Barriers and facilitators to physical activity in cancer survivors with pain: a systematic review

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Abstract

Purpose: Pain post-treatment is a debilitating symptom in the growing population of cancer survivors. While physical activity is an integral part of pain management, low levels of physical activity are often observed in this population. The aim of this systematic review is to gain insight into the barriers and facilitators to physical activity in cancer survivors afflicted with pain.

Methods: In December 2021, a systematic search was conducted using PubMed and Web of Science. All studies exploring barriers and/or facilitators to physical activity in cancer survivors with pain were included. The methodological quality of the evidence was appraised with the Mixed Methods Appraisal Tool (version 2018).

Results: Six articles were included. Current literature was limited and mostly focused on female breast cancer survivors. The identified barriers and facilitators could be categorized into six different domains: the logistical, symptoms, cognitive, clinical, social, and knowledge domain. The barrier of pain was reported as a barrier on its own that is closely linked to other barriers in this specific population.

Conclusion: Barriers and facilitators to physical activity were categorized in six different domains. The barrier of pain distinguishes itself and brings along additional obstacles such as anxiety, fear, and avoidance behavior. Current evidence is limited and focuses mostly on female breast cancer survivors. Further research in larger cohorts representing various subsets of cancer survivors with pain is warranted, as well as studies that implement these insights in physical activity interventions.

Keywords: cancer survivor; pain; physical activity; barriers; facilitators

Introduction

In 2020, an estimated 19.3 million people were newly diagnosed with cancer worldwide and this number is expected to grow in the coming years [1]. Recent advances in cancer research have led to more efficient screening, earlier detection as well as more effective treatments and thus better survival [2, 3]. Consequently, the population of cancer survivors continues to grow. Common primary cancer treatments such as chemotherapy, surgery, and radiation therapy are all associated with short and long-term side effects that have been known to compromise body structure and function [4-6]. An estimated 47% of cancer survivors still experience pain after the completion of the primary treatment for cancer [7]. Pain in cancer survivors is associated with poorer employment [8], financial difficulties [9], and decreased quality of life [10] outcomes. In addition, lack of sleep, anxiety, depression, and fatigue are often reported [8-12].

Current evidence indicates that regular physical activity and exercise therapy have pain reducing effects in cancer survivors [13-15], along with other positive effects on quality of life, physical functioning, and fatigue [16-19]. Additionally, it entails little risk and is considered to be safe during all stages of cancer [20, 21]. Unfortunately, the side effects associated with cancer and its treatment often impact physical activity levels and leave many at risk of physical deconditioning [22]. Despite the known benefits, participation in and adherence to physical activity among cancer survivors is low with recent studies showing that a significant proportion of cancer survivors decrease physical activity post-diagnosis, and less than 40% of cancer survivors achieve the weekly recommendations for physical activity [23, 24].

Adherence to health interventions, such as physical activity, is a complex issue and is influenced by a variety of factors which are also interrelated to each other [25]. Understanding the barriers and facilitators to physical activity will help us better understand how this health behavior develops. Contrary to the approach in chronic musculoskeletal pain conditions, the knowledge that physical activity is a key part of chronic pain management, has not yet been instilled in the management of cancer survivors with pain as most research focuses on pharmacological, rather than non-pharmacological treatments. In addition, research in other populations with chronic pain show that the barriers and facilitators to physical activity are heavily influenced by the experience of pain itself [26, 27]. While research on barriers and facilitators has been conducted in the general population of cancer survivors, it's noteworthy that the existing literature seldom distinguishes between those with and without pain [28]. This illustrates the need to delve into this specific subset of survivors with pain, as these individuals have even an increased need for the beneficial effects of physical activity given the evidence for its role in the management of chronic pain [29].

Thus, identifying the barriers and facilitators to physical activity in this specific population of cancer survivors with pain is essential in understanding this health-related behavior [30]. Awareness of these factors will better equip healthcare professionals to improve engagement in physical activity and exercise-based interventions. Therefore, the main objective of this systematic review is to summarize the barriers and facilitators to physical activity in cancer survivors with pain.

Methods

This systematic review was registered within the International Prospective Register of Systematic Reviews (PROSPERO reference CRD42023397163) and adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [31].

Search Strategy

The systematic search of the literature was conducted using the databases PubMed and Web of Science. A first search was performed on the 15th of December 2021 and a second revision was done on the first of January 2023. The search strategy consisted of keywords such as, but not limited to "cancer", "pain", "physical activity", "barriers" and "facilitators". The complete search strategy can be found in *Appendix 1*.

Eligibility Criteria

Peer-reviewed papers that contained qualitative and/or quantitative data on barriers and/or facilitators to physical activity in cancer survivors with pain were included. The definition of cancer survivorship from The European Organization of Research and Treatment of Cancer (EORTC) was used: "patients who have completed their primary treatment (maintenance treatment can be ongoing)". Physical activity was interpreted according to the following definition provided by the WHO: "any bodily movements produced by skeletal muscles that require energy expenditure" [32]. Barriers and facilitators were defined in line with Clifford et al.[33] as any patient-reported reason for (not) initiating, participating in or adhering to any form of physical activity. Thoughts and beliefs around physical activity were also regarded as possible barriers or facilitators. The following inclusion criteria were applied: published in English, studies that contained qualitative and/or quantitative data, adults (aged ≥18), previously diagnosed with cancer and have completed all primary therapy (i.e., chemotherapy, surgery, radiation therapy), and experience pain. No specification towards the type, location or duration of pain was made to ensure a broad overview of this specific subset of cancers survivors with pain. Studies were excluded if the study did not report on barriers and/or facilitators from the perspective of the cancer survivors, and if the population was still receiving cancer treatment with curative intent, receiving palliative treatment or end-of-life care. If the full text was not available, the authors were contacted to obtain the full text and determine its eligibility for this review. A response period of two weeks was used, whereafter the study was moved to exclusion.

Selection Procedure

After removing the duplicates, each article was screened independently by three reviewers (J.K, A.D, S.V.D.). The articles were first screened based on title and abstract by using the inclusion and exclusion criteria in a set order. The second phase comprised screening the full text of the remaining articles against the same selection criteria in the same set order. Three reviewers (J.K, A.D, S.V.D) were involved with the screening process. At each stage, any conflicts between the reviewers were discussed

and resolved in a consensus meeting. If no consensus could be reached, the opinion of an additional reviewer (A.D.G) was considered.

Data Extraction

After the selection of relevant articles, the descriptive information of each included study was extracted and recorded in a predefined template. This was done double-blind by two reviewers (J.K and S.V.D), and any conflicts were discussed in a consensus meeting. Information extracted included study design, sample characteristics, data collection methods, physical activity interventions, and identified barriers and facilitators. The framework of physical activity barriers after cancer, established by Romero et al.[34], will be used as a starting point. This theoretical framework shows four important domains in which the barriers to physical activity in cancer survivors can be categorized, namely a logistical, symptoms, cognitive and a clinical domain. The authors will categorize the found barriers and facilitators in these domains. However, if new barriers or facilitators are identified that cannot be appropriately categorized within the existing framework, the authors will make modifications, as deemed necessary, to accommodate to this specific research context.

Methodological Quality Assessment

As this review primarily included qualitative studies, but also incorporated other quantitative study designs, the methodological quality of the selected studies was appraised using the Mixed Methods Appraisal Tool (MMAT-Version 2018) which is a tool designed for mixed studies reviews with a high inter-rater reliability [35]. A criterion was graded “yes” if there was sufficient information and a reduced likelihood of bias. A criterion was rated ‘‘no’’ if there was a high likelihood of bias and ‘‘can’t tell’’ if there was insufficient information. Two reviewers (J.K., S.V.D.) independently evaluated the methodological quality of the included studies. Any discrepancies were discussed and resolved in a consensus meeting. In accordance with the MMAT guidance document, there are no cut off values that could characterize low, medium or high quality studies. However, studies were assigned stars (*) to indicate an overall score with one being the lowest to five being the highest possible [36].

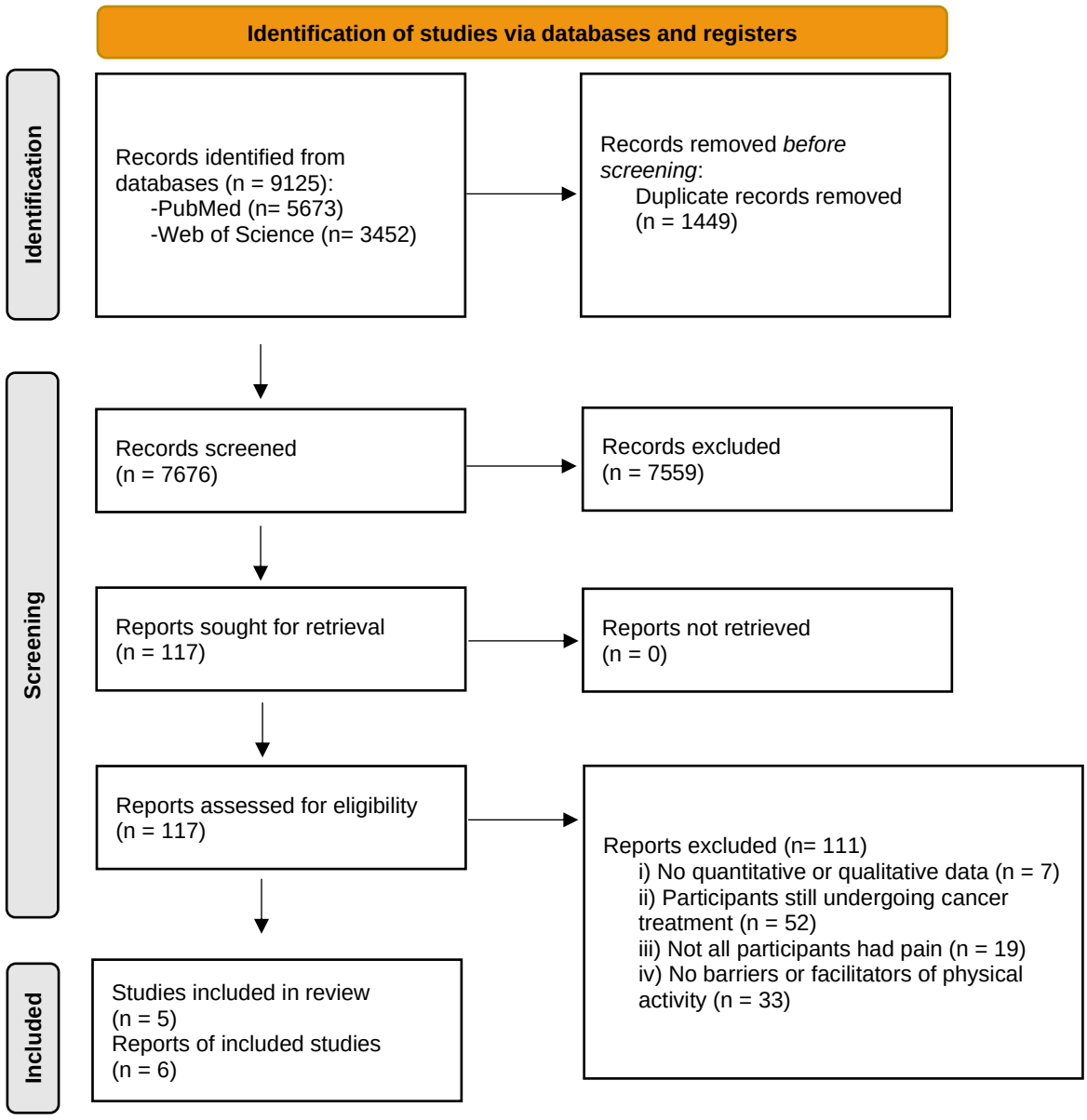
Results

Study Selection

The initial search retrieved 9,125 results. A total of 1,449 duplicates were removed. After the first screening of titles and abstracts, 7,559 articles were removed, and 117 articles were deemed relevant. After reviewing the full texts against the inclusion and exclusion criteria, an additional 91 articles were excluded. A flowchart of the selection process can be found in Figure 1. Of the 25 remaining articles, only 6 articles in which all participants had pain, were selected for this systematic review. The following 6 articles [37-42], consisting of five individual studies, were selected: Galantino et al. (2012); Nyrop et

al. (2016); Galantino et al. (2019); Osypiuk, Kilgore, et al. (2020); Osypiuk, Ligibel, et al. (2020) and Covington et al. (2021). The included studies consist of two qualitative[38, 40] and three mixed-methods studies[37, 39, 41, 42].The articles of Osypiuk, Kilgore, et al. (2020) and Osypiuk, Ligibel, et al. (2020) report on the same mixed methods study with one article [42] reporting on the quantitative results, including the pragmatic barriers and facilitators and the other article [41] focusing on the qualitative part of the study, reporting on the illness narratives.

Fig 1. PRISMA Flow Diagram [31] of the Literature Search



Methodological Quality

Details of the quality appraisal rating along with the in-depth grading for the individual criteria are available in Table 1. The qualitative and mixed method studies were assigned (*), which indicates the amount of criteria that were met. All studies met at least 60% of the quality criteria. Therefore, all studies were included in the review, but less importance was given to studies with lower quality during the synthesis and interpretation of results.

Table 1. Summary of MMAT Quality Assessment Grading

		Galantino et al. (2012)	Nyrop et al. (2016)	Galantino et al. (2019)	Osypiuk, Kilgore et al. (2020)	Osypiuk, Ligibel et al. (2020)	Covington et al. (2021)
MMAT Qualitative Study Design Criteria	(1.1) Relevant Approach	Y	Y	N	Y	Y	Y
	(1.2) Data Collection Methods	Y	Y	Y	Y	Y	Y
	(1.3) Adequately Derived Findings	Y	N	Y	Y	Y	Y
	(1.4) Results Interpretation Substantiated	Y	Y	N	Y	Y	Y
	(1.5) Coherence through Research Process	Y	Y	Y	Y	Y	Y
MMAT Quantitative Non-randomized Study Design Criteria	(3.1) Sample Representativeness	N/A	N/A	Y	N/A	Y	N/A
	(3.2) Appropriate Outcome Measures	N/A	N/A	Y	N/A	Y	N/A
	(3.3) Complete Outcome Data	N/A	N/A	Y	N/A	Y	N/A
	(3.4) Confounders Accounted	N/A	N/A	Y	N/A	N	N/A
	(3.5) Intervention Administered	N/A	N/A	N	N/A	N	N/A
MMAT Quantitative Descriptive Study Design Criteria	(4.1) Sample Strategy	N/A	N/A	N/A	N/A	N/A	N
	(4.2) Sample Representativeness	N/A	N/A	N/A	N/A	N/A	Y
	(4.3) Appropriate Outcome Measures	N/A	N/A	N/A	N/A	N/A	Y
	(4.4) Risk of Nonresponse Bias	N/A	N/A	N/A	N/A	N/A	Y
	(4.4) Appropriate Statistical Analysis	N/A	N/A	N/A	N/A	N/A	Y

MMAT Mixed Methods Study Design Criteria	(5.1) Adequate Rationale	N/A	N/A	Y	N/A	Y	Y
	(5.2) Effective Integration	N/A	N/A	Y	N/A	N	N
	(5.3) Adequate Interpretation	N/A	N/A	Y	N/A	N	Y
	(5.4) Divergences Addressed	N/A	N/A	Y	N/A	Y	Y
	(5.5) Adherence to Quality Criteria	N/A	N/A	N	N/A	N	Y
Quality Rating		*****	****	***	***		****

Quality Assessment Grading : Yes (Y), No/Can't Tell (N), Not applicable (N/A)

Study Characteristics

Collectively, 82 participants across five selected studies were included in this review. The sample sizes ranged from 8 to 36 subjects [37-42]. Four out of five studies consisted of a sample of only women [37, 39-42] and only one study included one male participant [39]. The mean/median age ranged between 59 and 64 years old. The total age range was between 39-87 years old.

Three studies focused exclusively on breast cancer survivors [38, 40-42]. Two studies included survivors from various cancer types [37, 42]. Diagnosed cancer stages ranged from 0-IV. All participants completed primary cancer treatment except for hormone therapy and surgery, chemotherapy, radiation therapy, endocrine therapy, or a combination were among the various treatments that participants received. The two studies that reported on the duration since cancer diagnosis showed a mean duration of 3 years [37] and of 4-5 years [41, 42]. In terms of pain description, two studies included participants with aromatase inhibitor-associated arthralgia (AIAA) [38, 40], one focused on cancer survivors with persistent post-surgical pain [41, 42], one included individuals with chemotherapy-induced peripheral neuropathy (CIPN) syndrome [39] and one study had no specific inclusion criteria for pain, but all participants experienced pain post-cancer treatment [37]. Concerning the level of pain intensity, only three studies reported an inclusion criterion of a minimum level of pain intensity: one study [38] included participants with a score greater than or equal to a 3/10 on a Visual Analogue Scale (VAS), one [39] defined the inclusion criterion as “at least mild symptoms” and the last study [40] excluded those that reported mild scores.

In all studies, barriers and facilitators to physical activity were seen as a secondary outcome. Most studies applied an exercise intervention, such as Qigong Mind-Body Exercise (Qigong) [41, 42], and yoga [38, 39] with a primary outcome of feasibility or preliminary effectiveness [38, 39, 41, 42]. Of the studies that did not use an intervention, one asked about activities of daily living and the fear of falling [37] and the other asked about motivation for trying a walking program as well as communication on physical activity as management for AIAA [40].

In terms of data collection, two studies employed semi-structured interviews [40-42], two utilized journal entries guided by reflective questions as well as observations [38, 39]; in one study accompanying weekly phone calls were made [38] and two studies made use of focus groups [37, 39]. The three mixed-method studies collected various data such as, but not limited to validated self-reported patient questionnaires, functional and physical measures, and feasibility and safety outcomes [41, 42]. The detailed description of each study is presented in table 2.

Synthesis of results

All included studies reported on facilitators, but only three out of five studies [37, 39, 41, 42] also reported on barriers to physical activity. An overview of the different barriers and facilitators across the different domains are shown in Figure 2.

Barriers in the *logistical domain* showed the interference of physical activity interventions with other commitments such as work, family, and travel [38, 42]. One study explicitly reported this as a lack of time [42]. Difficult accessibility due to a difficult commute or inconvenient timing of classes was also a barrier [42].

Facilitators on a logistical domain were described in terms of accessibility and adaptability. The limited space required to practice Qigong was explicitly reported as a facilitator in one study [41, 42]. Videos and/or online resources that were provided to aid home practice also encouraged the continuity of physical activity participation [38, 41, 42]. Adaptability, such as being able to use a form of physical support or make physical modifications to an exercise or activity were mentioned [37]. More specifically, Qigong offered slow, gentle movements within a more comfortable range and intensity, enabling participants to modify the movements to their level [41]. Transferability of skills from mind-body therapies was a facilitator reported in three studies [38, 39, 41, 42]. The integration of learned skills such as breathwork and meditation into daily living also aided mental well-being as it improved the ability to cope with stress, anxiety and pain and continue their activities [38, 39, 41, 42].

Barriers and facilitators related to the *symptoms domain* were mentioned in all studies. Health-related issues often limited the possibility to complete the physical activity intervention [39, 42]. Pain itself was identified as a barrier in two studies [37, 41]. Other physical issues such as limitations in the range of movement, fatigue, or symptoms of neuropathy were also mentioned [37, 39, 41]. The participants in the study of Galantino et al. [39] mentioned the direct relationship between physical activity and an increase in CIPN symptoms, with pain being one of them, as a barrier to engage in physical activity [39]. Benefits to physical well-being was identified across all studies as facilitating physical activity. Many survivors reported the positive changes concerning their pain and improvements in physical functioning, energy, posture, flexibility, balance and mobility throughout the interventions [38, 41, 42]. In addition, benefits towards mental well-being was also identified as a facilitator in three studies [38, 39, 41, 42]. Physical activity helped to release tension and brought a sense of relaxation; some participants reported feeling calmer and thinking clearer [38, 41, 42]. A source of difficulty was anxiety and fear of movement, which participants explained more specifically as a fear of pain as a result of being physically active [41].

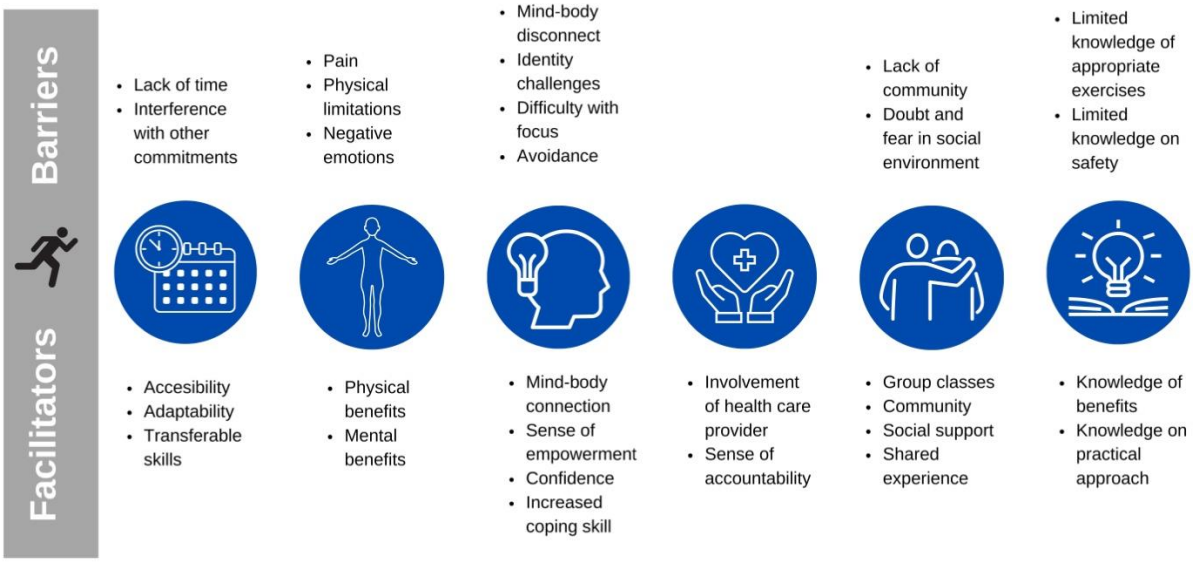
Similarly for the *cognitive domain*, one study emphasized the re-establishment of the mind-body connection, fostering self-acceptance of a new normal [41]. The sense of empowerment was also prevalent across all studies [38-42] and improvements in self-confidence were explicitly mentioned in two studies [39, 41, 42] . A last facilitator was the ability to take on an active role in their self-management and focusing on abilities instead of disabilities [38, 39, 41, 42]. Consequently, the disconnect between mind and body was identified as a barrier [41]. In accordance, the confrontation with this new identity as a cancer survivor could lead to a negative self-perception.. Problems with cognitive functioning such as difficulty staying focused was also identified as a barrier [42].

In the *clinical domain*, participants reported a facilitator concerning their consultations with healthcare providers; there was a preference of patients to have oncologists and/or general practitioners to address the topic of physical activity and arthralgia, and to provide recommendations regarding exercise [40].

The *social domain* shows how a social environment can encourage but also hinder physical activity. Covington et al.[37], who looked at the experience of cancer survivors with a fear of falling, mentioned that the feelings of doubt and fear in a social environment hinder participants to engage in activities [37]. Another study mentioned the avoidance of situations where participants are unable to fully execute movements and have to offer explanations for their limitations [41]. On the other hand, social support within a group setting was often identified as a key *facilitator* [38, 39, 41, 42]. Participants stated that they felt less isolated and more supported to exchange feelings and ideas amongst the group. The social role of the health care provider was acknowledged as well. The active involvement of the oncologist in multiple aspects such as education on benefits, advice, prescription, recommendation, and approval of physical activity was regarded as a facilitator [40]. One study specifically mentioned the need of patients to have healthcare providers discuss the benefits of exercise and its role in providing pain relief [40]. Additionally, regular reminders and being encouraged to initiate conversations on physical activity creates a sense of accountability and a way of becoming more proactive concerning their own health [40]. Non-medical health professionals such as exercise-instructors were also important in creating a supportive and positive environment [38].

Lastly, *knowledge* on physical activity was mentioned as a separate domain. Barriers such as a lack of knowledge on the suitability of exercises or a lack of knowledge of the possible benefits of physical activity could hinder participation. Consistently, in the study of Nyrop et al.[40] participants described how they were motivated to engage in activity behavior after receiving information on the positive effect of physical activity for aromatase inhibitor-associated arthralgia [40].

Fig 2. Overview of barriers and facilitators to physical activity across the different domains: logistical, symptoms, cognitive, clinical, social and knowledge.



317 Table 2. Summary of Study Characteristics

Author (Year, Country)	Study Design	Sample Characteristics	Data Collection	Type of Physical Activity	Results	
					Facilitators	**Barriers**
Galantino et al. [38] (2012), USA	Qual	*n*= 10 *MA:* 58 y *AR*: 50-71 y *Sex:* Female *Cancer:* Breast *Pain:* AIAA *MDSD:* Not reported	Journal entries, observation, weekly phone calls with reflective memos.	*Intervention*: Somatic yoga with meditation. *Setting:* Class-based and encouraged to continue home-based. *Duration: 8 w* *Frequency:* 2x/w, 90min sessions	**Logistical** 1) Accessibility - Practiced in class and at home 2) Transferrable skills - Breathwork - Meditation **Symptoms** 1) Physical - Pain relief - Improved physical functioning - Improved balance and flexibility - More energy 2) Mental - Relaxation - Stress and/or anxiety relief - Improved memory **Cognitive** - Active role in self-care - Improved pain coping - Improved stress coping - Sense of empowerment **Social** - Group-based classes. - Sense of community - Shared experience - Safe environment - Support from fellow participants - Support from instructors - Encouragement to exchange feelings, information, ideas	Not reported

Galantino et al. [39] (2019), USA	MMF	*n*= 10 *MedA: 64.4* y *AR*: 47-81 y *Sex: 9* Female, 1 Male *Cancer:* 5 Breast, 1 Ovarian, 2 Colon, 1 Uterine, 1 Bladder *Pain:* CIPN *MDSD:* Not reported	Observations, Reflective journals and focus group. Clinical functional measures PROMs Biomarkers	*Intervention*: Yoga-based program *Setting*: Class-based and instructed to continue home-based. *Duration: 8w* *Frequency*: 2x/w, 90min sessions	**Logistical** 1) Accessibility - In class and at home 2) Transferrable skills - Breathwork - Meditation **Symptoms** 1) Physical - Pain relief - Improved physical functioning - Improved balance and flexibility - Improved core stability - Neurogenic changes 2) Mental - Feeling relaxed and mindful - Reduced stress - Improved sleep **Cognitive** - Sense of empowerment - Improved confidence - Coping with anxiety **Social** - Resumption of work and hobbies - Group-based classes - Sense of community - Shared experience - Support from fellow participants	**Logistical** - Resumption of work - Time **Symptoms** 1) Physical - Increase of CIPN symptoms
Nyrop et al.[40] (2016), USA	Qual	*n*= 36 *MA:* 67 y *AR*: 46-87 y *Sex:* Female *Cancer:* Breast *Pain:* AIAA	Semi-structured interviews	Walking	**Symptoms** - Improved QoL 1) Physical - Arthralgia pain relief **Clinical** 1) Involvement of HCP *(oncologist)*	Not reported

		MDSD: Not reported			- Information on benefits - Prescription - Recommendation - Approval - Encouragement 2) Sense of accountability - Inquiries during routine clinic visits - Reporting PA participation to HCP - Other HCP repeats message.	
Osypiuk, Kilgore et al.[41] (2020), USA	Qual, part of MM pilot study	*n*= 18 *MA:* 55 y *AR*: 39-79 y *Sex:* Female *Cancer:* Breast *Pain:* PPSP *MDSD:* 4 y	Semi-structured Interviews	*Intervention*: Qigong Mind-Body Exercise *Setting*: Class-based and instructed to continue home-based. *Duration:12w* *Frequency*: 1x/w, 75min session (class) + 2-3 h/w (home)	**Logistical** 1) Accessibility - Practice outside class - Use of videos 2) Adaptability of exercise - Slow, gentle movements - More comfortable range and intensity of exercise **Symptoms** 1) Physical - Pain relief - Reduction in tension - Improved posture - Increased energy 2) Mental - Clearer mind - Feeling calm and at peace **Cognitive** - Mind-body connection - Awareness of emotions expressed through physical sensations - Body acceptance - Regaining trust in their body - Better pain coping - Sense of empowerment	**Symptoms** 1) Physical - Pain - Limitations in ROM - Muscle guarding due to pain and fear 2) Mental - Fear of movement and/or exercise - Fear of pain **Cognitive** 1) Mind-body disconnect - Feeling “stuck” - Feeling betrayed by bodies 2) Avoidance of activities - Due to pain - Due to inability to execute movements - Due to requiring explanations for limitations **Knowledge**

					- Renewed confidence - Focus on own abilities and strengths - Increased self-awareness **Social** - Group classes - Shared experience - Support from fellow participants	- Limited knowledge of exercise that is appropriate and safe
Osypiuk, Ligibel et al.[42] (2020), USA	MM pilot study	*n= 21* *MA:* 54 y *AR*: Not reported *Sex:* Female *Cancer:* Breast *Pain:* PPSP *MDSD:* 5.1 y	Semi-structured Interviews Feasibility and safety measures Functional measures PROMs	*Intervention*: Qigong Mind-Body Exercise *Setting*: Class-based and instructed to continue home-based. *Duration: 12w* *Frequency*: 1x/w, 75min session (class) + 2-3 h/w (home).	**Logistical** 1) Accessibility - Not location specific - Use of instructional aids 2) Adaptability of exercise - No fitness level required - Exercise components are adaptable 3) Transferrable skills - Breathwork - Stretches **Symptoms** 1) Physical - Pain relief - Improved strength - Improved flexibility and balance - Improved mobility - Increased energy - Reduction in tension 2) Mental - Feeling relaxed - Clearer mind **Cognitive** - Pain coping skill **Social** - Group-based classes	**Logistical** - Long or difficult commute - Inconvenient timing of classes - Interference of other commitments and/or scheduling conflicts - Lack of time **Symptoms** 1) Physical - Unrelated health issues 2) Mental - Difficulty staying focused

					- Non-judgmental atmosphere. - Shared experience	
Covington et al.[37] (2021); USA	MM	*n*= 8 *MA:* 61,5 y *AR*: 46-73 y *Sex:* Female *Cancer:* 5 Breast, 2 Gynecological, 1 Colon *Pain:* Average intensity: 5.1/10 *MDSD:* 3 y	Focus groups Functional measures PROMs	Daily activities	**Logistical** 1) Accessibility - If physical support is available e.g., hand rail 2) Adaptability - Slower pace **Cognitive** - Desire to regain a sense of 'normalcy' **Social** - Social support	**Logistical** 1) Physical environment - Obstacles - Outdoor environment with a high risk of falling **Symptoms** 1) Physical - Pain - Neuropathy - Fatigue - Body malfunctioning 2) Mental - Unsure of physical ability - Worry/ fear of falling - Heightened awareness **Cognitive** - Identity challenges - Feeling older - The need to be slow and careful - Finding their new role in society **Social** - Fear of falling in public - Feelings of doubt in public

AIAA=Aromatase Inhibitor Associated Arthralgia, AR= Age Range, CIPN = Chemotherapy Induced Peripheral Neuropathy, HCP = Health Care Provider, h = hours, MA = Mean Age, MedA = Median Age, MDSD = Mean Duration Since Diagnosis, MM = Mixed Methods Study Design, MMF = Mixed Methods Feasibility Study Design, min = minutes, PA = Physical Activity, PROMs = Patient Reported Outcome Measures, PPSP = Persistent Post-Surgical Pain, Qual = Qualitative Study Design, QoL = Quality of Life, ROM = Range of Motion, w = weeks, y = years

Discussion

This systematic review aimed at evaluating the barriers and facilitators to physical activity in cancer survivors with pain. The identified barriers and facilitators were categorized into the existing logistical, symptoms and cognitive domains described by Romero et al.[34]. Additionally, two new domains were identified as being relevant to the research, namely the 'social' and 'knowledge' domain. These new domains were added to the existing framework in order to more fully capture the range of barriers and facilitators.

When comparing findings of Clifford et al.[28], who looked at barriers and facilitators in cancer survivors irrespective of reports of pain, the results reveal similarities. Social benefits, improved physical and mental wellbeing and a sense of empowerment all work as facilitators to physical activity. In line with this, barriers such as physical health-related issues, logistical barriers and the lack of knowledge on safety and effectiveness of exercises hinder physical activity in the general population of cancer survivors as well as the subpopulation of those who experience pain.

However, it is distinctly evident from the included studies that pain is a barrier in itself, rather than merely a subtheme under the category of physical symptoms. Participants experience pain as a catalyst for other barriers such as uncertainty, anxiety, fear, and avoidance [41, 42]. To many cancer survivors, pain has been synonymous with “threat” as their experiences of pain are intricately interwoven with their experience of having cancer [43]. The sensation of pain can cultivate feelings of worry regarding cancer recurrence and lead to catastrophizing [44, 45]. As mentioned, pain was linked to maladaptive responses such as avoidance of activities. This can be explained by the fear-avoidance model, suggesting that individuals with pain will avoid taking part in physical activity due to a fear that it will worsen their pain and cause additional damage [46]. Although this model was originally described regarding musculoskeletal pain, the results of this review suggest that the fear-avoidance model seems to be universally applicable to pain. Pain science education (PSE) could help cancer survivors make sense of their pain. Recent literature has shown a promising role of PSE in the population of cancer survivors with pain [47, 48]. The combination of fear and a limited knowledge on the role and organization of physical activity [22, 41], may have contributed to participants’ worry and uncertainty around what types of physical activity were safe and suitable. This further emphasizes the importance of conversations about physical activity between healthcare professionals and patients [49, 50]. As a cancer diagnosis provides the possibility of a ‘teachable moment’ [51], it demonstrates the importance of initiating conversations around improving physical activity. One specific facilitator in the group of patients with AIAA was for the healthcare provider, preferably the oncologist, to address the importance of physical activity [40]. Undertaking physical activity is a complex behavior with many aspects that need to be considered. To overcome this barrier, space in health care interactions should be provided to discuss pain and its consequences and discuss physical activity not as a singular event, but as a continuous process with evolving needs.

No requirements towards the type of physical activity were made in the inclusion criteria of this review. The ACSM-guidelines (American College of Sports Medicine) for cancer survivors state that every cancer survivor should avoid inactivity, but most benefits in improving cancer-related health outcomes are gained when specific doses of aerobic, resistance, or a combination of the two trainings are met [20]. None of the included studies made use of an intervention that was geared towards aerobic or resistance training at a moderate-to-high intensity. Yet, mind-body interventions such as yoga and Qigong were heavily featured in the included studies. Engaging in physical activity for individuals that are largely inactive and afflicted with pain is understandably a big lifestyle transition. These mind-body activities can be seen as a gentler form of exercise and might be a stepping stone to aerobic and resistance training at a later moment in time. Existing literature already shows that mind-body therapies are known to positively affect breast cancer survivors' quality of life [52]. The integration of mind and body can offer multiple benefits, in one study participants described how the intervention re-established the mind-body connection and provided other psychological benefits like body acceptance [41, 42]. Equally, the accessibility and adaptability of these interventions as well as the transferability of skills like breathwork and meditation were highlighted as facilitating aspects of these interventions [38, 39, 41, 42]. However, it would be of interest to determine whether the barriers and facilitators to aerobic exercise or resistance training differ from those to low intensity activities.

This systematic review includes several strengths and limitations. The strengths of this review are the use of the PRISMA checklist [31] and the use of an existing framework [34] on barriers and facilitators towards physical activity in cancer survivors. Another strength is the methodological quality of the included studies, all studies ranged from moderate-to-high quality. There were several limitations with respect to sample characteristics of the included studies. The presented barriers and facilitators to physical activity were predominantly identified in cohorts of female cancer survivors. With only one male participant in the entire review, there is insufficient evidence that all these barriers and facilitators translate to male cancer survivors. Furthermore, most studies consisted of a sample of breast cancer survivors, with only two studies having a sample of various types of cancer [37, 39]. Therefore, no definitive conclusions can be drawn for other cancer types due to the limited nature of the cohort. A similar remark can be made toward the description of pain is the included studies, as information on duration, localization or type of pain was very limited. Also, most participants were white, English-speaking individuals from sound socio-economic backgrounds, so it is difficult to determine how cultural differences would impact the identified barriers and facilitators. The mean age across the selected studies was 60 years, and no study reported whether the participants had other existing chronic conditions that could influence the experienced barriers and facilitators [53]. As the life expectancy of cancer survivors increases, so does the prevalence of co-morbid chronic conditions within the population [54]. In addition, since the selected studies were linked to physical activity interventions, the presence of a selection bias of those who already are physically active or motivated to be active should be acknowledged. Although two studies only included participants with a low activity level, this does not disregard that the level of motivation might be higher in their sample [40-42]. A remark in line with other reviews on this specific population is that the included studies provide few details on pain such as the underlying pain mechanism or pain-related disability. Consequently, it is unknown how different aspects

of pain might alter the perceived barriers and facilitators to physical activity within this population. Lastly, a limitation was the small sample sizes and the low number of selected studies in this review. Future research should include the influence of the abovementioned factors as well as the influence of different cancer types and treatment strategies on barriers and facilitators.

Despite the high amount of cancer survivors that experience pain, it is clear that the population of cancer survivors with pain is an understudied group [7]. Future research is needed in this specific subset of cancer survivors as these understandings will lead to a more individualized and effective approach of physical activity in pain management.

Conclusion

In conclusion, the barriers and facilitators to physical activity identified in the population of cancer survivors with pain extended across logistical, symptoms, cognitive, social, and knowledge domains. An overlap was found with those in cancer survivors in general; however, the barrier of pain distinguishes itself and brings along additional obstacles such as anxiety, fear, and avoidance behavior. Understanding these different barriers and facilitators can help health care providers in better supporting their patients. However, current evidence is limited and focuses mostly on female breast cancer survivors. More research on the barriers and facilitators to physical activity in different types of cancer, on different types of physical activity and across different points in time is needed to optimize the approach of physical activity in cancer survivors with pain.

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Statements and Declarations

Author Contributions

All authors contributed to the idea and research question of this systematic review. The literature search and data-analysis were performed by Sophie Van Dijck and Janan Kothari. The first draft of the manuscript was written by Sophie Van Dijck and all authors commented on previous versions of the manuscript. All authors critically revised the work and approved the final manuscript.

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Disclosure of Interest

The authors report no conflicts of interest.

Appendix

Appendix 1 N/A Complete Search Strategy

Database	Search Strategy
PubMed	((Neoplasm OR Cancer OR Malignancy) AND (pain)) AND ((Physical activity) OR Exercise OR (Motor activity) OR (Motor function) OR (exercise therapy) OR training OR movement OR sport) AND (barrier OR obstacle OR facilitator OR encourage OR discourage OR hamper OR perception OR attitude OR belief OR experience OR preference OR expectation OR motivator OR motivation OR motivate OR preference OR participation OR engagement OR decision)
Web of Science	ALL= ((Cancer OR Malignancy OR Tumor OR Tumour OR Oncology OR neoplasms) AND (pain)) AND (Physical activity OR Exercise OR (Motor activity) OR (Motor function) OR (exercise therapy) OR training OR movement OR sport) AND (barrier OR obstacle OR facilitator OR encourage OR discourage OR hamper OR perception OR attitude OR belief OR experience OR preference OR expectation OR motivator OR motivation OR motivate OR preference OR participation OR engagement OR decision)