

## Digital Interventions in the Treatment of Sleep Disorders: Scoping Review

### Intervenções digitais no tratamento de distúrbios do sono: Revisão de Escopo

#### Leinylyson Fontinele Pereira

ORCID: <https://orcid.org/0000-0001-7564-452X>

Federal University of Delta of Parnaíba, Brazil

E-mail: leinylyson@gmail.com

#### Carine Alves Nery Santos

ORCID: <https://orcid.org/0000-0002-6843-5137>

Federal University of Delta of Parnaíba, Brazil

E-mail: carinenery@hotmail.com

#### RESUMO

Intervenções digitais para distúrbios do sono têm se apresentado eficazes e com possibilidade de grande alcance com a popularização dos dispositivos eletrônicos, especialmente as que utilizam Técnica Cognitivo Comportamental. No intuito de verificar a aplicabilidade e eficácia de outros tipos de intervenções digitais para distúrbios do sono, foi realizada uma busca sistemática de literatura baseada no PRISMA. De 1.234 artigos encontrados, foram incluídos 6 que atenderam a todos os critérios de inclusão e exclusão. Os estudos encontrados demonstram que as intervenções baseadas em mindfulness e ACT são promissoras, sugerindo uma melhora significativa na qualidade do sono, além de outros benefícios como melhora da fadiga, sonolência diurna e sintomas depressivos, embora tenham apresentado diferentes métodos de avaliação desse efeito, enquanto um programa de mensagens de texto revelou-se ineficaz. Portanto, através dessa revisão de escopo, pode-se concluir que além de oferecer uma técnica comprovadamente eficaz, a intervenção digital deve obter o envolvimento do paciente para que tenha bom impacto na melhoria da qualidade do sono.

**Palavras-chave:** Distúrbios do sono; Intervenções na Internet; Insônia; eSaúde; Revisão de escopo.

#### ABSTRACT

Digital interventions for sleep disorders have proven to be effective and potentially far-reaching with the popularization of electronic devices, especially those using Cognitive Behavioral Techniques. In order to verify the applicability and effectiveness of other types of digital interventions for sleep disorders, a systematic literature search was carried out based on PRISMA. Of 1,234 articles found, 6 were included that met all inclusion and exclusion criteria. The studies found demonstrated that interventions based on mindfulness and ACT are promising, suggesting a significant improvement in sleep quality, in addition to other benefits such as improvement in fatigue, daytime sleepiness and depressive symptoms, although they presented different methods of evaluating this effect, while a text messaging program proved ineffective. Therefore, it can be concluded that in addition to offering a proven effective technique, digital intervention must obtain patient involvement for it to be effective in improving sleep quality.

**Keywords:** Sleep disorders; Interventions on the Internet; Insomnia; eHealth; Scoping Review.

## INTRODUCTION

Sleep-wake disorders are described as disorders whose complaints, in common, are dissatisfaction about the quality and/or amount of sleep, resulting in harm and suffering during activities diurnal. Often, the sleep disorders they are accompanied by changes in mood, cognition, or other conditions clinical, including structural or anatomical features, which should be included in the follow-up multidisciplinary (APA, 2014).

Insomnia disorder is the most prevalent among all sleep disorders, reaching up to 50% of care patients primary and requires Cognitive Behavioral Therapy for Insomnia (CBT-I) as a first-class treatment line, regardless of underlying cause. Pharmacological treatment presents satisfactory results, such as CBT-I, but only CBT-I showed lasting effects after discontinuation of treatment. There is yet consensus worldwide about which treatment pharmacological it presents better efficiency or relationship risk-benefit (Perlis *et al.*, 2022). According to the most recent guidelines, pharmacological treatment is recommended for short use term and only if the TCC-I isn't available or is ineffective (Riemann *et al.*, 2023).

With the popularization of devices electronics and access facilitated to technologies fingerprints, there was an increase expressive at number of alternatives to improve the availability of interventions about sleep disorders using eHealth<sup>1</sup> techniques. In this context, a robust body of evidence puts the digital TCC-I as excellent intervention cost-effectiveness due to effectiveness and economy of scale (Soh *et al.*, 2020).

Others interventions directed at insomnia and others sleep disorders he has been used in digital format in order to facilitate accessibility to therapies previously restricted to format traditional face-to-face, such as example mindfulness (Kabat-Zinn, 2013), Acceptance and Commitment Therapy (ACT), which can be considered per some authors components of a approach cognitive-behavioral , but with characteristics that distinguish it from the traditional CBT-I multicomponent (Riemann *et al.*, 2023).

---

<sup>1</sup>eHealth is conceptualizad as to use safe and cost - effective information and communication technologies in health support and areas \_ health - related, including health services, surveillance, literature as well as education, and research Health Summary (WHO, 2023).

The delivery of this therapy to the user he can assume several formats and technologies digital, since text messages, e-mail, websites, smartphone apps, games serious, to the evolution to wearable devices, matching eHealth skills.

Internet interventions based on different therapeutic approaches can be effective in improving sleep and psychological symptoms associated with insomnia or depression, as evidence on digital CBT-I already shows. These interventions can offer advantages such as accessibility, convenience, personalization and privacy for users who suffer from sleep-related problems. The aim of this review is to identify clinically applicable digital interventions for sleep disorders, beyond those using CBT-I, by analyzing the quality of evidence from published studies on the subject.

## METHOD

This scoping review was performed using the PRISMA (Preferred Reported Items for Systematic Review and Meta-Analysis) guidelines. The acronym PICO was used to elaborate the research question, so that each element was defined as: Population - Patients with sleep disorders; Intervention - Digital interventions (serious games, applications, software, internet interventions); Comparison - without restrictions; Outcome - Sleep pattern.

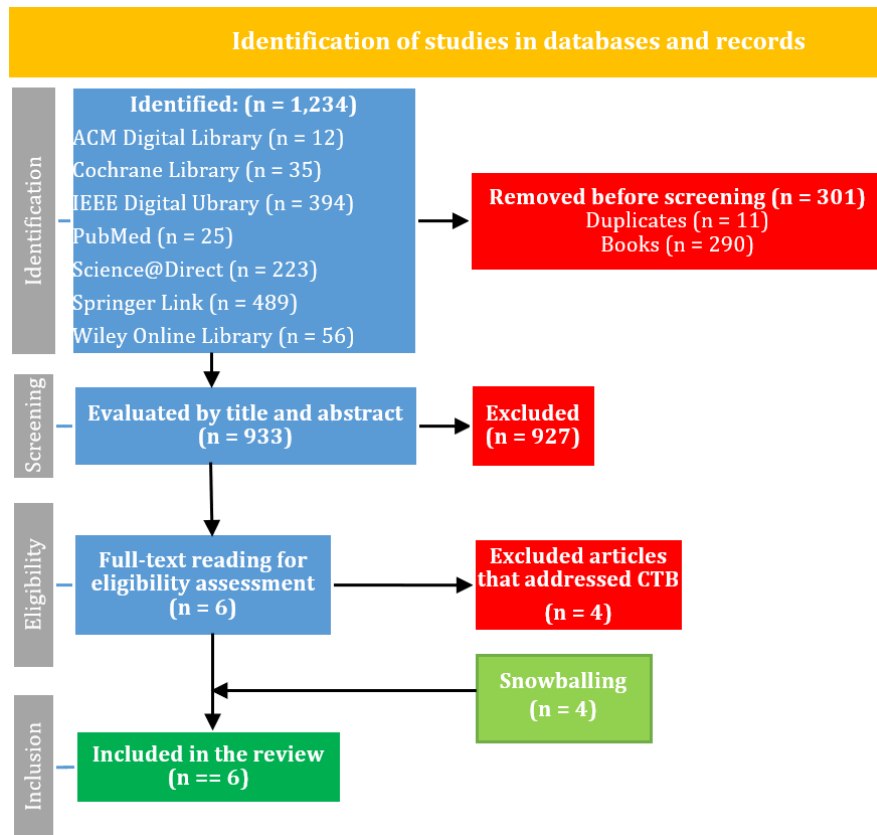
Databases PubMed, Science@Direct, Springer Link, Cochrane Library, Wiley Online Library, ACM Digital Library and IEEE Digital Library were systematically searched on June, 2023. The main search terms included: Sleep disorder; insomnia; serious games; internet intervention. The structure of this systematic review was developed in the Parsif.al online tool, following the available steps to plan, conduct and report.

Studies were included if: (1) the publication described an digital intervention directed sleep disorders or insomnia, (2) the publication was a controlled trial, (3) or the main article was written in English. Studies were excluded if: (1) the intervention included participants under 18 years old, (2) non-English language, (3) only digital CBT-I was used or (4) directed Obstructive Sleep Apnea (OSA).

The reason for excluding studies that address only digital CBT-I is due to the recent systematic review on the subject (Soh *et al.*, 2020). For OSA, there is a greater

concurrency of underlying structural causes, such as adenotonsillar hypertrophy, obesity, retrognathism, micrognathism, among other barriers to the patency of upper airway permeability, which would be less compatible with the main indication of non-pharmacological therapy (APA, 2014).

**Figure 1 – PRISMA flow diagram**



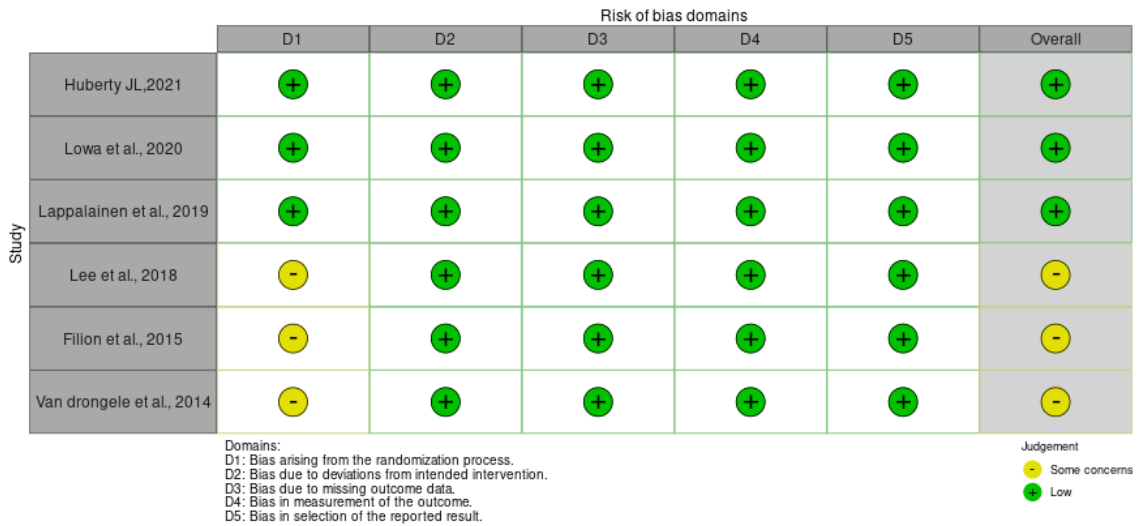
Two authors screened independently all titles and abstracts using Parsifal (Kitchenham, 2007). Subsequently, they screened all full texts of the remaining articles. Snowballing technique was performed, through references in the selected articles and previous reviews, together with the electronic search, aiming at a more comprehensive approach in the identification of controlled studies (Hopewell *et al.*, 2007). Discrepancies were discussed and resolved in follow-up meetings in consensus with the authors. Figure 1 shows the flowchart of the screening procedure.

## RESULTS

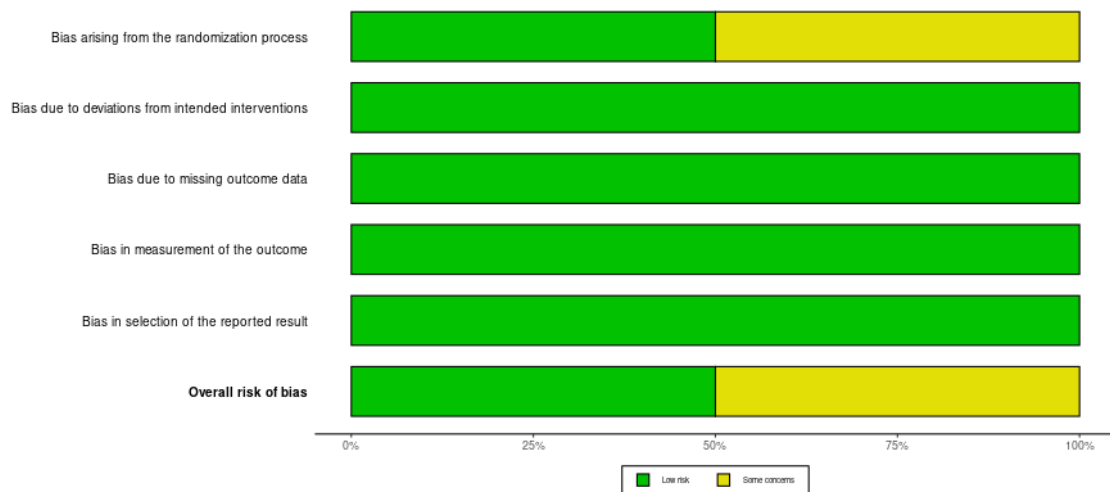
In total, 1,234 records were identified in the search (ACM Digital Library (12), Cochrane Library (35), IEEE Digital Library (394), PubMed (25), Science@Direct (223),

Springer Link (489) and Wiley Online Library (56)), of which 6 were included in this review.

**Figure 2 -Traffic-light plot (Rob 2.0)**



**Figure 3 - Summary Plot (Rob 2.0)**



Figures 2 and 3 shows the characterization of the tests clinical randomized included at revision referring to the origin of the articles and size sample of each study, respectively. The included articles were published between 2014 and 2021. Risk of bias analysis was performed using the Cochrane Risk of Bias Table tool (Rob 2.0) (Sterne, *et al.*, 2019).

## DISCUSSION

Sleep disorders, in general, are characterized by their frequent association with mental disorders, such as depression, anxiety or hyperactivity. Regardless of the underlying cause, these disorders have functional effects during the day, as well as qualitative or quantitative changes in sleep at night (APA, 2014).

The goal of treating insomnia is to improve sleep and alleviate suffering or dysfunction caused by poor sleep quality. Insomnia can be treated with psychological therapy, pharmacological therapy, or a combination of both. The American College of Physicians (ACP) and the European Sleep Research Society recommend cognitive behavioral therapy for insomnia (CBT-I) as an initial treatment for insomnia disorder with a strong degree of recommendation, maintaining a pharmacological indication or a combination of both. for cases refractory to psychotherapy (Quaasem, *et al.*, 2016; Rieman, *et al.*, 2023).

Psychological therapy options includes cognitive behavioral therapy for insomnia (CBT-I); multicomponent behavioral therapy or brief behavioral therapy (BBT) for insomnia; in addition to other interventions, such as stimulus control, relaxation strategies and sleep restriction. However, the evidence was insufficient to determine the effect of these interventions on overall outcomes in the population or in older people with insomnia disorders. There was also insufficient evidence to determine the effect of sleep restriction or relaxation therapy according to US and European Guidelines (Quaasem, *et al.*, 2016; Rieman, *et al.*, 2023).

Along with the development of sleep research and treatment, CBT-I itself has evolved. Nevertheless other intervention, e.g., Acceptance and Commitment Therapy – ACT (Hayes, 2016) and Mindfulness Based Stress Reduction - MBSR (Kabat-Zinn, 2013), have been developed currently for different disorders such as depression and anxiety.

The beneficial effect of digital CBT-I has been evidenced through a recent meta-analysis (Soh *et al.*, 2020). The traditional face-to-face psychosocial therapies presented are comparable with the same technique applied digitally, however with better costs, accessibility and psychological burden, without intercessor like face-to-face therapy.

With the increasing development of eHealth in recent years, other interventions with approaches beyond CBT-I have been commercially launched. However, the effectiveness of these interventions, if not proven to be beneficial and superior to harmful

effects, it breaks with the maximum health paradigm for treatments in relation to the non-maleficence principles, at the expense of time and resources, in addition to the possibility of worsening sleep conditions.

Circadian homeostasis is conditioned by endogenous and exogenous factors, including especially light. There is evidence that nighttime exposure to screen media devices can have detrimental effects on subjectively perceived sleep quality and daytime functioning due to projected light (Steele *et al.*, 2021). In view of this, interventions targeting sleep disorders through screens need to be evaluated for efficacy and safety.

Interventions for sleep disorders via the internet may vary in their effects, adherence and satisfaction, depending on the therapeutic approach, presentation format and user characteristics. This type of analysis can clarify the most relevant therapeutic targets. Mindfulness and ACT interventions were, respectively, more effective for participants with clinical than subclinical insomnia, although studies maintain the suggestion of better personalization (Lowa, *et al.*, 2020; Lappalainen, *et al.* 2019).

The studies found demonstrate that interventions based on mindfulness and ACT are promising, suggesting a significant improvement (p value <0.01) in sleep quality, in addition to other benefits such as improvement in fatigue, daytime sleepiness and depressive symptoms, although the methods for evaluating of this effect had been diferents (Huberty, *et al.*, 2021; Lowa, *et al.*, 2020; Lee & Jung, 2018). On the other hand, the text messaging program proved to be ineffective (Filion, *et al.* 2015), which implies that the guidance needs to be substantiated, personalized and delivered in an attractive format to the user and that, by combining these characteristics, has a potential effect on sleep quality (Van Drongelen, *et al.*, 2014).

## CONCLUSION

This scoping review shows that digital interventions beyond CBT-i suggest benefit in patients with insomnia and other sleep-related conditions. However, there are few studies that evaluate clinical outcomes to digital interventions, concluding that there isn't currently enough data to guarantee the applicability of these interventions, except for CBT-I. Therefore, there is a need for more randomized clinical trials and transparency in the methodology regarding the effectiveness of commercially available digital interventions.

The heterogeneity and small number of studies found in this review made categorization and comparison among them impossible. Despite this, it was possible to verify that the development of a digital intervention aimed at treating sleep disorders, as well as any e-Health, is only completed after its validation in clinical contexts and that, to offer proven effective technology, the intervention must be combined with factors to patient involvement to a satisfactory adherence to the intervention.

## REFERENCES

AMERICAN PSYCHIATRIC ASSOCIATION (APA). Diagnostic and Statistical Manual of Mental Disorders: DSM-5. 5. ed. Porto Alegre: Artmed, 2014.

FILION, A. JORDAN, G. D., CHAPUT, J., YBARRA, M., HAINE, J. Examining the influence of a text message-based sleep and physical activity intervention among young adult smokers in the United States. **BMC Public Health**. V. 15. 2015.

HAYES, S. C., Acceptance and Commitment Therapy, Relational Frame Theory, and the Third Wave of Behavioral and Cognitive Therapies - Republished Article. **Behavior Therapy**. v. 47, n. 6, p. 869-885. 2016.

HOPEWELL, S. CLARKE, M. J., LEFEBVRE, C., SCHERER, R., Hand search versus electronic search to identify randomized trial reports. **Cochrane Database of Systematic Reviews**. 2007.

HUBERTY J. L., GREEN J., PUZIA M. E., LARKEY L., LAIRD B., VRANCEANU A-M., VLISIDES-HENRY, R. Testing a mindfulness meditation mobile app for the treatment of sleep-related symptoms in adults with sleep disturbance: A randomized controlled trial. **PLoS ONE**. v. 16, n.1, 2021.

KABAT-ZINN, J. Full catastrophe living: using the wisdom of your body and mind to face stress, pain, and illness. 2013.

KITCHENHAM, B. Guidelines for performing Systematic Literature Reviews in Software Engineering, Version 2.3, EBSE Technical Report EBSE-2007-01. 2007

LAPPALAINEN, P., LANGRIAL, S., OINAS-KUKKONEN, H., MUOTKA, J., LAPPALAINEN, R., ACT for sleep - Internet-delivered self-help ACT for sub-clinical and clinical insomnia: A randomized controlled trial. **Journal of Contextual Behavioral Science**. v. 12, 2019.

LEE, R. A., JUNG., M.E., Evaluation of an mHealth App (DeStressify) on University Students' Mental Health: Pilot Trial. **Jmir mental health**. 2018.



LOWA, T., CONDUIT, R., VARMA, P., MEAKLIM, H., JACKSON, M.J., Treating subclinical and clinical symptoms of insomnia with a mindfulness-based smartphone application: A pilot study. **Internet Interventions**. 2020.

PERLIS, M. L., POSNER D., RIEMANN, D., BASTIEN, C. H., TEEL, J., THASE, M., Insomnia. **Lancet**. 2022.

QASEEM, A. KANSAGARA, D. FORCIEA, M. A., COOKE, M., DENBERG, T., Clinical Guidelines Management of Chronic insomnia Disorder in Adults: A Clinical Practice Guideline From the American College of Physicians. *Annals of internal medicine*. **ACP Journals**. v. 165, n.2, 2016.

RIEMANN, D., COLIN A., ESPIE, C., ALTENA, E., ARNARDOTTIR, E. S., BAGLIONI, C., BASSETTI, C. L. A., BASTIEN, C., BERZINA, N., BJORVATN, B., DIKEOS, D., GROSELJ, L. D., ELLIS, J. G., GARCIA-BORREGUERO, D., GEOFFROY, P. A., GJERSTAD, M., GONÇALVES, M., HERTENSTEIN, E. HOEDLMOSER, K., HION, T., HOLZINGER, B., JANKU, K., JANSSON-FRÖJMARK, M., JÄRNEFELT, H., JERNELÖV, S., JENNUM, P. J., KHACHATRYAN, S., KRONE, L., KYLE, S. D., LANCEE, J., LEGER, D., LUPUSOR, A., MARQUES, D. R., NISSEN, C., PALAGINI, L., PAUNIO, T., PEROGAMVROS, L., PEVERNAGIE, D., SCHABUS, M., SHOCHAT, T., SZENTKIRALYI, A., VAN SOMEREN, E., VAN STRATEN, A., WICHNIAK, A., VERBRAECKEN, J., SPIEGELHALDER, K., The European Insomnia Guideline: An update on the diagnosis and treatment of insomnia. **Journal of Sleep Research**. v. 32. 2023.

STERNE, J.P.T, SAVOVIĆ, J., PAGE, M.J., ELBERS, R. BLENCOWE, N.S., BOUTRON, I., CATES, C.J., CHENG, H., CORBETT, M.S., ELDRIDGE, S.M., EMBERSON, J.R., HERNÁN, M.A., HOPEWELL, S., 13 HRÓBJARTSSON, A., JUNQUEIRA, D.R., JÜNI, P., HIGGINS., J.P.T. RoB 2: a revised tool for assessing risk of bias in randomised trials. **BMJ**, 2019.

SOH, H. L., HO, R. C., HO, C. S., TAM, W.W., Efficacy of digital cognitive behavioral therapy for insomnia: a meta- analysis of randomized controlled trials. **Sleep Medicine**. 2020.

VAN DRONGELEN, A., BOOT, C. R. L, HYNEK, H., TWISK, J.W. R., SMID, T, VAN DER BEEK, A. J. Evaluation of an mHealth intervention aiming to improve health-related behavior and sleep and reduce fatigue among airline pilots. **Scand Journal Work Environment Health**. 2014.

WORLD HEALTH ORGANIZATION (WHO). eHealth. Available at: <https://www.emro.who.int/health-topics/ehealth>. 2023