



Psycho-oncology interventions focusing on fatigue and sleep disturbances

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Purpose of the review

Cancer-related fatigue (CRF) and sleep disturbances are common symptoms among patients with cancer. They are often conceptualized as a part of a larger symptom cluster, also comprising pain and emotional distress. Despite their prevalence and long-lasting effects, CRF and sleep disturbances are still poorly addressed in clinical settings. Specific interventions are needed to manage these symptoms.

Recent findings

In addition to conventional pharmacological therapies, other kinds of interventions are increasingly being developed in oncology. This review will discuss three categories of interventions for patients with cancer and their interest in alleviating CRF and sleep disturbances: physical exercises (e.g., aerobic, resistance training, running, free weights), psychological interventions (e.g., cognitive-behavioural therapy, psychoeducational interventions), and mind-body interventions (e.g., yoga, mindfulness, hypnosis). The multicomponent aspect of these interventions seems particularly important to address these symptoms.

Summary

The findings detailed in this review will allow the scientific community, as well as health professionals working in oncology settings, to be informed about new nonpharmacological therapeutic options to help patients to manage their symptoms. It could eventually help to improve existing interventions for these patients.

Keywords

cancer-related fatigue, interventions, oncology, psycho-oncology, sleep disturbances

INTRODUCTION

Cancer-related fatigue (CRF) can be defined as a distressing, persistent, and subjective feeling of physical, emotional and/or cognitive tiredness or exhaustion, which is related to cancer or its treatment. CRF is not proportional to the person's recent activity and interferes with their usual functioning [1]. A recent meta-analysis revealed that 52% of patients with cancer suffer from CRF, ranging from 14% to 100% according to the studies [2[■]]. CRF negatively impacts patients' physical, psychological and social functioning [2[■],3]. Risk factors for CRF are, among others, the presence of insomnia, pain and/or depression [2[■],3,4].

Regarding sleep disturbances, the most common symptoms in cancer patients are insomnia (including difficulties in falling or staying asleep, poor-quality sleep, or early waking) and hypersomnolence (excessive daytime sleepiness) [5,6]. The most studied sleep difficulty in oncology is insomnia. In this paper, we will mainly use the term 'sleep

disturbances' as some papers, especially meta-analyses, focused on several kinds of sleep disturbances, not only insomnia. According to recent studies, the prevalence of sleep disturbances among patients with cancer during or after their treatment varies between 32% and 61% [5,7[■],8[■],9], and is approximately three times higher than in the general population [10[■]]. Sleep disturbances can induce physical, psychological, and social issues, and

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Curr Opin Oncol 2022, 32:000–000

DOI:10.1097/CCO.0000000000000847

KEY POINTS

- CRF and sleep disturbances are two common symptoms among patients with cancer, which are generally part of a larger symptom cluster also including pain and emotional distress.
- There is a growing interest from patients, health professionals, and researchers for nonpharmacological interventions addressing these symptoms.
- Physical, psychological, and mind-body interventions decrease CRF and sleep disturbances in oncology and, among them, multicomponent interventions seem particularly relevant and effective.
- Further research is needed to improve existing interventions in oncology and to foster their use in clinical practice.

negatively impact the quality of life [7[■],8[■],9,10[■]]. The presence of depression, anxiety and/or pain is, among others, a risk factor for insomnia [8[■],9,10[■]]. CRF and sleep disturbances can persist for years after treatment completion and yet they remain underdiagnosed and undertreated [2[■],7[■],9,10[■],11,12[■]].

Strong associations exist between CRF and sleep disturbances, mostly insomnia [2[■],3,9,11,13]. More specifically, these two difficulties are generally considered to be part of a larger symptom cluster commonly reported among patients with cancer, and composed of CRF, sleep disturbances, pain and emotional distress, which are all correlated [3,8[■],11,14[■]]. In fact, it seems that the burden endured by oncological patients is linked to the mutual reinforcement of these symptoms [14[■]]. Given its centrality in the cluster, various studies have highlighted that targeting CRF seems to be particularly pertinent to improve the overall symptom burden [3,14[■]].

The use of multicomponent interventions, focusing on controllable risk factors (e.g., improving depression or insomnia to impact CRF), is particularly appropriate and recommended for the management of CRF and sleep disturbances in oncology [2[■],3]. Various kinds of interventions can be proposed to manage these symptoms. In this paper, we will not detail the pharmacological options available, as this is not the objective of the review. However, they have been reviewed by other authors and seem not to be optimal to address these symptoms [15,16]. We will rather focus on nonpharmacological interventions that can be divided into three main categories: physical interventions (based on physical activity), psychological interventions (e.g., cognitive-behavioural therapy (CBT), psychoeducational

interventions), and mind-body interventions (e.g., hypnosis, mindfulness, yoga). There is a growing interest among patients with cancer in these mind-body interventions, as they want to learn how to relieve their symptoms in a nonpharmacological complementary way. However, these interventions, especially the psychological and mind-body ones, are only starting to be scientifically assessed, and these studies often suffer from some methodological pitfalls (e.g., lack of randomization, no control group, small sample sizes), leading to small or moderate effect sizes. In this paper, we will review recent scientific work that has been done on nonpharmacological complementary interventions addressing CRF and sleep disturbances in oncology, and provide a summary for researchers and clinicians in the field on existing alternative therapeutic options and their efficacy. As CRF and sleep disturbances are mainly investigated among adult patients, we will not review here the interventions designed for children with cancer. However, some guidelines exist for the management of paediatric CRF [17] and a systematic review is ongoing about the management of sleep disturbances in children with cancer [18].

PHYSICAL INTERVENTIONS FOR FATIGUE AND SLEEP DISTURBANCES

Various studies have shown that CRF and sleep disturbances are related to the level of physical activity [3,4,10[■],19[■]]. It is therefore common practice to propose interventions based on physical exercise to oncological patients reporting such symptoms (see Table 1 for a summary of recent studies). Two recent systematic reviews and one meta-analysis showed the positive impact of physical activity (e.g., aerobic or anaerobic exercises, resistance training, core stability) on CRF in women with ovarian cancer [20[■]], and in adults suffering from different cancers [21[■],22]. Another meta-analysis from 2017 compared physical (e.g., walking, cycling, jogging, free weights), psychological (CBT or psychoeducational), and pharmacological interventions, and showed that physical exercise was the most effective to reduce CRF in patients with different cancer diagnoses [15]. In their randomized controlled trial, Mostafaei *et al.* [23] also showed that patients with breast cancer who benefitted from 6 weeks of moderate at-home physical activity (three 30-min sessions per week of stretching, dynamic, and resistance exercises scheduled after the chemotherapy sessions) reported a decrease of CRF right after the intervention and up to one month after. Exercise interventions are also effective in reducing sleep disturbances, as shown by a recent

Table 1. Summary of the recent studies detailed in the review

	Authors	Year	Type of study	N	Cancer diagnosis	Technique studied	Main results
Physical interventions	Belloni <i>et al.</i>	2021	SR & MA	10 studies	Mixed	PA (aerobic, anaerobic, resistance)	↘ CRF during and after treatment
	Yang <i>et al.</i>	2021	MA	6 studies	Breast cancer	PA (aerobic, walking, resistance, combination)	↗ sleep quality ↗ sleep efficiency ↘ sleep latency ↘ daytime dysfunction
	Mostafaei <i>et al.</i>	2021	RCT	60 patients	Breast cancer	PA (stretching, dynamic, resistance)	↘ CRF (up to 1-month postintervention)
	Nguyen <i>et al.</i>	2021	RCT	83 patients	Breast cancer	PA (wrist monitor + 1 training session + 5 counselling sessions)	↘ sleep disturbances
	Forbes <i>et al.</i>	2020	SR	14 studies	Mixed	PA (aerobic, balance, resistance)	↘ CRF.
	Jones <i>et al.</i>	2020	SR	34 studies	Ovarian cancer	PA (aerobic, yoga, resistance, core stability intervention)	↘ CRF during and after treatment
	Rastogi <i>et al.</i>	2020	RCT	50 patients	Breast and colorectal cancers	PA + written PA recommendations	↘ sleep disturbances
	Mustian <i>et al.</i>	2017	MA	113 studies	Mixed	PA (aerobic, anaerobic) vs psychological (CBT, psycho-education, combination) vs pharmacological	Higher efficacy of PA and psychological interventions to ↘ CRF during and after treatment
Psychological interventions	Ma <i>et al.</i>	2021	MA	14 studies	Breast cancer	Psychological (CBT for insomnia)	↘ insomnia ↗ sleep quality (both up to 1-year postintervention)
	Bandani-Susan <i>et al.</i>	2021	RCT	38 patients	Breast cancer	Psychological (mobile psycho-education)	↘ CRF
	Wang <i>et al.</i>	2020	SR & MA	7 studies	Mixed	Psychological (internet-based psycho-education)	↘ CRF
	Poort <i>et al.</i>	2020	RCT	134 patients	Mixed	Psychological (CBT) vs PA	CBT: ↘ CRF (up to 3-months postintervention)
	Nguyen <i>et al.</i>	2018	Pilot QE study	102 patients	Mixed	Psychological (face-to-face + phone psycho-education)	↘ CRF (severity and interference) ↘ sleep disturbances

Table 1 (Continued)

	Authors	Year	Type of study	N	Cancer diagnosis	Technique studied	Main results
Mind-body interventions	Yi <i>et al.</i>	2021	SR & MA	7 studies	Breast cancer	Mind-body (yoga)	↘ CRF ↘ Sleep disturbances
	Song <i>et al.</i>	2021	SR & MA	16 studies	Mixed	Mind-body (yoga)	↘ CRF
	Johns <i>et al.</i>	2021	SR & MA	23 studies	Mixed	Mind-body (mindfulness)	↘ CRF (maintained at 1 st follow-up)
	Suh <i>et al.</i>	2021	SR & MA	9 studies	Mixed	Mind-body (mindfulness)	↗ sleep quality
	Zetzi <i>et al.</i>	2021	RCT	173	Mixed	Mind-body (yoga)	↘ CRF, especially physical fatigue.
	Cohen <i>et al.</i>	2021	RCT	40 patients	Breast cancer	Mind-body (technology-based mindfulness + PA vs mindfulness alone vs PA alone)	Higher efficacy of mindfulness + PA to ↘ CRF than mindfulness or PA alone.
	Xunlin <i>et al.</i>	2020	SR & MA	29 studies	Mixed	Mind-body (mindfulness)	↘ CRF
	Park <i>et al.</i>	2020	RCT	74 patients	Breast cancer	Mind-body (mindfulness)	↘ CRF (up to 4-weeks postintervention)
	Zhao <i>et al.</i>	2020	RCT	136 patients	Breast cancer	Mind-body (mindfulness + CBT)	↘ insomnia (up to 6-months postintervention)
	Grégoire <i>et al.</i>	2020	RCT	95 patients	Mixed	Mind-body (self-care + self-hypnosis)	↘ CRF ↘ Sleep disturbances
	In press					Maintenance of these effects 1-year postintervention.	
Mendoza <i>et al.</i>	2017	RCT	44 patients	Mixed	Mind-body (hypnosis + CBT)	↘ CRF ↘ Sleep disturbances (both up to 3-months postintervention)	
Grégoire <i>et al.</i>	2017	CT	123 patients	Breast cancer	Mind-body (self-care + self-hypnosis; yoga) vs psychological (CBT)	Higher efficacy of mind-body intervention to ↘ CRF than yoga and CBT, up to 9-months postintervention.	

CBT, cognitive-behavioral therapy; CRF, cancer-related fatigue; CT, controlled trial; MA, meta-analysis; PA, physical activity; QE, quasi-experimental; RCT, randomized-controlled trial; SR, systematic review.

meta-analysis that underlined that physical activity (e.g., aerobic, resistance training, walking) was effective in improving sleep quality in breast cancer survivors [24]. More specifically, physical activity seemed to have a positive impact on sleep quality, sleep latency, sleep efficiency, and daytime dysfunction. In their study, Rastogi *et al.* [25] also reported that a 12-week intervention combining written physical activity recommendations and a physical activity module was more effective in decreasing sleep impairment in breast and colorectal cancer survivors compared with the group receiving only written exercise recommendations combined with written dietary guidelines and standardized e-mails giving information about healthy eating and stress management. Another recent study on breast cancer survivors [26] investigated the effect of a 12-week intervention including wearing a wrist activity monitor, a single face-to-face training session with a team member to receive behavioural feedback and set goals, and 5 telephone-delivered behavioural counselling sessions. Compared with the control group, the intervention increased the physical activity level of the participants and had a positive impact on sleep disturbances. In view of the studies discussed above, it seems that interventions based on physical activity are an effective therapeutic option to relieve CRF and sleep disturbances in patients with cancer. However, our clinical impression is that a lot of them are interested in more comprehensive interventions, including some kind of psychological work as well.

PSYCHOLOGICAL INTERVENTIONS FOR FATIGUE AND SLEEP DISTURBANCES

Among the various psychological interventions available for patients with cancer, CBT is generally considered to be the gold standard to relieve CRF and sleep disturbances. CBT is a structured psychotherapy, aiming to solve current problems and learn skills to modify dysfunctional thinking and behaviour [27]. Several studies have shown the positive effects of CBT on CRF and sleep disturbances in oncology (see Table 1). For example, in their study, Poort *et al.* [28] investigated the effects of a 12-week individual CBT intervention on CRF in patients with advanced breast, colorectal, or prostate cancer. The intervention was composed of several modules addressing different fatigue-perpetuating behaviours and cognitions. They showed that the intervention allowed a significant short- and medium-term (3 months postintervention) decrease in CRF, compared to an intervention based on supervised physical exercise or usual care. In a recent meta-analysis on women with breast cancer, Ma *et al.*

[29] showed that CBT interventions specifically designed for insomnia (generally composed of information about sleep hygiene, stimulus control strategies, sleep restriction, and cognitive restructuring) are effective in decreasing that symptom and improving sleep quality. These effects seem to persist up to one year after the interventions.

Other psychological interventions exist, such as psychoeducational interventions, where information is given to the patients about their symptoms and ways to manage them, and where their misconceptions are addressed (see Table 1). A recent meta-analysis investigated the benefits of internet-based psychoeducational interventions for patients with different cancers [30]. Results showed that such interventions allowed, among other effects, a decrease of CRF. In 2021, Bandani-Susan *et al.* [31] investigated the effects of a mobile psychoeducational intervention for women with breast cancer. Text messages were sent to them for 7 weeks, providing information about cancer, treatment, CRF, and body image. A decrease of CRF was reported after the intervention, compared to the control group who did not receive any messages. Another study assessed the benefits of a psychoeducational intervention involving tailored information and coaching to improve, among other symptoms, CRF and sleep disturbances of patients with different cancers [32]. Results showed a decrease of these symptoms after the intervention, compared to the control group. To the authors' knowledge, no clinical trial investigating the effects of a psychoeducational intervention on cancer patients' sleep disturbances was published during the last year. The studies described above showed the benefits of various psychological interventions, especially CBT, on CRF and sleep disturbances in oncology. However, multicomponent interventions seem to be a promising therapeutic option as they address both the physical and psychological dimensions of patients' quality of life.

MIND-BODY INTERVENTIONS FOR FATIGUE AND SLEEP DISTURBANCES

As stated above, mind-body interventions are increasingly being developed in oncology settings, with great interest from patients, health professionals, and researchers. Currently, the most studied adjunct interventions in oncology, with the most encouraging results, are yoga, mindfulness, and hypnosis (see Table 1).

First, yoga can be defined as 'a process of uniting the body via mind and spirit to promote physical and mental wellness' [33, p. 1017]. Two recent meta-analyses showed that this intervention (generally

consisting of breathing techniques, yoga postures, and meditation) may allow a decrease of CRF [34²²,35²³] and sleep disturbances [34²²] in cancer patients. The long-term effects of yoga on these symptoms are still to be confirmed [34²²]. In their study, Zetzl *et al.* [36²⁴] showed a small decrease of CRF in patients with different types of cancer after an 8-week yoga intervention (combining yoga postures with awareness, conscious breathing, and deep relaxation), compared to a control group. The physical dimension of fatigue was the most impacted by the intervention, compared with the emotional and cognitive dimensions.

Second, mindfulness involves a deliberate engagement in mindful exercises, which are based on the maintenance of awareness of the present moment, in a nonjudgmental and nonreactive manner [37]. Three recent systematic reviews and meta-analyses showed that various interventions based on mindfulness (e.g., mindfulness-based art therapy, mindfulness-based stress reduction, mindfulness-based cognitive therapy) allowed a reduction of CRF [38²⁵,39²⁶] and sleep disturbances [40²⁷] among patients with different cancers. In their randomized-controlled trial, Park *et al.* [41] showed the benefits of an 8-week mindfulness intervention (combining formal meditation exercises, psychoeducation based on cognitive therapy, and discussion among the participants) on breast cancer patients' CRF when compared to a control group. Mindfulness is often combined with other therapeutic modalities. For example, Cohen *et al.* [42²⁸] combined technology-based mindfulness (using a commercial bio-feedback device) and aerobic exercises in a population of breast cancer survivors. This intervention had a greater positive effect on CRF than the mindfulness or aerobic exercises given alone. In another study, Zhao *et al.* [43] investigated the effects of a multicomponent mindfulness-based group intervention composed of six sessions involving mindfulness meditation techniques, cognitive and behavioural strategies, and stress management. Compared to the control group, this intervention allowed a decrease of insomnia in breast cancer survivors, which lasted up to 6 months after the intervention.

Finally, hypnosis can be defined as 'a state of consciousness involving focused attention and reduced peripheral awareness characterized by an enhanced capacity for response to suggestion' [44, p. 6]. It is also frequently used in combination with other techniques. Very few studies investigating the effects of hypnosis on the quality of life of patients with cancer have been published since the beginning of 2020 and, to the authors' knowledge, none of them focused on CRF or sleep disturbances,

except for one. This study showed the important short- and long-term (1 year after the intervention) benefits of the combination of self-care (an empowerment CBT-based intervention focusing on specific tasks, aiming to retrain the patient to be an actor rather than an observer of their life condition [45]) and self-hypnosis learning targeting CRF and sleep disturbances of a mixed cancer population [46²⁹,47³⁰]. Another older study (2017) from the same team [48] compared the impact of three group interventions on the quality of life of 123 women with breast cancer. Results underlined the greater positive impact of the intervention combining self-care and self-hypnosis learning on CRF, compared to the two other interventions (yoga and CBT). This effect was maintained 9 months after the intervention. Finally, in another study from 2017, Mendoza *et al.* [49] investigated the effects of a combination of hypnosis and CBT (information about patients' symptoms and strategies to cope with them) on CRF and sleep disturbances in 44 patients with different cancers. Positive effects were shown on both symptoms and persisted up to 3 months after the intervention, compared to a control group that only participated in discussions regarding their symptoms.

CONCLUSION

In light of the studies described in this paper, it seems that defining the gold standard to manage CRF and sleep disturbances in patients with cancer is hazardous, especially given the small-to-moderate effect sizes of most existing interventions, and the inconsistent methodological quality of most studies [12¹,40³¹]. In addition, various therapeutic options exist, with positive results on these two symptoms, in which patients can learn techniques to improve their quality of life, in its physical and psychological dimensions, and take back control over their health and their body. Our review showed that multicomponent interventions seem to be particularly effective to improve quality of life. However, it is still unclear why, and which specific component of each intervention is the most useful to do so. It is possible that the multicomponent interventions impact the whole symptom cluster rather than a single symptom, allowing a higher improvement of quality of life. It is also possible that these multicomponent approaches can help each patient with one or two specific symptoms, leading to a general improvement of quality of life when considering the whole study sample. Future research in the field should focus more on the mechanisms of action involved, in order to propose more effective and less time- and money-consuming interventions to patients and

medical staff. However, in accordance with the recommendations of other authors [12[¶]], our opinion is that patients should have the possibility to choose an intervention that is pertinent for them and for which they are motivated. For example, a patient suffering from intense physical fatigue could benefit more from an exercise-based intervention than a patient reporting severe mental fatigue, for whom a psychological or mind-body intervention could be more relevant. It seems that several individual factors should be considered when proposing an intervention to a patient, such as the treatments received, the stage of the disease, and the patient's preference, for example. However, in general, multi-component interventions seem to be particularly effective to improve fatigue and sleep in cancer patients, especially the mind-body ones. Given the variety of interventions described above, and their encouraging results on cancer patients' CRF and sleep, it seems important that further research continues to investigate the effects of such techniques, in order to improve existing interventions in oncology settings. Thus, our team is currently carrying out a new study aiming to compare the effects of three mind-body interventions (hypnosis, mindful self-compassion meditation, and self-induced cognitive trance) on cancer patients' quality of life [50]. It could also be interesting to study the impact of such interventions according to the diagnosis and/or to the treatment received.

SEARCH STRATEGY

As this paper is not a systematic review, no systematic search strategy was used to select the articles discussed. We used PubMed (<https://pubmed.ncbi.nlm.nih.gov/>) with various combinations of the following keywords: cancer, oncology, sleep, sleep difficulties, sleep disturbances, fatigue, exercise, physical activity, mind-body, yoga, meditation, hypnosis, mindfulness, cognitive-behavioural therapy, CBT, psychological intervention, and psychoeducation. We then read the titles of all the articles published in 2020 and 2021, and their abstracts when they seemed relevant to our purpose. We selected the relevant articles to which we had access and read them entirely to see if they would fit our paper. As we had to limit our choice to 50 papers only, we chose as many papers as possible with strong methodologies (randomized controlled trials, meta-analyses, systematic reviews).

Acknowledgements

We want to thank all the patients who participated in the studies.

Financial support and sponsorship

This publication is supported by the CHU of Liège, the University of Liège, the Belgian National Fund for Scientific Research (FRS-FNRS - Télévie), the Belgian Cancer Foundation (2020-118), the Benoit Foundation, and the Léon Fredericq Foundation. C.G. is a postdoctoral researcher at FRS-FNRS. O.G. is research associate at FRS-FNRS.

Conflicts of interest

G.J. reports grants, personal fees and nonfinancial support from Novartis, grants, personal fees and nonfinancial support from Roche, grants, personal fees and nonfinancial support from Pfizer, personal fees and nonfinancial support from Lilly, personal fees and nonfinancial support from Amgen, personal fees and nonfinancial support from BMS, personal fees and nonfinancial support from Astra-Zeneca, personal fees from Daiichi Sankyo, personal fees from Abbvie, nonfinancial support from Medimmune, nonfinancial support from MerckKGaA, outside the submitted work. Other authors declare they have no conflicts of interest.

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- of special interest
- of outstanding interest

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7. Gonzalez BD, Eisel SL, Qin B, et al. Prevalence, risk factors, and trajectories of sleep disturbance in a cohort of African-American breast cancer survivors. *Support Care Cancer* 2021; 29:2761–2770.

This study focused on the trajectories of sleep disturbances during the cancer journey, on a large sample (n = 637) of breast cancer survivors (not treated for sleep disturbances). Sleep disturbances were clinically significant before diagnosis, as well as 10- and 24-months postdiagnosis. This confirms the fact that sleep disturbances do not end with treatment completion and can persist for years after diagnosis.

8. Hoang HTX, Molassiotis A, Chan CW, et al. New-onset insomnia among cancer patients undergoing chemotherapy: prevalence, risk factors, and its correlation with other symptoms. *Sleep Breath* 2020; 24:241–251.

This study showed a prevalence rate of insomnia of 42.8% (in 213 patients), which is similar to that of other studies. This study also confirmed that emotional distress is a risk factor for insomnia. Insomnia, depression, and anxiety were also shown to form a symptom cluster, which is in line with older studies showing the links between these symptoms and their concomitant presence among cancer patients.

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This manuscript reviewed the available nonpharmacological therapeutic options to manage insomnia in breast cancer. It confirmed the benefits of CBT, especially if designed specifically for insomnia (CBT-I), yoga, and other mind-body interventions. It also identified the lack of routine assessment of insomnia.

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This manuscript reviewed the available therapeutic options to manage CRF. It asserted that defining a gold standard for the treatment of this symptom remains elusive, as most studies showed, at most, moderate effects of interventions. It recommended that interventions be proposed based on the patients' needs.

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This recent study investigated the presence of symptom clusters in survivors of 7 different cancers (colorectal, breast, ovarian, thyroid, chronic lymphocytic leukemia, Hodgkin's lymphoma, non-Hodgkin's lymphoma, N = 1330). It confirmed the cluster of fatigue, insomnia, and depression, and its consistent association with pain and cognitive symptoms. Interestingly, this study also suggested a mutual reinforcement of these symptoms, and the centrality of fatigue in the cluster, among different cancer types and treatment regimens. This led to important suggestions for future research and clinical applications.

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This study showed a longitudinal association between light-intensity physical activity and less CRF over time, in 325 colorectal cancer survivors. This association persisted up to two years after cancer treatments, suggesting the long-term effects of interventions based on physical activity on CRF.

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This systematic review was based on 34 studies. It showed that women with ovarian cancer who had a higher level of physical activity also had lower CRF. This paper confirmed the relevance and feasibility of interventions based on physical activity for women with ovarian cancer.

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This systematic review and meta-analysis included 10 studies focusing on different cancer populations (breast, prostate, colorectal, and 'various' (unspecified) according to the studies). It showed the positive effects of physical exercise interventions on CRF across all populations and suggested a higher effect of such interventions on women with breast cancer and men with prostate cancer, during or after treatment. This is particularly interesting as few studies have assessed the difference in the efficacy of interventions according to the diagnosis or treatment status.

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23. Mostafaei F, Azizi M, Jalali A, *et al*. Effect of exercise on depression and fatigue in breast cancer women undergoing chemotherapy: a randomized controlled trial. *Heliyon* 2021; 7:e07657.
24. Yang H, Yang Z, Pan H, Zhou Q. Effects of physical activity on sleep problems in breast cancer survivors: a meta-analysis. *Support Care Cancer* 2021; 29:4023–4032.

This recent meta-analysis of 6 randomized controlled trials showed that interventions based on physical activity (e.g., aerobic, resistance training, walking, or a combination of the above) are effective in improving sleep quality in breast cancer survivors.

25. Rastogi S, Tevaarwerk AJ, Sesto M, *et al*. Effect of a technology-supported physical activity intervention on health-related quality of life, sleep, and processes of behavior change in cancer survivors: A randomized controlled trial. *Psycho-Oncology* 2020; 29:1917–1926.

This study showed a decrease of sleep disturbances in 45 breast and 5 colorectal cancer survivors after a 12-week intervention combining a survivorship care plan and a multicomponent physical activity module, including a Fitbit tracker and E-Mail feedback, in comparison with a control group (survivorship care plan only). Technology-supported physical activity is starting to be investigated in oncology and this recent study confirms its interest and relevance.

26. Nguyen NH, Vallance JK, Buman MP, *et al*. Effects of a wearable technology-based physical activity intervention on sleep quality in breast cancer survivors: The ACTIVE Trial. *J Cancer Surviv* 2021; 15:273–280.

This randomized controlled trial showed the benefit of a technology-supported physical activity intervention to improve sleep in 83 breast cancer survivors. Participants had to wear a wrist actigraph, which was used to measure sleep disturbances as well as to give feedback to the participants about their physical activity. This study suggested that wearable technologies are a promising therapeutic option in oncology.

27. Beck Institute for Cognitive Behavior Therapy. What is cognitive behavior therapy (CBT)? 2016. <https://www.beckinstitute.org/get-informed/what-is-cognitive-therapy/>. Accessed 26 June 2017.

28. Poort H, Peters MEWJ, van der Graaf WTA, *et al*. Cognitive behavioral therapy or graded exercise therapy compared with usual care for severe fatigue in patients with advanced cancer during treatment: a randomized controlled trial. *Ann Oncol* 2020; 31:115–122.

29. Ma Y, Hall DL, Ngo LH, *et al*. Efficacy of cognitive behavioral therapy for insomnia in breast cancer: a meta-analysis. *Sleep Med Rev* 2021; 55:101376.

This meta-analysis included 14 randomized controlled trials and investigated the effect of CBT interventions specifically designed to address insomnia in oncology (CBT-I). CBT is often recognized as the gold standard treatment to address insomnia, but there is a lack of consensus regarding its content. This study described the most common components of these interventions and confirmed their medium-to-large effects on insomnia and sleep quality. It also underlined that these effects persisted up to one year after the end of the intervention, which is particularly relevant in oncology where adverse effects of treatments often last for years.

30. Wang Y, Lin Y, Chen J, *et al*. Effects of Internet-based psycho-educational interventions on mental health and quality of life among cancer patients: a systematic review and meta-analysis. *Support Care Cancer* 2020; 28:2541–2552.

This manuscript analysed 7 randomized controlled trials that proposed various Internet-based psychoeducational interventions (i.e., website programs, e-mail counselling, or a psychoeducational session). The authors concluded that these interventions may be effective to decrease CRF in patients with different cancers, and could be used to complement usual care. This is the first review to assess the effect of such Internet-based interventions on cancer patients' CRF.

31. Bandani-Susan B, Montazeri A, Haghighizadeh MH, Araban M. The effect of mobile health educational intervention on body image and fatigue in breast cancer survivors: a randomized controlled trial. *Ir J Med Sci* 2021.

32. Nguyen LT, Alexander K, Yates P. Psychoeducational intervention for symptom management of fatigue, pain, and sleep disturbance cluster among cancer patients: a pilot quasi-experimental study. *J Pain Symptom Manag* 2018; 55:1459–1472.

33. Bridges L, Sharma M. The efficacy of yoga as a form of treatment for depression. *J Evid Based Complement Altern Med* 2017; 22:1017–1028.

34. Yi L-J, Tian X, Jin Y-F, *et al*. Effects of yoga on health-related quality, physical health and psychological health in women with breast cancer receiving chemotherapy: a systematic review and meta-analysis. *Ann Palliat Med* 2021; 10:1961–1975.

This systematic review and meta-analysis included 7 randomized controlled trials and focused on women with breast cancer during their chemotherapy. It showed that various interventions based on yoga allowed short-term improvements in fatigue and sleep disturbances but failed to show a medium- or long-term maintenance of these effects, highlighting the need for future research to continue assessing the long-term effects of such interventions.

35. Song J, Wang T, Wang Y, *et al*. The effectiveness of yoga on cancer-related fatigue: a systematic review and meta-analysis. *Oncol Nurs Forum* 2021; 48:207–228.

This systematic review and meta-analysis included 16 randomized controlled trials and showed positive effects of interventions based on yoga on CRF in patients undergoing chemotherapy or radiation therapy. This article suggested that interventions combining mixed types of yoga with supervised and self-practicing strategies increased patient adherence and the impact on CRF. This is in line with other studies showing the interest of multicomponent interventions.

36. Zetl T, Renner A, Pittig A, *et al*. Yoga effectively reduces fatigue and symptoms of depression in patients with different types of cancer. *Support Care Cancer* 2021; 29:2973–2982.

This randomized controlled trial (N = 173) showed the efficacy of an intervention based on yoga to decrease CRF in patients with different cancer diagnoses.

Interestingly, this article distinguished the different dimensions of fatigue, and physical fatigue was the most impacted by the intervention. It also suggested that the benefits of the intervention were higher for women with breast cancer than with other types of cancer, which is rarely assessed in oncology studies.

37. Carpenter JK, Conroy K, Gomez AF, *et al.* The relationship between trait mindfulness and affective symptoms: a meta-analysis of the Five Facet Mindfulness Questionnaire (FFMQ). *Clin Psychol Rev* 2019; 74:101785.

38. Johns SA, Tarver WL, Secinti E, *et al.* Effects of mindfulness-based interventions on fatigue in cancer survivors: a systematic review and meta-analysis of randomized controlled trials. *Crit Rev Oncol Hematol* 2021; 160:103290.

This recent systematic review and meta-analysis included 23 studies on different cancer populations, and showed the positive impact of various mindfulness-based interventions on CRF, with large effect size. This positive impact was maintained at the first follow-up (varying between 0.9- and 6-months postintervention, depending on the studies).

39. Xunlin NG, Lau Y, Klainin-Yobas P. The effectiveness of mindfulness-based interventions among cancer patients and survivors: a systematic review and meta-analysis. *Support Care Cancer* 2020; 28:1563–1578.

This systematic review and meta-analysis included 29 studies on different cancer populations. It showed that mindfulness-based interventions, especially mindfulness-based art therapy, were effective in decreasing CRF in patients with different cancer types.

40. Suh H-W, Jeong HY, Hong S, *et al.* The mindfulness-based stress reduction program for improving sleep quality in cancer survivors: a systematic review and meta-analysis. *Complement Ther Med* 2021; 57:102667.

This systematic review and meta-analysis included 9 randomized controlled trials focusing on the impact of mindfulness-based interventions on sleep disturbances in oncology. Results suggested that these interventions can help to decrease sleep disturbances in cancer survivors. The manuscript underlined the inconsistent methodological quality of the studies included, calling for other high methodological quality studies to confirm the results.

41. Park S, Sato Y, Takita Y, *et al.* Mindfulness-based cognitive therapy for psychological distress, fear of cancer recurrence, fatigue, spiritual well being, and quality of life in patients with breast cancer: A randomized controlled trial. *J Pain Symptom Manag* 2020; 60:381–389.

42. Cohen J, Rogers WA, Petruzzello S, *et al.* Acute effects of aerobic exercise and relaxation training on fatigue in breast cancer survivors: a feasibility trial. *Psycho-Oncology* 2021; 30:252–259.

This randomized-controlled trial (N = 40) assessed the feasibility and effects of an intervention combining physical exercise and technology-guided mindfulness training on CRF, in comparison with physical exercise only and relaxation only. More favourable evaluations from the participants were reported for the multi-component intervention, as well as a higher decrease of CRF. This study underlined the relevance of multicomponent and technology-supported inter-

ventions, as well as their acceptability and feasibility among breast cancer survivors.

43. Zhao Y, Liu J-E, Lewis FM, *et al.* Effects of mindfulness-based cognitive therapy on breast cancer survivors with insomnia: A randomised controlled trial. *Eur J Cancer Care* 2020; 29:e13259.

44. Elkins GR, Barabasz AF, Council JR, Spiegel D. Advancing research and practice: the revised APA Division 30 definition of hypnosis. *Int J Clin Exp Hypn* 2015; 63:1–9.

45. Bicego A, Monseur J, Collinet A, *et al.* Complementary treatment comparison for chronic pain management: a randomized longitudinal study. *PLoS One* 2021; 16:e0256001.

46. Grégoire C, Faymonville M-E, Vanhauzenhuysse A, *et al.* Effects of an intervention combining self-care and self-hypnosis on fatigue and associated symptoms in posttreatment cancer patients: a randomized-controlled trial. *Psycho-Oncology* 2020; 29:1165–1173.

This randomized controlled trial (N = 95) attested the benefits of a group intervention combining self-care and self-hypnosis on CRF and sleep disturbances in a mixed cancer population. Few recent studies have investigated the effects of hypnosis on CRF and sleep, except for this one.

47. Grégoire C, Faymonville M-E, Vanhauzenhuysse A, *et al.* Randomized-controlled trial of an intervention combining self-care and self-hypnosis on fatigue, sleep and emotional distress in post-treatment cancer patients: 1-year follow up. *Int J Clin Exp Hyp* 2022; 70:136–155.

This paper (accepted, not yet published) follows the previous one: it assessed the long-term effects of a group intervention combining self-care and self-hypnosis on patients' CRF and sleep difficulties. This is particularly relevant as long-term effects of mind-body interventions, especially hypnosis, are not routinely assessed in oncology studies. The study suggested long-term effects of the intervention, but further research is needed to confirm these results.

48. Grégoire C, Bragard I, Jerusalem G, *et al.* Group interventions to reduce emotional distress and fatigue in breast cancer patients: a 9-month follow-up pragmatic trial. *Brit J Cancer* 2017; 117:1442–1449.

49. Mendoza ME, Capafons A, Gralow JR, *et al.* Randomized controlled trial of the Valencia model of waking hypnosis plus CBT for pain, fatigue, and sleep management in patients with cancer and cancer survivors: Valencia model of waking hypnosis for managing cancer-related symptoms. *Psycho-Oncology* 2017; 26:1832–1838.

50. Grégoire C, Marie N, Sombrun C, *et al.* Hypnosis, meditation and self-induced cognitive trance to improve posttreatment oncological patients' quality of life: study protocol. *Front Psychol* 2022; 13:807741.