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Abstract

Objective: This study aims to examine the efficacy of light therapy in improving sleep quality, reducing fatigue, and alleviating emotional symptoms among patients diagnosed with gynecologic cancer.

Methods: A randomized controlled trial was conducted at a medical center in northern Taiwan. Participants were eligible if they were aged 18 years or older, had a physician-confirmed diagnosis of gynecologic cancer, and reported an Insomnia Severity Index – Chinese version (ISI-C) score of ≥ 9. Eligible participants were randomly assigned to either an experimental group or a control group (n = 47 per group). At baseline (T0), participants completed a demographic questionnaire, ISI-C, the Brief Fatigue Inventory – Taiwanese version (BFI-T), and the Distress Thermometer (DT). The experimental group received daily morning light therapy for 30–40 minutes over four weeks using a circadian-regulating light device. The control group continued their usual routines during the same period. Follow-up assessments were scheduled at day 7 (T1), day 14 (T2), day 21 (T3), and day 28 (T4). Data will be analyzed using generalized estimating equations (GEE) to evaluate the effects of the intervention on sleep quality, fatigue, and emotional symptoms.

Keywords: light therapy, gynecologic cancer, chemotherapy, sleep quality, fatigue, emotional symptoms.

Research Motivation and Significance

Gynecologic malignancies, including cervical, endometrial, and ovarian cancers, account for approximately 14.4% of all female cancers in Taiwan. Chemotherapy remains a mainstay treatment but is often accompanied by adverse symptoms such as fatigue, emotional distress, and sleep disturbances—each significantly impairing quality of life and possibly prognosis.Approximately 9% to 45% of cancer patients experience moderate-to-severe fatigue, and over half of women with gynecologic cancer report persistent sleep disturbances, often worsened by psychological symptoms. While pharmacological treatments exist, they frequently cause undesirable side effects. Consequently, interest has grown in non-pharmacological interventions like light therapy, which modulates circadian rhythms through suppression of melatonin and enhancement of serotonin.Re-Timer® light therapy glasses (500 nm wavelength, 500 lux) offer a safe, user-friendly, FDA-cleared home-based solution. By stimulating intrinsically photosensitive retinal ganglion cells (ipRGCs) and acting on the suprachiasmatic nucleus (SCN), Re-Timer® stabilizes circadian rhythms, thereby potentially improving sleep, fatigue, and mood regulation.Despite growing evidence, limited studies have evaluated the efficacy of light therapy in gynecologic cancer survivors. This study aims to assess the therapeutic effects of bright light therapy using Re-Timer® in alleviating chemotherapy-related sleep disturbances, fatigue, and emotional distress, and to provide evidence for clinical implementation of non-pharmacological symptom management strategies in this population.Methods

Research Design

This study utilized a randomized controlled trial (RCT) design and was implemented at the gynecologic outpatient department of a tertiary medical center in northern Taiwan.

Research Setting and Participants

This study was conducted at a tertiary medical center in northern Taiwan between May 13 and December 12, 2024.Eligible participants were individuals aged 18 years or older with a physician-confirmed diagnosis of gynecologic cancer and an Insomnia Severity Index-Chinese version (ISI-C) score of 9 or above. All participants provided written informed consent prior to enrollment.Exclusion criteria included the presence of visual impairment or photosensitivity that could interfere with the use of light therapy devices, a current diagnosis of psychiatric disorders or cognitive impairment, and any physical limitations that would hinder adherence to the intervention protocol or data collection due to disease severity.Sample Size Calculation and Randomization

Sample size was calculated using G*Power 3.1, assuming a medium effect size ($f = 0.25$), a significance level of $\alpha = 0.05$, and a statistical power of 0.80 for a two-group comparison. The estimated minimum sample size was 78 participants. Allowing for an anticipated attrition rate of 20%, the target enrollment was increased to 94 participants. Participants were randomly assigned to either the experimental or control group in a 1:1 ratio using the random number generator function in Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). Each group ultimately included 47 participants.

Data Collection and Ethical Considerations

Ethical Approval and Informed Consent：The study protocol was approved by the Institutional Review Board (IRB) of the participating medical center (CGH-IRB No. 202400345A3C601). Participant recruitment was conducted in the gynecologic outpatient department. Before enrollment, all participants received a thorough explanation of the study's objectives, procedures, potential risks, and anticipated benefits. They were assured that their personal data would be anonymized, securely stored, and used solely for academic research purposes. Participants were informed of their right to withdraw from the study at any time without affecting their ongoing clinical care. Written informed consent was obtained from all participants.

Baseline Assessment and Intervention：Following consent, participants completed baseline assessments (T0), including a demographic and treatment questionnaire, the Insomnia Severity Index – Chinese version (ISI-C), the Taiwanese version of the Brief Fatigue Inventory (BFI-T), and the Distress Thermometer (DT).Participants randomized to the experimental group were instructed to wear the Re-Timer® circadian regulator glasses for 30–40 minutes each morning within 30 minutes of waking, for four consecutive weeks. Participants recorded daily light therapy duration and sleep hours. If any discomfort occurred during the intervention, therapy was discontinued immediately, and support was provided by the research team.The control group was instructed to continue their regular daily routines without any light therapy intervention.

Follow-up Assessments：Outcome measures (ISI-C, BFI-T, and DT) were reassessed via an online questionnaire delivered through the LINE messaging app on Days 7 (T1), 14 (T2), 21 (T3), and 28 (T4) after the start of the intervention

Measurement Instruments

Demographic and Treatment-Related Variables：

Data collected included participants' age, body mass index (BMI), education level, marital status, religious affiliation, employment status, cancer type, cancer stage, use of sleep medications, and history of emotional distress. Treatment-related variables encompassed the current treatment modality, time since treatment completion, and general health status.

Sleep Quality：

Sleep quality was assessed using the Chinese version of the Insomnia Severity Index (ISI-C), which evaluates the severity and impact of insomnia symptoms over the past two weeks. The seven items cover:

Difficulty initiating sleep

Difficulty maintaining sleep

Early morning awakening

Satisfaction with current sleep pattern

Interference with daily functioning

Noticeable impairment in quality of life due to sleep problems

Degree of worry or distress about sleep difficulties

Each item is rated on a 5-point Likert scale (0–4), with total scores ranging from 0 to 28; higher scores indicate more severe insomnia. The original ISI was developed by Morin et al. (1993), and the Chinese version was validated by Yang et al. (2009). The ISI-C demonstrates excellent internal consistency (Cronbach's $\alpha = 0.91$) and high concurrent validity with the Chinese version of the Pittsburgh Sleep Quality Index ($r = 0.88$). A cutoff score of ≥9 yields a sensitivity of 91.8% and specificity of 91.2%.

Fatigue：

Fatigue severity was measured using the Taiwanese version of the Brief Fatigue Inventory (BFI-T), which was originally developed at the University of Texas MD Anderson Cancer Center (Mendoza et al., 1999). The BFI-T assesses fatigue experienced in the past 24 hours across nine items, each rated from 0 (no fatigue) to 10 (worst imaginable fatigue). The total score ranges from 0 to 90, with higher scores indicating greater fatigue severity. The BFI-T has demonstrated excellent reliability, with a Cronbach's α of 0.97 and test-retest reliability of 0.91 (Lin et al., 2006).

Emotional Symptoms：

Emotional distress was assessed using the Distress Thermometer (DT), a validated visual analog scale developed by Roth et al. (1988) to screen for distress caused by illness-related emotional issues such as anxiety, sadness, fear, and depression. Participants rate their level of distress on a scale from 0 (no distress) to 10 (extreme

distress), with a score of 5 representing moderate distress. In clinical practice, a cutoff score of 4 is commonly used to indicate significant distress. The Chinese version of the DT was adapted from the version provided by the National Comprehensive Cancer Network (NCCN). Wang et al. (2011) reported a sensitivity of 98% and a specificity of 73% for the DT.

.Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 26.0. To evaluate baseline homogeneity between the experimental and control groups, independent samples t-tests were used for continuous variables, while chi-square (χ^2) tests or Fisher's exact tests were applied for categorical variables, as appropriate. The effectiveness of the light therapy intervention on sleep quality, fatigue, and emotional distress across time points was assessed using generalized estimating equations (GEE), which account for correlated repeated measures and accommodate missing data. Statistical significance was set at a two-tailed p value of < 0.05.

Results

A total of 94 participants diagnosed with gynecologic cancer were enrolled and randomly allocated into the experimental and control groups with a 1:1 ratio (47 per group). During the study period, four participants withdrew due to health-related reasons, resulting in a final sample size of 90 (44 in the experimental group and 46 in the control group). The mean age was approximately 52 years. Baseline demographic and clinical characteristics were analyzed to ensure group equivalence. All variables were comparable between groups, except for body mass index (BMI), which showed a statistically significant difference and was adjusted for in subsequent analyses.

Primary and Secondary Outcomes：

Participants completed outcome assessments at baseline and weekly intervals for four weeks following the intervention (T1–T4).Sleep quality was assessed using the

Insomnia Severity Index – Chinese version (ISI-C).Fatigue was evaluated using the Brief Fatigue Inventory – Taiwan version (BFI-T).Emotional distress was measured using the Distress Thermometer (DT).All instruments were administered at baseline (T0), and at days 7 (T1), 14 (T2), 21 (T3), and 28 (T4).

Changes in these outcomes across timepoints and between groups were analyzed using generalized estimating equations (GEE), with BMI included as a covariate to adjust for baseline differences. This model allowed for evaluation of group, time, and interaction effects on outcome measures.

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