitations, the present study adds to the limited research on sleep and circadian treatments for midlife and older adults with SMI. TranS-C+UC, compared to UC-DT, was associated with improvements in depression symptoms and select sleep and circadian outcomes. These findings suggest that TranS-C holds promise for midlife and older adults with comorbid sleep and circadian problems and SMI. Moreover, improvements were observed in a "real world" practice setting—a community mental health center. Higher credibility and expectancy at the start of treatment predicted greater utilization and usefulness of TranS-C skills, which predicted less severe psychiatric symptoms, sleep and circadian dysfunction, and overall impairment. Together, findings highlight several benefits of TranS-C for midlife and older adults with SMI and suggest that boosting credibility and expectancy, as well as utilization and usefulness, may meaningfully improve TranS-C's immediate and long-term outcomes. Science of behavior change approaches, such as improving memory for treatment (Harvey et al., 2016) and focusing on habit formation (Harvey, Callaway et al., in press), hold promise in this regard.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Means, Standard Deviations, and Effect Sizes at Pre-treatment, Post-treatment, and 6-month Follow-up Assessments

	Pre				Post				6FU					
	UC-DT		TranS-C		UC-DT		TranS-C		UC-DT		TranS-C			
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	*d*pre-post	*d*pre-6FU
Primary Outcomes														
SDS	14.38	7.69	12.22	7.85	11.28	7.37	6.79	6.56	10.92	8.81	7.27	6.49	−0.29	−0.18
DSM5	25.58	11.50	24.16	9.22	22.64	10.96	16.95	10.08	23.08	9.70	21.27	10.83	−0.53	−0.10
PROMIS-SD	30.50	5.58	28.88	6.35	28.72	6.76	23.26	8.38	27.92	6.11	24.07	8.20	−0.57	−0.29
PROMIS-SRI	50.88	14.07	45.73	13.50	44.36	13.41	34.07	14.61	42.79	15.13	37.58	13.71	−0.40	−0.03
Secondary Outcomes														
QIDS	12.46	4.73	12.51	5.01	10.64	5.14	9.43	5.56	11.54	4.32	9.41	5.28	−0.23	−0.42
ASSIST	32.15	25.54	34.55	24.39	12.28	15.81	12.95	15.99	31.13	25.57	35.68	28.47	−0.11	0.09
WHODAS	84.31	28.15	77.49	24.90	81.96	31.77	71.38	26.12	75.82	28.24	76.47	24.21	−0.16	0.26
CDC Healthy Days	3.92	1.13	3.69	0.97	3.48	1.42	3.57	1.15	3.83	0.92	3.57	1.09	0.27	−0.04
Sleep Diary														
SE mean	77.29	12.66	74.76	13.95	76.40	13.34	81.79	9.70	75.32	14.04	81.57	11.28	0.57	0.64
SE variability	12.46	7.52	12.76	6.74	12.92	9.27	10.78	7.07	11.94	6.92	10.20	6.26	−0.36	−0.31
TST mean	429.56	96.16	417.54	115.29	439.08	89.54	422.45	89.66	429.74	112.97	433.84	106.07	−0.06	0.14
TST variability	102.57	55.58	98.37	48.08	117.94	81.53	98.80	97.72	96.19	47.64	90.69	44.61	−0.27	−0.04
TIB mean	556.55	89.75	555.43	90.39	570.20	90.41	517.89	91.33	569.66	93.52	530.09	98.85	−0.57	−0.43
TIB variability	101.66	59.43	96.66	48.20	130.38	86.77	86.66	83.99	92.60	44.91	80.04	48.20	−0.69	−0.19
TWT mean	129.95	92.99	137.60	75.25	142.50	98.06	92.62	44.45	141.44	86.89	96.13	60.29	−0.73	−0.67
TWT variability	73.90	52.33	80.14	49.83	92.12	92.93	59.83	50.62	79.63	56.32	53.97	35.71	−0.76	−0.63
BT mean	22.07	1.67	22.13	2.25	22.17	1.35	22.17	1.47	22.30	1.45	21.91	1.71	−0.04	−0.24
BT variability	1.37	1.19	1.46	1.30	1.30	0.83	0.90	0.95	1.67	1.69	1.01	0.72	−0.37	−0.60
WT mean	7.66	1.39	7.21	1.89	7.69	1.17	7.09	1.98	7.72	1.78	7.12	1.63	−0.09	−0.09
WT variability	1.17	0.63	1.42	1.04	1.62	1.04	1.13	0.93	1.20	0.57	1.23	0.90	−0.99	−0.23
Actigraphy														
TST mean	395.55	120.74	444.83	166.29	390.48	116.83	399.63	151.96	410.31	114.27	406.99	151.03	−0.23	−0.35
TST variability	125.88	64.65	130.08	77.59	128.01	81.52	119.02	81.65	126.18	86.31	121.51	86.27	−0.18	−0.12

	Pre				Post				6FU					
	UC-DT		TranS-C		UC-DT		TranS-C		UC-DT		TranS-C			
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	***d*pre-post**	***d*pre-6FU**
TWT mean	97.86	53.87	94.59	47.03	95.22	45.34	93.28	53.78	98.79	39.02	96.07	51.46	0.02	0.01
TWT variability	64.54	62.74	60.34	53.72	57.34	48.14	59.83	65.86	60.12	43.60	53.50	45.12	0.11	−0.06
Daytime mean	1249.04	568.97	1232.71	648.08	1349.33	621.34	1210.54	626.04	1364.76	636.90	1369.36	624.22	−0.21	0.01
Daytime variability	364.38	157.90	353.04	194.56	360.61	235.04	323.57	180.33	388.95	218.66	371.52	213.53	−0.13	−0.06
Sleep health composite	2.23	1.24	1.86	1.23	2.24	1.39	2.93	1.55	2.12	1.11	2.74	1.61	0.86	0.80

Note. PRE = pre-treatment assessment. POST = post-treatment assessment. 6FU = 6-month follow-up assessment. SDS = Sheehan Disability Scale. DSM5 = DSM-5 Cross-Cutting Measure. PROMIS-SD = Patient-Reported Outcomes Measurement Information System–Sleep Disturbance. PROMIS-SRI = Patient-Reported Outcomes Measurement Information System–Sleep-Related Impairment. QIDS = Quick Inventory of Depressive Symptoms. ASSIST = Alcohol, Smoking and Substance Involvement Screening Test. WHODAS = World Health Organization Disability Assessment Schedule 2.0. CDC Healthy Days= overall health question from the 4-question healthy days core module developed by the Centers for Disease Control and Prevention. SE = sleep efficiency (total sleep time/time in bed × 100). TST = total sleep time. TWT = total wake time. BT = bedtime, WT = wake time. Daytime mean = mean activity during hours not classified as sleep. Daytime variability = variability in activity during hours not classified as sleep. *d* pre-post = effect size for treatment effects from pre to post; *d* pre-FU = effect size for treatment effects from pre to 6-month follow-up; both *d*s are calculated using mean change scores and pretreatment raw SDs from each treatment condition, based on Feingold equation 5 (2009).

Table 2.

Multilevel Modeling Results for Primary and Secondary Outcomes

	Treatment condition effect at PRE			Treatment condition effect at POST			Treatment condition effect at 6FU		
	coef.	***SE***	***p***	***coef.***	***SE***	***p***	***coef.***	***SE***	***p***
SDS	−2.16	1.85	0.24	−2.03	1.69	0.23	−1.74	1.67	0.30
DSM5	−1.23	2.53	0.63	−3.43	2.08	0.10	−0.63	2.21	0.78
PROMIS-SD	−1.57	1.39	0.26	−3.44	1.38	**0.01**	−2.17	1.49	0.15
PROMIS-SRI	−4.96	3.32	0.14	−4.25	3.07	0.17	−0.46	2.86	0.87
Secondary Outcomes									
QIDS	0.07	1.16	0.95	−1.00	1.05	0.34	−2.26	0.98	**0.02**
ASSIST	2.52	6.01	0.67	0.25	4.53	0.96	1.83	4.11	0.66
WHODAS	−6.52	6.39	0.31	−3.29	5.62	0.56	5.77	5.00	0.25
CDC Healthy Days	−0.22	0.26	0.39	0.31	0.28	0.30	−0.12	0.25	0.63
Sleep Diary									
SE mean	−2.19	3.23	0.50	7.19	2.77	**0.01**	7.90	3.33	**0.02**
SE variability	0.25	1.78	0.89	−2.53	2.45	0.30	−1.90	1.77	0.28
TST mean	−14.65	25.36	0.56	−1.15	19.27	0.95	17.88	22.77	0.43
TST variability	−1.83	13.42	0.89	−17.77	22.05	0.42	−3.24	13.26	0.81
TIB mean	−4.75	22.35	0.83	−44.09	18.87	**0.02**	−31.77	21.10	0.13
TIB variability	−3.45	13.80	0.80	−40.14	20.98	0.06	−8.05	12.95	0.53
TWT mean	5.83	21.37	0.79	−53.57	17.48	**0.002**	−47.76	24.34	0.05
TWT variability	5.87	12.70	0.64	−38.26	18.80	**0.042**	−29.92	13.73	**0.03**
BT mean	0.14	0.47	0.77	−0.22	0.36	0.54	−0.65	0.49	0.19
BT variability	0.11	0.30	0.72	−0.51	0.33	0.12	−0.77	0.39	**0.047**
WT mean	−0.46	0.39	0.23	−0.17	0.24	0.48	−0.28	0.29	0.34
WT variability	0.24	0.20	0.22	−0.75	0.24	**0.002**	−0.21	0.22	0.34
Actigraphy									
TST mean	48.99	33.11	0.14	−37.39	23.55	0.11	−53.53	32.55	0.10
TST variability	3.34	16.71	0.84	−11.89	18.07	0.51	−6.41	25.13	0.80
TWT mean	−2.88	12.45	0.82	5.71	12.25	0.64	1.38	13.50	0.92
TWT variability	−4.70	14.49	0.75	8.96	16.10	0.58	1.07	17.18	0.95
Daytime mean	−15.45	141.85	0.91	−75.19	75.42	0.32	14.11	102.86	0.89
Daytime variability	−15.07	41.24	0.72	−13.12	51.10	0.80	6.54	51.60	0.90
Sleep health composite	−0.37	0.30	0.21	1.01	0.40	**0.01**	0.92	0.36	**0.01**

Note. PRE = pre-treatment assessment. POST = post-treatment assessment. 6FU = 6-month follow-up assessment. SDS = Sheehan Disability Scale. DSM5 = DSM-5 Cross-Cutting Measure. PROMIS-SD = Patient-Reported Outcomes Measurement Information System–Sleep Disturbance. PROMIS-SRI = Patient-Reported Outcomes Measurement Information System–Sleep-Related Impairment. QIDS = Quick Inventory of Depressive Symptoms. ASSIST = Alcohol, Smoking and Substance Involvement Screening Test. WHODAS = World Health Organization Disability Assessment Schedule 2.0. CDC Healthy Days= overall health question from the 4-question healthy days core module developed by the Centers for Disease Control and Prevention. SE = sleep efficiency (total sleep time/time in bed × 100). TST = total sleep time. TWT = total wake time. BT = bedtime, WT = wake time. Daytime mean = mean activity during hours not classified as sleep. Daytime variability = variability in activity during hours not classified as sleep.

Table 3.

Usefulness and Utilization Predicting Primary Outcomes at Post-Treatment and 6FU

	coef.	*SE*	*p*	95% CI	partial eta squared
SDS (Post)	Model: F(2, 37) = 6.42, $p = 0.004$, $R^2 = 0.26$				
Usefulness (Post)	−0.09	0.06	0.20	−0.22, 0.05	0.04
SDS (Pre)	0.40	0.13	0.003	0.14, 0.65	0.21
SDS (Post)	Model: F(2, 34) = 7.48, $p = 0.002$, $R^2 = 0.31$				
Utilization (Post)	−0.08	0.06	0.18	−0.20, 0.04	0.05
SDS (Pre)	0.40	0.12	0.003	0.14, 0.63	0.23
SDS (6FU)	Model: F(2, 39) = 10.06, $p < 0.001$, $R^2 = 0.34$				
Usefulness (6FU)	−0.08	0.05	0.12	0.18, 0.02	0.06
SDS (Pre)	0.49	0.11	<0.001	0.26, 0.72	0.32
SDS (6FU)	Model: F(2, 38) = 13.11, $p < 0.001$, $R^2 = 0.40$				
Utilization (6FU)	−0.14	0.05	**0.007**	−0.25, −0.04	0.17
SDS (Pre)	0.49	0.11	<0.001	0.27, 0.70	0.35
DSM5 (Post)	Model: F(2, 37) = 34.34, $p < 0.001$, $R^2 = 0.65$				
Usefulness (Post)	−0.12	0.07	0.09	−0.26, 0.02	0.07
DSM5 (Pre)	0.82	0.11	<0.001	0.59, 1.04	0.60
DSM5 (Post)	Model: F(2, 34) = 47.75, $p < 0.001$, $R^2 = 0.74$				
Utilization (Post)	−0.13	0.06	**0.03**	−0.25, 0.01	0.13
DSM5 (Pre)	0.83	0.10	<0.001	0.63, 1.02	0.69
DSM5 (6FU)	Model: F(2, 39) = 17.51, $p < 0.001$, $R^2 = 0.47$				
Usefulness (6FU)	−0.09	0.07	0.18	−0.23, 0.05	0.05
DSM5 (Pre)	0.75	0.13	<0.001	0.49, 1.01	0.47
DSM5 (6FU)	Model: F(2, 38) = 18.06, $p < 0.001$, $R^2 = 0.49$				
Utilization (6FU)	0.10	0.07	0.20	−0.25, 0.05	0.04
DSM5 (Pre)	0.76	0.13	<0.001	0.50, 1.02	0.48
PROMIS-SD (Post)	Model: F(2, 37) = 13.91, $p < 0.001$, $R^2 = 0.43$				
Usefulness (Post)	−0.17	0.07	**0.03**	−0.32, −0.02	0.13
PROMIS-SD (Pre)	0.73	0.17	<0.001	0.39, 1.07	0.34
PROMIS-SD (Post)	Model: F(2, 36) = 13.55, $p < 0.000$, $R^2 = 0.43$				
Utilization (Post)	−2.93	1.28	**0.03**	−5.52, −0.34	0.13
PROMIS-SD (Pre)	0.67	0.18	0.001	0.31, 1.02	0.29
PROMIS-SD (6FU)	Model: F(2, 39) = 10.38, $p < 0.001$, $R^2 = 0.35$				
Usefulness (6FU)	−0.13	0.06	**0.040**	−0.25, −0.006	0.10
PROMIS-SD (Pre)	0.67	0.17	<0.001	0.33, 1.01	0.29
PROMIS-SD (6FU)	Model: F(2, 38) = 11.72, $p < 0.001$, $R^2 = 0.38$				
Utilization (6FU)	−0.14	0.06	**0.040**	−0.27, −0.01	0.11
PROMIS-SD (Pre)	0.67	0.16	<0.001	0.34, 1.00	0.30
PROMIS-SRI (Post)	Model: F(2, 37) = 11.62, $p < 0.001$, $R^2 = 0.39$				
Usefulness (Post)	−0.16	0.14	0.24	−0.44, 0.11	0.04

	coef.	*SE*	*p*	95% CI	partial eta squared
PROMIS-SRI (Pre)	0.64	0.15	<0.001	0.34, 0.95	0.33
PROMIS-SRI (Post)	Model: $F(2, 34) = 13.23$, $p < 0.001$, $R^2 = 0.44$				
Utilization (Post)	−0.16	0.13	0.23	−0.43, 0.10	0.04
PROMIS-SRI (Pre)	0.65	0.15	<0.001	0.34, 0.96	0.35
PROMIS-SRI (6FU)	Model: $F(2, 39) = 10.22$, $p < 0.001$, $R^2 = 0.34$				
Usefulness (6FU)	−0.20	0.10	**0.047**	−0.40, −0.003	0.10
PROMIS-SRI (Pre)	0.53	0.13	<0.001	0.27, 0.80	0.30
PROMIS-SRI (6FU)	Model: $F(2, 38) = 11.47$, $p < 0.001$, $R^2 = 0.38$				
Utilization (6FU)	−0.24	0.11	**0.030**	−0.46, −0.02	0.12
PROMIS-SRI (Pre)	0.57	0.13	<0.001	0.31, 0.83	0.34

Note. Model = overall regression model statistics. Pre = pre-treatment assessment. Post = post-treatment assessment. 6FU = six-month follow-up assessment. SDS = Sheehan Disability Scale. DSM5 = DSM-5 Cross-Cutting Measure. PROMIS-SD = Patient-Reported Outcomes Measurement Information System–Sleep Disturbance. PROMIS-SRI = Patient-Reported Outcomes Measurement Information System–Sleep-Related Impairment. Dependent variable of each model is bolded. Bolded *p*-values represent effects of interest that remained significant after the Benjamini-Hochberg correction.

Table 4.

CEQ predicting Usefulness and Utilization at Post-Treatment and 6FU

	coef.	*SE*	*p*	95% CI	R^2
Total CEQ					
Usefulness (Post)	1.40	0.55	**0.02**	0.27, 2.52	0.15
Utilization (Post)	1.15	0.61	0.07	−0.09, 2.39	0.09
Usefulness (6FU)	1.55	0.61	**0.02**	0.30, 2.79	0.15
Utilization (6FU)	1.66	0.56	**0.005**	0.53, 2.80	0.20
Credibility					
Usefulness (Post)	2.95	1.43	0.047	0.04, 5.85	0.10
Utilization (Post)	2.33	1.59	0.15	0.91, 5.57	0.06
Usefulness (6FU)	4.07	1.56	**0.01**	0.91, 7.23	0.15
Utilization (6FU)	3.48	1.51	**0.03**	0.41, 6.55	0.13
Expectancy					
Usefulness (Post)	3.23	1.29	**0.02**	0.62, 5.84	0.15
Utilization (Post)	2.60	1.40	0.07	−0.25, 5.45	0.09
Usefulness (6FU)	2.83	1.46	0.06	0.14, 5.80	0.09
Utilization (6FU)	3.63	1.29	**0.008**	1.01, 6.24	0.18

Note. CEQ = Credibility/Expectancy Questionnaire. Post = post-treatment assessment. 6FU = six-month follow-up assessment. Independent variable is bolded. Bolded *p*-values remained significant after the Benjamini-Hochberg correction.