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The effect of psychologically informed practice with behavioural graded activity in cancer survivors: systematic review and meta-analysis

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Abstract

Purpose This systematic review and meta-analysis aimed to determine the effectiveness of psychologically informed practice (PIP) with behavioural graded activity (BGA) compared to (1) waitlist controls (WLC), (2) other interventions (OI), (3) PIP alone or (4) BGA alone in cancer patients and survivors (CPaS).

Methods PubMed, Web of Science and Embase were screened for randomised controlled trials encompassing BGA + PIP in CPaS. Effect sizes were inventoried for outcomes regarding physical activity (PA), quality of life (QoL) and debilitating symptoms (DS), which were assessed at four time points: post-intervention (PI), follow-up F1 (1 to 3 months), F2 (4 to 6 months) and F3 (> 6 months). The quality of the evidence was classified by the GRADE approach.

Results Thirty-three studies were found eligible, comprising 4330 participants. Significant effects with low heterogeneity of PIP + BGA comparing to WLC were found for anxiety (SMD − 1.29 [− 1.71; − 0.86]), depression (SMD − 0.79 [− 1.10; − 0.48]), functional impairment (SMD − 0.72 [− 0.95; − 0.50]), PA (self-reported: (SMD − 0.58 [− 0.84; − 0.32]) and objectively measured: (SMD − 0.51 [− 0.90; − 0.13])) and social impairment (SMD − 0.33 [− 0.58; − 0.08]). When comparing PIP + BGA to OI, fatigue (SMD − 0.35 [− 0.51; − 0.20]) and PA (SMD − 0.26 [− 0.41; − 0.11]) at PI, and fatigue (SMD − 0.34 [− 0.58; − 0.10]) at F1 were found significant with low heterogeneity. No significant effects were observed in the meta-analyses of studies comparing PIP + BGA to BGA or PIP alone.

Conclusions PIP with BGA has a favourable effect on DS, PA and QoL in CPaS when compared to non-behavioural interventions such as WLC, usual care and education. However, further research is needed on 'how' and 'when' PIP + BGA should be provided in cancer rehabilitation.

Implications for Cancer Survivors PIP + BGA has the potential to facilitate CPaS to reach the recommended amount of PA and reduce DS.

Keywords Adverse effects · Behaviour therapy · Exercise · Meta-analysis · Neoplasms · Quality of life

Introduction

Cancer is one of the most prevalent diseases in the world, with a burden estimated to have risen to 19.3 million new cases and 9.9 million deaths in 2020 [1]. For the most frequent occurring cancers, the 5-year survival has increased to 70% in most developed countries [2]. However, many cancer patients will experience a range of side effects and treatment-related problems that arise during and after treatment. During the treatment phase, most cancer patients will face adverse effects [3]. After completion of cancer treatments, sequelae can be long term or latent [4], with pain, fatigue, anxiety, depression and sleep disturbances being the most commonly occurring [3]. The highly debilitating nature of these not only result in significant limitations in cognitive functioning, psychosocial functioning and physical activity levels, but also in a reduced health-related quality of life (HRQoL) [3, 5, 6].

The past decades have demonstrated that physical exercise programmes during and after cancer treatment have favourable effects on cancer recurrence, survival rate, pain, daily functioning and global health [7, 8]. A recently published Cochrane review reported that exercise programmes, including

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goal setting, graded activity and guidance of how to perform behaviour, facilitates patients with and beyond cancer to reach and maintain the recommended amount of daily activity [9]. Behavioural graded activity (BGA) is a treatment based on operant conditioning, targeting patient's reported difficulties and chief complaints during participation in meaningful activities of daily living. This patient-tailored programme is based on an operant behavioural paradigm and teaches patients, after establishing a baseline tolerance level, how to gradually increase their meaningful activities in their daily life on a safe and time-contingent manner [10]. Considering this, BGA could enhance patients' willingness to maintain a healthy behaviour compared to other provided interventions [9].

Up until now, BGA has been investigated mainly in non-malignant chronic pain populations and demonstrated, for instance, positive effects on pain, debilitating symptoms and physical functioning [10–12]. However, BGA often occurs in a variety of behavioural therapies such as cognitive behavioural therapy (CBT), acceptance and commitment therapy (ACT) and other psychological programmes [13], which all fall under the denominator of psychologically informed practice (PIP) [14]. Graded activity appears foremost in CBT, which has demonstrated its positive effects on psychosocial functioning such as fatigue, depression, anxiety and HRQoL in cancer patients and survivors (CPaS) [15–18]. Other studies also demonstrated the benefit of the combination of CBT with physical exercise (PE) [17, 19].

The importance of determining the added value of PIP with BGA in cancer rehabilitation has been shown, as clinical guidelines recommend behavioural therapy or CBT and exercise [20, 21] with an individual approach based on functional needs, however without specific instructions for different symptoms. For this void, PIP and BGA can provide an evidence-based approach for different biopsychosocial symptoms within the cancer population.

However, so far, no systematic review has been published about the effect of PIP and BGA on different psychosocial symptoms, HRQoL and physical activity within cancer populations.

Therefore, the aim of this meta-analysis was to determine if PIP with BGA is more effective than (1) waitlist controls (WLC) or (2) other interventions in CPaS, on debilitating sequelae, HRQoL and physical activity level, and to evaluate the added value of BGA by comparing PIP with BGA to (3) PIP or (4) BGA alone.

Methods

Design

This systematic review and meta-analysis was completed following the PRISMA guidelines [22]. It was registered in Prospero under following number of classification: CRD42020190333.

Eligibility criteria

To be included, studies had to meet the following criteria: (1) Subjects of the experimental and control group needed to be identified as CPaS (cancer patients are individuals, who are diagnosed with cancer and currently receiving treatment with curative intent, and cancer survivors are individuals who have completed their primary cancer treatment (with the exception of maintenance therapy) and have no evidence of active disease [23]), and needed to be adults (18 years or older); (2) The intervention comprised of, or included BGA, in which goal-setting, time-contingent increase, patient and self-monitoring were indispensable components; (3) All types of control interventions were allowed; (4) Our main outcomes were debilitating (cancer-related) symptoms (such as anxiety, depression, fatigue, pain, insomnia/sleep, psychological distress and social impairment), HRQoL and physical activity level; (5) The design of the studies had to be randomised controlled trials (RCTs); (6) Studies needed to be written in English; and (7) Studies needed to be published past January 2000.

The next criteria were applied for exclusion: (1) Studies using healthy controls or patients with other diseases; (2) Studies with interventions that did not include BGA (e.g. interventions solely based on psychological aspects or without any active component, or studies with active components but without any behavioural aspects); (3) Studies with the following study design: literature reviews, cross-sectional studies, cohort studies, case reports, pilot studies, protocols, congress abstracts and letters.

Information sources

Articles regarding BGA in the cancer population were retrieved in PubMed, Web of Science and Embase based on the PICO acronym (population: CPaS; intervention: BGA (graded activity, graded exercise, operant conditioning, etc.) and PIP (ACT, behaviour strategies, cognition therapy, CBT, etc.)) with a filter on publication date (2000/01/01 to 2021/05/01). An overview of the applied search terms and their combinations can be found in Appendix Table 5.

Study selection

After removing duplicates, two reviewers (A.L. and I.R.) independently (i.e. blinded from each other) screened all the titles and abstracts for eligibility in a blinded standardised manner using the Rayyan software [24]. All divergences between the two reviewers were resolved by a third researcher (L.L.). Subsequently, two reviewers (A.L. and I.R.) screened the included abstracts on full-text, and any divergences were again resolved by a third researcher (L.L.). Additional studies were searched

independently by two researchers (A.L. and I.R.) via reverse citation and screening reference lists of included studies.

Data collection process

The data extraction file was created and based on the template of the data collection form provided by the Cochrane Collaboration [25], found in Appendix Table 7. For each study, sample size (*N*), age, intervention and control intervention (content and format), outcomes and outcome measurement, and effect size (95% CI) were put in the extraction file. When data were missing (i.e. standard deviation, mean or effect size), the author of the paper in question was contacted for more information. Two researchers (A.L. and I.R.) performed the data extraction independently, which was double-checked by a third researcher (L.L.) in case of divergences.

Quality assessment

The methodological quality was assessed by two researchers (A.L. and I.R.) independently using RoB 2: A revised Cochrane risk-of-bias tool for randomised trials. Judgement can be 'Low' or 'High' risk of bias or can express 'Some concerns' [26].

Besides that, a checklist was developed to assess the therapeutic validity of the studies, i.e. the requirements for BGA, which was subsequently checked and approved by an expert in the field (P.v.W). When the BGA-intervention of the included studies did not address a certain item, it was scored 0. A study was categorised as good if the following four criteria were present: the goal of the intervention is to improve function, the intervention uses goal-setting, the physical exercise is preceded by an educational session and the intervention is patient-tailored and time-contingent. Appendix Table 8 presents an overview of the BGA checklist.

For assessments of the overall quality of evidence for each outcome that included pooled data from RCTs only, the evidence was downgraded from 'high quality' by one level for serious: risk of bias, indirectness of evidence, inconsistency, imprecision of effect estimates or potential publication bias, as presented in the GRADE approach [27].

Summary measures

The primary outcome measure was the standardised mean difference (SMD) with 95% confidence intervals (CIs) for all outcomes of interest. If the SMD with 95% CIs was not reported, the mean difference, the mean change or the mean with their standard deviations or standard error were extracted in order to calculate the SMD for each outcome separately by using the Revman software (Review Manager 5.3.) and other calculators described in the Cochrane handbook [28].

Planned methods of analysis

Based on the intervention given to the control group, included studies were divided in four different categories: PIP with BGA versus WLC, PIP with BGA versus PIP, PIP with BGA versus BGA and PIP with BGA versus others. PIP incorporated interventions such as CBT, ACT and other psychological programmes. BGA was defined as a behavioural intervention with goal-setting, a gradual increase of activities and self-monitoring. WLC represented the no-intervention groups. Other intervention was defined as either usual care, physical activity as seen in a booklet, standard recommendation or education by itself. Comparing PIP with BGA to homogenous comparable interventions makes it easier to evaluate the added value of PIP with BGA, PIP alone and BGA alone.

A meta-analysis was performed for outcomes described in 2 or more studies. When different studies with identical participants had multiple outcomes, the most common and validated outcome was preferred. The method proposed by Higgins et al. was used for the assessment of the heterogeneity (I^2), in which the I^2 value represents the percentage of variability in effect estimates that can be attributed to heterogeneity rather than sampling error [28]. If I^2 was higher than 50%, subgroup analyses were performed based on the methodological quality of studies, evaluated by the ROB 2, and the quality of the given BGA intervention, which had to meet the four most valuable BGA items of the checklist. Both subgroup analyses were performed to possibly clarify the underlying systematic differences and avoid under- or overestimation of the effects. Sensitivity analyses were performed based on the population to evaluate the robustness of the effect. Results were described using SMD, for which a negative SMD indicated the degree to which the intervention (PIP with BGA) was more efficacious than the comparator [29].

In order to perform meta-analyses based on time of assessment, four different groups were formed: one post-intervention group and three follow-up groups. Follow-up F1 encompassed values from 1 to 3 months post-intervention, F2 from 4 to 6 months and F3 from more than 6 months after intervention.

Results

Study selection

The systematic search resulted in a total of 6733 articles, of which 33 articles (4330 participants) were included in this systematic review (Fig. 1) [30–62].

Study characteristics

All included studies were RCTs, with sample sizes ranging from 37 to 422 participants. All studies, except for one

[62], were conducted in high-income countries. Twenty-one of our studies investigated cancer survivors [30, 34, 36–39, 41, 43, 45–51, 53–57, 59] and the other twelve focused on cancer patients [31–33, 35, 40, 42, 44, 52, 53, 58, 61, 62]. Breast cancer was the most explored cancer, with nine studies on this condition [34, 36, 37, 43, 44, 50, 51, 56, 62], two studies referred to ovarian cancer [58, 61] and two to prostate cancer [33, 49]. The remaining 20 studies included all cancer types [30–32, 35, 38–42, 45–48, 52–55, 57, 59, 60].

Twelve studies were categorised in PIP with BGA versus WLC [30, 34, 36, 38, 39, 41, 43, 45, 53, 57, 59, 60], seven in PIP with BGA versus BGA [36, 40, 45–48, 57], six in PIP with BGA versus PIP [35, 36, 41, 44, 55, 59] and 18 in PIP with BGA in comparison to other interventions (e.g. usual care [31–33, 35, 37, 40, 50, 52, 58, 61], education [33, 42, 51, 54, 62] or physical activity [49, 52, 56]).

The length of the provided intervention varied from 1 [37, 49, 61] to 6 months [30–33, 38–40, 60]. The length of the follow-up assessments ranged from 10 weeks [60] to 2 years [32].

Twenty studies described self-reported physical activity [31, 33–37, 40, 43–45, 47–52, 54–57], 18 reported on fatigue [30, 31, 34, 37, 38, 40, 47, 49–58, 61], 17 on psychological distress [30, 32–38, 44, 45, 47, 49, 50, 54, 55, 57, 59], 14 on HRQoL [30, 33, 34, 36, 37, 42, 44, 45, 47, 52, 55, 56, 60, 61], 13 on depression [32–34, 37, 41, 42, 44, 46, 58–62], eleven on anxiety [32, 33, 37, 41, 42, 44, 46, 59–62], eleven on functioning [30, 33, 34, 36, 38, 42, 44, 45, 47, 52, 53, 55, 61], nine on objectively measured physical activity [33, 34, 37, 40, 48, 50, 53, 55, 56], eight on social impairments [33, 34, 41, 44–47, 54, 55, 59], five on pain [33, 35, 36, 44, 45], five on sleep/insomnia [35, 54, 55, 58, 61] and three on cognitive functioning [39, 47, 55]. In several articles, the absence of effect sizes and mean changes entailed contacting the authors [30–38, 40–46, 48, 49, 51–58]. Some authors did not reply and therefore were excluded [35] from the meta-analysis when SMD could not be calculated by formula provided by Cochrane handbook [28].

Quality assessment within studies

The risk of bias within studies can be found in Appendix Table 6. When studies had multiple arms, all the control groups were scored on risk of bias for each extracted outcome. All studies had a high risk of bias except for two [40, 48]. One study had a low risk of bias [48], and the other one had some concerns [40], both for the outcome of physical activity measured objectively.

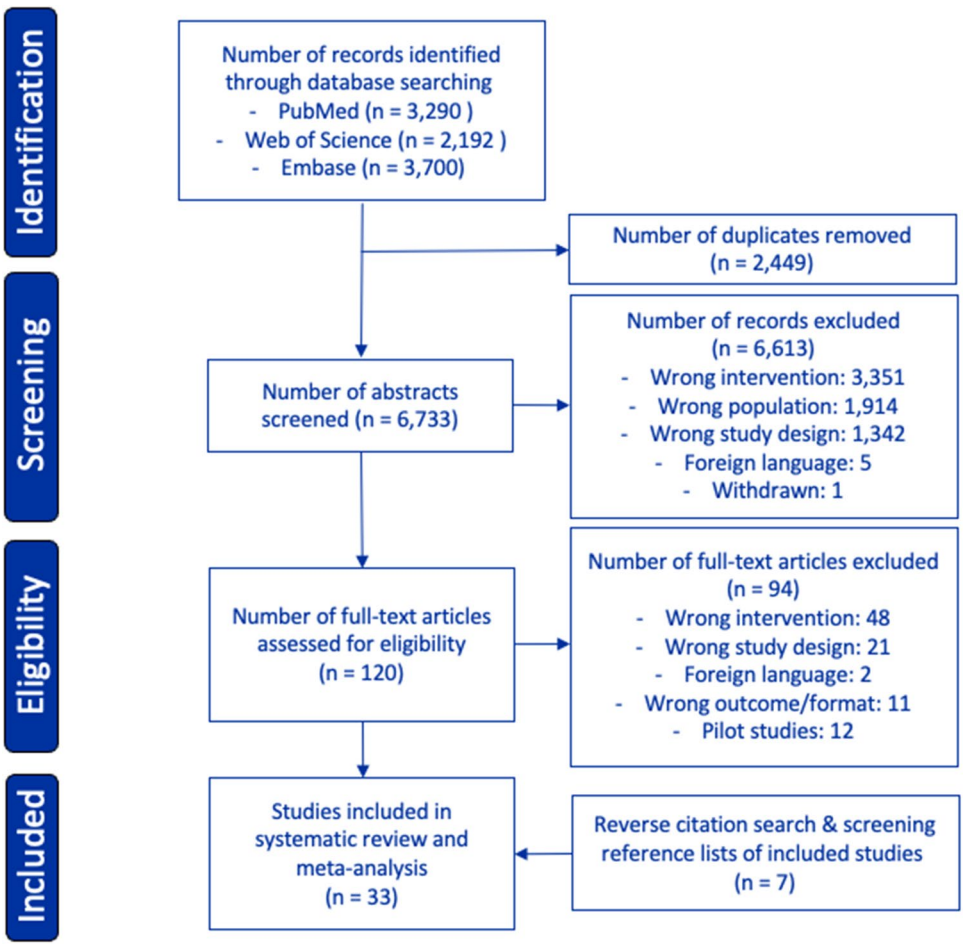


Fig. 1 Flowchart of the study selection process

A mean score of 6 out of 9 was found for the BGA checklist amongst studies, with 14 studies [31, 33, 37, 52–58] having the four most valuable BGA items present in the intervention given. An overview can be found in Table 1.

Synthesis of the results

This synthesis will discuss the significant meta-analyses of the different control interventions concerning the following outcome categories: debilitating symptoms, HRQoL and physical activity. The results of all meta-analyses are summarised in Table 2 and the effect size of single studies in Appendix Tables 9, 10, 11 and 12. An overview of the subgroup and sensitivity analyses can be found in Tables 3 and 4. For each control group, a summarizing GRADE table can be found in Appendix Table 13.

Debilitating (cancer-related) symptoms

Pain Pain demonstrated nonsignificant effect sizes (Table 2). No subgroup analysis could be performed and sensitivity analysis remained nonsignificant.

Fatigue

PIP + BGA versus WLC

PIP with BGA showed a significant decrease of fatigue (SMD = −0.86 [−1.18; −0.54]), with substantial heterogeneity in cancer survivors (I^2 = 61%) [30, 34, 38, 53, 57]. Subgroup analysis did not reduce the heterogeneity and sensitivity analysis could not be performed.

PIP with BGA versus others

The pooled analysis demonstrated that PIP with BGA significantly decreases fatigue (SMD = −0.35 [−0.51; −0.20]) with moderate heterogeneity (I^2 = 48%) [31, 37, 40, 49–52, 54, 56, 58, 61]. For follow-up F1, similar outcomes were found (SMD = −0.34 [−0.58; −0.10], I^2 = 47%) [31, 37, 51, 52, 54, 58]. For follow-up F2, the significant effect could not be preserved (Table 2) [31, 52]. No subgroup analysis could be performed. Sensitivity analysis based on populations remained robust (Table 4).

Anxiety

PIP + BGA versus WLC

PIP with BGA demonstrated a significant decrease in anxiety (SMD = −1.29 [−1.71; −0.86]; I^2 = 0%) [41, 60].

PIP with BGA versus others

Similar results were observed for post-intervention and follow-up F1, with considerable heterogeneity, respectively in cancer patients (SMD = −0.47 [−0.88; −0.06]; I^2 = 83%) [32, 33, 42, 62, 63] and (SMD = −1.54 [−2.88; −0.21]; I^2 = 87%) [61, 62]. For follow-up F2, an insignificant and homogeneous effect was found (Table 2) [32, 33]. Subgroup analysis could not reduce the high heterogeneity and sensitivity analyses based on population were not possible.

Depression

PIP + BGA versus WLC

Pooled analysis demonstrated that depression significantly decreased post-intervention (SMD = −0.79 [−1.10; −0.48]; I^2 = 0%) [34, 41, 60]. Sensitivity analysis remained robust (Table 4).

PIP + BGA versus others

The pooled post-intervention effect was in favour of PIP with BGA (SMD = −0.46 [−0.84; −0.09]), with considerable heterogeneity (I^2 = 82%) [32, 33, 42, 58, 61, 62]. In the follow-up F1, a larger effect was found (SMD = −1.43 [−2.46; −0.39]; I^2 = 89%) [58, 61, 62]. For follow-up F2, an insignificant and homogeneous effect was found [32, 33]. Subgroup analysis did not reduce the heterogeneity (Table 3) and sensitivity analysis based on population was not possible (Table 4).

Insomnia/sleep

PIP + BGA versus others

The post-intervention pooled effect was not significant and heterogeneous (Table 2) [54, 58, 61]. Subgroup analysis reduced the heterogeneity and the effect remained insignificant (Table 3) [54, 58]. Sensitivity analysis remained nonsignificant (Table 4).

Psychological distress

PIP + BGA versus WLC

The pooled analysis demonstrated that PIP including BGA decreases psychological distress (SMD = −0.58 [−0.82; −0.34]), with substantial heterogeneity (I^2 = 51%) [30, 34, 36, 38, 41, 45]. In the follow-up F1, a similar result was found (SMD = −0.89 [−1.76; −0.02]), with high heterogeneity (I^2 = 82%) [36, 59]. The high heterogeneity could be reduced for the low quality of given BGA (SMD = −0.67 [−0.90; −0.44], I^2 = 27%), and sensitivity analysis was not possible.

Table 1 BGA checklist

Articles	BGA checklist									
	Goal improving function	Healthcare worker with training	Pacing	Goal setting	Baseline values	Educational intervention	Individual adapted and time contingent	Support and reinforcement	Integrate daily life	Total BGA (out of 9)
Abrahams et al., 2017 [30]	**1**	1	1	**1**	1	*	**1**	1	1	8
Armes et al., 2007 [31]	**1**	1	1	**1**	*	**1**	**1**	1	*	7
Arving et al., 2019 [32]	**0**	1	*	**1**	*	**1**	**1**	1	1	6
Carmack Taylor et al., 2006 [33]	**1**	1	1	**1**	1	**1**	**1**	1	1	9
Daley et al., 2007 [34]	**1**	0	0	**1**	1	*	**1**	1	1	6
Dalton et al., 2004 [35]	**0**	1	*	**0**	1	*	**0**	1	*	3
Duijts et al., 2012 [36]	**0**	1	0	**0**	1	*	**0**	1	1	4
Fernandez-Rodriguez et al., 2020 [59]	**1**	1	0	*	1	*	**1**	1	*	5
Fillion et al., 2008 [37]	**1**	1	0	**1**	1	**1**	**1**	1	*	7
Gielissen et al., 2006 [38]	**1**	1	1	**1**	1	*	**1**	1	1	8
Goedendorp et al., 2010 [40]	**1**	1	1	**0**	1	**1**	**1**	1	*	7
Goedendorp et al., 2014 [39]	**1**	1	1	**1**	1	*	**1**	1	1	8
Gonzalez-Fernandez et al., 2018 [41]	**1**	1	0	*	1	*	**1**	1	*	5
Greer et al., 2019 [42]	**1**	1	1	**1**	1	**0**	**1**	0	1	7
Ham et al., 2019 [60]	**0**	0	0	**1**	*	*	*	1	*	2
Hatchett et al., 2013 [43]	**1**	1	0	**1**	1	*	**0**	1	*	5
Hopko et al., 2011 [44]	**0**	1	1	**1**	1	**0**	**1**	*	1	6
Korstjens et al., 2008 [45]	**1**	0	1	**1**	1	**1**	**1**	1	*	6
Korstjens et al., 2011 [46]	**1**	0	1	**1**	1	**1**	**1**	1	*	6
May et al., 2008 [48]	**1**	0	1	**1**	1	**1**	**1**	1	*	6
May et al., 2009 [47]	**1**	0	1	**1**	1	**1**	**1**	1	*	6
McGowan et al., 2013 [49]	**1**	1	1	**0**	1	**1**	*	1	*	6
Onyedibe et al., 2020 [62]	**0**	1	1	**1**	*	*	*	1	*	4
Pinto et al., 2005 [50]	**1**	*	*	**0**	1	**1**	**1**	1	1	6
Pinto et al., 2013 [51]	**1**	*	*	**0**	1	**1**	**1**	1	1	6
Poort et al., 2020 [52]	**1**	1	0	**1**	1	**1**	**1**	1	*	7
Prinsen et al., 2013 [53]	**1**	*	1	**1**	1	**1**	**1**	*	1	7
Sandler et al., 2017 [54]	**1**	*	1	**1**	1	**1**	**1**	1	*	7
Sheehan et al., 2020 [55]	**1**	*	1	**1**	1	**1**	**1**	1	*	7
Vallance et al., 2007 [56]	**1**	0	0	**1**	1	**1**	**1**	0	*	5
Van Weert et al., 2010 [57]	**1**	0	1	**1**	1	**1**	**1**	1	*	7
Zhang et al., 2018 [58]	**1**	0	*	**1**	1	**1**	**1**	1	*	6
Zhou et al., 2020 [61]	*	*	*	*	*	*	**1**	*	*	1

Abbreviations: *Study did not report the item; in bold: most valuable BGA items; 0: article did not include the item; 1: article did include the item

Social impairment

PIP + BGA versus WLC

Social impairment was significantly reduced in the PIP including BGA group (SMD = −0.33 [−0.58; −0.08]; I^2 = 0%), in the post-intervention pooled analysis [34, 41, 45]. No sensitivity analysis could be performed.

Health-related quality of life

Quality of life

PIP + BGA versus WLC

The QoL was significantly higher (SMD = −0.38 [−0.68; −0.09]) for PIP including BGA, with moderate heterogeneity (I^2 = 51%) [30, 34, 45, 60]. Subgroup analysis did not reduce the heterogeneity, and sensitivity analysis remained robust for cancer survivors (Table 4).

Functional impairment

PIP + BGA versus WLC

Patients receiving PIP with BGA had less functional impairment (SMD = −0.72 [−0.95; −0.50]; I^2 = 0%) [30, 34, 38, 53].

Emotional functioning Emotional functioning did not demonstrate significant effect sizes (Table 2). Subgroup or sensitivity analysis could not be performed.

Role functioning Role functioning did not show significant effect sizes (Table 2). No subgroup or sensitivity analysis could be performed.

Physical activity level

Self-reported physical activity

PIP + BGA versus WLC

Physical activity significantly increased (SMD = −0.58 [−0.84; −0.32]), with moderate heterogeneity (I^2 = 47%) [34, 36, 43, 45].

PIP + BGA versus others

Similar results were observed post-intervention (SMD = −0.26 [−0.41; −0.11]; I^2 = 44%) [31, 33, 37, 40, 49–52, 54, 56]. In the follow-up F1, 6 studies [31, 37, 49, 51, 52, 54] also showed a significant effect (SMD = −0.26 [−0.51; 0.00]) in a heterogenic environment (I^2 = 65%). In the follow-up F2, 3 studies [31, 33, 52] demonstrated insignificant effects (Table 2). Subgroup analysis made the heterogeneity of the follow-up F1 drop, and the effect size remained significant (SMD = −0.39 [−0.70; −0.08]; I^2 = 44%). Sensitivity analysis increased the effect of the cancer patients during follow-up F1 (SMD = −0.64 [−0.95; −0.34], I^2 = 0%).

PIP + BGA versus PIP

Post-intervention did not demonstrate a better effect, with high heterogeneity (Table 2) [36, 44, 55]. The same trend was observed after F1, with no heterogeneity [36, 44]. After sensitivity analysis, two studies remained in the cancer survivor group and the post-intervention effect size became larger and significant for PIP with BGA (SMD = −0.50 [-1.58; -0.58]; I^2 = 88%) (Table 4).

Objectively measured physical activity

PIP + BGA versus WLC

Two homogenic studies [34, 53] took an objective measure of physical activity with pooled analysis showing significantly better results (SMD = −0.51 [−0.90 to −0.13]; I^2 = 0%) post-intervention.

Discussion

The aims of this paper were first to examine the effectiveness of PIP with BGA in a cancer population on sequelae, HRQoL and physical activity. Secondly, PIP with BGA was compared to BGA alone and to PIP alone to identify the added value of BGA.

A total of 33 studies were included which together provided 14 outcomes divided over 4 control groups post-intervention and extended over 3 follow-up categories.

This meta-analysis revealed that PIP with BGA has a favourable effect on fatigue, anxiety, depression, psychological distress, social impairment, QoL, functional impairment and physical activity in comparison to WLC. The same result was found for psychological measures after 1 to 3 months. When PIP with BGA was compared to other interventions, significant effects were found for self-reported physical activity, fatigue, anxiety and depression. After 1 to 3 months, the significant reduction remained for fatigue, anxiety and depression. This positive and significant effect could not be preserved in analyses of studies comparing PIP with BGA to BGA alone or PIP alone.

The results obtained from these meta-analyses were consistent with previous literature. In 2011, a meta-analysis was performed to quantify the effects of behavioural and exercise

Table 2 Effect size estimates for comparisons and outcomes included in the meta-analysis

Outcome	PIP + BGA versus WLC		PIP + BGA versus others		PIP + BGA versus PIP		PIP + BGA versus BGA	
	SMD [95% CI], I^2 (*N*)		SMD [95% CI], I^2 (*N*)		SMD [95% CI], I^2 (*N*)		SMD [95% CI], I^2 (*N*)	
Debilitating (cancer-related) symptoms								
Pain	PI	0.04 [−0.34; 0.43], 69% (2)			PI	−0.01 [−0.24; 0.22], 0% (2)	PI	−0.04 [−0.55; 0.47], 83% (2)
					F1	−0.02 [−0.62; 0.57], 81% (2)	F1	0.03 [−0.37; 0.43], 72% (2)
Fatigue	PI	−0.86 [−1.18; −0.54]†, 61% (5)	PI	−0.35 [−0.51; −0.20]†, 48% (11)			PI	−0.27 [−0.63; 0.09], 61% (2)
			F1	−0.34 [−0.58; −0.10]†, 47% (6)				
			F2	−0.38 [−0.84; 0.08], 51% (2)				
Anxiety	PI	−1.29 [−1.71; −0.86]†, 0% (2)	PI	−0.47 [−0.88; −0.06]†, 83% (5)	PI	−0.06 [−0.42; 0.30], 0% (2)		
			F1	−1.54 [−2.88; −0.21]†, 87% (2)	F1	−0.18 [−0.54; 0.18], 0% (2)		
			F2	−0.14 [−0.33; 0.06], 0% (2)				
Depression	PI	−0.79 [−1.10; −0.48]†, 0% (3)	PI	−0.46 [−0.84; −0.09]†, 82% (6)	PI	0.09 [−0.27; 0.45], 0% (2)		
			F1	−1.43 [−2.46; −0.39]†, 89% (3)	F1	0.00 [−0.36; 0.37], 0% (2)		
			F2	−0.02 [−0.22; 0.17], 0% (2)				
Insomnia/sleep			PI	−1.12 [−2.60; 0.35], 95% (3)				
			F1	−0.35 [−0.72; 0.03], 0% (2)				
Psychological distress	PI	−0.58 [−0.82; −0.34]†, 51% (6)	PI	−0.02 [−0.15; 0.11], 0% (6)	PI	−0.09 [−0.40; 0.21], 23% (4)	PI	−0.12 [−0.59; 0.35], 64% (2)
	F1	−0.89 [−1.76; −0.02]†, 82% (2)	F1	−0.11 [−0.46; 0.23), 0% (2)	F1	−0.14 [−0.42; 0.14], 0% (3)	F1	−0.22 [−0.49; 0.05], 0% (2)
			F2	−0.04 [−0.23; 0.15], 0% (2)				
Social impairment	PI	−0.33 [−0.58; −0.08]†, 0% (3)	PI	0.11 [−0.23; 0.45], 14% (2)	PI	−0.16 [−1.28; 0.97], 90% (3)		
					F1	−0.03 [−0.70; 0.64], 67% (2)		
Health-related quality of life								
Quality of life	PI	−0.38 [−0.68; −0.09]†, 51% (4)	PI	−0.30 [−0.62; 0.03], 76% (5)	PI	−0.46 [−1.03; 0.11], 52% (2)		
			F2	−0.27 [−0.81; 0.28], 78% (2)				
Functional impairment	PI	−0.72 [−0.95; −0.50]†, 0% (4)						
Emotional functioning			PI	−0.24 [−0.81; 0.33], 80% (2)				
			F2	−0.01 [−0.45; 0.43], 67% (2)				
Role functioning					PI	−0.49 [−1.32; 0.34], 76% (2)		
Physical activity level								
Self-reported PA	PI	−0.58 [−0.84; −0.32]†, 47% (4)	PI	−0.26 [−0.41; −0.11]†, 44% (10)	PI	−0.26 [−0.80; 0.29], 78% (3)	PI	−0.06 [−0.33; 0.21], 57% (3)
			F1	−0.26 [−0.51; 0.00]†, 65% (6)	F1	−0.04 [−0.27, 0.19], 0% (2)		
			F2	−0.30 [−0.84; 0.24], 80% (3)				
Objectively measured PA	PI	−0.51 [−0.90; −0.13]†, 0% (2)	PI	−0.01 [−0.16; 0.15], 0% (5)			PI	−0.01 [−0.28; 0.26], 0% (2)

Abbreviations: †Significant differences observed ($p < 0.05$); *BGA*, behavioural grades activity; *CI*, confidence interval; *F1*, follow-up 1–3 months; *F2*, follow-up 4–6 months; I^2, statistical heterogeneity; *N*, number of studies used in pooled analysis; *PA*, physical activity; *PIP*, psychological informed practices; *SMD*, standardised mean difference; *WLC*, waitlist control

interventions in breast cancer patients and survivors [16]. The results indicated that behavioural techniques improved fatigue, depression, anxiety and stress.

For the effect of physical exercise interventions, statistically significant results were found on fatigue, depression, body-image and HRQoL [16].

Fatigue is one of the primarily studied sequelae in cancer. A meta-analysis published in 2017 indicated that behavioural techniques had statistically significant moderate effects on cancer-related fatigue, even compared to pharmaceutical interventions [65]. However, two other systematic reviews could not significantly support the effect of PIP and education on fatigue in cancer patients [18, 66]. The added value of graded activity on fatigue was investigated in a crossover trial, which demonstrated a significant reduction of cancer-related fatigue compared to the other CBT components (such as regulation of the sleep–wake rhythm and reformulation of fatigue-related cognitions) [67]. This meta-analysis could not analyse the added value of BGA for fatigue due to a lack of studies.

For the outcomes psychological distress, pain, QoL and physical activity, significant positive effects were found, which are in concordance with previous studies. A systematic review of 2015 investigated interventions including behavioural changes in breast cancer survivors and demonstrated significant changes in patients' physical activity [68]. Another review evaluated pain intensity, sensation, suffering or perceived control with a significant effect of all PIP interventions in women with metastatic breast cancer [66]. In the same review, RCTs could not support the effect of PIP on QoL [66]. On the other hand, Ye et al. [15] performed a meta-analysis that reinforced a significant positive effect of PIP on QoL, depression and anxiety in breast CPaS. An older meta-analysis with poor quality found that, overall, breast cancer patients who were administered CBT techniques had significantly less distress and pain than WLC or UC [69].

Implications for clinicians

This meta-analysis found evidence from RCTs that PIP with BGA appears to be effective in improving sequela, QoL and physical activity compared to non-behavioural interventions in CPaS. These results can be used to better inform patients about the benefits of including PIP with BGA in the rehabilitation programme [70]. In addition, recent findings of another meta-analysis demonstrated that exercise and psychological interventions are more effective in reducing fatigue, depression, anxiety and stress during and after cancer treatment, and they are significantly better than the available pharmaceutical options [65]. These findings could help physicians, nurses and patients make informed choices about the importance of including PIP with BGA in the standard care practice to reduce patient's medication use. Furthermore, PIP with BGA should be patient-tailored which makes it appropriate for every cancer stage. However, currently few studies report the adverse events of the intervention. So, it is not clear if there were any or if they were not reported. For future implementation, the adverse events of PIP with BGA should be first investigated and reported. Moreover, to avoid unforeseen situations, it might be interesting to request medical clearance before the intervention.

This review revealed that up to now BGA is not (well) defined in included studies; however, a big proportion of researchers apply BGA as part of their intervention. In this meta-analysis, clinicians can find a checklist, co-written by experts in the field of chronic pain, with an overview of the most important criteria. Nevertheless, it is not only important to put the emphasis on 'what' is BGA but also on 'how' it should be provided, in order to give clinicians, the best possible treatment plan [71]. For training purposes, a multidisciplinary collaboration can be recommended, so psychologists could focus on the behavioural and psychological aspects and physiotherapists on the behavioural and graded exercise aspects in their approach. Forthcoming protocols have been developed to implement a standardised programme of BGA in chronic pain populations, e.g. osteoarthritis, breast cancer survivors and low back pain patients [72–76].

Strengths and limitations

This meta-analysis included RCTs up to May 2021, has a large sample size ($n = 4330$) and is more comprehensive, than any previously published meta-analyses on psychotherapeutic and physical interventions in CPaS [15, 16]. In a cancer population, no meta-analysis was ever performed yet to compare PIP with BGA to other interventions in terms of various outcome measures.

However, several limitations of the current study should also be noted. First, high heterogeneity was observed in the pooling of various outcome measures in the intervention compared to WLC, PIP alone, BGA alone and other interventions. For this heterogeneity, several explanations can be found, such as a difference in subtype of patients (e.g. predominated fatigue, low activity level, anxiety, depression) or the inclusion of cancer patients as well as cancer survivors. In addition, despite our strict inclusion criteria, the differences in the approach to delivering the behavioural treatment might impute the observed heterogeneity, which can downgrade the strength of the results [15]. As a consequence, random effect analyses were used, resulting in wider confidence intervals and relatively more weight being given to smaller studies [77].

Second, in most studies, blinding of the therapists and/or patients is not possible for these behavioural interventions. This had a large impact on the risk of bias (ROB 2), which clearly decreased the quality of studies [78].

Finally, publication bias was detected for the outcomes of fatigue and functional impairment in the WLC, self-reported physical activity in the PIP group and anxiety and depression in the other interventions. As a result, studies with minor or negative results could have been missed.

Table 3 Effect size estimates for comparisons and outcomes included in the sub-analysis based on quality of the given BGA

Outcome	PIP + BGA versus WLC	PIP + BGA versus Other	PIP + BGA versus PIP	PIP + BGA versus BGA
	SMD [95% CI], I^2 (*N*)	SMD [95% CI], I^2 (*N*)	SMD [95% CI], I^2 (*N*)	SMD [95% CI], I^2 (*N*)
Debilitating (cancer-related) symptoms				
Fatigue	PI H: –0.94 [–1.80; –0.09] †, 77% (2) L: –0.86 [–1.25; –0.47] †, 62% (3)			
Anxiety		PI H: –0.11 [–0.47; 0.25], (1) L: –0.60 [–1.13; –0.07] †, 87% (4)		
Depression		PI H: –0.45 [–1.28; –0.37] †, 86% (2) L: –0.49 [–0.99; 0.01], 85% (4) F1 H: –1.13 [–1.65; –0.62] †, (1) L: –1.65 [–3.80; 0.50], 94% (2)		
Insomnia		PI H: –0.34 [–0.71; 0.03], 0% (2) L: –2.76 [–3.41; –2.11] †, (1)		
Psychological distress	PI H: –0.24 [–0.58; 0.10], (1) L: –0.67 [–0.90; –0.44] †, 27% (5)			
Social impairment			PI H: –1.39 [–2.11; –0.66] †, (1) L: 0.41 [–0.51; 1.33], 81% (2)	
Health-related quality of life				
Quality of life	PI H: –0.20 [–0.54; 0.14], (1) L: –0.46 [–0.83; –0.08] †, 53% (3)	PI H: –0.22 [–0.58; 0.13], 69% (3) L: –0.45 [–1.36; 0.46], 90% (2)		
Physical activity level				
Self-reported PA		F1 H: –0.39 [–0.70; –0.08] †, 44% (4) L: –0.08 [–0.41; 0.26], 70% (2) F2 H: –0.30 [–0.84; 0.24], 80% (3)	PI H: –1.10 [–1.79; –0.40] †, (1) L: 0.02 [–0.21; 0.25], 0% (2)	PI H: 0.05 [–0.27; 0.37], (1) L: –0.12 [–0.55; 0.31], 76% (2)

Abbreviations: † Significant differences observed ($P < 0.05$); *BGA*, behavioural grades activity; *CI*, confidence interval; *F1*, follow-up 1-3 months; I^2, statistical heterogeneity; *H*, high quality; *L*, low quality; *N*, number of studies used in pooled analysis; *PA*, physical activity; *PIP*, psychological informed practices; *SMD*, standardized mean difference; *WLC*, waitlist control

Table 4 Effect size estimates for comparisons and outcomes after the sensitivity analysis based on population

Outcome	PIP + BGA versus WLC		PIP + BGA versus Other		PIP + BGA versus PIP		PIP + BGA versus BGA	
	SMD [95% CI], I^2 (*N*)		SMD [95% CI], I^2 (*N*)		SMD [95% CI], I^2 (*N*		SMD [95% CI], I^2 (*N*)	
Debilitating (cancer-related) symptoms								
Pain	PI	CS: 0.04 [–0.34; 0.43], 69% (2)			PI	CP: 0.08 [–0.36; 0.52] (1)	PI	CS: –0.04 [–0.55; 0.47], 83% (2)
						CS: –0.05 [–0.31; 0.22] (1)	F1	CS: 0.03 [–0.37; 0.43], 72% (2)
					F1	CP: –0.35 [–0.80; 0.09] (1)		
						CS: 0.25 [–0.01; 0.52] (1)		
Fatigue	PI	CS: –0.86 [–1.18; –0.54] †, 61% (5)	PI	CP: –0.48 [–0.69; –0.28] †, 19% (5)			PI	CP: –0.45 [–0.77; –0.14] † (1)
				CS: –0.25 [–0.44; –0.06] †, 44% (6)				CS: –0.09 [–0.41; 0.24] (1)
			F1	CP: –0.54 [–0.96; –0.12] †, 60% (3)				
				CS: –0.20 [–0.42; 0.02], 0% (3)				
			F2	CP: –0.38 [–0.84; 0.08], 51% (2)				
Anxiety	PI	CP: - 1.28 [–1.87; –0.69] † (1)	PI	CP: –0.47 [–0.88; –0.06] †, 83% (5)	PI	CP: –0.15 [–0.58; 0.29] (1)		
		CS: –1.29 [–1.91; –0.66] † (1)	F1	CP: –1.54 [–2.88; –0.21] †, 87% (2)		CS: 0.12 [–0.52; 0.75] (1)		
			F2	CP: –0.14 [–0.33; 0.06], 0% (2)	F1	CP: –0.13 [–0.56; 0.31] (1)		
						CS: –0.30 [–0.94; 0.34] (1)		
Depression	PI	CP: –0.82 [–1.38; –0.26] † (1)	PI	CP: –0.46 [–0.84; –0.09] †, 82% (6)	PI	CP: 0.06 [–0.38; 0.50] (1)		
		CS: –0.78 [–1.15; –0.40] †, 0% (2)	F1	CP: –1.43 [–2.46; –0.39] †, 89% (3)		CS: 0.15 [–0.48; 0.79] (1)		
			F2	CP: –0.02 [–0.22; 0.17], 0% (2)	F1	CP: 0.00 [–0.44; 0.44] (1)		
						CS: 0.01 [–0.62; 0.65] (1)		
Insomnia			PI	CP: –1.58 [–3.87; 0.70], 97% (2)				
				CS: –0.21 [–0.79; 0.37] (1)				
			F1	CP: –0.43 [–0.92; 0.05] (1)				
				CS: –0.22 [–0.81; 0.36] (1)				
Psychological distress	PI	CS: –0.58 [–0.82; –0.34] †, 51% (6)	PI	CP: –0.04 [–0.35; 0.27], 54% (2)	PI	CP: 0.04 [–0.40; 0.48] (1)	PI	CS: –0.12 [–0.59; 0.35], 64% (2)
	F1	CS: –0.89 [–1.72; –0.02] †, 82% (2)		CS: 0.02 [–0.16; 0.19], 0% (4)		CS: –0.16 [–0.59; 0.27], 41% (3)	F1	CS: –0.22 [–0.49; 0.05], 0% (2)
			F1	CS: –0.11 [–0.46; 0.23], 0% (2)	F1	CP: –0.03 [–0.47; 0.41] (1)		
			F2	CP: –0.04 [–0.23; 0.15], 0% (2)		CS: –0.21 [–0.61; 0.20], 14% (2)		
Social impairment	PI	CS: –0.33 [–0.58; –0.08] †, 0% (3)	PI	CP: 0.23 [–0.13; 0.58] (1)	PI	CP: –0.03 [–0.47; 0.41] (1)		
				CS: –0.15 [–0.73; 0.43] (1)		CS: –0.23 [–2.49; 2.02], 95% (2)		
					F1	CP: –0.34 [–0.78; 0.11] (1)		
						CS: 0.35 [–0.28; 0.99] (1)		
Health-related quality of life								
Quality of life	PI	CP: –0.01 [–0.54; 0.53] (1)	PI	CP: –0.36 [–0.78; 0.07], 81% (4)	PI	CP: –0.22 [–0.66; 0.22] (1)		
		CS: –0.47 [–0.77; –0.16] †, 48% (3)		CS: –0.10 [–0.40; 0.21] (1)		CS: –0.81 [–1.49; –0.14] † (1)		
			F2	CP: –0.27 [–0.81; 0.28], 78% (2)				
Functional impairment	PI	CS: –0.72 [–0.95; –0.50] †, 0% (4)						
Emotional functioning			PI	CP: –0.24 [–0.81; 0.33], 80% (2)				
			F2	CP: –0.01 [–0.45; 0.43], 67% (2)				

Table 4 (continued)

Outcome	PIP + BGA versus WLC		PIP + BGA versus Other		PIP + BGA versus PIP		PIP + BGA versus BGA
	SMD [95% CI], I^2 (*N*)		SMD [95% CI], I^2 (*N*)		SMD [95% CI], I^2 (*N*)		SMD [95% CI], I^2 (*N*)
Role functioning					PI	CP: –0.10 [–0.55; 0.34] (1)	
						CS: –0.95 [–1.64; –0.27] † (1)	
Physical activity level							
Self-reported PA	PI	CS: –0.58 [–0.84; –0.32] †, 47% (4)	PI	CP: –0.27 [–0.58; 0.05], 63% (4)	PI	CP: 0.06 [–0.38; 0.50] (1)	PI CP: –0.35 [–0.67; –0.02] † (1)
				CS: –0.24 [–0.42; –0.07] †, 36% (6)		CS: –0.50 [–1.58; –0.58] †, 88% (2)	CS: 0.07 [–0.13; 0.28], 0% (2)
			F1	CP: –0.64 [–0.95; –0.34] †, 0% (2)	F1	CP: –0.18 [–0.62; 0.26] (1)	
				CS: –0.07 [–0.25; 0.11], 15% (4)		CS: 0.01 [–0.26; 0.28] (1)	
			F2	CP: –0.30 [–0.84; 0.24], 80% (3)			
Objectively measured PA	PI	CS: –0.51 [–0.90; –0.13] †, 0% (2)	PI	CP: –0.03 [–0.26; 0.21], 0% (2)			PI CP: –0.19 [–0.68; 0.30] (1)
				CS: 0.01 [–0.20; 0.22], 0% (3)			CS: 0.07 [–0.25; 0.39] (1)

Abbreviations: † Significant differences observed ($P < 0.05$); *BGA*, behavioural grades activity; *CI*, confidence interval; *CP*, cancer patients; *CS*, cancer survivors; *F1*, follow-up 1-3 months; I^2, statistical heterogeneity; *N*, number of studies used in pooled analysis; *PA*, physical activity; *PIP*, psychological informed practices; *SMD*, standardized mean difference; *WLC*, waitlist control

Future recommendations

Further studies are encouraged to address the remaining gaps highlighted by this review. First, more RCTs should provide a solid description of their graded activity programme to specify BGA. In this meta-analysis, a lot of studies with behavioural interventions were included for BGA and a checklist was used to score and verify the quality of the provided BGA. However, studies with a low score on the BGA checklist had several criteria that were not reported which can lead to an under- or over-estimation of the results. This checklist could help future researchers with better reporting of details on their provided intervention. Second, future work should examine whether clinical and demographic characteristics influence outcomes following PIP with BGA because in this systematic review, no additional subgroup analyses could be added since too many subgroup analyses can potentially lead to misleading results [79]. Besides, more studies of each cancer stage are needed to be able to make a clear distinction at what time point PIP with BGA or BGA alone should be incorporated in the cancer treatment. For instance, a meta-analysis about fatigue in cancer patients concluded that it would be more favourable to give patients physical exercise during their primary treatment, whereas psychological and physical exercise combined with psychological intervention might be most effective for survivors who have completed primary treatment [65]. Similar results were not clearly observed in our meta-analysis after sensitivity analysis, this due to a lack of studies. Third, to optimise patient treatments, future studies are needed to find the optimal sequence and dosage of BGA for cancer patients, including virtual versus face-to-face sessions, provided in-group versus individually. Additionally, to engage patients to their care, studies should incorporate qualitative assessments which can provide greater insight into their experiences on the provided intervention [80].

Lastly, as a result of the COVID-19 situation, assurance had an increasing interest in eHealth modalities in routine care over the past few years. Thus, more research about the acceptability and feasibility of implementing telehealth BGA in cancer populations will be warranted [81].

Conclusions

PIP with BGA had a favourable effect on several debilitating symptoms, physical activity level and HRQoL in CPaS when compared to non-behavioural interventions such as WLC, education, physical activity and usual care. However, these significant positive results could not be preserved when the intervention was compared to other PIP and BGA alone. Future studies should focus on providing a clear framework for the administration of BGA and further research is needed on 'how' and 'when' PIP and BGA should be provided in the cancer rehabilitation.

Appendix 1

Table 5 Search strategy

	P		I	
	Cancer patients and survivors		Behavioural graded activity	
MeSH terms	Neoplasms		Conditioning, Operant	
	Cancer survivors		Behavior Therapy: Cognitive Behavioral Therapy Acceptance and Commitment Therapy	
Free terms	Benign	Malignity	Acceptance and Commitment Therapy	Conditioning Therapies
	Blastoma	Melanoma	Behavior Modification	Conditioning Therapy
	Blastomas	Metastases	Behavior Therapies	Graded activities
	Cancer	Metastasis	Behavior Therapy	Graded activity
	Cancers	Neoplasia	Behavioral graded activity	Graded exercise
	Carcinoma	Neoplasias	Behaviour Modification	Graded exercises
	Carcinomas	Neoplasm	Behaviour Therapies	Gradual activity
	Carcinomatoses	Neoplasma	Behaviour Therapy	Gradual exercise
	Carcinomatosis	Neoplasms	Behavioural graded activity	Operant conditioning
	Carcinomatous	Oncological	Cognition Therapy	Paced activities
	Ganglioma	Oncology	Cognitive Behavior Therapies	Paced activity
	Gangliomas	Post-cancer*	Cognitive Behavior Therapy	Paced exercise
	Hodgkin disease	Sarcoma	Cognitive Behavioral Therapies	Pacing activities
	Hodgkin's disease	Sarcomal	Cognitive Behavioral Therapy	Pacing activity
	Leucaemia	Sarcomas	Cognitive Behaviour Therapies	Pacing therapies
	Leukaemia	Sarcomatogenous	Cognitive Behaviour Therapy	Pacing therapy
	Leukemia	Sarcomatosis	Cognitive Behavioural Therapies	Time contingent
	Lymphoma	Sarcomatous	Cognitive Behavioural Therapy	Time-contingent
	Lymphomas	Tumor	Cognitive Psychotherapies	
	Malign	Tumoral	Cognitive Psychotherapy	
	Maligna	Tumors	Cognitive Therapies	
	Malignances	Tumour	Cognitive Therapy	
	Malignancies	Tumoural		
	Malignancy	Tumours		
	Malignant			

Abbreviations: *P*, population; *I*, intervention; *MeSH*, medical subheading

Embase search strategy: ((("Neoplasms" OR "Cancer Survivors") OR "benign") OR "cancer") OR "cancers") OR "carcinoma") OR "carcinomas") OR "carcinomatous") OR "carcinomatoses") OR "carcinomatosis") OR "malign") OR "maligna") OR "malignances") OR "malignancies") OR "malignancy") OR "malignant") OR "malignity") OR "melanoma") OR "neoplasia") OR "neoplasias") OR "neoplasm") OR "Neoplasma") OR "oncological") OR "oncology") OR "sarcoma") OR "sarcomal") OR "sarcomatogenous") OR "sarcomatosis") OR "sarcomatous") OR "sarcomas") OR "tumour") OR "tumor") OR "tumoral") OR "tumours") OR "tumors") OR "tumoural") OR "post-cancer") OR "neoplasm metastasis") OR ("neoplasm" AND "metastasis")) OR "metastasis") OR "metastases") OR "lymphoma") OR "lymphomas") OR "leukaemia") OR "leukemia") OR "blastoma") OR "blastomas") OR "ganglioma") OR "gangliomas") OR "Hodgkin disease") OR "Hodgkin's disease") OR "Leucaemia")) AND (((((((((((((((((((((((((((((((((((((("acceptance and commitment therapy" OR "behavior modification") OR "behaviour modification") OR "behavior therapies") OR "behaviour therapies") OR "behavior therapy") OR "behaviour therapy") OR "behavioral graded activity") OR "behavioural graded activity") OR "cognition therapy") OR "cognitive behaviour therapies") OR "cognitive behavior therapies") OR "cognitive behaviour therapy") OR "cognitive behavioral therapy") OR "cognitive behavioral therapies") OR "cognitive behavioural therapies") OR "cognitive behavioural therapy") OR "cognitive psychotherapies") OR "cognitive psychotherapy") OR "cognitive therapies") OR "cognitive therapy") OR "conditioning therapies") OR "conditioning therapy") OR "graded activities") OR "graded exercise") OR "graded exercises") OR "graded activity") OR "gradual activity") OR "gradual exercise") OR "operant conditioning") OR "paced activity") OR "paced exercise") OR "paced activities") OR "pacing activity") OR "pacing therapy") OR "pacing therapies") OR "time contingent") OR "time-contingent"))).

Appendix 2

Table 6 Risk of bias

Study	Outcome	ROB 1	ROB 2	ROB 3	ROB 4	ROB 5	Overall judgement
		ROB judgement			Low/High/Some		
Abrahams et al. (2017)	Fatigue	Low	Some concerns	Low	High	Low	High
	Functional impairment	Low	Some concerns	Low	High	Low	High
	Psychological distress	Low	Some concerns	Low	High	Low	High
	Quality of life	Low	Some concerns	Low	High	Low	High
Armes et al. (2007)	Fatigue	Some concerns	Some concerns	High	High	Low	High
	Self-reported PA	Some concerns	Some concerns	High	High	Low	High
Arving et al. (2019)	Anxiety	Some concerns	Some concerns	High	High	Low	High
	Depression	Some concerns	Some concerns	High	High	Low	High
	Psychological distress	Some concerns	Some concerns	High	High	Low	High
Carmack-Taylor et al. (2007) (Usual care)	Anxiety	Some concerns	Some concerns	Low	High	Low	High
	Depression	Some concerns	Some concerns	Low	High	Low	High
	Emotional functioning	Some concerns	Some concerns	Low	High	Low	High
	Pain	Some concerns	Some concerns	Low	High	Low	High
	Objectively measured PA	Some concerns	Some concerns	Low	Low	Low	High
	Self-reported PA	Some concerns	Some concerns	Low	High	Low	High
	Psychological distress	Some concerns	Some concerns	Low	High	Low	High
	Quality of life	Some concerns	Some concerns	Low	High	Low	High
	Role functioning	Some concerns	Some concerns	Low	High	Low	High
	Social functioning	Some concerns	Some concerns	Low	High	Low	High
Carmack-Taylor et al. (2007) (Education)	Anxiety	Some concerns	Some concerns	Some concerns	High	Low	High
	Depression	Some concerns	Some concerns	Some concerns	High	Low	High
	Emotional functioning	Some concerns	Some concerns	Some concerns	High	Low	High
	Pain	Some concerns	Some concerns	Some concerns	High	Low	High
	Objectively measured PA	Some concerns	Some concerns	Some concerns	Low	Low	High
	Self-reported PA	Some concerns	Some concerns	Some concerns	High	Low	High
	Psychological distress	Some concerns	Some concerns	Some concerns	High	Low	High
	Quality of life	Some concerns	Some concerns	Some concerns	High	Low	High
	Role functioning	Some concerns	Some concerns	Some concerns	High	Low	High
	Social functioning	Some concerns	Some concerns	Some concerns	High	Low	High
Daley et al. (2007)	Depression	Low	Some concerns	Low	High	Low	High
	Emotional functioning	Low	Some concerns	Low	High	Low	High
	Fatigue	Low	Some concerns	Low	High	Low	High
	Functional impairment	Low	Some concerns	Low	High	Low	High
	Objectively measured PA	Low	Some concerns	Low	Some concerns	Low	High
	Self-reported PA	Low	Some concerns	Low	High	Low	High
	Quality of life	Low	Some concerns	Low	High	Low	High
	Social impairment	Low	Some concerns	Low	High	Low	High
Dalton et al. (2004) (Usual care)	Functional impairment	High	High	Some concerns	High	Some concerns	High
	Insomnia	High	High	Some concerns	High	Some concerns	High
	Pain	High	High	Some concerns	High	Some concerns	High
	Self-reported PA	High	High	Some concerns	High	Some concerns	High
	Psychological distress	High	High	Some concerns	High	Some concerns	High
Dalton et al. (2004) (PIP)	Functional impairment	High	High	Some concerns	High	Some concerns	High
	Insomnia	High	High	Some concerns	High	Some concerns	High
	Pain	High	High	Some concerns	High	Some concerns	High
	Self-reported PA	High	High	Some concerns	High	Some concerns	High
	Psychological symptoms	High	High	Some concerns	High	Some concerns	High
Duijts et al. (2012)	Pain	Some concerns	Some concerns	High	High	Low	High
	Self-reported PA	Some concerns	Some concerns	High	High	Low	High
	Psychological distress	Some concerns	High	High	High	High	High
Fillion et al. (2008)	Fatigue	Some concerns	Some concerns	High	High	Low	High
	Self-reported PA	Some concerns	Some concerns	High	High	Low	High
	Objectively measured PA	Some concerns	Some concerns	High	High	Low	High
	Psychological distress	Some concerns	Some concerns	High	High	Low	High
Gielissen et al. (2006)	Fatigue	Low	Low	High	High	Low	High
	Functional impairment	Low	Low	High	High	Low	High
	Psychological symptoms	Low	Low	High	High	Low	High
Goedendorp et al. (2010)	Fatigue	Low	Some concerns	Low	High	Low	High
	Objectively measured PA	Low	Some concerns	Low	Low	Low	Some concerns
	Self-reported PA	Low	Some concerns	Low	High	Low	High
Goedendorp et al. (2014)	Cognitive impairment	Some concerns	Some concerns	Low	High	Low	High
Gonzalez-Fernandez et al. (2018)	Anxiety	Some concerns	High	High	High	Low	High
	Depression	Some concerns	High	High	High	Low	High
	Psychological symptoms	Some concerns	High	High	High	Low	High
	Social impairment	Some concerns	High	High	High	Low	High
Greer et al. (2019)	Anxiety	Some concerns	High	Low	High	Low	High
	Depression	Some concerns	High	Low	High	Low	High
	Quality of life	Some concerns	High	Low	High	Low	High
Ham et al. (2019)	Anxiety	Low	High	High	High	Low	High
	Depression	Low	High	High	High	Low	High
	Quality of life	Low	High	High	High	Low	High
Hatchett et al. (2013)	Self-reported PA	Some concerns	High	High	High	Low	High

Table 6 (continued)

Hopko et al. (2011)	Anxiety	Low	Some concerns	Low	High	Low	High
	Depression	Low	Some concerns	Low	High	Low	High
	Emotional functioning	Low	Some concerns	Low	High	Low	High
	Pain	Low	Some concerns	Low	High	Low	High
	Self-reported PA	Low	Some concerns	Low	High	Low	High
	Psychological symptoms	Low	Some concerns	Low	High	Low	High
	Quality of life	Low	Some concerns	Low	High	Low	High
	Role functioning	Low	Some concerns	Low	High	Low	High
	Social impairment	Low	Some concerns	Low	High	Low	High
Korstjens et al. (2008) (WLC)	Emotional functioning	Some concerns	Some concerns	Low	High	Low	High
	Pain	Some concerns	Some concerns	Low	High	Low	High
	Self-reported PA	Some concerns	Some concerns	Low	High	Low	High
	Psychological distress	Some concerns	Some concerns	Low	High	Low	High
	Quality of life	Some concerns	Some concerns	Low	High	Low	High
	Role functioning	Some concerns	Some concerns	Low	High	Low	High
	Social impairment	Some concerns	Some concerns	Low	High	Low	High
Korstjens et al. (2008) (BGA)	Emotional functioning	Low	Some concerns	Low	High	Low	High
	Pain	Low	Some concerns	Low	High	Low	High
	Psychological distress	Low	Some concerns	Low	High	Low	High
	Quality of life	Low	Some concerns	Low	High	Low	High
	Role functioning	Low	Some concerns	Low	High	Low	High
	Social functioning	Low	Some concerns	Low	High	Low	High
Korstjens et al. (2011)	Anxiety	Low	Some concerns	Low	High	Low	High
	Depression	Low	Some concerns	Low	High	Low	High
May et al. (2008)	Objectively measured PA	Low	Low	Low	Low	Low	Low
	Self-reported PA	Low	Low	Low	High	Low	High
May et al. (2009)	Quality of life	Low	Low	Low	High	Low	High
	Cognitive impairment	Low	Low	Low	High	Low	High
McGowan et al. (2013)	Fatigue	Some concerns	High	Some concerns	High	Low	High
	Self-reported PA	Some concerns	High	Some concerns	High	Low	High
	Psychological distress	Some concerns	High	Some concerns	High	High	High
Onyedibe et al. (2020)	Anxiety	Low	Some concerns	Some concerns	High	Low	High
	Depression	Low	Some concerns	Some concerns	High	Low	High
Pinto et al. (2005)	Fatigue	High	Low	Low	High	Low	High
	Objectively measured PA	High	Low	Low	Low	Low	High
	Self-reported PA	High	Low	Low	High	Low	High
	Psychological distress	High	Low	Low	High	Low	High
Pinto et al. (2013)	Fatigue	Some concerns	Low	Some concerns	High	Low	High
	Self-reported PA	Some concerns	Low	Some concerns	High	Low	High
Poort et al. (2019)	Emotional functioning	Low	Low	Low	High	High	High
	Fatigue	Low	Low	Low	High	High	High
	Functional impairment	Low	Low	Low	High	High	High
	Self-reported PA	Low	Low	Low	High	High	High
	Quality of life	Low	Low	Low	High	High	High
Prinsen et al. (2013)	Fatigue	Low	Some concerns	High	High	Low	High
	Functional impairment	Low	Some concerns	High	High	Low	High
	Objectively measured PA	Low	Some concerns	High	Low	Low	High
Sandler et al. (2017)	Fatigue	Low	Some concerns	High	High	High	High
	Self-reported PA	Low	Some concerns	High	High	High	High
	Psychological distress	Low	Some concerns	High	High	Low	High
	Sleep	Low	Some concerns	High	High	High	High
	Social impairment	Low	Some concerns	High	High	High	High
Sheehan et al. (2020)	Cognitive impairment	High	Low	Low	High	Low	High
	Emotional functioning	High	Low	Low	High	Low	High
	Fatigue	High	Low	Low	High	Low	High
	Insomnia	High	Low	Low	High	Low	High
	Self-reported PA	High	Low	Low	High	Low	High
	Objectively measured PA	High	Low	Low	High	Low	High
	Psychological distress	High	Low	Low	High	Low	High
	Quality of life	High	Low	Low	High	Low	High
	Role functioning	High	Low	Low	High	Low	High
	Social impairment	High	Low	Low	High	Low	High
Vallance et al. (2007)	Fatigue	Low	Low	Low	High	Low	High
	Objectively measured PA	Low	Low	Low	High	Low	High
	Self-reported PA	Low	Low	Low	High	Low	High
	Quality of life	Low	Low	Low	High	Low	High
Van Weert et al. (2010) (WLC)	Fatigue	High	Low	Low	High	Low	High
Van Weert et al. (2010) (BGA)	Fatigue	Low	Low	Low	High	Low	High
Zhang et al. (2017)	Depression	Low	Low	Low	High	Low	High
	Fatigue	Low	Low	Low	High	Low	High
	Sleep	Low	Low	Low	High	Low	High
Zhou et al. (2020)	Anxiety	Low	Some concerns	High	High	Some concerns	High
	Depression	Low	Some concerns	High	High	Some concerns	High
	Fatigue	Low	Some concerns	High	High	Some concerns	High
	Functional impairment	Low	Some concerns	High	High	Some concerns	High
	Quality of life	Low	Some concerns	High	High	Some concerns	High
	Sleep	Low	Some concerns	High	High	Some concerns	High

Abbreviations: PA, physical activity, PIP, psychologically informed practice, BGA, behavioural graded activity, WLC, waitlist control

Appendix 3

Table 7 Data extraction file

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
PIP + BGA versus waitlist control										
Abrahams et al. 2017 [30], The Netherlands	132 severely fatigued cancer survivors (CIS ≥35) **Baseline:** I: 66 C: 66 **PI: 6m** I: 66 C: 64 **No follow-up**	I: 52.5 ± 8.2 C: 50.5 ± 7.6	Time since diagnosis I: 43.7 ± 31 m C: 39.0 ± 25.5 m	**CBT:** PIP: - Module 1: goal setting - Module 2-7: work packages on fatigue-perpetuating factors - Module 8: realization of treatment goals BGA: - Module 5: work package on deregulated activity pattern	6 months: - 3 face-to-face sessions - 8 web-based modules	Waitlist control	6 months	Fatigue Severity	CIS-F	SMD_{PI_r}: −1.03 [−1.39; −0.66]
								Functional impairment	SIP 8	SMD_{PI_r}: −0.66 [−1.01; −0.31]
								Psychological distress	BSI 18	SMD_{PI_r}: −0.88 [−1.24; −0.52]
								Quality of Life	EORTC-QLQ-C30	SMD_{PI_r}: −0.66 [−1.01; −0.31]
Daley et al. 2007 [34], UK	72 breast cancer survivors **Baseline:** I: 34 C: 38 **PI:** 8w I: 33 C: 33 **Follow-up F2:** 16w PI	I: 51.6 ± 8.8 C: 51.1 ± 8.6	Time since therapy I: 17.6 ± 7.4 m C: 16.7 ± 5.9 m	**CBT/PE** PIP: Cognitive behavioral techniques for promoting exercise behavior change-weeks 1−4: cognitive reappraisal and consciousness raising - weeks 5-8: goal setting, self-monitoring and finding social support PA (BGA): - Moderate-intensity exercise - Maintaining exercised through tailored regime	8 weeks 3 sessions per week (50min) - 30 min exercise - 20 min exercise counselling	Waitlist control	8 weeks	Depression	BDI-II	SMD_{PI_r}: −0.66 [−1.13; −0.18] SMD_{F2_r}: −0.48 [−0.95; −0.01]
								Fatigue	RPFS	SMD_{PI_r}: −0.42 [−0.89; 0.05] SMD_{F2_r}: −0.23 [−0.69; 0.24]
								Functional well-being	Subscale FACT-G/-B	SMD_{PI_r}: −0.53 [−1.00; −0.06] SMD_{F2_r}: −0.34 [−0.81; −0.12]
								Physical fitness (Objectively measured PA)	Submaximal, 8-minute, single-stage walking test performed on a treadmill	SMD_{PI_r}: −0.63 [−1.10; −0.16] SMD_{F2_r}: −0.26 [−0.73; −0.20]
								Physical conditioning competence (Self-reported PA)	Subscale PSPP	SMD_{PI_r} −0.76 [−1.24; −0.28] SMD_{F2_r}: −0.58 [−1.06; −0.11]
								Emotional well-being (Psychological distress)	Subscale FACT-G/-B	SMD_{PI_r}: −0.27 [0.74; −0.19] SMD_{F2_r}: −0.31 [−0.77; 0.16]
								Quality of Life	FACT-G	SMD_{PI_r}: −0.59 [−1.06; −0.12] SMD_{F2_r}: −0.43 [−0.90; 0.04]
								Social/family well-being (social)	Subscale FACT-G/-B	SMD_{PI_r}: −0.48 [−0.95; −0.01] SMD_{F2_r}: −0.34 [−0.80; 0.13]
Duijts et al. 2012 [36], The Netherlands	422 breast cancer survivors reporting treatment-induced menopausal symptoms **Baseline:** **I: 106** **C_1: 103** C_2: 104 C_3: 109 **PI:** 12w **Follow-up F1:** 3m PI	48.2 ± 5.6 I: 49.0 ± 4.9 C: 47.8 ± 6.0	NM	**CBT/PE:** CBT (PIP): Relaxation exercises, focus on hot flashes, night sweats, problem areas.	concurrently: 6 weekly group sessions of 90 min	Waitlist control	12 weeks	Bodily pain	SF-36 subscale	SMD_{PI_r}: 0.23 [−0.05; 0.50] SMD_{F1_r}: 0.07 [−0.21; 0.34]
				PE (GA): - Selecting appropriate form of exercise - Achieve target heart rate (60 to 80% Karvonen) 12 weeks	Individually tailored, home-based - 2.5-3h per week - telephone interviews in weeks 4 and 8			Physical functioning (Self-reported PA)	SF-36 subscale	SMD_{PI_r}: −0.32 [−0.59; −0.04] SMD_{F1_r}: −0.19 [−0.46; 0.08]
								Mental component (psychological distress)	SF-36 subscale	SMD_{PI_r}: −0.58 [−0.99; −0.1] SMD_{F1_r}: −0.48 [−0.88; −0.08]
Fernandez-Rodriguez 2020 [59], Spain	66 cancer survivors with emotional distress (HADS subscale ≥ 8) **Baseline:** **I: 22** **C1: 27** C2: 17 **PI:** 12w **I: 17** **C1: 23** C2: 12 **Follow-up F1 3 months**	51.66 ± 6.76 I: NM C: NM	NM	**Behavioural activation:** PIP: Self-observation and -report, rehearsal and behavior modeling, elaboration of activity hierarchies, behavior programming, contingency management, acceptance of distancing from emotions and thoughts. BGA: Time-contingent, reestablishing relevant day-to-day routines and activities.	12 weeks 12 group sessions (90 minutes, 6 people)	Waitlist control	12 weeks	Anxiety	HADS-A	SMD_{F1_r}: −1.71 [−2.38; −1.05]
								Depression	HADS-D	SMD_{F1_r}: −1.15 [−1.76; −0.54]
								Avoidance and psychological inflexibility (psychological distress)	AAQ-II	SMD_{F1_r}: −1.37 [−2.00, −0.74]
								Social impairment	BADS subscale	SMD_{F1_r}: −1.08 [−1.68; −0.47]

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Gielissen et al. 2006 [38], The Netherlands	112 fatigued (CIS >35) cancer survivors **Baseline:** I: 50 C: 48 **PI:** 6m I: 38 C: 44 **No follow-up**	I: 44.6 ± 9.9 C: 45.3 ± 10.3	Time since therapy I: 5.5 ± 4.3 y C: 4.6 ± 3.4 y	**CBT:** PIP: Focus on Perpetuating factors: inadequate coping with the cancer experience, fear of disease recurrence, dysfunctional beliefs concerning fatigue, sleep dysregulation, activity dysregulation, low social support BGA: Establishing baseline, alternating rest and activity, preventing bursts, increase activity 1min per day.	6 months Varied treatments: 5 to 26 sessions (12.5 ± 4.7)	Waitlist control	6 months	Fatigue severity Functional impairment Psychological distress	CIS-F SIP-8 SCL-90	SMD_{FU}: –1.09 [–1.51; –0.66] SMD_{FU}: –0.82 [–1.24; –0.40] SMD_{FU}: –0.64 [–1.05; –0.23]
Goedendorp et al. 2014 [39], The Netherlands	112 severely fatigued (CIS >35) cancer survivors **Baseline:** I: 56 C: 56 **PI:** 6m **No follow-up**	I: 44.6 ± 9.9 C: 45.3 ± 10.3	Time since therapy I: 5.5 ± 4.3 y C: 4.6 ± 3.4 y	**CBT** PIP: Focus on Perpetuating factors: inadequate coping with the cancer experience, fear of disease recurrence, dysfunctional beliefs concerning fatigue, sleep dysregulation, activity dysregulation, low social support BGA: Establishing baseline, alternating rest and activity, preventing bursts, increase activity 1min per day.	6 months Varied treatments: 5 to 26 sessions (12.5 ± 4.7)	Waitlist control	6 months	Cognitive functioning	CIS-concentration	SMD_{FU}: –0.45 [–0.85; –0.05]
Gonzalez-Fernandez et al. 2018 [41], Spain	66 cancer survivors with emotional distress (HADS subscale ≥ 8) **Baseline:** **I: 22** **C1: 27** C2: 17 **PI:** 12w **I: 17** **C1: 23** C2: 12 **No follow-up**	51.66 ± 6.76 I: NM C: NM	NM	**Behavioural activation:** PIP: Self-observation and -report, rehearsal and behavior modeling, elaboration of activity hierarchies, behavior programming, contingency management, acceptance of distancing from emotions and thoughts. BGA: Time-contingent, re-establishing relevant day-to-day routines and activities.	12 weeks 12 group sessions (90 minutes, 6 people)	Waitlist control	12 weeks	Anxiety Depression Avoidance and psychological inflexibility (psychological distress) Social impairment	HADS-A HADS-D AAQ-II BADS subscale	SMD_{FU}: –1.29 [–1.91; –0.66] SMD_{FU}: –0.96 [–1.56; –0.37] SMD_{FU}: –1.00 [–1.6; –0.40] SMD_{FU}: –0.38 [–0.95; 0.19]
Ham et al. 2019 [60], South Korea	80 cancer patients with depressive symptoms (>16 on BDI-II and/or >39 on STAI) Baseline: I: 28 C1: 26 **C2: 26** PI: I: 21 C1: 21 **C2: 21**	I: 41.90 ± 11.30 C1: 43.52 ± 10.37 C2: 47.10 ± 11.19	NM	**CBT:** PIP psychoeducation, behavioural activation, relaxation training, cognitive restructuring, problem-solving **BGA:** Planning activities within behavioural activation	10 weeks Via application One session per day excluding weekends 48 sessions of 10–15 min	Waitlist control	10 weeks	Anxiety Depression Health-related quality of life	STAI (state anxiety) BDI-II SF-36	SMD_{PU}: –1.28 [–1.87; –0.69] SMD_{PU}: –0.82 [–1.38; –0.26] SMD_{PU}: –0.01 [–0.55; 0.53]
Hatchett et al. 2013 [43], USA	74 sedentary breast cancer survivors **Baseline:** I: 36 C: 38 **PI:** 12w **No follow-up**	NM	Time since diagnosis I: 5 m C: 3 m	**Social cognitive theory:** PIP: Goal setting, time management, self-regulation, self-efficacy, self-monitoring, overcoming barriers BGA: Goal setting, anticipated result of exercise, Exercise role identity.	12 weeks 8 e-mails Access to e-counselor	Waitlist control	12 weeks	Physical activity vigorous intensity (self-reported PA)	PAR-7D subscale	SMD_{FU}: –0.91 [–1.39; –0.43]

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Korstjens et al. 2008 [45], The Netherlands	209 cancer survivors with minimal 3 psychological or physical problems (≥ 3m last cancer-treatment) **Baseline:** **I: 76** **C1: 62** C2: 71 **PI:** 12w **I: 70** **C1: 60** C2: 66 **No follow-up**	49.5 ± 10.4 y I: 47.8 ± 10.5 C: 51.3 ± 8.8y	Time since therapy: 1.5 ± 2.1 y I: 1.2 ± 1.3 y C: 1.9 ± 2.7 y	**CBT/PE:** CBT (PIP): Problem solving therapy: Self-management skills in striving for personal goals (work, household, PA, ..) PE (BGA): - Tailormade basic training program: aerobic bicycle training (30 min), muscle strength training (30 min), group sports and games (1h), - Information on exercise physiology, illness perceptions, and self-management.	12 weeks Once a week CBT Twice a week PE	Waitlist control	12 weeks	Role limitations (Emotional functioning) Bodily Pain Physical functioning (Self-reported PA) Mental health (psychological distress) Quality of Life (General Health perception) Role limitations, physical (Role functioning) Social functioning	SF-36 subscale SF-36 subscale SF-36 subscale SF-36 subscale SF-36 subscale SF-36 subscale SF-36 subscale	SMD_{PIt}: –0.27 [–0.61; 0.07] SMD_{PIt}: –0.17 [–0.50; 0.17] SMD_{PIt}: –0.56 [–0.89; –0.23] SMD_{PIt}: –0.24 [–0.58, 0.10] SMD_{PIt}: –0.20 [–0.54; 0.14] SMD_{PIt}: –0.55 [–0.89; –0.21] SMD_{PIt}: –0.24 [–0.57; 0.10]
Prinsen et al. 2013 [53], The Netherlands	37 Severely fatigued (CIS ≥35) cancer survivors **Baseline:** I: 23 C: 14 **PI:** 6m **No follow-up**	I: 48.5 ± 9.2 C: 50.7 ± 10.9	Time since therapy I: 52.2 ± 63.8 m C: 45.3 ± 36.8 m	**CBT:** PIP: Post-cancer fatigue, insufficient coping, fear of disease recurrence, dysfunctional cognitions, dysregulation of sleep, low social support and negative social interaction. BGA: Tailored PE (walking or cycling), baseline, increased by 1min each activity day, goal (120min). Gradually, PE will be replaced by other activities (personal goals).	6 months Number of 1h sessions until the goal is reached. Individually tailored.	Waitlist control	6 months	Fatigue Functional impairment Physical activity (Objectively measured PA)	CIS-F SIP-8 Actigraphy	SMD_{PIt}: –1.45 [–2.2; –0.70] SMD_{PIt}: –1.15 [–1.87; –0.43] SMD_{PIt}: –0.28 [–0.95; 0.39]
Van Weert et al. 2010 [57], The Nederland	209 cancer survivors with minimal 3 psychological or physical problems (≥ 3m last cancer-treatment) **Baseline:** **I: 76** **C1: 62** C2: 71 **PI:** 12w **I: 70** **C1: 60** C2: 62 **No follow-up**	I: 47.8 ± 10.5 C: 51.3 ± 8.8	Time since therapy I: 1.2 ± 1.3 y C: 1.9 ± 2.7 y	**CBT/PT:** CBT (PIP): Self-management: 1-4th session: Distress, exercise physiology and relaxation 5–12th session: Problem-solving process PE (BGA): Individual goal, self-monitoring and acquiring mastery experiences Aerobic + strength training	12weeks 24h × 1w 2h sessions Homework: 30m × 1w 12 weeks Individual PE: 24h × 2w 1h sessions Group sports /games: 24h × 2w 1h sessions	Waitlist control	12 weeks	General fatigue	MFI subscale	SMD_{PIt}: –0.57 [–0.91; –0.23]
PIP + BGA versus other interventions										
PIP + BGA versus usual care										
Armes et al. 2007 [31], UK	55 cancer patients completing cytotoxic treatment **Baseline:** I: 28 C: 27 **PI:** 9–12w **Follow-up F1:** 1m PI **Follow-up F2:** 6m PI	I: 57 ± 12.1 C: 61.3 ± 10.6	NM	**CBT:** PIP: - Session 1-3: cognitive, behavioral and general approach BGA: - Session 2: Cognitive: goal setting behavioral: activity scheduling and graded task management - Session 3: behavioral: modification of goal setting, activity scheduling and graded task management	9 to 12 weeks (length of cytotoxic treatment) 3 individual sessions, 60 minutes, 3 to 4 weekly (coinciding with administration chemotherapy)	Usual care: guidelines National Comprehensive Cancer Network	Depending on cytotoxic treatment,	Fatigue Physical functioning (Self-reported PA)	VAS-F EORTC-QLQ-C30	SMD_{PIt}: –0.33 [–0.87; 0.21] SMD_{F1t}: –0.70 [–1.25; –0.15] SMD_{F2t}: –0.67 [–1.22; –0.12] SMD_{PIt}: –0.09 [–0.63; 0.45] SMD_{F1t}: –0.68 [–1.24; –0.13] SMD_{F2t}: –0.48 [–1.03; 0.06]

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Arving et al. 2019 [32], Norway & Sweden	291 cancer patients **Baseline:** I: 145 C: 146 **PI:** 6w **Follow-up F2:** 4m PI **Follow-up F3:** 18m PI	61 (range, 22-81)	Time since diagnosis: mean 107 d Time since therapy: I: mean 27 d	**CBT:** PIP: - Session 1: introduction to stress and stress responses - Session 3-8: higher intensity stress management BGA: - Session 1: benefits of physical activity, instructions for physical exercise at home - All sessions: motivating to increase physical activity	Within 6 weeks: - All patients: session 1 at the start + session 2 (face-to-face or over telephone) Within 35 weeks: - Patients avoidance behavior/intrusive thoughts (≥ 9 IES) and/or anxiety and depression (≥ 8 HADS): extra sessions 3-8	Patient education and physical training	6 weeks	Anxiety Depression Stress (psychological distress)	HADS-A HADS-D ELSS	SMD_{P1r}: –0.11 [–0.34; 0.12] SMD_{F2r}: –0.16 [–0.39; 0.07] SMD_{F3r}: –0.05 [–0.28; 0.18] SMD_{P1r}: –0.08 [–0.31; 0.15] SMD_{F2r}: 0.00 [–0.23; 0.23] SMD_{F3r}: –0.08 [–0.31; 0.15] SMD_{P1r}: –0.17 [–0.40; 0.06] SMD_{F2r}: –0.10 [–0.33; 0.13] SMD_{F3r}: –0.12 [–0.35; 0.11]
Carmack Taylor et al. 2006 [33], USA	134 prostate cancer patients receiving androgen-ablation **Baseline:** **I: 46** **C1: 37** C2: 51 **PI:** 6m I: 36 C1:31 **Follow-up F2:** 6m PI I: 35 C1: 34	69.2 (range, 44.8 - 89.0)	Time since therapy mean 32.7 m	**lifestyle support program:** PIP: In-session skills practice and homework, reviewing homework and weekly goals, goal-setting, problem-solving barriers to goal attainment. BGA: Goal setting, incorporate at least 30min of moderate intensity activity most days of the week.	6 months 16 weekly sessions 4 biweekly sessions 1.5h in groups of 8	Usual care: mail with educational material and community resources	6 months	Anxiety Depression Role limitation (emotional functioning) Pain Endurance (objectively measured PA) Physical functioning (Self-reported PA) Mental component (psychological distress) Quality of Life Role limitation (Role functioning) Social functioning	STAI CES-D SF-36 subscale BPI 6MWT (meters) SF-36 subscale SF-36 subscale SF-36 subscale SF-36 subscale SF-36 subscale	$SMD_{P1r(E+UC)}$: –0.11 [–0.47; 0.25] $SMD_{F2r(E+UC)}$: –0.08 [–0.44; 0.28] $SMD_{P1r(E+UC)}$: –0.05 [–0.41; 0.30] $SMD_{F2r(E+UC)}$: –0.08 [–0.43; 0.28] $SMD_{P1r(E+UC)}$: 0.05 [–0.31; 0.41] $SMD_{F2r(E+UC)}$: 0.22 [–0.14; 0.57] $SMD_{P1r(E+UC)}$: 0.20 [–0.16; 0.56] $SMD_{F2r(E+UC)}$: 0.19 [–0.17; 0.55] $SMD_{P1r(E+UC)}$: 0.05 [–0.31; 0.41] $SMD_{F2r(E+UC)}$: 0.16 [–0.20; 0.52] $SMD_{P1r(E+UC)}$: –0.01 [–0.37; 0.34] $SMD_{F2r(E+UC)}$: 0.17 [–0.19; 0.53] $SMD_{P1r(E+UC)}$: 0.15 [–0.21; 0.51] $SMD_{F2r(E+UC)}$: 0.10 [–0.26; 0.46] $SMD_{P1r(E+UC)}$: 0.02 [–0.34; 0.37] $SMD_{F2r(E+UC)}$: 0.01 [–0.35; 0.37] $SMD_{P1r(E+UC)}$: 0.09 [–0.27; 0.45] $SMD_{F2r(E+UC)}$: 0.06 [–0.30; 0.41] $SMD_{P1r(E+UC)}$: 0.23 [–0.13; 0.58] $SMD_{F2r(E+UC)}$: 0.10 [–0.25; 0.46]
Dalton et al. 2004 [35], USA	121 cancer patients with elevated scores on BPP scales Baseline: **I: 45** **C1: 33** C2: 43 **PI:** 5w **Follow-up F1:** 1m PI **Follow-up F2:** 6m PI	52 ± NM I: NM C: NM	Time since diagnosis: I: mean 51.4 m	**Profile-tailored CBT**: PIP: Systematically selected in response to patient characteristics Environmental influences, loss of control, health care avoidance, past and current experience, physiologic responsivity, thoughts of disease progression BGA: - Loss of control: activity planning - Health care avoidance: list activities in combination with desensitization	5 weeks 5 sessions of 50 minutes (optional: 3/5 telephone) Homework Pain diary	Usual care: Pain dairy	5 weeks	Pain intensity Pain interference (functional impairment) Insomnia Physical component (Self-reported PA) Mental component (psychological distress)	BPI subscale BPI subscale Symptom distress scale SF-12 subscale SF-12 subscale	Mean change I_{PI}: –2.1 Mean change C_{PI}: –0.0 Mean change I_{6m}: –0.3 Mean change C_{6m}: –0.1 Mean change I_{PI}: –0.9 Mean change C_{PI}: 0.5 Mean change I_{PI}: –0.1 Mean change C_{PI}: –1.0 Mean change I_{PI}: 1.6 Mean change C_{PI}: –3.8 Mean change I_{1m}: 2.1 Mean change C_{1m}: –5.4 Mean change I_{PI}: –0.1 Mean change C_{PI}: –0.8 Mean change I_{1m}: –1.2 Mean change C_{1m}: 1.8

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Fillion et al. 2008 [37], Canada	94 breast cancer patients **Baseline:** I: 44 C: 43 **PI:** 4w **Follow-up F1:** 3m PI	52.47 ± 9.91 I: 53.09 ± 9.65 y C: 51.84 ± 10.25 y	NM	**Stress-management psycho-education/PE:** Stress-management psycho-education (PIP): - Walking sessions with behavioral influences - Psycho-education management sessions: muscle-relaxation PE (BGA): - Focus on benefits and immediate outcomes of exercise - focus on choice and control of exercise - feedback after every session to reinforce self-efficacy - motivation and positive outcomes	4 weeks 4 group meetings of 2,5 hours: - 1h walking training - 1,5h psycho-educative fatigue management 1 telephone booster	Usual care: - Conventional medical follow-up, - Invited to take part in a stress management / physical activity group intervention.	4 weeks	Fatigue Physical Fitness (Objectively measured PA) Physical component (Self-reported PA) Mental component (psychological distress)	MFI Treadmill walking test SF-12 subscale SF-12 subscale	SMD_{PIr}: –0.19 [–0.61; 0.23] SMD_{F1Ir}: –0.34 [–0.76; 0.08] SMD_{PIr}: –0.11 [–0.53; 0.31] SMD_{F1Ir}: –0.06 [–0.48; 0.36] SMD_{PIr}: –0.29 [–0.71; 0.13] SMD_{F1Ir}: –0.16 [–0.58; 0.26] SMD_{PIr}: 0.23 [–0.19; 0.66] SMD_{F1Ir}: –0.04 [–0.46; 0.38]
Goedendorp et al. 2010 [40], The Netherlands	240 cancer patients (without lung or head and neck cancer) **Baseline:** **I: 82** **C1: 81** C2: 77 **PI:** 6m **I: 75** **C1: 71** C2: 72 **No follow-up**	56.7 ± 10.8 I: 55.6 ± 11.3 C: 57.3 ± 11.1	NM	**CBT:** PIP: Discuss activity-related cognitions, fatigue-related cognitions, sleep-wake rhythm, effects of cancer treatment, contact with others and plans for future. BGA: Stepwise increase PA, activity-related cognitions discuss	6 months 10 × 1-hour session Booklet	Usual care: Guidelines of the cancer center (multidisciplinary, no supportive care for fatigue)	6 months	Fatigue severity Objectively measured PA Self-reported PA	CIS-F Actometer QPA	SMD_{PIr}: –0.52 [–0.82; 0.21] SMD_{PIr}: –0.08 [–0.39; 0.22] SMD_{PIr}: –0.21 [–0.53; 0.11]
Pinto et al. 2005 [50], USA	86 Breast cancer patients **Baseline:** I: 43 C: 43 **PI:** 3m I: 39 C: 43 **No follow-up**	I: 53.42 ± 9.08 C: 52.86 ± 10.38	Time since diagnosis I: 1.74 ± 1.49 C: 1.93 ± 1.37	**Home-Based Physical Activity Intervention:** Counseling (PIP): Identify health problems, motivational readiness, solve barriers to PE, PE-goals. PE (BGA): Instructions: how to exercise at a moderate-intensity level, to monitor heart rate, to warm-up and cool down	3 months Weekly calls 3 months 1 face-to-face session Home-based First week: 10min, twice a week Gradually increase: 30min 5 times a week.	Usual care: No counseling related to PA, Symptom questionnaire. Weekly calls for 3 months	3 months	Fatigue Objectively measured PA Self-reported PA Psychological symptoms	VAS-F Caltrac accelerometer 7-D PAR POMS	SMD_{PIr}: –0.67 [–1.11; –0.24] SMD_{PIr}: 0.04 [–0.38; 0.46] SMD_{PIr}: –0.75 [–1.19; –0.31] SMD_{PIr}: 0.03 [–0.39; 0.46]
Poort et al. 2020 [52], The Netherlands	134 Fatigued (CIS ≥ 35) cancer patients **Baseline:** **I: 46** **C1: 46** C2: 42 **Follow-up F1:** 4 w PI **follow-up F2:** 12w PI	I: 63.50 ± 8.15 C: 63.93 ± 8.98	Time since diagnosis C: 5.83 ± 5.46 y	**CBT:** PIP: Reduce severe fatigue and fatigue-related disability: activities or areas of functioning affected by the patient's fatigue. BGA: Module 4: regulation of activity:	12 weeks 10 × 1h individual sessions.	Usual care: National guidelines by the Netherlands Comprehensive Cancer Organization.	12 weeks	Emotional functioning Fatigue Functional Impairments Physical functioning (Self-reported PA) Quality of Life	EORTC-QLQ-C30 CIS-F SIP-8 EORTC-QLQ-C30 EORTC-QLQ-C30	$SMD_{PIr(PA+UC)}$: –0.53 [–0.90; –0.17] $SMD_{F1r(PA+UC)}$: –0.43 [–0.79; 0.07] $SMD_{F2r(PA+UC)}$: –0.23 [–0.59; 0.13] $SMD_{PIr(PA+UC)}$: –0.24 [–0.59; 0.12] $SMD_{F1r(PA+UC)}$: –0.19 [–0.55; 0.16] $SMD_{F2r(PA+UC)}$: –0.19 [–0.55; 0.17] $SMD_{PIr(PA+UC)}$: –0.29 [–0.65; –0.07] $SMD_{F1r(PA+UC)}$: –0.27 [–0.63; 0.08] $SMD_{F2r(PA+UC)}$: –0.23 [–0.59; 0.12] $SMD_{PIr(PA+UC)}$: –0.71 [–1.08; –0.34] $SMD_{F1r(PA+UC)}$: –0.63 [–0.99; –0.26] $SMD_{F2r(PA+UC)}$: –0.62 [–0.99; –0.26] $SMD_{PIr(PA+UC)}$: –0.60 [–0.97; –0.24] $SMD_{F1r(PA+UC)}$: –0.70 [–1.06; –0.33] $SMD_{F2r(PA+UC)}$: –0.54 [–0.91; –0.18]

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Zhang et al. 2018 [58], China	67 moderately fatigued (PFS >4) ovarian cancer patients **Baseline:** I: 33 C: 34 **PI:** 12w **Follow-up F1:** 3m PI	I: 18-35: (*n*=2) 36-45: (*n*=6) 46-55: (*n*=14) 56-65: (*n*=11) C: 18-35: (*n*=2) 36-45: (*n*=6) 46-55: (*n*=16) 56-65: (*n*=10)	NM	**CBT/PE:** CBT (PIP): Phase 1: establish a trusting relationship and identifying the patient's thoughts. Phase 2: assessment of fatigue and monitor erroneous thinking Phase 3: goal setting: reinforcing physical, emotional and spiritual coping strategies.	12 weeks 1 session a week 60min each session Online intervention provided by nurses	Usual care: Drug education, balanced diet recommendations, health education about ovarian cancer chemotherapy	12 weeks	Depression	SDS	SMD_{P1r}: −0.89 [−1.4; −0.39] SMD_{F1r}: −1.13 [−1.65; −0.62]
				PE (BGA): Personal training goals. Program follows the time-tested principles of patient-oriented care.	12 weeks 3-5 sessions a week 25-60 min each session Home-based program (self-help manual) Monitored by nurses (telephone)			Fatigue	PFS	SMD_{P1r}: −0.53 [−1.02; −0.04] SMD_{F1r}: −0.83 [−1.33; −0.33]
								Sleep	PSQI	SMD_{P1r}: −0.43 [−0.91; 0.06] SMD_{F1r}: −0.43 [−0.92; 0.05]
Zhou et al. 2020 [61], China	73 patients with ovarian cancer receiving chemotherapy Baseline: I: 37 C: 36 PI: I: 37 C: 36	I: 58.64 ± 13.82 C: 60.23 ± 15.78		**CBT:** - Establish a harmonious nurse-patient relationship - Brochures with education and cognitive techniques - cognitive notebook - exercise intervention - relaxation therapy - ideamotor BGA: Behavioural interventions: exercises include stairs climbing, walking, isometric contraction, etc., once a day for 10 minutes (then gradually extended to 20 or 30 minutes) for each	At home 1 month Combined with conventional nursing interventions	Usual care: conventional nursing interventions in chemotherapy; methods and drugs of chemotherapy, psychological counselling, health education.	1 month	Anxiety	SAS	SMD_{P1r}: −0.80 [−1.27; −0.32] SMD_{F1r}: −0.90 [−1.38; −0.42]
								Depression	SDS	SMD_{P1r}: −0.39 [−0.84; −0.09] SMD_{F1r}: −0.59 [−1.06; −0.12]
								Fatigue	RPFS - Behavioural	SMD_{P1r}: −0.89 [−1.37; −0.41]
								Functional	EORTC-QLQ-C30 subscale	SMD_{P1r}: 1.52 [−2.10; 0.32]
								Sleep quality	PSQI	SMD_{P1r}: −2.76 [−3.41; −2.11]
								QOL	EORTC-QLQ-C30	SMD_{P1r}: −0.93 [−1.42; −0.45]
PIP + BGA versus education										
Carmack Taylor et al. 2006 [33], USA	134 prostate cancer patients receiving androgen-ablation **Baseline:** **I: 46** C1: 37 **C2: 51** **PI: 6m** I: 36 C2: 44 **Follow-up F2** I: 35 C2: 44	69.2 (range, 44.8-89.0)	Time since therapy: mean 32.7 m	**Lifestyle support program:** PIP: In-session skills practice and homework, reviewing homework and weekly goals, goal-setting, problem-solving barriers to goal attainment. BGA: Goal setting, incorporate at least 30min of moderate intensity activity most days of the week.	6 months 16 weekly sessions 4 biweekly sessions 1,5h in groups of 8	Educational support program: Group discussions with different topics, sexuality, treatment side effects, emotional well-being.	6 months 16 weekly sessions 4 biweekly sessions 1,5h in groups of 8	Anxiety	STAI	$SMD_{P1r(E+UC)}$: −0.11 [−0.47; 0.25] $SMD_{F2r(E+UC)}$: −0.08 [−0.44; 0.28]
								Depression	CES-D	$SMD_{P1r(E+UC)}$: −0.05 [−0.41; 0.30] $SMD_{F2r(E+UC)}$: −0.08 [−0.43; 0.28]
								Role limitation (emotional functioning)	SF-36 subscale	$SMD_{P1r(E+UC)}$: 0.05 [−0.31; 0.41] $SMD_{F2r(E+UC)}$: 0.22 [−0.14; 0.57]
								Pain	BPI	$SMD_{P1r(E+UC)}$: 0.20 [−0.16; 0.56] $SMD_{F2r(E+UC)}$: 0.19 [−0.17; 0.55]
								Endurance (Objectively measured PA)	6MWT (meters)	$SMD_{P1r(E+UC)}$: 0.05 [−0.31; 0.41] $SMD_{F2r(E+UC)}$: 0.16 [−0.20; 0.52]
								Physical functioning (Self-reported PA)	SF-36 subscale	$SMD_{P1r(E+UC)}$: −0.01 [−0.37; 0.34] $SMD_{F2r(E+UC)}$: 0.17 [−0.19; 0.53]
								Mental component (psychological distress)	SF-36 subscale	$SMD_{P1r(E+UC)}$: 0.15 [−0.21; 0.51] $SMD_{F2r(E+UC)}$: 0.10 [−0.26; 0.46]
								Quality of life	SF-36 subscale	$SMD_{P1r(E+UC)}$: 0.02 [−0.34; 0.37] $SMD_{F2r(E+UC)}$: 0.01 [−0.35; 0.37]
								Role limitation (Role functioning)	SF-36 subscale	$SMD_{P1r\ (E+UC)}$: 0.09 [−0.27; 0.45] $SMD_{F2r\ (E+UC)}$: 0.06 [−0.30; 0.41]
								Social functioning	SF-36 subscale	$SMD_{P1r(E+UC)}$: 0.23 [−0.13; 0.58] $SMD_{F2r(E+UC)}$: 0.10 [−0.25; 0.46]

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Greer et al. 2019 [42], USA	145 cancer patients with anxiety (HADS-anxiety >7) **Baseline:** I:72 C:73 **PI:** 12w **No follow-up**	56.45 ± 11.30 I: 55.86 ± 10.08 C: 57.03 ± 12.42	Time since diagnosis I: 7.49 (range, 1.99-24.28) m C: 7.69 (range, 1.86-23.26) m	**CBT:** PIP: - Psychoeducation - Relaxation Training - Activity Planning and Pacing - Problem-Solving Communication BGA: - Activity planning and pacing	12 weeks Mobile app 6 sessions (20-30min) Homework exercises	Health education program (Information about): side effects of cancer treatment, exercise, nutrition, memory and cognition, sexual health, QOL	12 weeks Mobile app 6 sessions (20-30min)	Anxiety Depression Quality of Life	HAM-A HADS-D FACT-G	SMD_{Pit}: –0.14 [–0.46; 0.19] SMD_{Pit}: –0.14 [–0.47; 0.18] SMD_{Pit}: –0.001 [–0.33; 0.32]
Onyedibe et al. 2020 [62], Nigeria	31 breast cancer patients with anxiety and depression (HADS-A >10, HADS-D >8) Baseline: I:20 C:19 PI: I:18 C: 16 Follow-up F1 I: 16 C: 16	I: 45.37 ± 9.96 C: 48.91 ± 6.91	Time since diagnosis: I: <1y: 12.5% 1-5 year: 68.8% 6–10years: 12.5% >10years: 6.3% C: <1y: 40% 1–5 year: 20% 6–10years: 40% Over 10years: 0	**CBT:** PIP: cognitive restructuring, behavioural strategies, and self-expression BGA: Activity scheduling was introduced in the fifth session and participants were guided on how to use it at home.	12 weeks 12 90-minute sessions in group	Education: Booklet containing information on cancer, psychological issues with cancer and how to cope with cancer	12 weeks	Anxiety Depression	HADS-A HADS-D	SMD_{Pit}: –1.75 [–2.50; –1.00] SMD_{F1t}: –2.27 [–3.09; –1.45] SMD_{Pit}: –1.84 [–2.60; –1.08] SMD_{F1t}: –2.78[–3.69; –1.88]
Pinto et al. 2013 [51], USA	192 Breast cancer patients **Baseline:** I: 106 C: 86 **PI:** 3m I: 88 C: 83 **Follow-up F1:** 3m PI I: 85 C:77 **Follow-up F3:** 9m PI I: 82 C: 76	I: 56.1 ± 9.9 C: 55.9 ± 9.9	Time since diagnosis I: 3.0 ± 2.2 y C: 2.9 ± 2.1 y	**Health carer provider advice for PE:** HCP (PIP): PE advise: 5As counselling strategy Counselling: strengthening self-efficacy, self-monitoring, setting PE-goals and planning for exercise. PE (BGA): Individualized baseline, motivational readiness, goals gradually increased. 3 months (clinician or document)	8 calls 3 months 30min/day, 5 days/week	Education: PA advise: 5As counseling strategy No counseling related to PA, Symptom questionnaire.	3 months (clinician or document) 8 calls	Fatigue Self-reported PA	FACT-F 7-D PAR	SMD_{Pit}: –0.13 [–0.42; 0.15] SMD_{F1t}: –0.22 [–0.51; 0.06] SMD_{F3t}: –0.26 [–0.55; 0.02] SMD_{Pit}: –0.23 [–0.52; 0.05] SMD_{F1t}: –0.26 [–0.54; 0.03] SMD_{F3t}: –0.07 [–0.35; 0.22]
Sandler et al. 2017 [54], Australia	46 fatigued (SOMA subscale ≥ 3) cancer survivors **Baseline:** I: 22 C: 24 **PI:** 12w I: 18 C: 21 **Follow-up F1:** 12w PI I: 18 C: 22	I: 53.1 ± 10.3 C: 49.3 ± 8.6	Time since therapy I: 8.9 ± 4.5 m C: 7.6 ± 2.3 m	**CBT/PE:** CBT (PI): Psycho-education, sleep-wake cycle disturbance management and neuro-cognitive disturbance management PE (BGA): Activity pacing, barriers to pacing, review progress, goal setting	12 weeks 6 to 8 individual 55 min consultations with CP 12 weeks 5 individual 45min consultations with EP	CBT education: Principles of CBT GET education:	Book 1 session with clinical psychologist Book 1 session with exercise physiologist	Fatigue Sleep disorders Self-reported PA Mood disorder (psychological distress) Social functioning	SOMA (SPHERE subscale) PSQI IPAQ PSYCH (SPHERE subscale) SF-36 subscale	SMD_{Pit}: –0.75 [–1.36; –0.15] SMD_{F1t}: 0.17 [–0.41; 0.75] SMD_{Pit}: –0.21 [–0.79; 0.37] SMD_{F1t}: –0.22 [–0.81; 0.36] SMD_{Pit}: –0.07 [–0.65; 0.51] SMD_{F1t}: –0.02 [–0.60; 0.56] SMD_{Pit}: –0.06 [–0.64; 0.51] SMD_{F1t}: –0.26 [–0.84; 0.32] SMD_{Pit}: –0.15 [–0.73; –0.43] SMD_{F1t}: 0.04 [–0.54; –0.62]
PIP + BGA versus PE										
McGowan et al. 2013 [49], Canada	282 Prostate cancer survivors **Baseline:** I: 141 C: 141 **PI:** 1m I: 103 C: 114 **Follow-up F1:** 2m PI I: 98 C: 102	I: 68.9 (range, 47-88) C: 67.9 (range, 48-89)	Time since diagnosis I: 27.0 ± 16.8 m C: 25.6 ± 6.5 m	**Behaviour change intervention Self-administered + Telephone-assisted:** PIP: Self-administered implementation intention intervention: S.M.A.R.T. goal setting, detailed plan, barriers and strategies PAE(BGA): Counseling: assist with goal setting and planning. Guideline for American cancer survivors	1 month To complete on their own After implementation intention plus a telephone call. Two-page summary fact sheet	PA: Guideline for American cancer survivors	Two-page summary fact sheet	Fatigue Physical activity (min/week) (Self-reported PA) Mental component (psychological distress)	PFS LSI Subscale SF-36	SMD_{Pit}: –0.17 [–0.41; 0.06] SMD_{Pit}: –0.06 [–0.29; 0.17] SMD_{F1t}: 0.08 [–0.15; 0.32] SMD_{Pit}: –0.04 [–0.27; 0.19]

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Poort et al. 2020 [52], The Netherlands	134 Fatigued (CIS ≥ 35) cancer patients **Baseline:** **I: 46** C1: 46 **C2: 42** **PI:** 12 w **Follow-up F1:** 4 w PI **follow-up F2:** 12w PI	I: 63.50 ± 8.15 C: 60.67 ± 10.75	Time since diagnosis I: 5.31 ± 4.95 y C: 6.17 ± 5.29 y	**CBT:** PIP: Reduce severe fatigue and fatigue-related disability: activities or areas of functioning affected by the patient's fatigue. BGA: Module 4: regulation of activity:	12 weeks 10 × 1h individual sessions.	GET (PA) Graded exercise program: Aerobic and resistance training	12 weeks Weekly 2h supervised sessions	Emotional functioning	EORTC-QLQ-C30	$SMD_{PI\pi(PA+UC)}$: −0.53 [−0.90; −0.17] $SMD_{F1\pi(PA+UC)}$: −0.43 [−0.79; 0.07] $SMD_{F2\pi(PA+UC)}$: −0.23 [−0.59; 0.13]
								Fatigue	CIS-F	$SMD_{PI\pi(PA+UC)}$: −0.24 [−0.59; 0.12] $SMD_{F1\pi(PA+UC)}$: −0.19 [−0.55; 0.16] $SMD_{F2\pi(PA+UC)}$: −0.19 [−0.55; 0.17]
								Functional Impairments	SIP-8	$SMD_{PI\pi(PA+UC)}$: −0.29 [−0.65; −0.07] $SMD_{F1\pi(PA+UC)}$: −0.27 [−0.63; 0.08] $SMD_{F2\pi(PA+UC)}$: −0.26 [−0.62; 0.10]
								Physical functioning (Self-reported PA)	EORTC-QLQ-C30	$SMD_{PI\pi(PA+UC)}$: −0.71 [−1.08; −0.34] $SMD_{F1\pi(PA+UC)}$: −0.63 [−0.99; −0.26] $SMD_{F2\pi(PA+UC)}$: −0.62 [−0.99; −0.26]
								Quality of Life	EORTC-QLQ-C30	$SMD_{PI\pi(PA+UC)}$: −0.60 [−0.97; −0.24] $SMD_{F1\pi(PA+UC)}$: −0.70 [−1.06; −0.33] $SMD_{F2\pi(PA+UC)}$: −0.54 [−0.91; −0.18]
Vallance et al. 2007 [56], Canada	377 breast cancer survivors **Baseline:** **I: 94** I_2: 94 I_3: 93 **C: 96** **PI:** 12w **I: 81** I2: 88 I3: 84 **C: 85** **No follow-up**	58 (range, 30-90) I: 57 (range, 31-88) C: 57 (range, 37-90)	Time since diagnosis 39.0 ± 11.3 I: 38.9 ± 10.7 m C: 39.9 ± 11.2 m	Theory of planned behaviour (PIP): Participant-centered activities perceived behavioral control and goal setting.	12 weeks Home-based Guidebook (10 chapters)	PA: Standard public health recommendation	12 weeks: Home-based 30min moderate /vigorous 5 d /week	Fatigue	FS	$SMD_{PI\pi}$: −0.06 [−0.35; 0.22]
								7-day pedometer step count (physical activity objective)	Digi-Walker pedometer	$SMD_{PI\pi}$: 0.05 [−0.23; 0.34]
				Theory-based PE (BGA): Walking program, learn-to-jog program, standard public health recommendation	12 weeks Home-based 30min moderate /vigorous 5 d /week			Self-reported PA	LSI	$SMD_{PI\pi}$: −0.23 [−0.52; 0.05]
								Quality of Life	FACT-B	$SMD_{PI\pi}$: −0.10 [−0.40; 0.21]
PIP + BGA versus BGA										
Duijts et al. 2012 [36], The Netherlands	422 breast cancer survivors reporting treatment-induced menopausal symptoms **Baseline:** **I: 106** C_1: 103 **C_2: 104** C_3: 109 **PI:** 12w **I: 90** C_1: 89 **C_2: 87** C_3: 86 **Follow-up F1:** 3m PI **I: 89** C_1: 84 **C_2: 79** C_3: 88	48.2 ± 5.6 I: 49.0 ± 4.9 C: 47.7 ± 5.6	NM	**CBT/PE:** CBT (PIP): Relaxation exercises, focus on hot flashes, night sweats and problem areas	12 weeks Concurrently: 6 weekly group sessions of 90 min	PA (BGA): - Selecting appropriate form of exercise - Achieve target heart rate (60 to 80% Karvonen)	12 weeks Individually tailored, home-based 2,5-3h per week, telephone interviews in weeks 4 and 8	Bodily pain	SF-36 subscale	$SMD_{PI\pi}$: 0.21 [−0.06; 0.49] $SMD_{F1\pi}$: 0.22 [−0.05; 0.50]
				PE (GA): - Selecting appropriate form of exercise - Achieve target heart rate (60 to 80% Karvonen)	Individually tailored, home-based - 2,5-3h per week - telephone interviews in weeks 4 and 8			Physical functioning (Self-reported PA)	SF-36 subscale	$SMD_{PI\pi}$: 0.09 [−0.18; −0.36] $SMD_{F1\pi}$: 0.20 [−0.07; 0.48]
								Mental component (psychological distress)	SF-36 subscale	$SMD_{PI\pi}$: −0.39 [−0.87; 0.08] $SMD_{F1\pi}$: −0.34 [−0.82; 0.13]
Goedendorp et al. 2010 [40], The Netherlands	240 cancer patients (without lung or head and neck cancer) **Baseline:** **I: 82** C1: 81 **C2: 77** **PI:** 3m **I: 75** C1: 71 **C2: 72** **No follow-up**	56.7 ± 10.8 I: 55.6 ± 11.3 C: 57.1 ± 10.0	NM	CBT PIP: Discuss activity-related cognitions, fatigue-related cognitions, sleep-wake rhythm, effects of cancer treatment, contact with others and plans for future. BGA: Stepwise increase PE, discuss activity-related cognitions.	6 months 10 × 1-hour session Booklet	BGA: Stepwise increase PA, discuss activity-related cognitions.	3 months 2 × 1-hour session Booklet	Fatigue severity	CIS-F	$SMD_{PI\pi}$: −0.45 [−0.77; −0.14]
								PA objective	Actometer	$SMD_{PI\pi}$: −0.19 [−0.68; 0.30]
								Self-reported PA	QPA	$SMD_{PI\pi}$: −0.35 [−0.67; −0.02]

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Korstjens et al. 2008 [45], The Netherlands	209 cancer survivors with minimal 3 psychological or physical problems (≥ 3m last cancer-treatment) **Baseline:** **I: 76** C1: 62 **C2: 71** **PI:** 12w **I: 70** C1: 60 **C2: 66** **Follow-up F1:** 3m PI **I: 67** C1: 60 **C2: 65**	49.5 ± 10.4 I: 47.8 ± 10.5 C: 49.9 ± 11.3	Time since therapy: 1.5 ± 2.1 y I: 1.2 ± 1.3 y C: 1.4 ± 2.1 y	**CBT/PE:** CBT (PIP): Problem solving therapy: Self-management skills in striving for personal goals (work, household, PA,) PE (BGA): - Tailormade basic training program: aerobic bicycle training (30 min), muscle strength training (30 min), group sports and games (1h), - Information on exercise physiology, illness perceptions, and self-management.	12 weeks Once a week CBT Twice a week PE	PE (BGA): - Tailormade basic training program: aerobic bicycle training (30 min), muscle strength training (30 min), group sports and games (1h), - Information on exercise physiology, illness perceptions, and self-management.	12 weeks Twice a week (2h)	Role limitations (Emotional functioning) Pain Mental health (psychological distress) Role limitations (Role functioning) Social functioning	SF-36 subscale SF-36 subscale SF-36 subscale SF-36 subscale SF-36 subscale	SMD_{F1r}: 0.00 [–0.32; 0.33] SMD_{F1r}: 0.11 [–0.21; 0.44] SMD_{F1r}: –0.30 [–0.63; 0.02] SMD_{F1r}: –0.18 [–0.51; 0.14] SMD_{F1r}: 0.09 [–0.23; –0.42] SMD_{F1r}: –0.16 [–0.49; 0.16] SMD_{F1r}: –0.02 [–0.34; 0.30] SMD_{F1r}: –0.15 [–0.48; 0.17] SMD_{F1r}: 0.00 [–0.32; 0.33] SMD_{F1r}: –0.14 [–0.47; 0.18]
Korstjens et al. 2011 [46], The Netherlands	147 cancer survivors with minimal 3 psychological or physical problems (≥ 3m last cancer-treatment) **Baseline:** I: 76 C: 71 **PI:** 12w **Follow-up F1:** 3m PI **Follow-up F3:** 9m PI	49.5 ± 10.4 I: 47.8 ±10.5 C: 49.9 ± 11.3	Time since therapy: 1.5 ± 2.1 y I: 1.2 ± 1.3 y C: 1.4 ± 2.1 y	**CBT/PE:** CBT (PIP): Problem solving therapy: Self-management skills in striving for personal goals (work, household, PA, ..) PE (BGA): - Tailormade basic training program: aerobic bicycle training (30 min), muscle strength training (30 min), group sports and games (1h), - Information on exercise physiology, illness perceptions, and self-management.	12 weeks Once a week CBT Twice a week PE	PE (BGA): - Tailormade basic training program: aerobic bicycle training (30 min), muscle strength training (30 min), group sports and games (1h), - Information on exercise physiology, illness perceptions, and self-management.	12 weeks Twice a week (2h)	Anxiety Depression	HADS-A HADS-D	SMD_{F1r}: 0.07 [–0.25; 0.40] SMD_{F1r}: 0.05 [–0.27; 0.37] SMD_{F3r}: 0.16 [–0.16; 0.48] SMD_{F1r}: 0.03 [–0.30; 0.35] SMD_{F1r}: 0.00 [–0.32; 0.32] SMD_{F3r}: 0.02 [–0.30; 0.35]
May et al. 2009 [47], The Netherlands	147 cancer survivors with minimal 3 psychological or physical problems (≥ 3m last cancer-treatment) **Baseline:** I: 76 C: 71 PI: I: 70 C: 66 **Follow-up F1: 3m PI** **Follow-up F3: 9m PI**	48.8 ± 10.9 I: 47.8 ± 10.5 C: 49.9 ± 11.3	Time since therapy 1.3 ± 1.7 y I: 1.2 ± 1.3 y C: 1.4 ± 2.1 y	**CBT/PE:** Principles of self-management: goal selection, info collection, info processing and evaluation, decision making, action and self-reaction CBT (PIP): Self-management skills: solve personal problems. PE (BGA): Personalized program: Bicycle training (30min) Muscle strength training (30min) Group sport (1h)	12 weeks 1x week (2h/session) 2x week (2h/session) Supervised group session.	PE (BGA): Principles of self-management: goal selection, info collection, info processing and evaluation, decision making, action and self-reaction Personalized program: Bicycle training (30min) Muscle strength training (30min) Group sport (1h)	12 weeks 2x week (2h/session) Supervised group session.	Cognitive functioning Quality of Life	EORTC-QLQ-C30 subscale EORTC-QLQ-C30	SMD_{F1r}: 0.02 [–0.31; 0.34] SMD_{F1r}: 0.02 [–0.31; 0.34] SMD_{F3r}: 0.13 [–0.20; 0.45] SMD_{F1r}: 0.10 [–0.23; 0.42] SMD_{F1r}: 0.22 [–0.11; 0.54] SMD_{F3r}: 0.03 [–0.29; 0.35]

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
May et al. 2008 [48], The Netherlands	147 cancer survivors with minimal 3 psychological or physical problems (≥ 3m last cancer-treatment) **Baseline** I: 76 C: 71 **PI:** 12w I: 62 C: 54 **No follow-up**	48.8 ± 10.9 I: 47.8 ± 10.5 C: 49.9 ± 11.3	Time since therapy 1.3 ± 1.7 I: 1.2 ± 1.3 y C: 1.4 ± 2.1 y	**CBT/PE:** Principles of self-management: goal selection, info collection, info processing and evaluation, decision making, action and self-reaction	12 weeks	CBT + PE: Principles of self-management: goal selection, info collection, info processing and evaluation, decision making, action and self-reaction	12 weeks	Physical fitness (PA objective)	VO_2 peak	$SMD_{PI;I}$: 0.07 [–0.25; 0.39]
								Self-reported PA	PASE	$SMD_{PI;I}$: 0.05 [–0.27, 0.37]
				CBT (PIP): Self-management skills: solve personal problems. PE (BGA): Personalized program: Bicycle training (30min) Muscle strength training (30min) Group sport (60)	Once a week (2h/session) Twice a week (2h/session) Supervised group session.	PE (BGA): Personalized program: Bicycle training (30min) Muscle strength training (30min) Group sport (60)	2x week (2h/session) Supervised group session.			
				Walking program	Home-based From the 6th week	Walking program	Home-based From the6th week			
Van Weert et al. 2010 [57], The Nederland	209 cancer survivors with minimal 3 psychological or physical problems (≥ 3m last cancer-treatment) **Baseline:** **I: 76** C1: 62 **C2: 71** **PI:** 12w **I: 70** C1: 60 **C2: 62** **No follow-up**	I: 47.8 ± 10.5 C: 49.9 ± 11.3	Time since therapy I: 1.2 ± 1.3 y C: 1.4 ± 2.1 y	**CBT/PE:** CBT (PIP): Self-management: 1-4th session: Distress, exercise physiology and relaxation 5−12th session: Problem-solving process	12weeks Once a week (2h/sessions) Homework (30m/week)	PE (BGA): - Individual goal, self-monitoring and acquiring mastery experiences - Aerobic + strength training	12 weeks Individual PT: twice a week (1h/sessions) Group sports / games: twice a week (1h/sessions)	General fatigue	MFI subscale	$SMD_{PI;I}$: –0.09 [0.41; 0.24]
				PE (BGA): - Individual goal, self-monitoring and acquiring mastery experiences - Aerobic + strength training	12 weeks -Individual PA: twice a week (1h/sessions) -Group sports /games: twice a week (1h/sessions)					
PIP + BGA versus PIP										
Dalton et al. 2004 [35], USA	121 cancer patients with elevated scores on BPP scales **Baseline:** **I: 45** C1: 33 **C2: 43** **PI:** 5w **Follow-up F1:** 1m PI **Follow-up F2:** 6m PI	52 ± NM I: NM C: NM	Time since diagnosis: I: mean 51.4 m C: mean 27.5 m	**Profile-tailored CBT** PIP: - Systematically selected in response to patient characteristics Environmental influences, loss of control, health care avoidance, past and current experience, physiologic responsivity, thoughts of disease progression BGA: - Loss of control: activity planning - Health care avoidance: list activities in combination with desensitization	5 weeks 5 sessions of 50 minutes (optional: 3/5 telephone) Homework Pain diary	CBT (PIP): - Session 1: assessment of attitudes, beliefs and behavior - Session 2-3: relaxation and attention diversion - Session 4-5: dysfunctional thoughts and maladaptive behavior (imagery, social reinforcement and positive self-statement)	5 weeks 5 sessions of 50 minutes (optional: 3/5 telephone) Homework Pain diary	Pain intensity	BPI subscale	Mean change I_{PI}: –2.1 Mean change C_{PI}: –0.5
								Pain interference (functional impairment)	BPI subscale	Mean change I_{PI}: –0.9 Mean change C_{PI}: 1.5
								Insomnia	Symptom distress scale	Mean change I_{1m}: –0.1 Mean change C_{1m}: –0.2 Mean change I_{6m}: –0.0 Mean change C_{6m}: –1.9
								Physical score (Self-reported PA)	SF-12 subscale	Mean change I_{PI}: 1.6 Mean change C_{PI}: –1.5 Mean change I_{1m}: 2.1 Mean change C_{1m}: 0.9
								Mental score (psychological distress)	SF-12 subscale	Mean change I_{PI}: –0.1 Mean change C_{PI}: 0.2 Mean change I_{1m}: –1.2 Mean change C_{1m}: 2.1

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Duijts et al. 2012 [36], The Netherlands	422 breast cancer survivors reporting treatment-induced menopausal symptoms **Baseline:** **I: 106** C_1: 103 C_2: 104 **C_3: 109** **PI:** 12w **I: 90** C_1: 89 C_2: 87 **C_3: 86** **Follow-up F1:** 3m PI **I: 89** C_1: 84 C_2: 79 **C_3: 88**	48.2 ± 5.6 I: 49.0 ± 4.9 C: 48.2 ± 5.7	NM	**CBT/PT:** CBT (PIP): Relaxation exercises, focus on hot flashes, night sweats and problem areas. PA (BGA): - Selecting appropriate form of exercise, - Achieve target heart rate (60 to 80% Karvonen)	12 weeks Concurrently: 6 weekly group sessions of 90 min Individually tailored, home-based - 2,5-3h per week - telephone interviews in weeks 4 and 8	CBT (PIP) Relaxation exercises, focus on hot flashes, night sweats and problem areas.	12 weeks 6 weekly group sessions of 90 min	Bodily pain Physical functioning (Self-reported PA) Mental component (psychological distress)	SF-36 subscale SF-36 subscale SF-36 subscale	SMD_{PI_r}: –0.05 [–0.31; 0.22] SMD_{F1_r}: 0.25 [–0.01; 0.52] SMD_{PI_r}: 0.01 [–0.26; 0.28] SMD_{F1_r}: 0.01 [–0.26; 0.28] SMD_{PI_r}: –0.18 [–0.63; 0.27] SMD_{F1_r}: –0.36 [–0.82; 0.09]
Fernandez-Rodriguez et al. 2020 [59], Spain	66 cancer survivors with emotional distress (HADS subscale ≥ 8) **Baseline:** **I: 22** C1: 27 **C2: 17** **PI:** 12w **I: 17** C1: 23 **C2: 12** **Follow-up F1: 3 months**	51.66 ± 6.76 I: NM C: NM	NM	**Behavioral activation:** PIP: Self-observation and -report, rehearsal and behavior modeling, elaboration of activity hierarchies, behavior programming, contingency management, acceptance of distancing from emotions and thoughts. BGA: Time-contingent, reestablishing relevant day-to-day routines and activities.	12 weeks 12 group sessions (90 minutes, 6 people)	ACT (PIP): Metaphors and experiential exercise, rehearsal and behavior modeling, behavioral programming, contingency management.	12 weeks 12 group sessions (90 minutes, 6 people)	Anxiety Depression Avoidance and psychological inflexibility (psychological distress) Social impairment	HADS-A HADS-D AAQ-II BADS subscale	SMD_{F1_r}: –0.30 [–0.94; 0.34] SMD_{F1_r}: 0.01 [–0.62; 0.65] SMD_{F1_r}: 0.07 [–0.57; 0.70] SMD_{F1_r}: 0.35 [–0.28; 0.99]
Gonzalez-Fernandez et al. 2018 [41], Spain	66 cancer survivors with emotional distress (HADS subscale ≥ 8) **Baseline:** **I: 22** C1: 27 **C2: 17** **PI:** 12w **I: 17** C1: 23 **C2: 12** **No Follow-up**	51.66 ± 6.76 I: NM C: NM	NM	**Behavioral activation:** PIP: Self-observation and -report, rehearsal and behavior modeling, elaboration of activity hierarchies, behavior programming, contingency management, acceptance of distancing from emotions and thoughts. BGA: Time-contingent, re-establishing relevant day-to-day routines and activities.	12 weeks 12 group sessions (90 minutes, 6 people)	ACT (PIP): Metaphors and experiential exercise, rehearsal and behavior modeling, behavioral programming, contingency management.	12 weeks 12 group sessions (90 minutes, 6 people)	Anxiety Depression Avoidance and psychological inflexibility (psychological distress) Social impairment	HADS-A HADS-D AAQ-II BADS subscale	SMD_{PI_r}: 0.12 [–0.52; 0.75] SMD_{PI_r}: 0.15 [–0.48; 0.79] SMD_{PI_r}: 0.27 [–0.36; 0.91] SMD_{PI_r}: 0.91 [0.25; 1.58]

Table 7 (continued)

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Hopko et al. 2011 [44], USA	80 breast cancer patients with depression (ADIS-IV ≥ 4) **Baseline:** I: 42 C: 38 **PI:** 8w I: 32 C: 33 **Follow-up F1:** 3m PI **Follow-up F2:** 6m PI **Follow-up F3:** 12m PI	55.4 ± 11.9 I: 56.4 ± 11.1 C: 54.3 ± 11.2	Time since diagnosis: 3.2 ± 3.9 y I: 3.5 ± 4.0 y C: 2.8 ± 3.9 y	**Behavioral activation:** PIP: Motivational exercises, depression psychoeducation, systematically increased activity. BGA: Self-monitoring exercise, setting baseline activity hierarchy, goal setting every week.	8 weeks 8 sessions (1h)	Problem-solving therapy (PIP): Motivational exercises, depression psychoeducation, introduction to problem-solving therapy (targeting specific cancer symptoms)	8 weeks 8 sessions (1.5h)	Anxiety	BAI	SMD_{PI_E}: –0.15 [–0.58; 0.29] SMD_{F1_E}: –0.13 [–0.56; 0.31] SMD_{F2_E}: –0.29 [–0.74; 0.15] SMD_{F3m_E}: –0.29 [–0.74; 0.15]
								Depression	BDI-II	SMD_{PI_E}: 0.06 [–0.38; 0.50] SMD_{F1_E}: 0.00 [–0.44; 0.44] SMD_{F2_E}: –0.15 [–0.59; 0.29] SMD_{F3_E}: –0.16 [–0.59; 0.28]
								Emotional functioning	SF-36 subscale	SMD_{PI_E}: 0.21 [–0.23; 0.65] SMD_{F1_E}: 0.19 [–0.25; 0.63] SMD_{F2_E}: 0.03 [–0.40; 0.47] SMD_{F3_E}: –0.11 [–0.55; 0.33]
								Bodily pain	SF-36 subscale	SMD_{PI_E}: 0.08 [–0.36; 0.52] SMD_{F1_E}: –0.35 [–0.80; 0.09] SMD_{F2_E}: –0.57 [–1.02; –0.12] SMD_{F3_E}: –0.65 [–1.10; –0.20]
								Physical functioning (Self-reported PA)	SF-36 subscale	SMD_{PI_E}: –0.06 [–0.38; 0.50] SMD_{F1_E}: –0.18 [–0.62; 0.26] SMD_{F2_E}: –0.28 [–0.72; 0.16] SMD_{F3_E}: –0.26 [–0.70; 0.18]
								Mental health (psychological distress)	SF-36 subscale	SMD_{PI_E}: 0.04 [–0.40; 0.48] SMD_{F1_E}: –0.03 [–0.47; 0.41] SMD_{F2_E}: –0.10 [–0.53; 0.34] SMD_{F3_E}: –0.07 [–0.51; 0.37]
								Quality of Life	QOLI	SMD_{PI_E}: –0.22 [–0.66; 0.22] SMD_{F1_E}: –0.06 [–0.50; 0.38] SMD_{F2_E}: –0.35 [–0.79; 0.09] SMD_{F3_E}: –0.06 [–0.50; 0.38]
								Role functioning	SF-36 subscale	SMD_{PI_E}: –0.10 [–0.55; 0.34] SMD_{F1_E}: –0.64 [–1.09; –0.19] SMD_{F2_E}: –0.07 [–0.51; 0.37] SMD_{F3_E}: –0.42 [–0.86; 0.02]
								Social functioning	SF-36 subscale	SMD_{PI_E}: –0.03 [–0.46; 0.41] SMD_{F1_E}: –0.34 [–0.78; 0.11] SMD_{F2_E}: –0.60 [–1.05; –0.15] SMD_{F3_E}: –0.54 [–0.98; –0.09]

Study	Sample (*N*)	Age (mean years ± SD) unless otherwise stated	Follow-up (mean ± SD) unless otherwise stated	Intervention		Control		Outcomes	Outcome measurement	Effect size (95% CI)
				Content	Format	Content	Format			
Sheehan et al. 2020 [55], Ireland	37 fatigued (FACT-F < 45) cancer survivors **Baseline:** I: 19 C: 18 **PI:** 10w **No follow-up**	I: 53.9 ± 2.3 C: 56.3 ± 2.0	Time since therapy I: 2.9 ± 0.5 y C: 1.6 ± 0.4 y	**Education, self-monitoring and exercise self-efficacy:** PIP: overcoming barriers, setting goals, identifying key social support, pros and cons of exercise.	10 weeks Tip sheets and worksheets Weekly calls and texts to monitor (provide reinforcements, positive feedback)	The health education intervention (PI): - Fatigue management, sleep hygiene, diet, nutrition and CBT - Buddy system for social support, diaries and self-monitoring, goal setting and reinforcement.	10 weeks 1h group session, once a week	Cognitive functioning	EORTC QLQ-C30 subscale	SMD_{PI}: −0.93 [−1.61; −0.25]
								Fatigue	FACT-F	SMD_{PI}: −1.30 [−2.01; −0.58]
								Insomnia	ISI	SMD_{PI}: −0.61 [−1.27; 0.05]
				PA (BGA): Tailored classes. Progressive aerobic exercise (brisk walking) and stretching. Increase session duration: 2 min / week.	10 weeks 1−5 week: 2 supervised sessions a week 6−10 week: 1 supervised session a week + home-based sessions			Aerobic fitness (PA objective)	6-MWT (m)	SMD_{PI}: −1.54 [−2.29; −0.80]
								Physical functioning (Self-reported PA)	EORTC QLQ-C30 subscale	SMD_{PI}: −1.1 [−1.79; −0.40]
								Fear of Physical Activity (Psychological distress)	FAPX-B	SMD_{PI}: −0.59 [−1.25; −0.07]
								Quality of Life	EORTC QLQ-C30	SMD_{PI}: −0.81 [−1.49; −0.14]
								Role functioning	EORTC QLQ-C30 subscale	SMD_{PI}: −0.95 [−1.64; −0.27]
								Social functioning	EORTC QLQ-C30 subscale	SMD_{PI}: −1.39 [−2.11; −0.66]

Abbreviations: *6MWT*, 6-min walk test; *7-D PAR*, 7-day Physical Activity Recall Scale; *AAQ-II*, Acceptance and Action Questionnaire-II; *ACT*, acceptance and commitment therapy; *ADIS-IV*, Anxiety Disorders Interview Schedule–IV; *BADS*, Behavioral Activation for Depression Scale; *BAI*, Beck Anxiety Inventory; *BDI-II*, Beck Depression Inventory-II; *BPI*, Brief Pain Inventory; *BPP*, Biobehavioural Pain Profile; *BSI-18*, Brief Symptom Inventory 18; *CBT*, cognitive behavioural therapy; *CES-D*, Centers for Epidemiologic Studies-Depression; *CIS-F*, Fatigue Severity Subscale of the Checklist Individual Strength; *CP*, clinical psychologist; *ELSS*, Everyday Life Stress Scale; *EORTC-QLQ-C30*, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30; *ES*, effect size; *FACT-B*, Functional Assessment of Cancer Therapy-Breast; *F1*, follow-up 1 to 3 months; *F2*, follow-up 4 to 6 months; *F3*, follow-up > 7 months; *FACT-F*, Functional Assessment of Cancer Therapy-Fatigue; *FACT-G*, Functional Assessment of Cancer Therapy-General; *FAPX-B*, Fear of Physical Activity and Exercise-Breast Cancer Questionnaire; *FOM*, Fatigue Outcome Measure; *FS*, fatigue scale; *GET*, graded exercise therapy; *GMCB*, group-mediated cognitive behavioural; *HADS*, Hospital Anxiety and Depression Scale; *HADS-A*, Hospital Anxiety and Depression Scale-anxiety; *HADS-D*, Hospital Anxiety and Depression Scale-Depression; *HAM-A*, Hamilton Anxiety Rating Scale; *IPAQ*, International Physical Activity Questionnaire; *ISI*, Insomnia Severity Index; *LSI*, Leisure Score Index; *MD*, mean difference; *MET*, metabolic equivalent; *MFI*, The Multi-dimensional Fatigue Inventory; *PA*, physical activity; *PASE*, Physical Activity Scale Ederly; *PFS*, Piper Fatigue Scale; *PHQ-9*, Patient-Health Questionnaire-9; *PI*, psychological intervention; $_{PI}$, post-intervention; *POMS*, Profile of Mood States; *PSPP*, Physical Self-perception Profile; *PSQI*, Pittsburgh Sleep Quality Index; *PSYCH*, subscale from the SPHERE questionnaire; *r*, (revman) calculators; *RPFS*, Revised Piper Fatigue Scale; *SCL-90*, Symptom Checklist 90; *SDS*, The Zung Self-rating Depression Scale; *SF-12*, Short-form 12; *SF-36*, Short Form-36; *SF-36 PF*, MOS 36-item Short Form Health Survey Physical Functioning Subscale; *SIP*, Sickness Impact Profile; *SMD*, standard mean difference; *SOMA*, somatic fatigue, subscale of Somatic and Psychological HEalth REport; *STAI*, State/Trait Anxiety Inventory; *TBP*, therapy planned behaviour; *VAS-F*, visual analogue scale of global fatigue; *QOLI*, Quality of Life Inventory; *QPA*, Questionnaire Physical Activity

Appendix 4

Table 8 BGA checklist

Intervention characteristics	Elaboration	Yes/no/NR
Was the primary goal of treatment improvement of functioning in daily living?	- Yes: Improvement of functioning is clearly stated as the primary goal - No: Pain relief or other goals were set up front	
The therapist was required to have a healthcare degree and to have a minimal training in BGA?	- Yes: The therapist was a healthcare provider trained in an operant BGA - No: The therapist was not a healthcare provider or was not trained in BGA	
Pacing: did the therapist starts with assessing the patient's activity patterns and corrects him/her if necessary?	- Yes: The therapist assessed the patient's routine (an activity diary may aid). Afterwards, he/she used pacing or shaping as a strategy when coming upon patients with inadequate activity patterns (e.g. avoiding or persisting in activities) - No: Patterns were not assessed and/or pacing was not used as a tool before starting behavioural graded activity	
Goal setting: did the patient self-select activities of daily living, followed by a process of shared decision-making with the therapist?	- Yes: Patient's self-selected activities of daily living were determined by what he/she wanted to achieve (e.g. he/she wants to be able to garden twice a week for 4 consecutive hours) - No: Activities were selected by therapist and/or activities were equal to everyone	
Were baseline values individually determined and used for tailored treatment?	- Yes: Baseline values were individually determined and used for tailored treatment - No: Baseline values were not determined or used in the treatment	
Was the BGA preceded by an educational intervention?	- Yes: BGA was preceded by an educational intervention which removed barriers for self-efficacy (e.g. CBT, PNE…) - No: BGA was not preceded by any educational intervention	
Was there an individually based scheme made on a time-contingent basis for each goal?	- Yes: Weekly increase (fixed) of the level (duration) of activities. The exact increase and duration are based on the baseline values and agreement in the tailored programme - No: Increase or decrease of the activity level is based for example on the amount of pain	
During the intervention, support and reinforcement were provided by the therapist?	- Yes: The therapist provided support (e.g. telephone, next appointment…) and verbal and/or non-verbal reinforcement, during the intervention - No: The therapist did not provide any support. The patient could not contact the therapist with problems, and he/she did not receive any reinforcement or feedback, during the intervention	
Was the patient able to integrate the gradually increased activities in his/her daily life (generalization phase)?	- Yes: The goal was reached, and the patient could integrate new activities in his/her daily life by theirselve - No: The goal was not reached, and the patient could not integrate new activities in his/her daily life by theirselve	

Abbreviations: *BGA*, behavioural graded activity; *CBT*, cognitive behavioural therapy; *PNE*, pain neuroscience education, Bold: **primary content**

Appendix 5

Table 9 Effect sizes for *single study* analyses: post-intervention

Outcome	Study	Control group	Statistics for each study SMD (95%CI), significance level
Debilitating (cancer-related) symptoms			
Pain	[33]	Others	0.20 [−0.16; 0.56], $p=0.27$
Fatigue	[55]	PIP	−1.30 [−2.01; −0.58], $p<\mathbf{0.001}$
Anxiety	[46]	BGA	0.07 [−0.25; 0.40], $p=0.65$
Depression	[46]	BGA	0.03 [−0.30; 0.35], $p=0.87$
Insomnia/sleep	[55]	PIP	−0.37 [−1.02; 0.28], $p=0.26$
Social impairment	[45]	BGA	0.00 [−0.32; 0.33], $p=0.98$
Emotional functioning	[45]	WLC	−0.27 [−0.61; 0.07], $p=0.11$
	[45]	BGA	−0.00 [−0.32; 0.33], $p=0.99$
	[44]	PIP	0.21 [−0.23; 0.65], $p=0.35$
Cognitive functioning	[39]	WLC	−0.45 [−0.85; −0.05], $p<\mathbf{0.05}$
	[47]	BGA	0.02 [−0.31; 0.34], $p=0.91$
	[55]	PIP	−0.93 [−1.61; −0.25], $p<\mathbf{0.05}$
Health-related quality of life			
Quality of life	[47]	BGA	0.10 [−0.23; 0.42], $p=0.56$
Functional impairment	[45]	BGA	−0.02 [−0.34; 0.30], $p=0.90$
	[52]	Others	−0.29 [−0.65; 0.07], $p=0.12$
Role functioning	[45]	BGA	−0.02 [−0.34; 0.30], $p=0.90$
	[33]	Others	0.09 [−0.27; 0.45], $p=0.62$
Physical activity level			
Objectively measured PA	[55]	PIP	−1.54 [−2.29; −0.80], $p<\mathbf{0.001}$

Abbreviations: *BGA*, behavioural grades activity; *CI*, confidence interval; *PIP*, psychological informed practices; *SMD*, standardised mean difference; *WLC*, waitlist control

Appendix 6

Table 10 Effect sizes for *single study* analyses: follow-up F1

Outcome	Study	Control group	Statistics for each study SMD (95%CI), significance level
Debilitating (cancer-related) symptoms			
Pain	[36]	WLC	0.07 [−0.21; 0.34], $p=0.64$
	[33]	Others	0.20 [−0.16; 0.56], $p=0.27$
Anxiety	[59]	WLC	−1.71 [−2.38; −1.05], $p<\mathbf{0.001}$
	[46]	BGA	0.05 [−0.27; 0.37], $p=0.76$
Depression	[59]	WLC	−1.15 [−1.76; −0.54], $p<\mathbf{0.001}$
	[46]	BGA	0.00 [−0.32; 0.32], $p=1.00$
Social impairment	[59]	WLC	−1.08 [−1.68; −0.47], $p<\mathbf{0.001}$
	[45]	BGA	−0.14 [−0.47; 0.18], $p=0.38$
	[54]	Others	0.04 [−0.54; 0.62], $p=0.90$
Emotional functioning	[45]	BGA	0.11 [−0.21; 0.44], $p=0.49$
	[52]	Others	−0.43 [−0.79; −0.07], $p=\mathbf{0.05}$
	[44]	PIP	0.19 [−0.25; 0.63], $p=0.40$
Cognitive functioning	[47]	BGA	0.02 [−0.31; 0.34], $p=0.91$
Health-related quality of life			
Quality of life	[47]	BGA	0.22 [−0.11; 0.54], $p=0.19$
	[44]	PIP	−0.06 [−0.50; 0.38], $p=0.80$
	[52]	Others	−0.70 [−1.06; −0.33], $p<\mathbf{0001}$
Functional impairment	[45]	BGA	−0.15 [−0.48; 0.17], $p=0.36$
	[52]	Others	−0.27 [−0.63; 0.08], $p=0.13$
Role functioning	[45]	BGA	−0.15 [−0.48; 0.17], $p=0.36$
	[44]	PIP	−0.64 [−1.09; −0.19], $p<\mathbf{0.05}$
Physical activity level			
Self-reported PA	[36]	WLC	−0.19 [−0.46; 0.08], $p=0.17$
	[36]	BGA	0.20 [−0.07; 0.48], $p=0.14$
Objectively measured PA	[37]	Others	−0.06 [−0.48; 0.36], $p=0.78$

Abbreviations: *BGA*, behavioural grades activity; *CI*, confidence interval; *PA*, physical activity; *PIP*, psychological informed practices; *SMD*, standardised mean difference; *WLC*, waitlist control

Appendix 7

Table 11 Effect sizes for *single study* analyses: follow-up F2

Outcome	Study	Control group	Statistics for each study SMD (95%CI), significance level
Debilitating (cancer-related) symptoms			
Pain	[44]	PIP	−0.57 [−1.02; −0.12], $p < \mathbf{0.05}$
	[33]	Others	0.19 [−0.17; 0.55], $p = 0.30$
Fatigue	[34]	WLC	−0.23 [−0.69; 0.24], $p = 0.33$
Anxiety	[44]	PIP	−0.29 [−0.74; 0.15], $p = 0.19$
Depression	[34]	WLC	−0.48 [−0.95; −0.01], $p = 0.05$
	[44]	PIP	−0.15 [−0.59; 0.29], $p = 0.50$
	[58]	Others	−1.13 [−1.65; −0.62], $p < \mathbf{0.001}$
Social impairment	[34]	WLC	−0.34 [−0.81; 0.12], $p = 0.15$
	[44]	PIP	−0.60 [−1.05; −0.15], $p < \mathbf{0.001}$
	[33]	Others	0.10 [−0.25; 0.46], $p = 0.58$
Emotional functioning	[44]	PIP	0.03 [−0.40; 0.47], $p = 0.88$
Psychological distress	[34]	WLC	−0.31 [−0.77; 0.16], $p < \mathbf{0.05}$
Health-related quality of life			
Quality of life	[34]	WLC	−0.43 [−0.90; 0.04], $p = 0.07$
	[44]	PIP	−0.35 [−0.79; 0.09], $p = 0.12$
Functional impairment	[34]	WLC	−0.34 [−0.80; 0.13], $p = 0.16$
	[52]	Others	−0.23 [−0.59; 0.12], $p = 0.20$
Role functioning	[44]	PIP	−0.07 [−0.51; 0.37], $p = 0.74$
	[33]	Others	0.06 [−0.30; 0.41], $p = 0.76$
Physical activity level			
Self-reported PA	[34]	WLC	−0.58 [−1.06; −0.11], $p < \mathbf{0.05}$
	[44]	PIP	−0.28 [−0.72; 0.16], $p = 0.22$
Objectively measured PA	[34]	WLC	−0.26 [−0.73; 0.20], $p = 0.27$
	[33]	Others	0.16 [−0.20; 0.52], $p = 0.38$

Abbreviations: *BGA*, behavioural grades activity; *CI*, confidence interval; *PA*, physical activity; *PIP*, psychological informed practices; *SMD*, standardised mean difference; *WLC*, waitlist control

Appendix 8

Table 12 Effect sizes for *single study* analyses: follow-up F3

Outcome	Study	Control group	Statistics for each study SMD (95%CI), significance level
Debilitating (cancer-related) symptoms			
Pain	[44]	PIP	−0.65 [−1.10; −0.20], $p < \mathbf{0.05}$
Fatigue	[51]	Others	−0.26 [−0.55; 0.02], $p = 0.07$
Anxiety	[46]	BGA	0.16 [−0.16; 0.48], $p = 0.33$
	[44]	PIP	−0.29 [−0.74; 0.15], $p = 0.19$
	[32]	Others	−0.05 [−0.28; 0.18], $p = 0.65$
Depression	[46]	BGA	0.02 [−0.30; 0.35], $p = 0.88$
	[44]	PIP	−0.16 [−0.59; 0.28], $p = 0.49$
	[32]	Others	−0.08 [−0.31; −0.15], $p = 0.52$
Social impairment	[44]	PIP	−0.54 [−0.98; −0.09], $p < \mathbf{0.05}$
Emotional functioning	[44]	PIP	−0.11 [−0.55; 0.33], $p = 0.61$
Cognitive functioning	[47]	BGA	0.13 [−0.20; 0.45], $p = 0.44$
Psychological distress	[44]	PIP	−0.07 [−0.51; 0.37], $p = 0.75$
	[32]	Others	−0.12 [−0.35; 0.11], $p = 0.32$
Health-related quality of life			
Quality of life	[47]	BGA	0.03 [−0.29; 0.35], $p = 0.85$
	[44]	PIP	−0.06 [−0.50; 0.38], $p = 0.80$
Role functioning	[44]	PIP	−0.42 [−0.86; 0.02], $p = 0.06$
Physical activity level			
Self-reported PA	[44]	PIP	−0.26 [−0.70; 0.18], $p = 0.24$
	[51]	Others	−0.07 [−0.35; 0.22], $p = 0.65$

Abbreviations: *BGA*, behavioural grades activity; *CI*, confidence interval; *PIP*, psychological informed practices; *SMD*, standardised mean difference; *WLC*, waitlist control

Appendix 9

Table 13 Grades of Recommendation, Assessment, Development and Evaluation (GRADE)

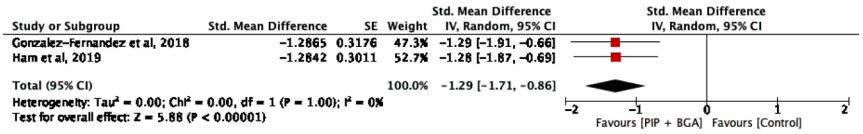
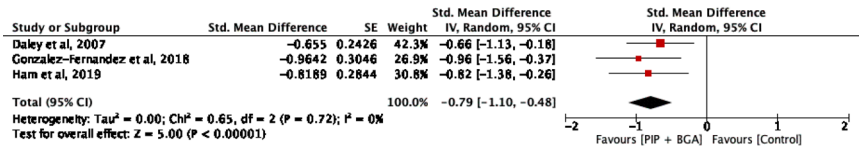
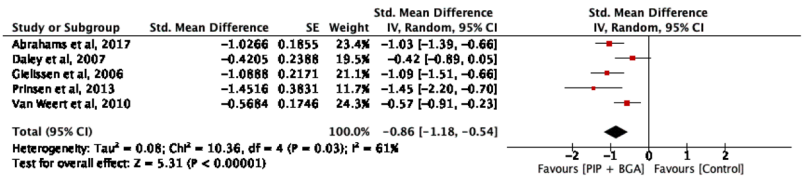
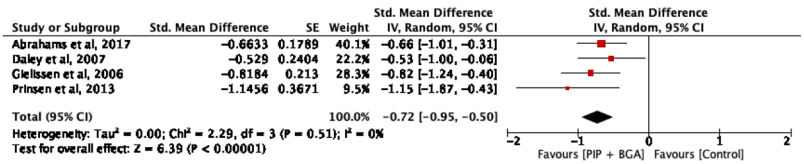
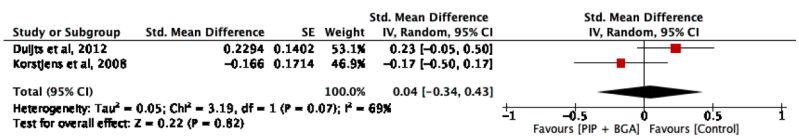
Patients or population: cancer patients or survivors Intervention: PIP + BGA Comparison: WLC				
Outcomes	**Probable outcome with intervention**	**No of participants**	**Quality of the evidence (GRADE)**	**Comments**
Anxiety at the end of treatment measured by multiple scales including BAI, HAM-A, STAI, HADS-A, SAS Higher scores indicate higher levels of anxiety	The mean anxiety in the intervention group was -1.29 SDs lower (95% CI -1.71 to -0.86)	146 (2 studies)	⨁⨁⊖⊖ Low[a,c]	
				
Depression at the end of treatment measured by multiple scales including BDI-II, CES-D, SDS, HADS-D Higher scores indicate higher levels of depression	The mean depression level in the intervention group was -0.79 SDs lower (95% CI -1.10 to -0.48]	218 (3 studies)	⨁⨁⊖⊖ Low[a,c]	
				
Fatigue at the end of the treatment measured by multiple scales including CIS-F, FACT-F, PFS, RPFS, SOMA, MFI, VAS-F, FS Higher scores indicate higher levels of fatigue	The mean fatigue in the intervention group was -0.86 SDs lower (95% CI -1.18 to -0.54)	562 (5 studies)	⨁⊖⊖⊖ Very low[a,b,d]	
				
Functional impairment at the end of the treatment measured by multiple scales including SIP-8 and BPI Higher scores indicate higher levels of functional impairment	The mean functional impairment in the intervention group was -0.72 SDs lower (95% CI -0.95 to -0.50)	353 (4 studies)	⨁⊖⊖⊖ Very low[a,c,d]	
				
Pain at the end of the treatment measured by multiple scales including BPI and SF-36 subscale Higher scores indicate higher pain intensity	The mean pain intensity in the intervention group was 0.04 SDs higher (95% CI -0.34 to 0.43)	347 (2 studies)	⨁⊖⊖⊖ Very low[a,b,d]	
				
Physical activity at the end of the treatment measured by objective instruments including 6MWT, actigraphy, actometer, Caltrac accelerometer, pedometer, submaximal walking test treadmill, VO_2 peak	The mean physical activity (objective) in the intervention group was -0.51 SDs higher (95% CI -0.90 to -0.13)	109 (2 studies)	⨁⨁⊖⊖ Low[a,c]	

Table 13 (continued)

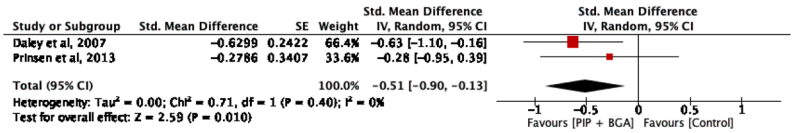
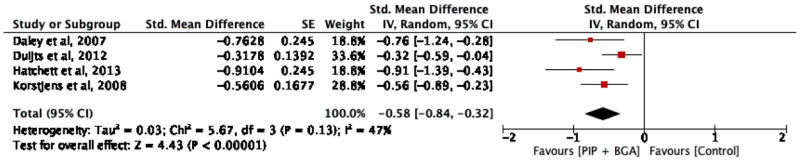
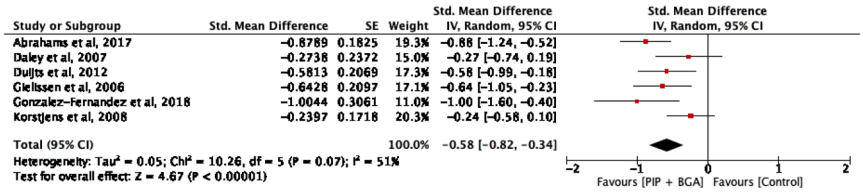
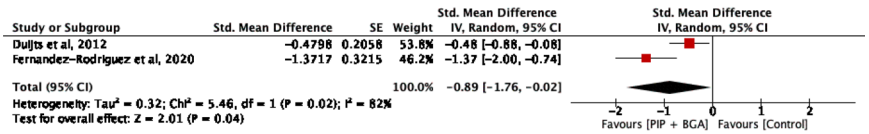
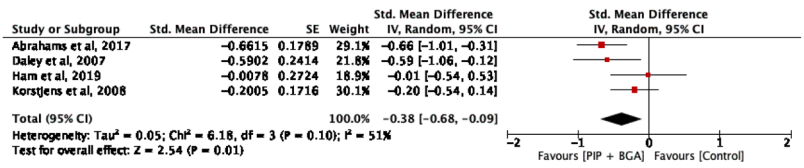
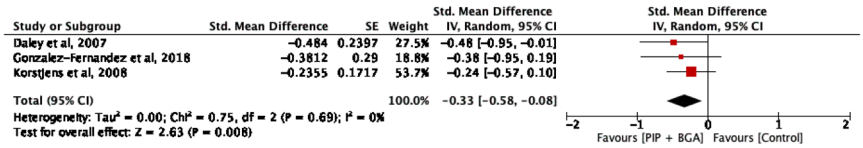
Higher scores indicate higher physical activity				
				
Physical activity at the end of the treatment measured by self-reported questionnaires including IPAQ, LSI, PAR 7D subscale, PASE, QPA, EORTC-QLQ-C30, MFI, PSPP subscale, SF-12 subscale, SF-36 subscale Higher scores indicate higher physical activity	The mean physical activity (self-reported) in the intervention group was -0.58 SDs higher (95% CI -0.84 to -0.32)	493 (4 studies)	⊕⊕⊕⊖ Moderate[a]	
				
Psychological distress at the end of the treatment measured by self-reported questionnaire including AAQ-II, BFI-18, ELSS, FACT-G/B, FAPX-B, POMS, SCL-90, PSYCH, SF-12 subscale, SF-36 subscale Higher scores indicate higher psychological distress	The mean psychological distress in the intervention group was -0.58 SDs lower (95% CI -0.82 to -0.34)	712 (6 studies)	⊕⊕⊕⊖ Moderate[a]	
				
Psychological distress at F1 measured by self-reported questionnaires including AAQ-II, BFI-18, ELSS, FACT-G/B, FAPX-B, POMS, SCL-90, PSYCH, SF-12 subscale, SF-36 subscale Higher scores indicate higher psychological distress	The mean psychological distress in the intervention group was -0.89 SDs lower (95% CI -1.76 to -0.02)	258 (2 studies)	⊕⊕⊕⊖ Moderate[a]	
				
Quality of life at the end of the treatment measured by multiple scales including EORTC-QLQ-C30, FACT-G/B, QOLI, SF-12, SF-36 Higher scores indicate lower quality of life	The mean quality of life in the intervention group was -0.38 SDs higher (95% CI -0.68 to -0.09)	396 (4 studies)	⊕⊕⊕⊖ Moderate[a]	
				
Social impairment at the end of the treatment measured by multiple scales including FACT-G/B subscale, BADS subscale, SF-36 subscale, EORTC-QLQ-C30 Higher scores indicate higher social impairment	The mean social impairment in the intervention group was -0.33 SDs lower (95% CI -0.58 to -0.08)	259 (3 studies)	⊕⊕⊖⊖ Low[a,c]	
				

Table 13 (continued)

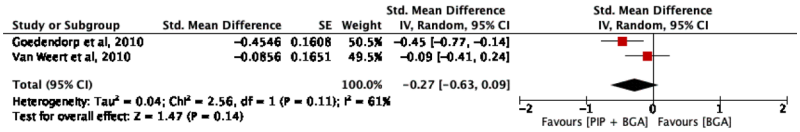
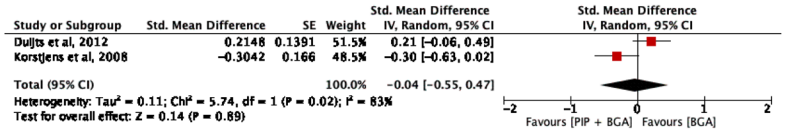
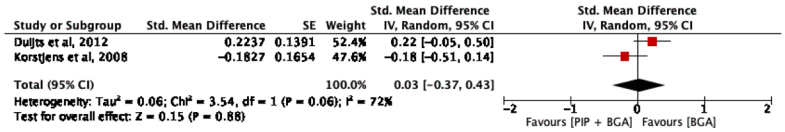
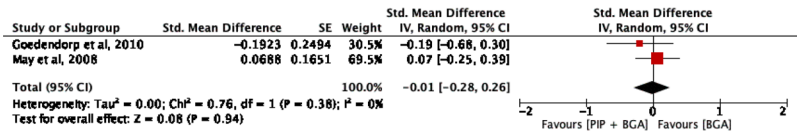
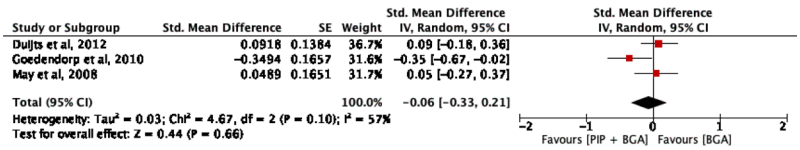
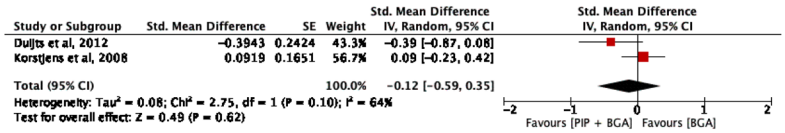
Patients or population: cancer patients or survivors Intervention: PIP + BGA Comparison: BGA				
Outcomes	**Probable outcome with intervention**	**No of participants**	**Quality of the evidence (GRADE)**	**Comments**
Fatigue at the end of the treatment measured by multiple scales including CIS-F, FACT-F, PFS, RPFS, SOMA, MFI, VAS-F, FS Higher scores indicate higher levels of fatigue	The mean fatigue in the intervention group was -0.27 SDs lower (95% CI -0.63 to 0.09)	310 (2 studies)	⊕⊖⊖⊖ Very low[a,b,c]	
				
Pain at the end of the treatment measured by multiple scales including BPI and SF-36 Higher scores indicate higher pain intensity	The mean pain intensity in the intervention group was -0.04 SDs lower (95% CI -0.55 to 0.47)	340 (2 studies)	⊕⊖⊖⊖ Very low[a,b,c]	
				
Pain at F1 measured by multiple scales including BPI and SF-36 Higher scores indicate higher pain intensity	The mean pain intensity in the intervention group was 0.03 SDs higher (95%CI -0.37 to 0.43)	356 (2 studies)	⊕⊖⊖⊖ Very low[a,b,c]	
				
Physical activity at the end of the treatment measured by objective instruments including 6MWT, actigraphy, actometer, Caltrac accelerometer, pedometer, submaximal walking test treadmill, VO_2 peak Higher scores indicate higher physical activity	The mean physical activity (objective) in the intervention group was -0.01 SDs higher (95% CI -0.28 to 0.26]	310 (2 studies)	⊕⊕⊕⊖ Moderate[c]	
				
Physical activity at the end of the treatment measured by self-reported questionnaires including IPAQ, LSI, PAR 7D subscale, PASE, QPA, EORTC-QLQ-C30, MFI, PSPP subscale, SF-12 subscale, SF-36 subscale Higher scores indicate higher physical activity	The mean physical activity (self-reported) in the intervention group was -0.06 SDs higher (95% CI -0.33 to 0.21)	516 (3 studies)	⊕⊕⊖⊖ Low[a,b]	
				
Psychological distress at the end of the treatment measured by self-reported questionnaires including AAQ-II, BFI-18, ELSS, FACT-G/B, FAPX-B, POMS, SCL-90, PSYCH, SF-12 subscale, SF-36 subscale Higher scores indicate higher psychological distress	The mean psychological distress in the intervention group was -0.12 SDs lower (95% CI -0.59 to 0.35)	356 (2 studies)	⊕⊖⊖⊖ Very low[a,b,c]	
				

Table 13 (continued)

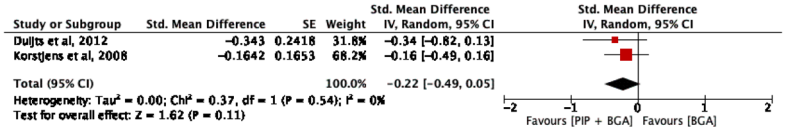
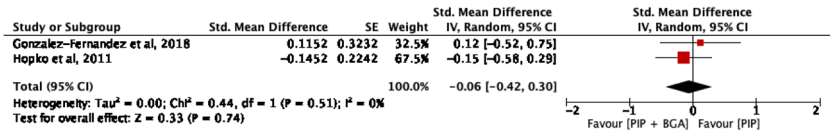
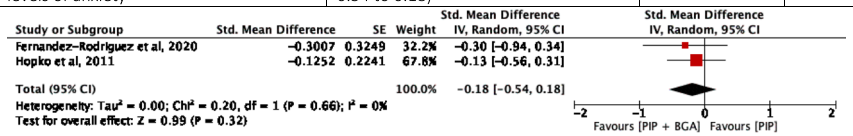
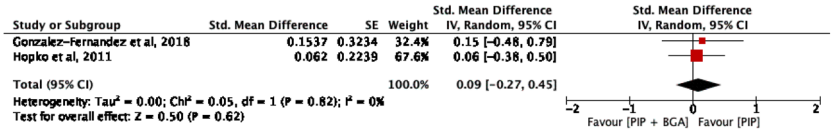
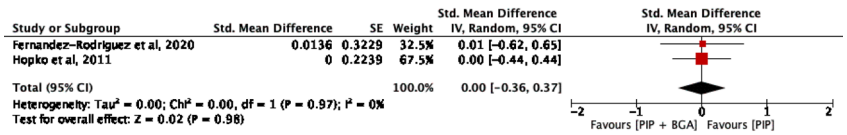
Psychological distress at F1 measured by self-reported questionnaires including AAQ-II, BFI-18, ELSS, FACT-G/B, FAPX-B, POMS, SCL-90, PSYCH, SF-12 subscale, SF-36 subscale Higher scores indicate higher psychological distress	The mean psychological distress in the intervention group was -0.22 SDs lower (95% CI -0.49 to 0.05)	356 (2 studies)	⨁⊖⊖⊖ Very low[a,b,c]	
				
Patients or population: cancer patients or survivors Intervention: PIP + BGA Comparison: PIP				
Outcomes	**Probable outcome with intervention**	**No of participants**	**Quality of the evidence (GRADE)**	**Comments**
Anxiety at the end of treatment measured by multiple scales including BAI, HAM-A, STAI, HADS-A, SAS Higher scores indicate higher levels of anxiety	The mean anxiety in the intervention group was -0.06 SDs lower (95% CI -0.42 to 0.30)	119 (2 studies)	⨁⨁⊖⊖ Low[a,c]	
				
Anxiety at F1 measured by multiple scales including BAI, HAM-A, STAI, HADS-A, SAS Higher scores indicate higher levels of anxiety	The mean anxiety in the intervention group was -0.18 SDs lower (95% CI -0.54 to 0.18)	119 (2 studies)	⨁⨁⊖⊖ Low[a,c]	
				
Depression at the end of treatment measured by multiple scales including BDI-II, CES-D, SDS, HADS-D Higher scores indicate higher levels of depression	The mean depression level in the intervention group was 0.09 SDs higher (95% CI -0.27 to 0.45)	119 (2 studies)	⨁⨁⊖⊖ Low[a,c]	
				
Depression at F1 measured by multiple scales including BDI-II, CES-D, SDS, HADS-D Higher scores indicate higher levels of depression	The mean depression level in the intervention group was 0.00 SDs lower (95% CI -0.36 to 0.37)	119 (2 studies)	⨁⨁⊖⊖ Low[a,c]	
				
Pain at the end of the treatment measured by multiple scales including BPI and SF-36 Higher scores indicate higher pain intensity	The mean pain intensity in the intervention group was -0.01 SDs higher (95% CI -0.24 to 0.22)	290 (2 studies)	⨁⨁⊖⊖ Low[a,c]	

Table 13 (continued)

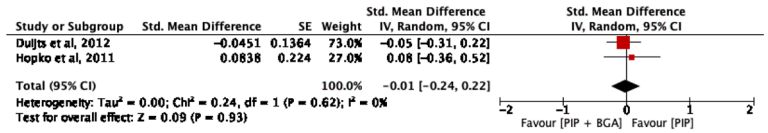
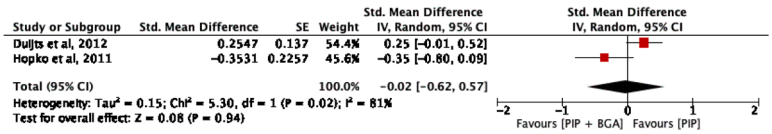
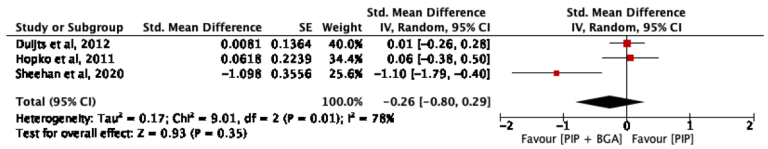
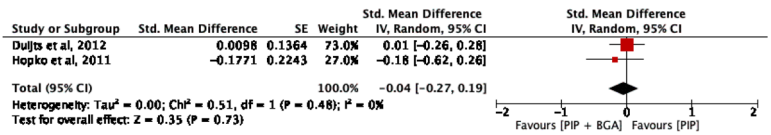
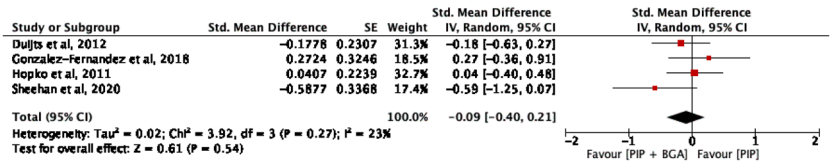
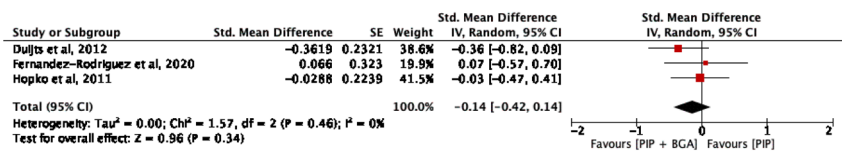
				
Pain at F1 measured by multiple scales including BPI and SF-36 Higher scores indicate higher pain intensity	The mean pain intensity in the intervention group was -0.02 SDs lower (95% CI -0.62 to 0.57)	290 (2 studies)	⊕⊖⊖⊖ Very low[a,b,c]	
				
Physical activity at the end of the treatment measured by self-reported questionnaires including IPAQ, LSI, PAR 7D, PASE, QPA, EORTC-QLQ-C30, MFI, PSPP, SF-12, SF-36 Higher scores indicate higher physical activity	The mean physical activity (self-reported) in the intervention group was -0.26 SDs higher (95% CI -0.80 to 0.29)	327 (3 studies)	⊖⊖⊖⊖ Very very low[a,b,c,d]	
				
Physical activity at F1 measured by self-reported questionnaires including IPAQ, LSI, PAR 7D subscale, PASE, QPA, EORTC-QLQ-C30, MFI, PSPP subscale, SF-12 subscale, SF-36 subscale Higher scores indicate higher physical activity	The mean physical activity (self-reported) in the intervention group was -0.04 SDs higher (95% CI -0.27 to 0.19)	290 (2 studies)	⊕⊕⊖⊖ Low[a,c]	
				
Psychological distress at the end of the treatment measured by self-reported questionnaires including AAQ-II, BFI-18, ELSS, FACT-G/B, FAPX-B, POMS, SCL-90, PSYCH, SF-12 subscale, SF-36 subscale Higher scores indicate higher psychological distress	The mean psychological distress in the intervention group was -0.09 SDs lower (95% CI -0.40 to 0.21)	366 (4 studies)	⊖⊖⊖⊖ Very very low[a,b,c,d]	
				
Psychological distress at F1 measured by self-reported questionnaires including AAQ-II, BFI-18, ELSS, FACT-G/B, FAPX-B, POMS, SCL-90, PSYCH, SF-12 subscale, SF-36 subscale Higher scores indicate higher psychological distress	The mean psychological distress in the intervention group was -0.14 SDs lower (95% CI -0.42 to 0.14)	329 (3 studies)	⊕⊕⊖⊖ Low[a,c]	
				
Quality of life at the end of the treatment measured by multiple scales including EORTC-QLQ-C30, FACT-G/B, QOLI, SF-12, SF-36 Higher scores indicate lower quality of life	The mean quality of life in the intervention group was -0.46 SDs higher (95% CI -1.03 to 0.11)	117 (2 studies)	⊕⊕⊖⊖ Low[a,c]	

Table 13 (continued)

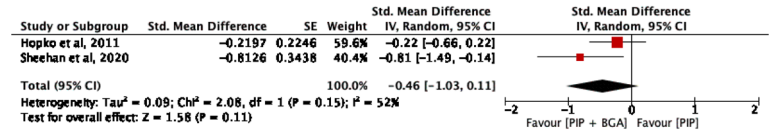
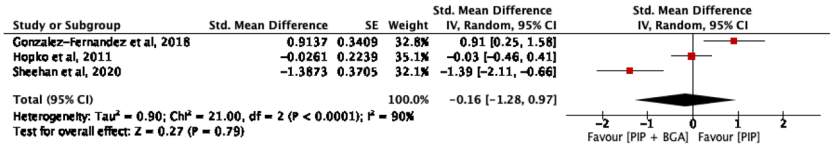
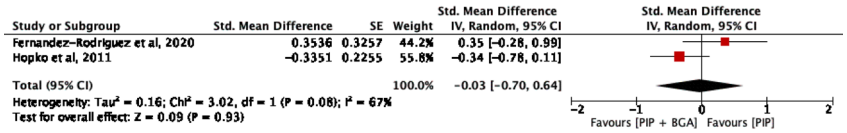
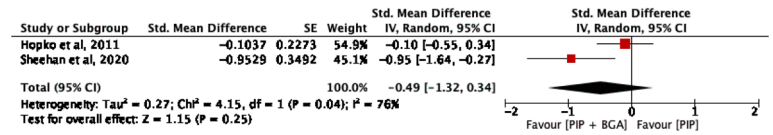
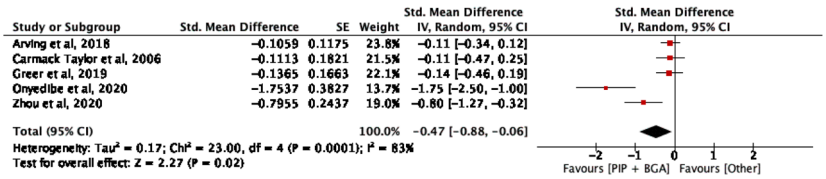
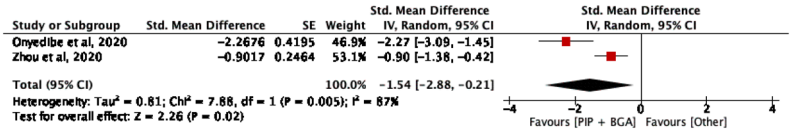
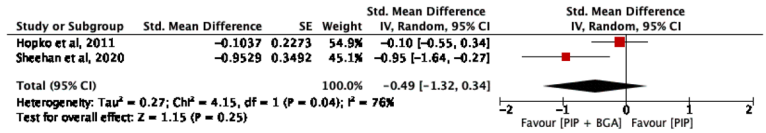
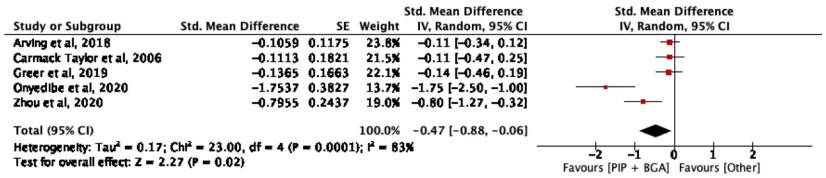
				
Social impairment at the end of the treatment measured by multiple scales including FACT-G/B subscale, BADS subscale, SF-36 subscale, EORTC-QLQ-C30 Higher scores indicate higher social impairment	The mean social impairment in the intervention group was -0.16 SDs lower (95% CI -1.28 to 0.97)	166 (3 studies)	⨁⊖⊖⊖ Very low[a,c]	
				
Social impairment at F1 measured by multiple scales including FACT-G/B subscale, BADS subscale, SF-36 subscale, EORTC-QLQ-C30 Higher scores indicate higher social impairment	The mean social impairment in the intervention group was -0.03 SDs lower (95% CI -0.70 to 0.64)	119 (2 studies)	⨁⊖⊖⊖ Very low[a,b,c]	
				
Role functioning at the end of the treatment measured by multiple scales including SF-36 and EORTC-QLQ-C30 Higher scores indicate lower role functioning	The mean role function in the intervention group was -0.49 SDs higher (95% CI -1.32 to 0.34)	117 (2 studies)	⨁⨁⊖⊖ Low[a,c]	
				
Patients or population: cancer patients or survivors Intervention: PIP + BGA Comparison: Others (education, physical activity, usual care)				
Outcomes	**Probable outcome with intervention**	**No of participants**	**Quality of the evidence (GRADE)**	**Comments**
Anxiety at the end of treatment measured by multiple scales including BAI, HAM-A, STAI, HADS-A, SAS Higher scores indicate higher levels of anxiety	The mean anxiety in the intervention group was -0.47 SDs lower (95% CI -0.88 to -0.06)	637 (5 studies)	⨁⊖⊖⊖ Very low[a,b,d]	
				
Anxiety at F1 measured by multiple scales including BAI, HAM-A, STAI, HADS-A, SAS Higher scores indicate higher levels of anxiety	The mean anxiety in the intervention group was -1.54 SDs lower (95% CI -2.88 to -0.21)	104 (2 studies)	⨁⊖⊖⊖ Very low[a,b,c]	
				

Table 13 (continued)

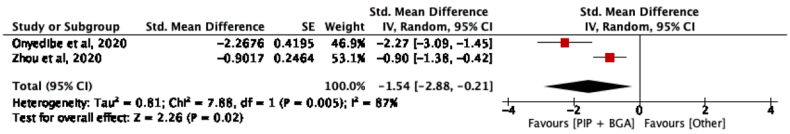


Patients or population: cancer patients or survivors
Intervention: PIP + BGA
Comparison: Others (education, physical activity, usual care)

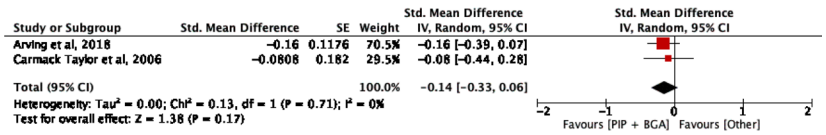
Outcomes	Probable outcome with intervention	No of participants	Quality of the evidence (GRADE)	Comments
Anxiety at the end of treatment measured by multiple scales including BAI, HAM-A, STAI, HADS-A, SAS Higher scores indicate higher levels of anxiety	The mean anxiety in the intervention group was -0.47 SDs lower (95% CI -0.88 to -0.06)	637 (5 studies)	⨁⊖⊖⊖ Very low[a,b,d]	



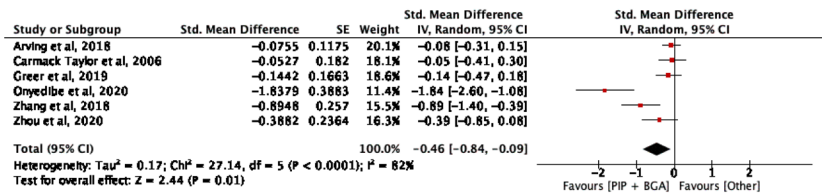
Anxiety at F1 measured by multiple scales including BAI, HAM-A, STAI, HADS-A, SAS Higher scores indicate higher levels of anxiety	The mean anxiety in the intervention group was -1.54 SDs lower (95% CI -2.88 to -0.21)	104 (2 studies)	⨁⊖⊖⊖ Very low[a,b,c]	



Anxiety at F2 measured by multiple scales including BAI, HAM-A, STAI, HADS-A, SAS Higher scores indicate higher levels of anxiety	The mean anxiety in the intervention group was -0.14 SDs lower (95% CI -0.33 to 0.06)	388 (2 studies)	⨁⨁⊖⊖ Low[a,c]	



Depression at the end of treatment measured by multiple scales including BDI-II, CES-D, SDS, HADS-D Higher scores indicate higher levels of depression	The mean depression level in the intervention group was -0.46 SDs lower (95% CI -0.84 to -0.09)	704 (6 studies)	⨁⊖⊖⊖ Very low[a,b,d]	



Depression at F1 measured by multiple scales including BDI-II, CES-D, SDS, HADS-D Higher scores indicate higher levels of depression	The mean depression level in the intervention group was -1.43 SDs lower (95% CI -2.46 to -0.39)	171 (3 studies)	⊖⊖⊖⊖ Very very low[a,b,c,d]	

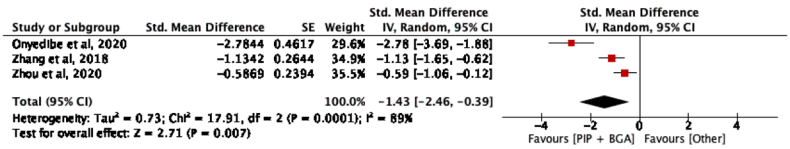


Table 13 (continued)

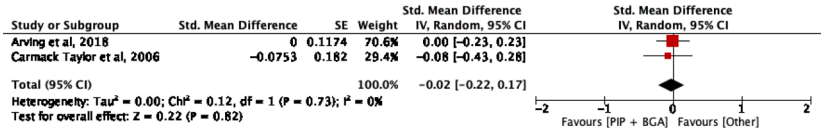
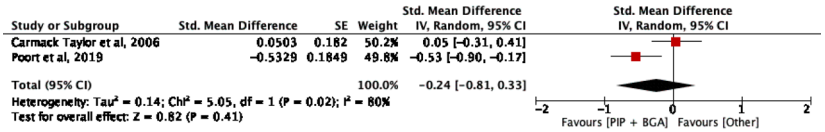
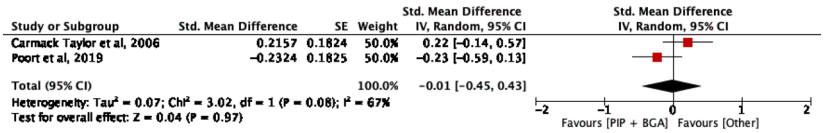
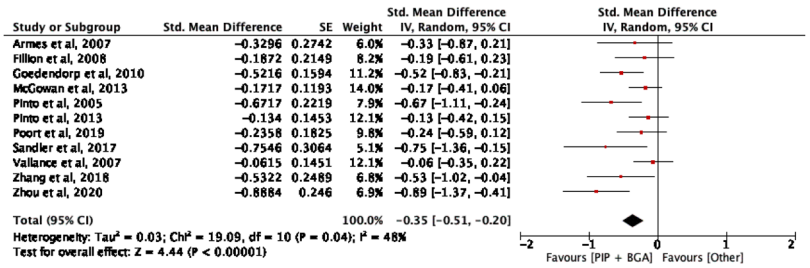
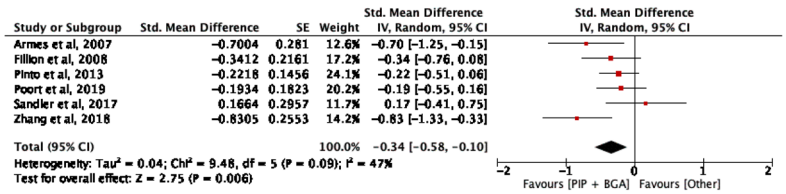
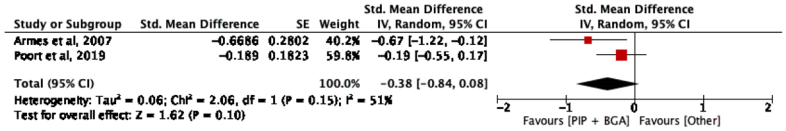
Depression at F2 measured by multiple scales including BDI-II, CES-D, SDS, HADS-D Higher scores indicate higher levels of depression	The mean depression level in the intervention group was -0.02 SDs lower (95% CI -0.22 to 0.17)	388 (2 studies)	⨁⨁⨀⨀ Low[a,c]	
				
Emotional functioning at the end of treatment measured by multiple scales including Higher scores indicate higher levels of emotional impairment	The mean emotional impairment in the intervention was -0.24 SDs lower (95% CI -0.81 to 0.33)	268 (2 studies)	⨁⨀⨀⨀ Very low[a,b,c]	
				
Emotional functioning at F2 measured by multiple scales including SF-36 and EORTC-QLQ-C30 Higher scores indicate higher levels of emotional functioning	The mean emotional impairment in the intervention was -0.01 SDs lower (95% CI -0.45 to 0.43)	189 (2 studies)	⨁⨀⨀⨀ Very low[a,b,c]	
				
Fatigue at the end of the treatment measured by multiple scales including CIS-F, FACT-F, PFS, RPFS, SOMA, MFI, VAS-F, FS Higher scores indicate higher levels of fatigue	The mean fatigue intensity in the intervention group was -0.35 SDs lower (95% CI -0.51 to -0.20)	1340 (11 studies)	⨁⨁⨁⨀ Moderate[a]	
				
Fatigue at F1 measured by multiple scales including CIS-F, FACT-F, PFS, RPFS, SOMA, MFI, VAS-F, FS Higher scores indicate higher levels of fatigue	The mean fatigue intensity in the intervention group was -0.34 SDs lower (95% CI -0.58 to -0.10)	542 (6 studies)	⨁⨁⨁⨀ Moderate[a]	
				
Fatigue at F2 measured by multiple scales including CIS-F, FACT-F, PFS, RPFS, SOMA, MFI, VAS-F, FS Higher scores indicate higher levels of fatigue	The mean fatigue intensity in the intervention group was -0.38 SDs lower (95% CI -0.84 to 0.08)	147 (2 studies)	⨁⨁⨀⨀ Low[a,c]	
				

Table 13 (continued)

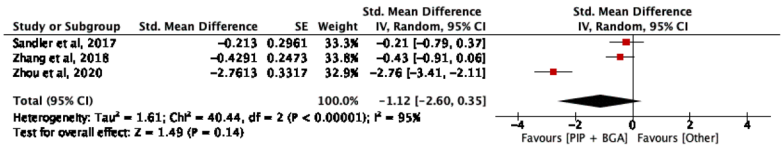
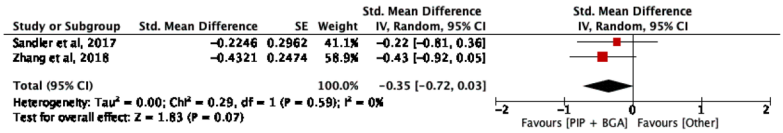
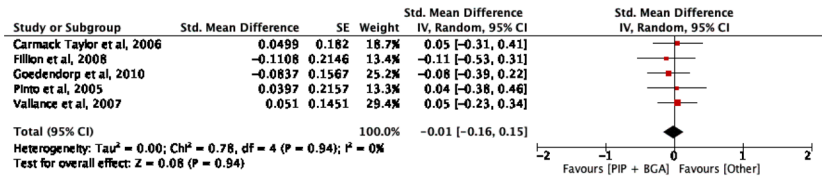
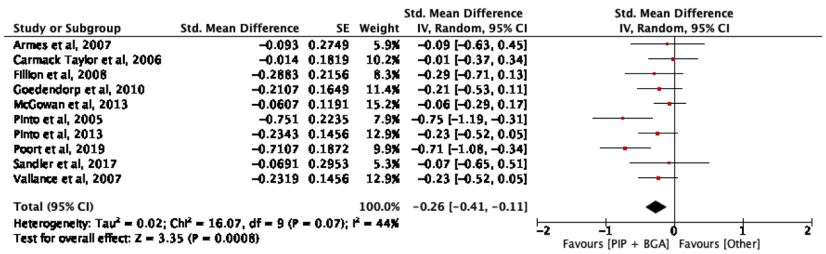
Insomnia/sleep at the end of treatment measured by multiple scales including ISI, PSQI, symptom distress scale Higher scores indicate higher levels of insomnia or sleep difficulties	The mean insomnia and sleep difficulties in the intervention group were -1.12 SDs lower (95% CI -2.60 to 0.35)	186 (3 studies)	⨁⊖⊖⊖ Very low[a,b,c]	
				
Insomnia/sleep at F1 measured by multiple scales including ISI, PSQI, symptom distress scale Higher scores indicate higher levels of insomnia or sleep difficulties	The mean insomnia and sleep difficulties in the intervention group were -0.35 SDs lower (95% CI -0.72 to 0.03)	113 (2 studies)	⨁⨁⊖⊖ Low[a,c]	
				
Physical activity at the end of the treatment measured by objective instruments including 6MWT, actigraphy, actometer, Caltrac accelerometer, pedometer, submaximal walking test treadmill, VO_2 peak Higher scores indicate higher physical activity	The mean physical activity (objective) in the intervention group was -0.01 SDs higher (95% CI -0.16 to 0.15)	630 (6 studies)	⨁⨁⨁⨁ High	
				
Physical activity at the end of the treatment measured by self-reported questionnaires including IPAQ, LSI, PAR 7D subscale, PASE, QPA, EORTC-QLQ-C30, MFI, PSPP subscale, SF-12 subscale, SF-36 subscale Higher scores indicate higher physical activity	The mean physical activity (self-reported) in the intervention group was -0.26 SDs higher (95% CI -0.41 to -0.11)	1283 (10 studies)	⨁⨁⨁⊖ Moderate[a]	
				
Physical activity at F1 measured by self-reported questionnaires including IPAQ, LSI, PAR 7D subscale, PASE, QPA, EORTC-QLQ-C30, MFI, PSPP subscale, SF-12 subscale, SF-36 subscale Higher scores indicate higher physical activity	The mean physical activity (self-reported) in the intervention group was -0.26 SDs higher (95% CI -0.51 to 0.00)	761 (6 studies)	⨁⨁⊖⊖ Low[a,b]	

Table 13 (continued)

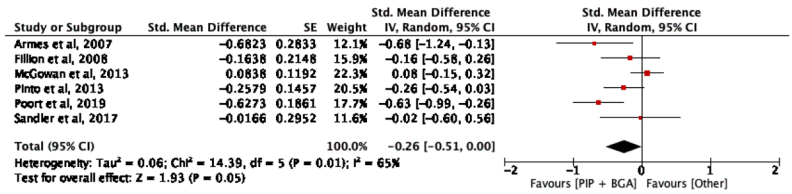
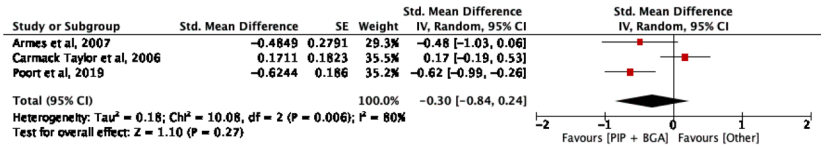
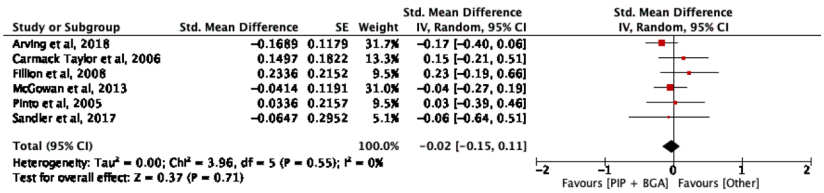
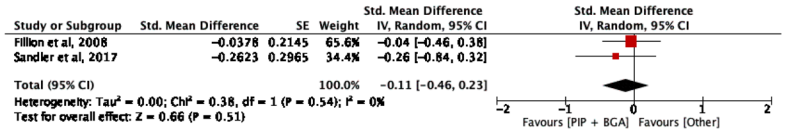
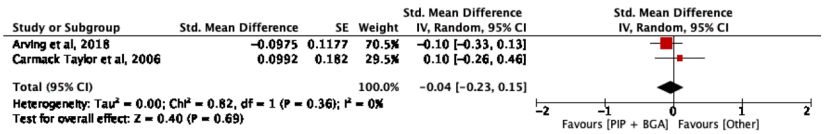
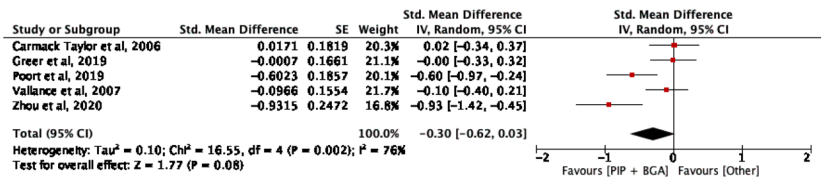
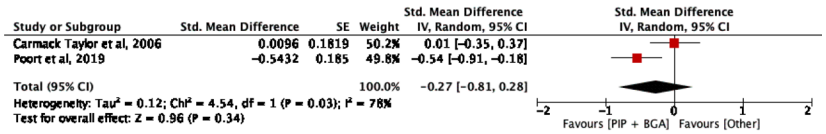
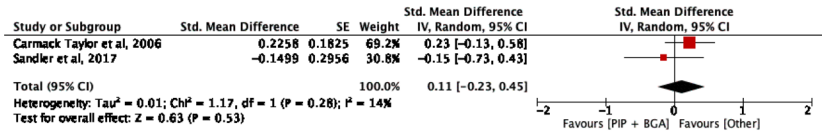
			
Physical activity at F2 measured by self-reported questionnaires including IPAQ, LSI, PAR 7D subscale, PASE, QPA, EORTC-QLQ-C30, MFI, PSPP subscale, SF-12 subscale, SF-36 subscale Higher scores indicate higher physical activity	The mean physical activity (self-reported) in the intervention group was -0.30 SDs higher (95% CI -0.84 to 0.24)	230 (3 studies)	⊕⊖⊖⊖ Very low[a,b,c]
			
Psychological distress at the end of the treatment measured by self-reported questionnaires including AAQ-II, BFI-18, ELSS, FACT-G/B, FAPX-B, POMS, SCL-90, PSYCH, SF-12 subscale, SF-36 subscale Higher scores indicate higher psychological distress	The mean psychological distress in the intervention group was -0.02 SDs lower (95% CI -0.15 to 0.11)	508 (6 studies)	⊕⊕⊕⊖ Moderate[a]
			
Psychological distress at F1 measured by self-reported questionnaires including AAQ-II, BFI-18, ELSS, FACT-G/B, FAPX-B, POMS, SCL-90, PSYCH, SF-12 subscale, SF-36 subscale Higher scores indicate higher psychological distress	The mean psychological distress in the intervention group was -0.11 SDs lower (95% CI -0.46 to 0.23)	140 (2 studies)	⊕⊕⊖⊖ Low[a,c]
			
Psychological distress at F2 measured by self-reported questionnaires including AAQ-II, BFI-18, ELSS, FACT-G/B, FAPX-B, POMS, SCL-90, PSYCH, SF-12 subscale, SF-36 subscale Higher scores indicate higher psychological distress	The mean psychological distress in the intervention group was -0.04 SDs lower (95% CI -0.23 to 0.15)	374 (2 studies)	⊕⊕⊖⊖ Low[a,c]
			
Quality of life at the end of the treatment measured by multiple scales including EORTC-QLQ-C30, FACT-G/B, QOLI, SF-12, SF-36 Higher scores indicate lower quality of life	The mean quality of life in the intervention group was -0.30 SDs higher (95% CI -0.62 to 0.03)	583 (5 studies)	⊕⊕⊖⊖ Low[a,b]
			

Table 13 (continued)

Quality of life at F2 measured by multiple scales including EORTC-QLQ-C30, FACT-G/B, QOLI, SF-12, SF-36 Higher scores indicate lower quality of life	The mean quality of life in the intervention group was -0.27 SDs higher (95% CI -0.81 to 0.28)	189 (2 studies)	⨁⊖⊖⊖ Very low[a,b,c]	
				
Social impairment at the end of the treatment measured by multiple scales including EROS, FACT-G/B, social impairment Higher scores indicate higher social impairment	The mean social impairment in the intervention group was 0.11 SDs higher (95% CI -0.23 to 0.45)	146 (2 studies)	⨁⨁⊖⊖ Low[a,c]	
				

[a]Downgraded once for serious limitations to study quality
[b]Downgraded once for serious inconsistency
[c]Downgraded once for serious imprecision
[d]Downgraded once for high probability of reporting bias

Abbrevations: 6MWT: 6-min walk test; 7-D PAR: 7 day Physical Activity Recall scale; AAQ-II: Acceptance and Action Questionnaire-II; ACT: Acceptance and commitment therapy; BADS: Behavioral Activation for Depression Scale; BAI: Beck Anxiety Inventory; BDI-II: Beck depression inventory-II; BPI: Brief Pain Inventory; BGA: behavioural graded activity CES-D: Centers for Epidemiologic Studies-Depression; CIS-F: Fatigue Severity subscale of the Checklist Individual Strength; ELSS: Everyday Life Stress Scale; EORTC-QLQ-C30: European Organization for Research and Treatment of Cancer Quality of Life Questionnaire Core 30; ES: Effect size; FACT-B: Functional Assessment of Cancer Therapy-Breast; F1: Follow-up 1 to 3 months; F2: Follow-up 4 to 6 months; F3: Follow-up > 7 months; FACT-F: Functional Assessment of Cancer Therapy – Fatigue; FACT-G: Functional Assessment of Cancer Therapy-General; FAPX-B: Fear of Physical Activity and Exercise-Breast Cancer questionnaire; FOM: Fatigue Outcome Measure; FS: fatigue scale; GET: Graded Exercise Therapy; HADS: Hospital Anxiety and Depression Scale; HAM-A: Hamilton Anxiety Rating Scale; IPAQ: International Physical Activity Questionnaire; ISI: Insomnia severity Index; LSI: Leisure Score index; MD: Mean difference; MET: Metabolic equivalent; MFI: The Multi-dimensional Fatigue Inventory; PASE: Physical Activity Scale Ederly; PFS: Piper fatigue scale; PHQ-9: Patient-Health Questionnaire-9; PIP: psychological informed practice; POMS: Profile of Mood states; PSPP: Physical Self Perception Profil; PSQI: Pittsburg sleep quality index; PSYCH: subscale from the SPHERE questionnaire; RPFS: Revised Piper Fatigue Scale; SCL-90: Symptom Checklist 90; SDS: The Zung self-rating depression scale; SF-12: Short-form 12; SF-36: Short Form-36; SF-36 PF: MOS 36-item Short Form Health Survey Physical Functioning subscale; SIP: Sickness Impact Profile; SMD: Standard mean difference; SOMA: somatic fatigue, subscale of Somatic and Psychological HEalth REport; STAI: State/trait Anxiety Inventory; TBP: therapy planned behavior; VAS-F: visual analogue scale of global fatigue; QOLI: Quality of Life Inventory; QPA: Questionnaire Physical Activity; WLC: waitlist control

Author contribution AL: methodology, data collection, writing — original draft, review and editing, project administration and funding acquisition; IR: methodology, data collection and writing — original draft, review and editing, project administration; JN: supervision, methodology and writing — review and editing and funding acquisition; DB: supervision, methodology and writing — review and editing and funding acquisition; CPvW: supervision and writing — review and editing; CFdLP: supervision and writing — review and editing; ER: validation and writing — review and editing; LL: conceptualization, methodology, supervision, data collection and writing — review and editing, validation and data collection.

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Declarations

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