Effectiveness of mindfulness-based therapy versus progressive muscle relaxation on sleep disturbances among individuals with digital addiction

Eficácia da terapia baseada em mindfulness versus relaxamento muscular progressivo em distúrbios do sono em indivíduos com dependência digital

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Abstract

Introduction: Digital addiction refers to an impulse control disorder characterized by compulsive use of digital devices, mobile phones, online platforms and digital gadgets. Individuals suffer from poor sleep quality that affects the mental health due to digital addiction. **Objective:** To compare the effects of mindfulness-based therapy (MBT) and progressive muscle relaxation (PMR) on sleep disturbances among individuals with digital addiction. **Methods:** Sixty participants were recruited based on the eligibility criteria. Initially, participants were screened for digital addiction using validated questionnaire circulated through Google forms. Sleep disturbances were assessed using the Pittsburgh Sleep Quality Index (PSQI) and the Insomnia Severity Index (ISI). The participants were randomly allocated (1:1) into two groups: MBT group (n = 30) received MBT for 30 minutes per session, five days a week and additional 10 minutes of daily home practice for eight weeks; PMR group (n = 30) received PMR for 30 minutes per session, five days a week and additional 10 minutes of daily home practice for eight weeks. Statistical analysis was performed using SPSS version 21.0. **Results:** Post-test PSQI mean ± standard deviation values were 5.50 ± 0.97 for MBT and 7.00 ± 0.79 for PMR, and post-test ISI values were 7.50 ± 1.04 for MBT and 9.00 ± 0.79 for PMR. MBT significantly improved sleep disruptions compared with PMR ($p < 0.0001$). **Conclusion:** Both therapies effectively reduced sleep disturbances in those with digital addiction, although MBT was more effective.

Keywords: Behavioral addiction. Sleep wake disorders. Mindfulness. Progressive muscle relaxation. Quality of life.

Resumo

Introdução: *A dependência digital refere-se a um transtorno do controle de impulsos caracterizado pelo uso compulsivo de dispositivos digitais, telefones celulares, plataformas online e aparelhos eletrônicos. Indivíduos com dependência digital sofrem com má qualidade do sono, o que afeta a saúde mental.* ***Objetivo:*** *Comparar os efeitos da terapia baseada em* mindfulness *(MBT) e do relaxamento muscular progressivo (RMP) nos distúrbios do sono em indivíduos com dependência digital.* ***Métodos:*** *Sessenta participantes foram recrutados com base nos critérios de elegibilidade. Inicialmente, os participantes foram avaliados quanto à dependência digital utilizando um questionário validado distribuído via Google Forms. Os distúrbios do sono foram avaliados utilizando o Índice de Qualidade do Sono de Pittsburgh (PSQI) e o Índice de Gravidade da Insônia (ISI). Os participantes foram alocados aleatoriamente (1:1) em dois grupos: o grupo MBT (n = 30) recebeu MBT por 30 minutos por sessão, cinco dias por semana, com 10 minutos adicionais de prática diária em casa durante oito semanas; e o grupo RMP (n = 30) recebeu RMP por 30 minutos por sessão, cinco dias por semana, com 10 minutos adicionais de prática diária em casa durante oito semanas. A análise estatística foi realizada utilizando o software SPSS, versão 21.0.* ***Resultados:*** *Os valores de média ± desvio-padrão do PSQI no pós-teste foram 5,50 ± 0,97 para MBT e 7,00 ± 0,79 para RMP, e do ISI no pós-teste foram 7,50 ± 1,04 para MBT e 9,00 ± 0,79 para RMP. A MBT melhorou significativamente os distúrbios do sono em comparação com o RMP (p < 0,0001).* ***Conclusão:*** *Ambas as terapias reduziram efetivamente os distúrbios do sono em indivíduos com dependência digital, embora a MBT tenha sido mais eficaz.*

Palavras-chave: *Dependência comportamental. Transtornos do ciclo sono-vigília. Mindfulness. Relaxamento muscular progressivo. Qualidade de vida.*

Introduction

Digital addiction is a term used to describe an impulse control illness including compulsive interaction with smart devices, digital technologies, and online systems, such as social networking sites, video games, online platforms, mobile devices, and digital gadgets. This branch of cyber psychology is new and examines excessive and compulsive use of digital platforms, devices, and media. Addiction is a major chronic illness that affects reward, motivation, memory, and other brain circuits. If left untreated, it can cause relapses, progressive development, and even death.[1] The World Health Organization officially acknowledged digital technology addiction as a global issue in 2020. Excessive online activity and internet use cause erratic sleep patterns or insomnia at night and impair one's ability to manage time, energy, and attention during the day. Among those who are addicted to the gadgets, anxiety and sleep disorders are frequently linked results.[2]

Digital addiction has a negative impact on a person's well-being.[3] There are still many unanswered problems, including whether excessive blue-light exposure from prolonged daytime and nighttime use of digital device screens causes disordered sleep or is a result of changes in motivation, memory function, mood, food, and other lifestyle factors.[4] Excessive gadgets usage can even affect the nutritional status in teenagers.[5] India is the world's second-largest online market, with 700 million internet users. From roughly 4% in 2007 to roughly 47% today, the country has demonstrated an exponential growth pattern. According to research, it has become an essential part of our daily lives for work, social interactions, and personal time, but abuse and addiction have turned into an unseen danger to our sleep and mental health.[6]

In South Indian medical students, the incidence of digital addiction was reported to be 46.15% among men and 33.33% among women, and 51.3% of people reported having poor sleep.[7] Sleep is a homeostatically controlled physiological condition of unconsciousness. In recent years, there has been much focus paid to the connection between teenage sleep issues and cell phone use.[8] Sleep is essential for immunological, thermoregulatory, and endocrine system.[9] Problematic cell phone use affects one in four children and adolescents and is associated with anxiety, depression, and poor sleep quality.[10] Oversleeping during the day and poor sleep quality were positively correlated with media device use before bed.[11] Sleep disturbances are a common comorbidity associated with digital addiction.[12]

One of the top ten warning indicators of youth suicide is sleep disturbance.[13] Reducing sleep disturbances may help prevent mental health issues, including depression.[14] Antipsychotics, psychotropic drugs (such as anticholinergic), sedatives, and hypnotic agents, especially those in the family of Z pharmaceuticals or non-benzodiazepine benzodiazepine receptor agonists, are among the medications that are frequently connected to

odd sleep-related behaviours. Stimulus control therapy and relaxation therapies like mindfulness and progressive muscle relaxation (PMR) are the non-pharmacological interventions used for sleep disturbances.[15] If left untreated, sleep disturbances can raise the risk of accidents and cause a number of dangerous side effects.[16] Lack of sleep can impair cognitive function and cause erroneous memories.[17] Cognitive behavioral therapy is typically recommended as the initial course of treatment for people suffering from insomnia.[18]

Mindfulness-based interventions (MBIs) are a complementary and alternative medicine treatment that focus on increasing awareness. It was initially created to assist individuals experiencing stress, anxiety, sadness, or pain.[19] Mindfulness programs have emerged with various adaptations or adjustments, such as mindfulness-based therapy for insomnia,[20] mindfulness meditation intervention,[21] and mindfulness awareness program.[22] PMR is the second most popular strategy for increasing sleep quality. It can be achieved by three techniques: Jacobson's, overt progressive, and covert progressive.[23]

The Pittsburgh Sleep Quality Index (PSQI), a widely used self-reported questionnaire, is considered a generic tool to measure sleep quality in varied groups. The PSQI encompasses a comprehensive variety of measures relevant to sleep quality such as habitual sleep efficiency, sleep latency, duration, subjective sleep quality, sleep disruptions, use of sleeping medicine, and daytime dysfunction, and it provides references for clinical decisions.[24]

On the other hand, the Insomnia Severity Index (ISI) focuses on the subjective symptoms and effects of insomnia, as well as the level of concern or discomfort produced by these challenges. There are seven items on the ISI that measure how severe sleep-onset and sleep-maintenance issues (including nocturnal and early morning awakenings) are, how satisfied people are with their current sleep schedule, how much sleep problem interferes with their daily lives, how noticeable the impairment is, and how distressed or worried they are about the sleep issue.[25]

Digital addiction can affect physiological sleep regulation by disrupting circadian rhythms, reducing melatonin secretion during nighttime screen exposure, and raising cognitive alertness, resulting in delayed sleep onset and poor sleep quality. Previous research has demonstrated that various types of mindfulness and meditation, such as PMR, influence melatonin levels in various biological fluids in the body.

Mindfulness meditation on a regular basis has been linked to higher physiological levels of melatonin, with some positive effects.[4,26] In therapeutic practice, PMR and mindfulness exercises are often used methods to lessen psychological distress. While PMR is a well-known physiological relaxation technique that eases physical tension, mindfulness concentrates on controlling attention and being aware of the present moment without passing judgment. Researchers can ascertain whether the therapeutic advantages stem from general relaxation effects linked to conventional relaxation techniques or from mindfulness-specific cognitive processes by comparing these two approaches.[27] While prior research has shown a strong correlation between excessive use of smartphones or other digital devices and poor sleep quality, few studies has examined the effectiveness of non-pharmacological interventions for managing sleep disturbances in people with digital addiction.[10]

Although various studies have looked into the link between digital addiction and poor sleep quality, the majority of prior research has focused on prevalence and psychological repercussions rather than therapeutic methods.[4,7] Furthermore, there is insufficient comparison evidence for mindfulness-based therapy and PMR in people suffering from digital addiction. As a result, the purpose of this study is to compare the efficacy of mindful-ness-based therapy and PMR in treating sleep disrup-tions among people with digital addiction.

Methods

This research was a parallel-group, two-arm randomized controlled trial with a 1:1 allocation ratio, structured within a superiority paradigm. The study was carried out in a single tertiary care teaching hospital associated with a private medical college and university, and it was conducted in accordance with institutional ethics standards (01/12/2024/ISRB/FR/SCPT).

Participants were first assessed for digital addiction using the Digital Addiction Scale, a validated questionnaire that assesses problematic and excessive usage of digital gadgets. The questionnaire was provided electronically via Google Forms. Those who met the criteria for digital addiction were further assessed for sleep problems using PSQI and ISI. The detailed method was discussed and informed consent has been acquired from the participants.

Inclusion criteria were as follows: daily digital media use for non-academic purposes ≥ 4 hours; both male and female; age between 18 and 25 years; PSQI score > 5; ISI score ≥ 8. Exclusion criteria were diagnosed psychiatric disorders (e.g., clinical depression, anxiety disorders, schizophrenia); currently receiving therapy (psychological counselling, psychiatric treatment); use of medications affecting sleep (sleeping pills, antidepressants, anxiolytics) in the past month; chronic medical conditions known to impact sleep (e.g., epilepsy, thyroid disorders, chronic pain syndromes); engagement in regular mind-fulness, meditation, yoga, or PMR practice in the last six months.

Outcome measures and procedure

Initially, 90 individuals volunteered for the study. However, the final sample comprised 60 participants after removing those who did not satisfy the inclusion criteria or chose to withdraw (Figure 1). The sample size was calculated using G*Power with a moderate effect size (0.5), which is commonly used in similar research. The computation used a significance level (α) of 0.05 and a statistical power of 95%. Taking into account potential dropouts and response variability, a final sample size of 60 individuals was included.

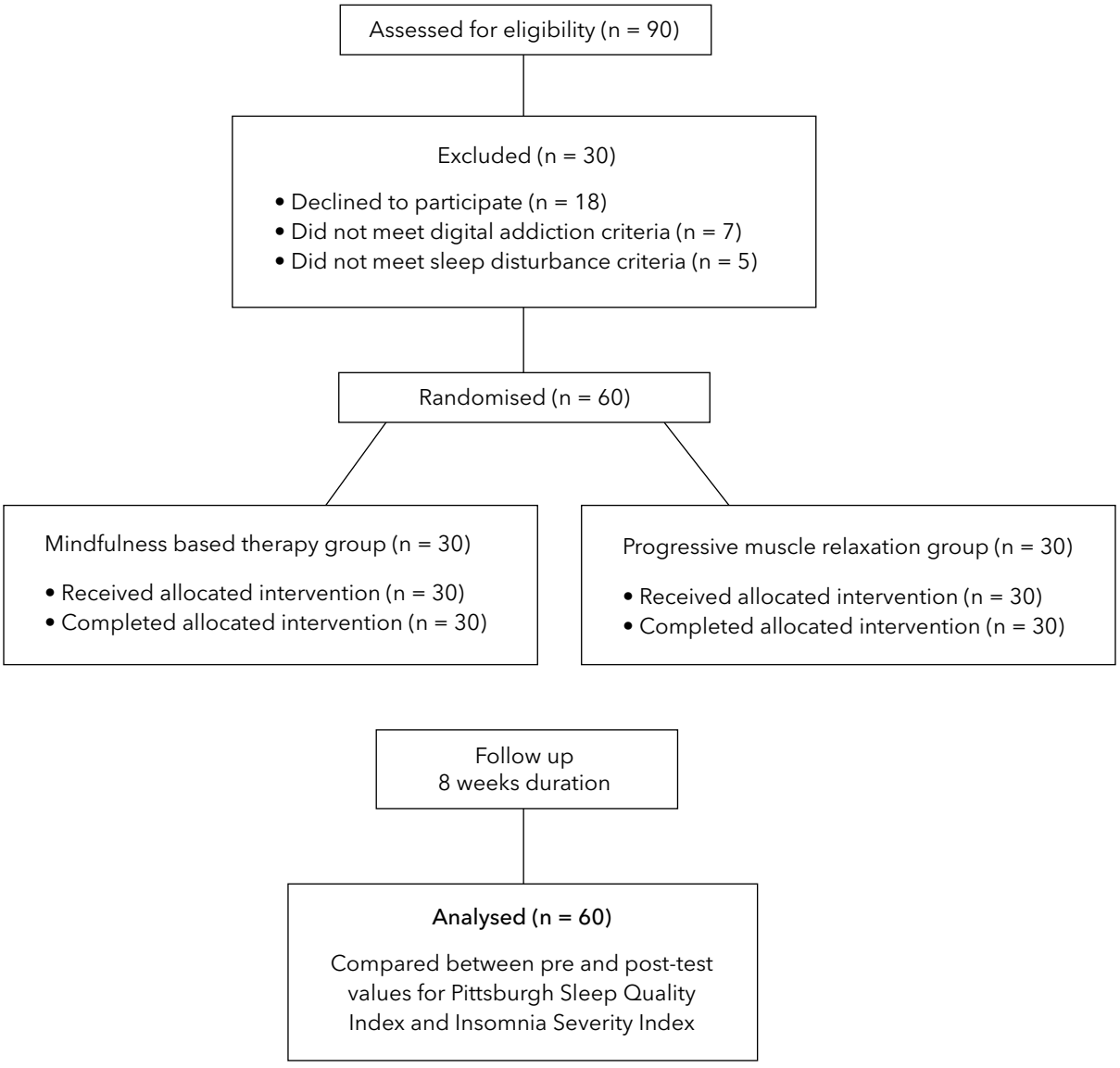

Figure 1 - Consort flow chart diagram.

The study was conducted at a private college and hospital. Eligible participants were randomly allocated into two groups (MBT or PMR) consisting of 30 members each using computer generated random sampling method. Due to feasibility and accessibility, participants were recruited using convenience sampling from university students; however, random allocation was utilized to prevent allocation bias. An independent researcher who was not involved in the intervention or outcome evaluation generated the random allocation sequence using computer-based randomization. The allocation order was kept hidden until the participants were assigned to their groups.

Throughout the trial, participants were kept unaware of their group assignment. Due to the nature of behavioral therapies, blinding the therapist administering the intervention was not possible; nonetheless, participants were not informed of the study's comparative hypothesis to reduce expectation bias. Examination was performed prior to and following the completion of eight weeks of study, and the data were statistically analysed for the comparative effectiveness of both the interventions.

MBT group

MBT was performed over a period of eight weeks with the participants attending 30 minutes per session, five days a week, accompanied by 10 minutes of daily home practice. The session was conducted in a quiet distraction free environment beginning with brief check in where participants reflected on their previous night's sleep and recent digital habits.

The participants were asked to sit comfortably and perform mindful breathing technique (inhalation and exhalation). The participants were asked to close their eyes and gently focus on the natural rhythm of their breath and when their thoughts wandered, they were instructed to focus on their breathing. They were instructed to perform 10 minutes mindful breathing at night and avoid mobile phone 30 minutes before bed.

In body scan technique, participants were asked to lie down comfortably, and to focus on each part of their body from toes to head acknowledging sensations without judgements. The participants were asked to recognise and detach from difficult emotions for emotional awareness and regulation. Mindfulness of wakefulness concept was introduced to the participants where they were encouraged to stay present with their emotions and thoughts while being awake at night rather than reacting to them. Loving kindness meditation was instructed to the participants where they were asked to silently repeat "may I be peaceful, may I accept myself as I am". Participants were encouraged to develop and practice personal affirmations, such as: "It's okay that I didn't sleep well last night; this doesn't define me." "Using my phone was a habit; I'm learning and improving each day."

Mindful walking is a mindfulness-based activity that integrates present-moment awareness with physical mobility.[28] It directs focus to breathing and body feelings while walking. This exercise promotes stress reduction and relaxation, which may enhance sleep quality. Participants were told to walk slowly and deliberately paying particular attention to each footfall, the sensation of their feet contacting the ground, the rhythm of their steps, their surroundings, and were encouraged to examine their impulse to swipe or check their phone, being advised to take a conscious pause before engaging with their device.

The mindfulness-based session had five organised exercises: mindful breathing, body scan meditation, emotional awareness and regulation, loving-kindness meditation and mindful walking. Each session included 10 minutes of sustained mindful breathing. Each session included a complete body scan cycle from toes to head. Participants repeated loving-kindness affirmations 5–10 times, depending on their comfort level. As a result, each session consisted of five mindfulness exercises delivered over the course of 30 minutes. Progressions were noted; pre- and post-assessment were done using PSQI and ISI.

PMR group

Participants received an 8-week intervention that included five 30-minute sessions per week, as well as 10 minutes of daily home practice. The goal was to alleviate physical and emotional tension that causes sleep disruptions, especially those exacerbated by excessive screen exposure and digital overstimulation. Each session followed a structured format. Participants were asked to lie down comfortably and were trained to focus attention on specific muscle groups, one at a time. They were asked to tense each muscle area for 5-7 seconds (without generating discomfort) before progressively releasing the tension while exhaling, keeping tension and relaxation distinct. A brief interval of 10-15 seconds was kept between each group to allow for profound relaxation.

The muscle groups were addressed by clenching fists, bending elbows and tightening biceps, raising eyebrows, squeezing eyes shut and scrunching cheeks, clenching teeth (lightly), pressing head back gently, taking a deep breath and holding, tightening abdominal muscles, squeezing thigh muscles, pulling toes toward face, curling toes downward. Progressive muscular relaxation targeted ten key muscular groups: hands, forearms, biceps, forehead, eyes and cheeks, jaw, neck, chest, belly, thighs and feet. Each muscle group was contracted for 5-7 seconds and then relaxed for 10-15 seconds. The contraction-relaxation cycle was repeated twice for each muscle group during each session, for a total of about 20 contraction-relaxation cycles. Participants were asked to breathe slowly and diaphragmatically during the practice, focusing on the sensations of calm spreading through their bodies. Each session ended with 2-3 minutes of silent repose, during which participants were urged to remain still, breathe gently and be mindful of their relaxed state. This cool-down interval served to reinforce the relaxing effects of the workout.

Ten minutes of home practice were advised, and participants were asked to avoid mobile phones 30 minutes before bed. Progressions were noted, pre- and post-assessments were done using PSQI and ISI. The interventions were administered by a physiotherapy professional who had received training in MBT and PMR techniques. A standardized protocol was adhered to ensure consistency in the delivery of sessions for all participants throughout the 8-week intervention period. The investigator carefully observed participants progressions throughout the intervention period to ensure adherence to the intervention regimen. Throughout the sessions, observational notes on participation and compliance were taken. The basic data utilized in the research were gathered from baseline and post-intervention assessments using the PSQI and ISI. To reduce sample attrition and treatment discontinuity, participants were reminded of the intervention sessions on a frequent basis and urged to participate consistently throughout the study duration. Clear instructions and follow-up communication were provided to guarantee compliance with the intervention regimen.

Statistical analysis

Statistical examination was conducted using SPSS 21.0. Statistical significance was indicated by $p < 0.05$.

The data were imported into a Microsoft Excel spread sheet, organized, and analysed. The Shapiro-Wilk test and visual analysis of histograms were used to ensure that the data distribution was normal. Parametric tests (paired and independent t-tests) were used in statistical analysis because the data met the normality assumption. Results are presented as mean ± standard deviation (SD). In addition, 95% confidence intervals were generated for mean differences to measure the precision of treatment effects.

Independent t-tests were used to compare groups, whereas the paired t-tests were used to compare within-group (pre- and post-intervention) conditions for all outcome measures, including the PSQI and ISI. Although repeated-measures ANOVA could give extra models for longitudinal analysis, the two-time-point design (pre- and post-intervention) and normally distributed data led to the selection of paired and independent t-tests.

Results

Baseline parameters were similar amongst groups, with no significant differences found (Table 1). The two groups showed substantial reductions in sleep disturbance scores after the 8-weeks intervention ($p < 0.001$ within groups). Between-group comparisons revealed that the MBT group improved sleep quality more than the PMR group, with moderate to large effect sizes (Cohen's $d > 0.5$), indicating that the findings are statistically and clinically relevant. Tables 2 and 3 show detailed mean scores, standard deviations, p-values, and effect sizes.

Table 1 - Baseline characteristics of participants

Variable	Groups		p-value
	MBT	PMR	
Age	21.30 ± 2.12	21.43 ± 2.28	0.82
Gender (M/F)	17/13	19/11	0.59
DST (hours)	7.50 ± 1.40	7.70 ± 1.60	0.61
PSQI score	11.77 ± 1.36	11.53 ± 1.04	0.44
ISI score	15.97 ± 1.59	15.63 ± 1.13	0.34

Note: MBT = mindfulness-based therapy (n = 30); PMR = progressive muscle relaxation (n = 30); M/F = male/female; DST = daily screen time. PSQI = Pittsburgh Sleep Quality Index; ISI = Insomnia Severity Index. Data presented as mean ± standard deviation.

Table 2 - Pre and post-test values of Pittsburgh Sleep Quality Index (PSQI) and Insomnia Severity Index (ISI)

Groups	PSQI				ISI			
	Pre-test	Post-test	t-value	p-value	Pre-test	Post-test	t-value	p-value
MBT	11.77 ± 1.36	5.50 ± 0.97	53.6577	< 0.001	15.97 ± 1.59	7.50 ± 1.04	63.5000	< 0.001
PMR	11.53 ± 1.04	7.00 ± 0.79	48.9344	< 0.001	15.63 ± 1.13	9.00 ± 0.79	74.1274	< 0.001

Note: MBT= mindfulness-based therapy (n = 30); PMR = progressive muscle relaxation (n = 30). Data presented as mean ± standard deviation.

Table 3 - Comparison between post-test result values of Pittsburgh Sleep Quality Index (PSQI) and Insomnia Severity Index (ISI)

Groups	Mean	SD	t-value	p-value	Cohen's
PSQI					
MBT	5.47	1.01	6.5645	< 0.001	1.69
PMR	7.00	0.79	6.5645	< 0.001	1.69
ISI					
MBT	7.50	1.04	6.2885	< 0.001	1.63
PMR	9.00	0.79	6.2885	< 0.001	1.63

Note: MBT = mindfulness-based therapy (n = 30); PMR = progressive muscle relaxation (n = 30); SD = standard deviation. Cohen's d effect size.

Post-test results for both the PSQI and ISI were statistically significant ($p < 0.0001$), as shown in Figure 2. Specifically, the MBT group achieved lower mean values on the PSQI (5.47) and ISI (7.50) than the PMR group (7.00 and 9.00, respectively). This indicates that MBT is more effective than PMR at reducing sleep disturbances.

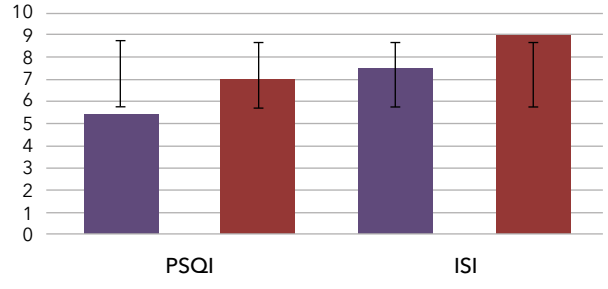

Figure 2 - Comparison between mean post-intervention PSQI and ISI scores for MBT and PMR groups with standard deviation error bars.

Note: PSQI = Pittsburgh Sleep Quality Index; ISI = Insomnia Severity Index; MBT = mindfulness-based therapy (n = 30; purple bars); PMR = progressive muscle relaxation (n = 30; red bars).

Discussion

The current study examined the efficacy of MBT vs PMR in reducing sleep disruptions in people with digital addiction. Both therapies significantly improved sleep quality, however MBT showed higher gains in PSQI and ISI scores than PMR. According to the statistical analysis, both groups exhibited significant improvements in PSQI and ISI, but participants in the MBT group demonstrated greater improvement.

A review by Dresp-Langley and Hutt[4] found that excessive use of digital devices, especially at night, disturbs circadian rhythms and changes neurochemical pathways that regulate sleep, including dopamine and serotonin. Prolonged exposure to blue light from screens inhibits melatonin secretion and delays sleep onset, resulting in chronic sleep deprivation in adolescents and young people. These findings are consistent with the findings of the current study, in which people with digital addiction had poor baseline sleep quality, emphasizing the strong link between excessive digital device usage and sleep disruptions.

An earlier randomized clinical trial done by Black et al.[29] found that mindfulness meditation significantly

improved sleep quality and reduced daytime impairment in older persons with mild sleep disruptions. Participants who received the mindfulness intervention had higher PSQI scores and lower fatigue and depressed symptoms than those who received sleep hygiene information. These results confirm the results of the current investigation, demonstrating that MBT may be an effective non-pharmacological method for enhancing sleep quality and lowering sleep-related daytime dysfunction. While their research focused on older populations, our data show that MBT is helpful in young adults with digital addiction, implying that treatment works across age ranges.

Hayajneh et al.,[30] assessing the effect of mindfulness training among nurses, found that it significantly reduced sleep disruptions, improved overall sleep quality, and helped to lower psychological stress and emotional tiredness, both of which contribute to sleep issues. These findings lend credence to the current study's findings, demonstrating that mindfulness-based therapy can be an effective non-pharmacological technique for improving sleep quality in those who are experiencing sleep disruptions caused by psychological or behavioural issues.

On the other hand, Khokhar et al.[31] investigated the effectiveness of progressive muscle relaxation in athletes experiencing sleep problems and found that PMR dramatically enhanced sleep initiation and total sleep quality. The intervention included a systematic head-to-toe muscle contraction and relaxation strategy that reduces physiological arousal and promotes relaxation prior to sleep. These findings are consistent with the findings of the current study, demonstrating that gradual muscle relaxation can be an effective non-pharmacological way to minimizing sleep disruptions and improving sleep quality. PMR can be a useful non-pharmacological strategy for people who have high somatic tension or physiological alertness.

A previous study by Simon et al.[32] examined how progressive muscle relaxation affected sleep during a daytime nap and found that the method greatly enhanced slow-wave sleep, a crucial stage linked to restorative sleep and recuperation. According to the research, increasing muscular relaxation encourages deeper sleep stages and lowers physiological alertness. These outcomes are consistent with the findings of the current investigation, indicating that gradual muscle relaxation may be a useful non-pharmacological strategy for enhancing sleep quality and lowering sleep disruptions. From a clinical perspective, the study's findings suggest that mindfulness-based therapy could be a useful and non-pharmacological solution for addressing sleep disruptions in people with digital addiction. As young individuals' usage of digital devices grows, accessible behavioural therapies like mindfulness training may prove effective in improving sleep quality and general psychological well-being.

The present study has some limitations that must be addressed: sleep outcomes were measured using self-reported questionnaires (PSQI and ISI) rather than objective techniques like polysomnography or actigraphy; and the study focused on participants aged 18 to 25, limiting applicability to other age groups. Therefore, future studies should have larger, multicentre sample sizes, and could evaluate the effectiveness of these interventions on stress levels among individuals with digital addiction.

Conclusion

Both MBT and PMR are effective in reducing sleep disturbances among participants with digital addiction, but MBT seems to be more effective when compared with progressive muscle relaxation.

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Author contribution

Conceptualization: PK, AS, VS. Methodology: PK, AS, DS. Visualization, and software & validation: VS, VJ. Formal analysis: PK, VS. Investigation & data collection: AS, DS, VJ, NM. Data curation: VS. Resources, writing of the original draft, and project administration: PK, AS. Writing – Review & editing: DS, VJ, NM. Supervision: PK.

Data availability statement

The datasets created and analyzed during the current investigation can be obtained from the corresponding author upon reasonable request.

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