Critical Reviews in Oncology / Hematology 210 (2025) 104718

Contents lists available at ScienceDirect

Critical Reviews in Oncology / Hematology

journal homepage: www.elsevier.com/locate/critrevonc

Physical activity guidelines in oncology: A systematic review of the current recommendations

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ARTICLE INFO

Keywords:
Physical activity
Guidelines
Cancer care
Physical activity recommendation

ABSTRACT

This review aims to summarize the recommendations endorsed by scientific societies regarding physical activity for patients with cancer. A systematic search was conducted to identify guidelines endorsed by scientific societies and published in the last 15 years dedicated to physical activity for cancer patients. The AGREE II instrument was used to assess the methodological quality of the guidelines. Results are presented as qualitative synthesis. A total of 11 guidelines met the inclusion criteria. Seven were considered high quality, scoring ≥60 % in the AGREE II tool. All the guidelines recommended to include aerobic and resistance training as types of activities. Regarding the physical activity dosage, most suggested a generic 150 minutes/week of moderate-intensity activity plus resistance training twice a week. Three guidelines reported instructions for exercise prescription, including frequency, intensity, and duration of training sessions. Six guidelines reported exercise testing/medical clearance instructions, 9 provided considerations regarding adaptation/precautions, and 7 detailed the specialists for referral. Four guidelines considered motivational aspects related to physical activity and cancer. Although important steps have been made in the more recent recommendations, effort is needed to produce high-quality research in the exercise-oncology field, with the ultimate aim of developing more tailored guidelines.

1. Introduction

Cancer is one of the leading causes of disease burden worldwide, which is set to grow soon. The latest estimates report that in 2022, there were about 20 million new cancer cases, nearly 10 million related deaths (Bray et al., 2024), and the predictions based on demographics indicate an increase of 77 % in cancer cases by 2050, reaching 35 million (Bray et al., 2024). At the same time, the constant advances in early detection and treatment have improved and probably will continue to increase survival rates, leading to a high prevalence of people living after a cancer diagnosis (Bray et al., 2024). This epidemiological picture also implies that the overall scale of patients experiencing symptoms, side effects, impairments in quality of life, and long-term physical and psychological sequelae, requiring supportive strategies such as physical exercise intervention, will grow (Stout et al., 2021). Indeed, over the years, physical exercise has been consistently demonstrated to be a safe and feasible approach, not only under and after treatment but also as optimization of a patient's physical fitness before treatment, which leads to better treatment outcomes, fewer complications, and quicker recovery (Del Bianco et al., 2024; Voorn et al., 2023). A first randomized controlled study, conducted in the late 1980s on 45 patients with breast cancer undergoing chemotherapy, showed that 10 weeks of aerobic training was effective in improving functional capacity, body composition, and patient-reported nausea (MacVicar et al., 1989; Winningham &

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https://doi.org/10.1016/j.critrevonc.2025.104718
Received 23 December 2024; Received in revised form 24 March 2025; Accepted 30 March 2025
Available online 5 April 2025

MacVicar, 1988; Winningham et al., 1989). Similarly, another trial conducted in the early 1990s in Europe demonstrated that aerobic training was effective in attenuating the declines in physical performance, pain, diarrhea, and shorter hospital duration in patients undergoing stem cell transplantation (Dimeo et al., 1997). Since these pioneering investigations, several other high-quality trials have been performed over the years (Courneya et al., 2014; Courneya et al., 2009; Irwin et al., 2015), and in 2005 a first epidemiological study observed a positive association between physical activity level and survival in patients affected by breast cancer(Holmes et al., 2005), further strengthening the importance of exercise in the oncological context. To date, high-level of evidence highlights that physical exercise improves several physical variables, including cardiorespiratory fitness (Avancini et al., 2022; Jones et al., 2012), muscle strength (Padilha et al., 2017), and body composition (Koeppel et al., 2021), as well as to manage different treatment-related side effects, such as fatigue (Mustian et al., 2017), peripheral neuropathy (Guo et al., 2023), anemia (Avancini, Belluomini, et al., 2021). Overall, physical exercise may enhance patients 'quality of life (Yang et al., 2023), and additionally, more and more observational evidence correlates physical activity with better survival in the cancer context (Friedenreich, Cook, et al., 2020; Verheijden et al., 2023).

The convincing benefits and advances in the field, in terms of published systematic reviews and meta-analyses have permitted the transition from expert consensus to the development of evidence-based guidelines (Winningham et al., 1986). In this light, different guidelines on physical exercise in cancer patients have been released by international organizations and scientific societies, including the American Cancer Society (ACS)(Rock et al., 2012; Rock et al., 2022), American Society of Clinical Oncology (ASCO)(Ligibel et al., 2022), American College of Sports Medicine (ASCM)(Campbell et al., 2019; Schmitz et al., 2010), and Exercise & Sports Science Australia (ESSA)(Hayes et al., 2019; Hayes et al., 2009), but their implementation is still poor since most patients are insufficiently active (Avancini et al., 2024; Avancini, Trestini, et al., 2023; Gregory et al., 2024; Wong et al., 2018). Various extrinsic factors may impact the acceptance and usage of guidelines, including individual (e.g., clinicians' and stakeholders' knowledge), organizational, and context features (Correa et al., 2020; Pereira et al., 2022). On the contrary, other issues that may negatively influence the implementations can be intrinsic to the guidelines themselves. For instance, including generic indications, not entirely explicit or ambiguous, may limit the credibility of such guidelines, as well as the low methodological quality or the poorly written (Correa et al., 2020; Guerra-Farfan et al., 2023; Lenzer, 2013). Regarding physical activity in cancer, a systematic review including 16 guidelines has assessed the quality of these recommendations and observed that just the

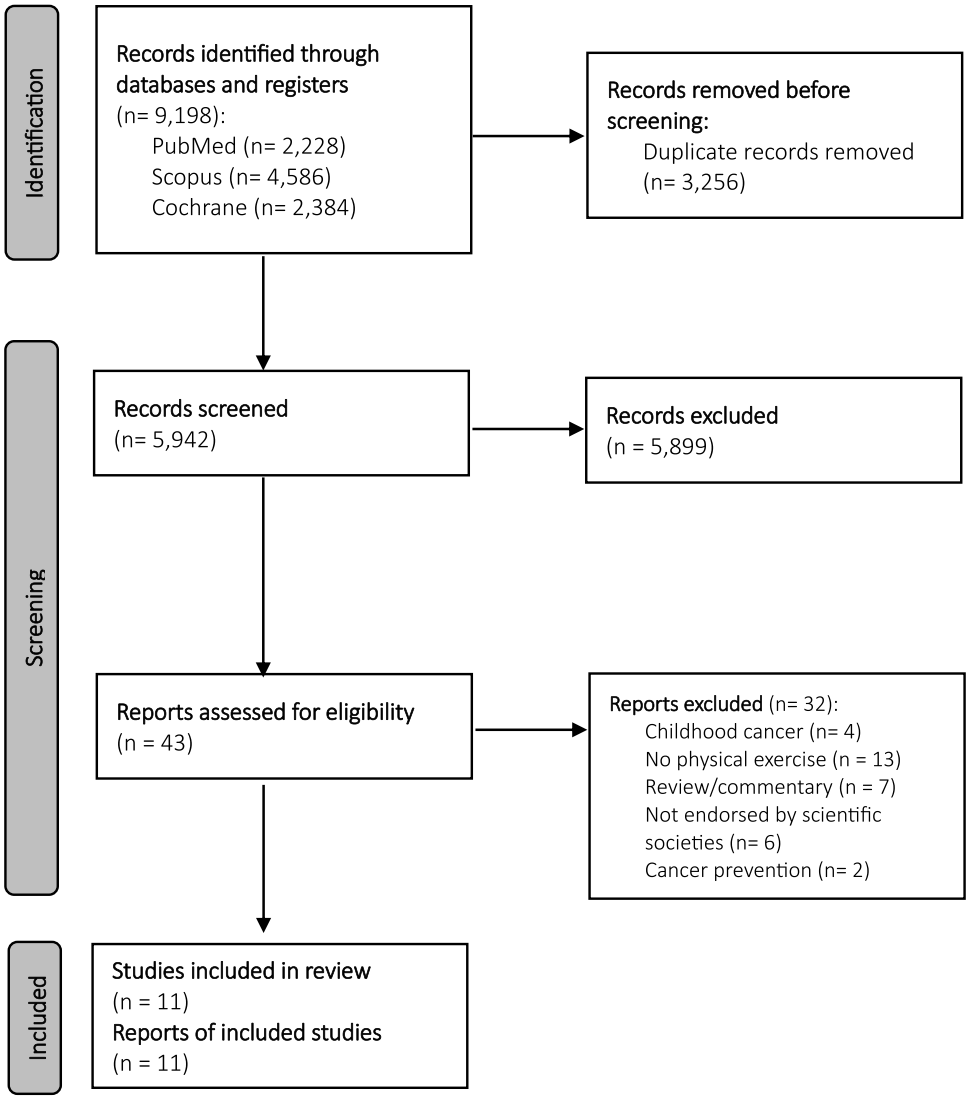

Fig. 1. Study flow-chart.

Table 1
Risk of bias of the included studies, according to the AGREE II instrument.

Authors, year	Scope and Purpose	Stakeholder involvement	Rigor of development	Clarity of presentation	Applicability	Editorial independence	Overall assessment
Cormie et al. 2018	61 %	67 %	10 %	39 %	17 %	58 %	33 %
Campbell et al. 2019	94 %	44 %	67 %	94 %	25 %	67 %	67 %
Segal et al. 2017	89 %	83 %	65 %	50 %	17 %	58 %	67 %
Ligibel et al. 2022	100 %	94 %	92 %	78 %	50 %	100 %	83 %
Neuzillet et al. 2020	78 %	39 %	60 %	78 %	4 %	92 %	67 %
Rock et al. 2012	61 %	39 %	15 %	61 %	13 %	33 %	33 %
Rock et al. 2022	89 %	67 %	67 %	83 %	67 %	83 %	83 %
Schmitz et al. 2010	78 %	50 %	33 %	67 %	17 %	42 %	50 %
Hayes et al. 2009	61 %	6 %	8 %	72 %	8 %	50 %	33 %
Campbell et al. 2022	94 %	72 %	69 %	83 %	4 %	67 %	83 %
Hayes et al. 2019	94 %	56 %	46 %	100 %	33 %	67 %	67 %

"applicability" and "implementability" domains obtained the lowest scores, probably partially explaining their poor implementation (Zhou et al., 2023). However, this work included only two guidelines dedicated to physical activity; the others were primarily focused on disease medical management or other lifestyle habits, e.g., nutrition, and included physical activity as additional information (Zhou et al., 2023). Additionally, the synthesis lacks summarizing the information regarding the amount of needed exercise and the adaptation regarding different conditions/comorbidity (Zhou et al., 2023). Nevertheless, more than ten guidelines focused on physical activity in patients with cancer as the first aim have been published, and to our knowledge, no synthesis about their quality and recommendations/adaptations they suggested have been performed.

For these reasons and to address future research, the primary purpose of the current review is to systematically summarize the current published guidelines regarding the "*dosage*" of physical activity recommended to patients with cancer. The secondary aims include the identification of the specific adaptations/precautions for exercise testing, programming, referral, and motivational aspects.

2. Methods

Following the preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) methodology (Page et al., 2021), a systematic literature search was conducted on April 15th, 2024, and updated on September 9th to identify the published physical activity clinical practice guidelines for adult patients with cancer. The following inclusion criteria for the articles were applied: i) being endorsed by an organization/association representing oncology or rehabilitation health disciplines or professionals that provide guidance, recommendations, or clinical pathways; ii) including information regarding the amount of physical activity that patients should perform; iii) being published in English, Scandinavian, or Italian language; iv) be focused on adults patients with cancer; v) being published between 2008 and 2024. Guidelines not focused on physical activity and the oncological population or published before 2008 were excluded. This systematic review was registered on PROSPERO (CRD42024500420).

2.1. Search strategy

A systematic search was conducted on the Cochrane Central Register of Controlled Trials (CENTRAL), PubMed/MEDLINE (National Library of Medicine), and Scopus. The research string was composed of terms related to physical exercise (e.g., physical activity, exercise therapy, aerobic exercise, resistance training), cancer (e.g., cancer, carcinoma, malignancy), guidelines (e.g., recommendation, position statement, expert consensus), combined by the Boolean operators "AND" and "OR" (Appendix 1). In addition, a hand-search was performed by screening the reference list of the eligible articles and the sites (e.g., those of the American College of Sports Medicine, the Exercise Sports Science Australia) based on the authors' knowledge of recognized bodies that develop guidelines.

2.2. Study selection and data extraction

After removing the duplicate, the studies' eligibility was assessed using a two-step process. Firstly, two authors (A.B. and L.T.) independently performed the title and abstract screening, and uncertain articles were inserted for full-text assessment. Secondly, the selected studies underwent full-text review by three independent authors (A.A., A.B., L. T.), and discrepancies or conflicts were resolved by the discussion with a fourth author (M.Q.). For each eligible study, the following details were extracted by three authors (C.L., T.B. and M.Q.): i) article characteristics (e.g., first author, title, year of publication, journal of publication, scientific society who endorsed the guidelines); ii) population (e.g., cancer type, staging, anticancer treatment, time since diagnosis); iii) physical

Table 2
Overview of the current published physical activity recommendations for patients with cancer.

Institution/ Scientific Society	Year	Cancer type, stage, and treatments	Physical activity recommendations (type, frequency, duration, intensity, progression)
American College of Sports Medicine (Campbell et al., 2019; Schmitz et al., 2010)	2010	▪ Type: breast, prostate, colon, gynecologic, and hematological cancer; ▪ Stage: all; ▪ Treatment: during/after.	▪ General: Avoid inactivity and be as physically active as abilities and conditions allow. Aerobic exercise ▪ For breast, prostate, colon gynecologic, and hematological (no HSCT) cancers: 150 min. per week of moderate intensity, or 75 min. per week of vigorous-intensity or an equivalent combination of moderate and vigorous intensity; activity should be done in episodes of at least 10 min., and exceeding guidelines could provide additional benefits. ▪ For patients with HSCT: perform exercise every day at light intensity and lower intensity progression. Resistance exercise ▪ For prostate, colon, gynecologic, and hematological cancers: 2 days per week, including muscle-strengthening activities involving all major muscle groups. ▪ For breast cancer: start with 16 supervised sessions at very low resistance; progress resistance at small increments. ▪ For prostate cancer who undergo radical prostatectomy: add pelvic floor exercises. ▪ For colon cancer with a stoma: start with low resistance and progress slowly to avoid herniation at the stoma. ▪ For patients with HSCT, resistance training might be more important than aerobic exercise.
	2019	▪ Type: all; ▪ Stage: all; ▪ Treatment: during/after.	*Overall* Aerobic exercise ▪ Frequency: at least 3 times per week. ▪ Duration: at least 30 min. per session. ▪ Intensity: moderate. ▪ Progression: not mentioned. ▪ Length: at least 8–12 weeks. Resistance exercise ▪ Frequency: at least 2 times per week. ▪ Duration: at least 2 sets for 8–15 repetitions. ▪ Intensity: at least 60 % of the one-maximal repetition (1RM). ▪ Progression: not mentioned ▪ Length: at least 8–12 weeks. *To improve anxiety symptoms* ▪ Aerobic exercise alone: 3 times/week, for 30–60 min. per session at 60–80 % HRmax for 12 weeks. ▪ Resistance exercise alone: efficacy not demonstrated. ▪ Combined exercise: aerobic exercise, 2–3 times/week, for 20–40 min. per session at 60–80 % HRmax for 6–12 weeks; resistance exercise, 2–3 times/week for 2 sets of 8–12 reps at 65–85 % 1RM for 6–12 weeks. *To improve depressive symptoms* ▪ Aerobic exercise alone: 3 times/week, for 30–60 min. per session at 60–80 % HRmax for 12 weeks. ▪ Resistance exercise alone: efficacy not demonstrated. ▪ Combined exercise: aerobic exercise, 2–3 times/week, for 20–40 min. per session at 60–80 % HRmax for 6–12 weeks; resistance exercise, 2–3 times/week for 2 sets of 8–12 reps at 65–85 % 1RM for 6–12 weeks. *To improve fatigue* ▪ Aerobic exercise alone: 3 times/week, for 30 min. per session at 65 % HRmax for 12 weeks. ▪ Resistance exercise alone: 2 times/week, for 2 sets of 12–15 reps at 60 % 1RM for 12 weeks. ▪ Combined exercise: aerobic exercise, 3 times/week, for 30 min. per session at 65 % HRmax for 12 weeks; resistance exercise, 2 times/week for 2 sets of 12–15 reps at 60 % 1RM for 12 weeks. *To improve quality of life* ▪ Aerobic exercise alone: 2–3 times/week, for 30 min. per session at 60–80 % HRmax for 12 weeks. ▪ Resistance exercise alone: 2–3 times/week, for 2–3 sets of 8–15 reps at 60–75 % 1RM for 12 weeks. ▪ Combined exercise: aerobic exercise, 2–3 times/week, for 20–30 min. per session at 60–80 % HRmax for 12 weeks; resistance exercise, 2–3 times/week for 2 sets of 8–15 reps at 60–80 % 1RM for 12 weeks. *To improve lymphedema* ▪ Aerobic exercise alone: no evidence. ▪ Resistance exercise alone: 2–3 times/week, for 1–3 sets of 8–15 reps at 60–70 % 1RM for 52 weeks. ▪ Combined exercise: no evidence. *To improve physical function* ▪ Aerobic exercise alone: 3 times/week, for 30–60 min. per session at 60–85 % HRmax for 8–12 weeks. ▪ Resistance exercise alone: 2–3 times/week, for 2 sets of 8–15 reps at 60–75 % 1RM for 8–12 weeks. ▪ Combined exercise: aerobic exercise, 3 times/week, for 20–40 min. per session at 60–85 % HRmax for 8–12 weeks; resistance exercise, 2–3 times/week for 2 sets of 8–12 reps at 60–75 % 1RM for 8–12 weeks.
International Bone Metastases Exercise Working Group (Campbell et al., 2022)	2022	▪ Type: all; ▪ Stage: advanced with bone metastases ▪ Treatment: during/after.	▪ The same indications proposed by the American College of Sports Medicine in 2019.

(*continued on next page*)

Table 2 (*continued*)

Institution/ Scientific Society	Year	Cancer type, stage, and treatments	Physical activity recommendations (type, frequency, duration, intensity, progression)
Exercise and Sports Science Australia (Hayes et al., 2019; Hayes et al., 2009)	2009	▪ Type: all; ▪ Stage: all; ▪ Treatment: during/after.	Aerobic exercise ▪ Frequency: 3–5 times/week, but daily exercise may be preferable for deconditioned patients. ▪ Duration: at least 20–30 min. per session. Short bouts with rest intervals should be considered for deconditioned patients. ▪ Intensity: moderate, i.e., 50–75 % Vo2max or HRres, 60–80 %HRmax or 11–14 RPE. ▪ Progression: slower and gradual for deconditioned patients. Patients should meet frequency and duration goals before increasing the intensity. Resistance exercise ▪ Frequency: at least 1–3 times per week, with a rest day between sessions. ▪ Duration: 1–4 sets of 6–10 exercises. ▪ Intensity: 50–80 % of 1RM. ▪ Progression: as for aerobic exercise.
	2019	▪ Type: all; ▪ Stage: all; ▪ Treatment: during/after.	Aerobic exercise ▪ Frequency and duration: for patients able to accrue at least 20 min. exercise sessions should be spread across the week, avoiding two consecutive days with no planned exercise; for deconditioned patients, multiple bouts per day (<20 min. duration) each and every day is recommended. ▪ Intensity: moderate, unless the patient prefers to exercise at low intensity, or the presence of symptoms prevents moderate or high intensity. ▪ Progression: modifying mode, frequency, duration, or intensity of exercise. Resistance exercise ▪ Frequency: at least 2 times per week with at least 48 hours recovery. ▪ Intensity: at least 60 % of the one-maximal repetition (1RM). ▪ Progression: through modifications to the number and type of exercise, load, sets, and/or repetitions. ▪ Additional indications: • Periodization: exercise mode, intensity, and volume can vary over time considering specific events (e.g., surgery), in preparation for subsequent survivorship phase (e.g., second-line therapy), or introduction of new exercise modes. • Progression: progressive overload can occur; it could be slower and more gradual for deconditioned patients or those at risk of exacerbating treatment-related side effects. • Autoregulation: prescription should be flexible to allow patients to autoregulate prescription parameters.
Clinical Oncology Society of Australia (Cormie et al., 2018)	2018	▪ Type: all; ▪ Stage: all; ▪ Treatment: during/after.	Aerobic exercise ▪ At least 150 min. per week of moderate-intensity or 75 min. per week of vigorous-intensity aerobic exercise. Resistance exercise ▪ 2–3 times/week at moderate to vigorous intensity.
American Cancer Society (Rock et al., 2012; Rock et al., 2022)	2012	▪ Type: all; ▪ Stage: all; ▪ Treatment: during/after.	▪ General: avoid inactivity, return to normal daily activities as soon as possible following diagnosis, and follow the recommendation of the American College of Sports Medicine published in 2010. Aerobic exercise ▪ At least 150 min. per week of moderate-intensity or 75 min. per week of vigorous-intensity aerobic exercise or an equivalent combination of moderate and vigorous-intensity aerobic exercise. Resistance exercise ▪ At least 2 times/week.
	2022	▪ Type: all; ▪ Stage: all; ▪ Treatment: during/after.	▪ General: move more and sit less. Aerobic exercise ▪ At least 150–300 min. per week of moderate-intensity or 75–150 min. per week of vigorous-intensity aerobic exercise Resistance exercise ▪ At least 2 times/week.
French medical and surgical societies involved in digestive cancers* (Neuzillet et al., 2021)	2020	▪ Type: digestive cancers ▪ Stage: all; ▪ Treatment: during/after.	Perioperative setting ▪ Limit sedentary behaviors and encourage regular exercise, with progressive implementation and considering postoperative limitations, by combining aerobic and resistance exercise before and after surgery. During (chemo)-radiotherapy ▪ Limit sedentary behaviors and encourage regular exercise, with progressive implementation and considering postoperative limitations, by combining aerobic and resistance exercise. During systemic treatment ▪ Limit sedentary behaviors and encourage regular exercise, with progressive implementation and considering postoperative limitations, by combining aerobic and resistance exercise. Advanced palliative phase ▪ No recommendations. After treatment ▪ Colorectal cancer: 150 min. of moderate aerobic exercise distributed throughout the week and 2 times/week of resistance exercises, respecting 1–2 days of recovery between the sessions. ▪ All other tumors: Limit sedentary behaviors and encourage regular exercise, with progressive implementation and considering postoperative limitations, by combining aerobic and resistance exercise.
American Society of Clinical Oncology (Ligibel et al., 2022)	2022	▪ Type: all; ▪ Stage: all; ▪ Treatment: during.	▪ It should be recommended to perform regular aerobic and resistance exercise during active treatment. ▪ The current evidence does not allow for the creation of specific dosing guidance for the duration or intensity of exercise during treatment required to favorably affect outcomes.
Exercise for people with cancer guideline development group (Segal et al., 2017)	2017	▪ Type: all; ▪ Stage: all; ▪ Treatment: all.	Aerobic exercise ▪ At least 150 min. per week of moderate intensity spread over 3–5 days. Resistance exercise ▪ At least 2–3 times/week, 2 sets for 8–10 reps.

activity indication (e.g., amount of proposed physical activity, adaptation or specific recommendations for testing and programming, recommendation for referring, recommendation for motivational/psychological aspects during physical activity). A Microsoft Excel spreadsheet was created to collect data.

2.3. Quality of the evidence assessment

Two independent authors (A.A. and A.B.) assessed the quality of guidelines using the Appraisal of Guidelines for Research & Evaluation (AGREE) II tool (Enterprise). The AGREE II comprised a total of 23 items categorized in an overall 6 domains, i.e., scope and purpose, stakeholder involvement, rigor of development, clarity of presentation, applicability, and editorial independence. Each item is rated on a 7-point Likert Scale ("*strongly disagree*" to "*strongly agree*"), and the sum of each domain, then scaled as a standardized percentage (range 0–100 %), was calculated. Additionally, AGREE II encloses global items, one related to the overall guideline quality (7-point scale, from "*lowest possible quality*" to "*highest possible quality*") and one dedicated to the recommendation on whether to use the guidelines in practice or not (recommendation for use: "*yes*", "*yes with modifications*", "*no*"). Based on a prior study, high-quality articles are classified as those that reached an AGREE II score $\geq$ 60 % (Stout et al., 2021).

2.4. Data synthesis

According to the Guidance on the Conduct of Narrative Synthesis in Systematic Reviews (Popay et al., 2006), a qualitative synthesis using tables and a narrative description of the extracted guidelines is provided.

3. Results

The search has produced 9198 results. After duplicate removals and screening for title/abstract and, subsequently, for full-text, 11 guidelines were included in the current review (Fig. 1.) (Campbell et al., 2022; Campbell et al., 2019; Cormie et al., 2018; Hayes et al., 2019; Hayes et al., 2009; Ligibel et al., 2022; Neuzillet et al., 2021; Rock et al., 2012; Rock et al., 2022; Schmitz et al., 2010; Segal et al., 2017). Seven guidelines were developed by societies based in North America (Campbell et al., 2022; Campbell et al., 2019; Ligibel et al., 2022; Rock et al., 2012; Rock et al., 2022; Schmitz et al., 2010; Segal et al., 2017), three in Australia (Cormie et al., 2018; Hayes et al., 2019; Hayes et al., 2009), and one in Europe (Neuzillet et al., 2021). Overall, three guidelines, those of the ACS 2022, ACSM 2019, and ESSA 2019 (Campbell et al., 2019; Hayes et al., 2019; Rock et al., 2022), were updates of the prior published recommendations from the same scientific societies (Hayes et al., 2009; Rock et al., 2012; Schmitz et al., 2010). Four guidelines were published between 2009 and 2017 (Hayes et al., 2009; Rock et al., 2012; Schmitz et al., 2010; Segal et al., 2017) and the remaining 7 from 2018 until 2024 (Campbell et al., 2022; Campbell et al., 2019; Cormie et al., 2018; Hayes et al., 2019; Ligibel et al., 2022; Neuzillet et al., 2021; Rock et al., 2022). Nine recommendations addressed all cancer types (17, 18, 20−26), one digestive cancers (Neuzillet et al., 2021), and one breast, prostate, colon, gynecologic, and hematological malignancies (Schmitz et al., 2010). While 10 guidelines enclosed recommendations for all cancer stages (Campbell et al., 2019; Cormie et al., 2018; Hayes et al., 2019; Hayes et al., 2009; Ligibel et al., 2022; Neuzillet et al., 2021; Rock et al., 2012; Rock et al., 2022; Schmitz et al., 2010; Segal et al., 2017), one was dedicated to patients with bone metastases (Campbell et al., 2022). Regarding the timing of treatments, 10 guidelines enclosed instructions for patients during or after therapies (Campbell et al., 2022; Campbell et al., 2019; Cormie et al., 2018; Hayes et al., 2019; Hayes et al., 2009; Neuzillet et al., 2021; Rock et al., 2012; Rock et al., 2022; Schmitz et al., 2010; Segal et al., 2017), and one was focused on those undergoing treatments (Ligibel et al., 2022). Table 1 details the guidelines' methodological quality. Seven out of 11 guidelines met an overall score $\geq$ 60 % and thus were judged of high quality (Campbell et al., 2022; Campbell et al., 2019; Hayes et al., 2019; Ligibel et al., 2022; Neuzillet et al., 2021; Rock et al., 2022; Segal et al., 2017), with the domains regarding the rigor of development and applicability reaching the lowest scores. Five were recommended for use in clinical practice (Campbell et al., 2022; Campbell et al., 2019; Hayes et al., 2019; Ligibel et al., 2022; Rock et al., 2022), five were recommended with modification (Hayes et al., 2009; Neuzillet et al., 2021; Rock et al., 2012; Schmitz et al., 2010; Segal et al., 2017), and one was not considered adequate for clinical practice use (Cormie et al., 2018).

3.1. Physical activity recommendations: type and dosage

A detailed overview of the current physical activity recommendations for patients with cancer is shown in Table 2. Eight out of 11 guidelines proposed unique physical activity recommendations for the entire oncological population (Campbell et al., 2022; Cormie et al., 2018; Hayes et al., 2019; Hayes et al., 2009; Ligibel et al., 2022; Rock et al., 2012; Rock et al., 2022; Segal et al., 2017), whereas one included specific indications for cancer types (Schmitz et al., 2010), one for outcomes of interest (e.g., fatigue, anxiety, depression, etc.) (Campbell et al., 2019), and one based on the treatments/cancer phases (e.g., preoperative period, during radiotherapy, etc.) (Neuzillet et al., 2021). Regarding the type of activities, all the guidelines recommended embracing a combination of aerobic and resistance training in the prescription (Campbell et al., 2022; Campbell et al., 2019; Cormie et al., 2018; Hayes et al., 2019; Hayes et al., 2009; Ligibel et al., 2022; Neuzillet et al., 2021; Rock et al., 2012; Rock et al., 2022; Schmitz et al., 2010; Segal et al., 2017). Six guidelines suggested an average physical activity dosage of 150 minutes per week of moderate-intensity aerobic training (or the equivalent of vigorous-intensity, i.e., 75 minutes) and two times/week of resistance training, reporting few indications about duration, measurement of intensity, and progression (Cormie et al., 2018; Neuzillet et al., 2021; Rock et al., 2012; Rock et al., 2022; Schmitz et al., 2010; Segal et al., 2017). Three recommendations, those endorsed by ACSM in 2019 and ESSA in 2009 and 2019, provided more instructions, suggesting at least 3 times/week of aerobic training, for 20–30 minutes each session at moderate intensity, and 6–10 resistance exercises at least 1–3 times/week, 1–4 sets for 8–15 repetitions at moderate intensity (at least 50–60 % of the one-maximal repetitions) (Campbell et al., 2019; Hayes et al., 2019; Hayes et al., 2009). One guideline referred to recommendations published in another guideline (Campbell et al., 2022), and those published by ASCO stated that the current evidence did not allow the development of specific exercise dosage guidance (Ligibel et al., 2022). The guidelines by Neuzillet et al. dedicated to digestive cancers organized by treatment/cancer phases and suggested: 150 minutes per week of moderate-intensity aerobic training and two times per week of resistance training for patients with colorectal cancer who had completed treatments, while no recommendations for advanced/palliative setting, and general indications, without detailed exercise dosage for perioperative, and during local/systemic treatment phases (Neuzillet et al., 2021). Whereas some indications regarding progression are available in the ESSA guidelines (Hayes et al., 2019; Hayes et al., 2009), generic or no instructions were made across the others (Campbell et al., 2022; Campbell et al., 2019; Cormie et al., 2018; Ligibel et al., 2022; Neuzillet et al., 2021; Rock et al., 2012; Rock et al., 2022; Schmitz et al., 2010; Segal et al., 2017).

3.2. Adaptations, precautions, and recommendations for physical activity testing, programming, referring, and motivational aspects

Dedicated recommendations for physical activity testing, programming, referring, and motivational aspects are presented in Table 3. Six out of 11 guidelines reported some information regarding testing (Campbell et al., 2022; Campbell et al., 2019; Hayes et al., 2019; Neuzillet et al., 2021; Schmitz et al., 2010; Segal et al., 2017). Of these,

Table 3
Recommendations/precautions for physical activity in patients with cancer.

Institution/ Scientific Society	Year	Recommendations/precautions
American College of Sports Medicine (Campbell et al., 2019; Schmitz et al., 2010)	2010	*For testing* ■ General medical assessment for breast, prostate, colon, gynecologic, and hematological cancers: • evaluation for peripheral neuropathies and musculoskeletal morbidities secondary to treatment regardless of time since treatment; • evaluation of fracture risk in patients undergoing hormone therapy; • evaluation of the safety of exercise in patients with known metastatic bone disease; • evaluation of the safety of exercise in patients with known cardiac conditions (secondary to cancer or not); ■ Cancer site-specific medical assessments: • Breast cancer: evaluation for arm/shoulder morbidity before upper body exercise; • Prostate cancer: evaluation of muscle strength and wasting; • Colon cancer: patients should be evaluated as having established consistent and proactive infection prevention behaviors for an existing ostomy before engaging in exercise training more vigorous than a walking program; • Gynecologic cancer: obese patients may require additional assessment for the safety of activity beyond cancer-specific risk; evaluation for lower extremity lymphedema before vigorous aerobic or resistance training. ■ Exercise testing: • Follow ACSM guidelines for testing before moderate-vigorous aerobic exercise; • One-repetition maximum testing has been demonstrated to be safe in patients with breast cancer and at risk of lymphedema; ■ Contraindications to exercise testing: • Follow ACSM recommendations. *For programming/prescription* ■ Contraindications for starting an exercise program: • For breast, prostate, colon, gynecologic, and hematological cancers: allow adequate time to heal after surgery (>8 weeks); not exercise patients who have extreme fatigue, anemia, or ataxia; follow ACSM recommendations concerning cardiovascular and pulmonary contraindications; • For breast cancer: women with immediate arm or shoulder problems secondary to treatment should seek medical care to resolve the issue before training the upper body; • For colon cancer: physician permission for patients with ostomy before starting contact sports and weight training; • For gynecology cancer: women with swelling or inflammation in the abdomen, groin, or lower extremity should seek medical care to resolve the issue before training the lower body; ■ Reason for stopping an exercise program: • For breast cancer: changes in arm/shoulder symptoms or swelling should result in a reduction or avoidance of upper body exercise until after appropriate medical evaluation and treatment resolves the issues; • For colon cancer: hernia, ostomy-related systemic infection; • For gynecologic cancers: changes in swelling or inflammation of the abdomen, groin, or lower extremity should result in a reduction or avoidance of lower body exercise until after appropriate medical evaluation and treatment resolves the issues; ■ Injury risk issues: • Patients with bone metastasis or with cardiac conditions may require exercise modifications and supervision to avoid fractures; • Patients undergoing chemotherapy or radiotherapy may have a compromised immune function and thus a high risk of infection; • Fore breast cancer: arm/shoulder should be exercised, but proactive injury prevention approaches (e.g., wearing a well-fitting compression garment) are encouraged; be aware of fracture risk among those treated with hormone therapy or having osteoporosis or bone metastases; • For prostate cancer: be aware of fracture risk among those treated with ADT or having osteoporosis or bone metastases; • For colon cancer: avoid excessive intra-abdominal pressures for patients with an ostomy; • For myeloma: should be treated as if they have osteoporosis; (*continued on next page*)

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Institution/ Scientific Society	Year	Recommendations/precautions
		• For gynecologic cancer: lower body should be exercised, but proactive injury prevention approaches (e.g., wearing a well-fitting compression garment) are encouraged; be aware of fracture risk among those treated with hormone therapy or having osteoporosis or bone metastases; *For referring* ▪ Not mentioned *For motivational aspects* ▪ Not mentioned
	2019	*For testing* ▪ Medical clearance: • A triage, based on the National Comprehensive Cancer Network Survivorship Guidelines, is recommended to determine the need for medical clearance. ▪ Exercise testing: • A comprehensive assessment of all health-related physical fitness components is necessary. • Be aware of the patient's health history and any general contraindications before commencing exercise testing. • Be familiar with the most common toxicities associated with cancer treatments. • No evidence that the level of medical supervision required for symptom-limited or maximal cardiopulmonary exercise testing needs to be different for patients with cancer than other populations. • For patients with bone metastases and/or known (or suspected) osteoporosis, assessment of muscle strength/endurance involving the musculatures and skeletal sites in the bone lesions should be avoided. • Older patients or those treated with neurotoxic chemotherapy may benefit from balance and mobility assessments to evaluate the risk of falling. • Patients should be screened for evident or underlying cardiovascular disease using the ACSM preparticipation guidelines to determine the need for a cardiopulmonary exercise test. *For programming/prescription* ▪ Bone loss/metastases: • Avoid movement that places an excessively high load on fragile skeletal sites. • Modify the programs based on the site of bone lesions. • Preventing falls must be a goal to indirectly prevent the risk of fracture. • Be aware of signs and symptoms of bone metastases in patients (e.g., pain at the level of bone lesion). Patients who report bone pain should be referred to the medical team for clinical evaluation before continuing exercise. ▪ Lymphedema: • Insufficient evidence to support or refute the advice to wear a compression garment during exercise; this remains the patient's preference. ▪ Older adults: • Combine the ACSM guidelines for cancer with those for older adults. ▪ Ostomy: • Empty the ostomy bag before starting the exercise. • Resistance training should start with low resistance and progressively slowly under the guidance of trained exercise professionals. • To avoid the risk of parastomal hernia, regulate intra-abdominal pressure by correct lifting technique and avoid the use of the Valsalva maneuver. • Modify any core exercise which causes excessive intra-abdominal pressure. • Get medical advice on ways to maintain hydration prior to, during, and after exercise for patients with an ileostomy who are at risk of dehydration. • Wear an ostomy protector/shield for those patients doing contact sports or at risk of a blow to the ostomy. ▪ Peripheral neuropathy: • Stability, balance, and gait should be assessed before exercise; balance training can be considered as indicated. • If neuropathy affects stability, consider alternative aerobic exercise rather than walking or use a treadmill with safety handrails. • For resistance training, monitor hand discomfort when using hand-held weights, consider using dumbbells with a soft/rubber coating, wear padded gloves, and use resistance machines over free weights.

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Institution/ Scientific Society	Year	Recommendations/precautions
		▪ Stem cell transplantation: • Encourage home-based exercise. • Full recovery of the immune system is recommended before returning to gym facilities with the general public. • Start with light intensity, short durations, but high frequency, and progress slowly. • Exercise volume should be adapted on a daily basis based on the individual's presentation. ▪ Symptom cluster: • Symptoms and side effects of cancer treatment rarely appear in isolation; symptoms cluster are the norm, especially in patients with metastatic disease and those undergoing treatment. • Exercise professionals must be aware of this complexity and prepared to refer patients back to the medical team. ▪ Sun safety: • Exercise professionals should recommend that cancer survivors engage in sun protective practices when exercising outdoors since they have an increased risk for secondary skin cancers. *For referring* ▪ Experts who are best suited to prescribe exercise for patients with cancer are rehabilitation specialists (i.e., physical therapists, occupational therapists, physiatrists) and certified exercise physiologists. *For motivational aspects* ▪ Not mentioned
International Bone Metastases Exercise Working Group (Campbell et al., 2022)	2022	*For testing* ▪ Before testing/training: • A risk assessment should be performed to inform the likelihood of a skeletal complication from exercise. • Consultation with the medical team is strongly encouraged to obtain key medical information and establish bidirectional communication for initial assessment. ▪ For the test: • Use professional judgment to determine if exercise testing is necessary by weighing the risks and benefits of including the test or if the testing protocols may need to be modified. • Avoid testing or use with caution those that place stress (high loads or compressive force) on a lesion site. • Consider the potential of fall risk when using treadmills or ambulatory machines. *For programming/prescription* ▪ Put greater emphasis on postural alignment, controlled movement, and proper technique. ▪ Monitor overall response to each exercise prescribed and adjust prescription as appropriate to reduce the potential risks of exercise-related events. ▪ Monitor each session for changes in pain level using a standardized tool, neurological symptoms, and activities of daily living. *For referring* ▪ Experts who are best suited to prescribe exercise for patients with bone metastases are physical therapists and clinical exercise physiologists (or equivalent) who have additional cancer exercise training and appropriate experience in working with people with a cancer diagnosis. *For motivational aspects* ▪ Not mentioned
Exercise and Sports Science Australia (Hayes et al., 2019; Hayes et al., 2009)	2009	*For testing* ▪ Not mentioned *For programming/prescription* ▪ Exercise program should be flexible and adjusted according to changes in treatment, side effects, and the patient's functional and physical status. ▪ Avoid swimming or use of public facilities during periods of increased infection. ▪ Avoid high-impact activities/contact sports in patients with primary or metastatic bone cancer, in those having low platelet counts, or in patients experiencing pain. ▪ Avoid activities requiring balance or coordination and specific resistance exercises (e.g., free weights) in patients with ataxia, dizziness, or peripheral neuropathy. ▪ Exercise intensity and duration should be prescribed to tolerance in patients experiencing nausea, dyspnea, fatigue, or muscle weakness. *For referring* ▪ Not mentioned *For motivational aspects* ▪ Support by the treating specialist is crucial for compliance and adherence to the exercise program. ▪ Practitioners should consider the wants/needs of the patients and ensure the exercise program is enjoyable and builds confidence.
	2019	*For testing* ▪ Assessment should include patient and family health history, cancer diagnosis and treatment, risk, presence and severity of treatment-related toxicities, and physical activity/exercise history.

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Institution/ Scientific Society	Year	Recommendations/precautions
		■ Screening tools should be used for developing an initial health and risk profile for a patient. ■ Medical clearance should be considered on a case-by-case basis. ■ Determine patient capacity and perform physical assessment. *For programming/prescription* ■ Anemia • For aerobic components: multiple bouts daily are likely appropriate, starting with shorter sessions at least 3–4 times/week; • Rating perceived exertion or breathless scales could be more useful than heart rate monitoring. • Supervision is recommended. ■ Thrombocytopenia • Supervision is recommended. • Avoid exercise with increased risk of falls or blunt-force trauma. • Avoid risk of impact/point pressure when using equipment and excessive blood pressure elevation. • Monitor signs of bleeding. ■ Neutropenia • Encourage good hygiene practices (e.g., hand washing, cleaning exercise equipment). • For patients advised to avoid crowded locations, a home-based program should be preferred. • Avoiding high-intensity exercise. ■ Arthralgia • Mode and intensity should be guided by symptom response. ■ Cachexia • Greater emphasis on resistance training. • Considering the underlying causes that may necessitate a reduction in high-energy cost exercise. • Consider referral to a dietitian. ■ Sarcopenia • Greater emphasis on resistance training. • Consider referral to a dietitian. ■ Bone loss • Greater emphasis on resistance training and inclusion of impact loading. • Impact loading is contraindicated for bone metastases. • Consider the inclusion of balance training to reduce fall risk. ■ Bone tumors • Avoid resistance exercises that load the lesioned sites. • Exercise intensity should be determined by symptom tolerability (pain). ■ Pain: • For localized pain, start by choosing exercises that avoid the area and progress slowly, including activities that involve the area of pain. • For generalized pain, start with low exercise dosage and progress slowly. • In case of new or worsening pain, refer patients to clinicians. • Pain medication side effects may influence exercise prescription/response.

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Institution/ Scientific Society	Year	Recommendations/precautions
		■ Post-surgical wound healing: • Exercising non-affected body parts allows for an early return to exercise and may assist wound healing and limit structural and functional decline. ■ Fatigue: • Low intensity may be as effective as high intensity. Short bouts of high-intensity exercise may be better tolerated. • Assess whether reduced muscle mass, strength, or cardiorespiratory fitness may contribute to fatigue to better address exercise prescription. • Avoid total rest, as this will exacerbate fatigue. ■ Fever: • Exercise is contraindicated. ■ Infection, including cellulitis: • Exercise is contraindicated until infection or cellulitis has responded to antibiotic treatment or if cardiovascular/physiological consequences of the infection are still present. • For cellulitis, a temporary modification of the prescription may allow for the affected limb to be rested while the other is exercised. ■ Sleep: • Consider the individual responses to exercise. ■ Sexual dysfunction: • Include pelvic floor exercises. ■ Dyspnea: • Consider daily aerobic exercise at moderate-high intensity. • Supervision is recommended. ■ Chest pain: • Exercise is contraindicated ■ Cardiovascular toxicity: • Be aware of contraindications and signs for cessation of exercise training. • Particular care in identifying appropriate starting exercise prescriptions and increments for progression should be small. • Supervision is recommended. ■ Lymphoedema: • Proposed moderate-high intensity exercise, starting at lower intensities/loads with smaller progression. • Wearing compression garments during exercise if accepted by the patient. • Supervision is recommended. ■ Vomiting, nausea, loose bowel motions: • Remove modes of exercise that exacerbate side effects. • Reduce intensity and/or duration of session and increase bouts per day. • Consider the risk of dehydration and manage accordingly. • If the presence or severity of the side effect is unusual, consider the program suspension. • Supervision is recommended.

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Institution/ Scientific Society	Year	Recommendations/precautions
		■ Urinary incontinence: • Include pelvic floor exercises. • High-impact activities may need to be avoided. • Ensure proximity to bathroom facilities, incontinence pads, or change of clothing. ■ Peripheral neuropathy: • Low-impact exercises may be less painful. • Supervision is recommended unless deemed safe. • Include balance/proprioception exercise. ■ Dizziness: • Include low to moderate-intensity exercises. • Include balance/proprioception training. • Seated exercise should be considered if symptom severity makes the patient unable/unsafe to walk or stand. • If new or changing symptoms onset during exercise, the exercise should be ceased. • Home-based programs may be important for patients with neurological symptoms with restricted mobility. ■ Cognition: • Combine exercise with cognitive activities. ■ Obesity: • Increase the amount of exercise, especially aerobic ones (daily). • Water-based exercise of swimming may be helpful for patients having weight-related joint problems. ■ Type 2 diabetes mellitus: • Daily aerobic exercise, no more than 2 consecutive days without exercise; resistance training more than 2 times/week. • Encourage patients to monitor blood glucose levels before, during, and after exercise; it can be helpful to schedule exercise at a similar time of day and time post-meal to standardize response and reduce the risk of hypoglycemic events. ■ Arthritis: • Low-impact and water-based exercises may be preferred by patients. • Flexibility activities should be included to counteract stiffness. • A substantial increase in pain or swelling during/following exercise may indicate the need for exercise prescription modification. • Patients may need to rest from exercise during an acute period when symptoms flare. • For patients having muscle atrophy a greater emphasis on resistance training should be given. ■ Anxiety/depression: • Higher dosage of aerobic exercise is associated with greater reductions of symptoms. • Avoiding unnecessary burdens/pressures through exercise prescription. ■ Cardiovascular disease: • For hypertension, extend and monitor warm-up and cool-down periods. • For chronic heart failure, exercise intensity should be below the myocardial ischemic threshold. • Be aware of absolute and relative contraindications, including signs for cessation of exercise testing and training. • Supervision is recommended. ■ Presence of peripherally-inserted central catheter (PICC):

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Institution/ Scientific Society	Year	Recommendations/precautions
		• No available data on the risk of PICC damage or dislodgement during exercise. • Recommend dressings change if they become impaired/soiled from exercise. • Ensure not to catch on anything if PICC is not fully covered. • If the patient is fearful of damaging PICC or experiencing pain/discomfort, emphasize lower-body exercise. • Slowly introduce upper-body mobility exercises and encourage arm movement outside of exercise. ▪ Presence of urinary catheter: • High impact or ground impact activities may cause urinary leakage. • Wrapping the catheter bag in a thin towel or putting it in a ziplock bag during exercise since it could become soiled or smelly due to sweating during exercise. • Use a waist belt if patients desire to attach the catheter bag to themselves. ▪ Ostomies: • Compression garments can help support the weakened abdominal wall and reduce movement of the bag during exercise. • Swimming is safe once the stoma has healed. • Avoid excessive abdominal pressure due to the risk of peristomal hernia. *For referring* ▪ Experts who are best suited to prescribe exercise for patients with cancer are accredited exercise physiologists. *For motivational aspects* ▪ Implement behavior change techniques, including goal setting, self-monitoring, individualized education, and social support to improve adherence. ▪ Support patients in achieving goals, identifying and helping a patient problem-solve general and cancer-specific issues and barriers: • Hair loss and wigs: Understanding patients' views and concerns and providing support and advice to them. Exercising with a wig may be uncomfortable, especially in the presence of others without a wig. The absence of hair can lead to increased sweat running from the heat to the face and eyes; a sweatband or exercising in a cooler environment may be helpful. • Time and scheduling: Time barriers may vary among patients. Reminding patients of their motivators for exercise and the priority of exercise goals versus day-to-day priorities will help them prioritize time accordingly. • Fear of causing or exacerbating treatment-related side effects. Keeping a daily logbook of the presence of treatment-related side effects in the absence and during exercise phases. This will help to understand what and how symptoms may change with exercise. • Skin irritation or discomfort: identify and solve factors that may cause skin irritations and promote skin hygiene and care. • End-of-life/nearing death: Ensure that patients guide the exercise goals also in this phase.
Clinical Oncology Society of Australia (Cormie et al., 2018)	2018	*For testing* ▪ Not mentioned. *For programming/prescription* ▪ Exercise recommendations should be tailored to the individual's abilities. *For referring* ▪ Experts who are best suited to prescribe exercise for patients with cancer are accredited exercise physiologists or physiotherapists with experience in cancer care. *For motivational aspects* ▪ Not mentioned.
American Cancer Society (Rock et al., 2012; Rock et al., 2022)	2012	*For testing* ▪ Not mentioned. *For programming/prescription* ▪ Exercise should be delayed in patients with severe anemia until this is improved. ▪ Avoid public gyms and pools for patients with compromised immune function until the white blood cell counts return to safe levels. Patients completing a bone marrow transplant are usually advised to avoid such exposures for one year after transplantation. ▪ In patients with severe fatigue from therapy, performing 10 min. of light exercise daily is recommended. ▪ Avoid chlorine exposure (pools) to irradiated skin for patients undergoing radiation. ▪ In patients with indwelling catheters or feeding tubes, take caution or avoid pool, lake/ocean water, or other microbial exposure to reduce the infection risk and resistance training in the area of the catheter. ▪ Consider modification to the exercise program in consultation with physicians for patients with multiple or uncontrolled comorbidities. ▪ Caution in activities requiring balance or coordination in patients with ataxia or peripheral neuropathy. *For referring* ▪ Not mentioned. *For motivational aspects*

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Institution/ Scientific Society	Year	Recommendations/precautions
		■ Behavioral support strategies can be used to help patients maintain a physically active lifestyle, such as short-term supervised exercise, support groups, telephone counseling, motivational interviewing, and cancer patients-specific print materials.
	2022	*For testing* ■ Not mentioned. *For programming/prescription* ■ Not mentioned. *For referring* ■ Refer patients to appropriate healthcare professionals and evidence-based programs. ■ Experts who are best suited to prescribe exercise for patients with cancer are exercise physiologists or rehabilitation specialists. *For motivational aspects* ■ Not mentioned.
French medical and surgical societies involved in digestive cancers* (Neuzillet et al., 2021)	2020	*For testing* ■ Evaluate physical condition including: performance status, history of the disease and symptoms, fatigue, pain, physical activity habits/level, physical fitness, especially aerobic capacity/exercise tolerance, strength, dynamic and static balance. *For programming/prescription* ■ During the perioperative phase: • Exercise is contraindicated in the following cases: extreme fatigue, symptomatic anemia, severe infectious syndrome, decompensation of cardiopulmonary disease, lytic bone lesions of the spine or long bones. • An adaptation of the exercise prescription is necessary in the following cases: cardiopulmonary comorbidities, osteoporosis with high risk of fractures, significant amyotrophy, peripheral neuropathy, impaired mobility and stability of the joints, lymphoedema, recent abdominal scar, digestive or urinary stomas. • Comorbidities should be considered and detailed to the professional supervising the sessions for safe support. • In the early postoperative setting of abdominal surgery avoid concentric exercises stressing the muscles of the abdominal wall after laparotomy. • In the early postoperative setting after a thoracotomy, avoid exercises in the Valsalva maneuver and stretching the trunk. • In patients with anal incontinence, avoid activities with impact on the ground or in Valsalva maneuver and promote exercises of the perineal muscles. • In patients with radiodermatitis, take precautions with aquatic activities. • In patients with ostomy, avoid concentric exercises involving the muscles of the abdominal wall in early postoperative period after laparotomy; avoid activities at risk of shock to the stoma; adapt the duration and the time pf the activity to the flow of the stoma. ■ During systemic treatment: • Comorbidities should be considered and detailed to the professional supervising the sessions for safe support. • Avoid activity in patients with implantable chambers while the infusion is ongoing; avoid activities at risk of shock on the device. • In patients with PICC-line, avoid activities at risk of shock or friction on the device and aquatics activities. • Avoid Valsalva maneuvering activities, activities at risk of shock, and prone positions in patients with peritoneal carcinomatosis. • In patients with bone metastases, avoid activities at risk of shock and with impact on the ground, depending on the location of the metastatic lesion. • In patients affected by thromboembolic events, avoid activities that may cause shock with anticoagulants and monitor the intensity of exercise. • For hand-foot syndrome caused by treatment, avoid impact on the ground if active events. • For increased photosensitivity, wear sunscreen and hat for outdoor activities. • For cardiotoxicity, special attention to tolerance/perception of effort in aerobic activities. *For referring* ■ For patients in the perioperative or (chemo)radiotherapy or after-treatment context, refer them to an adapted physical activity professional, in particular, those patients with barriers to practice (comorbidities, intense fatigue, negative belief/fear in exercise). ■ For patients during systemic therapy, refer them to an adapted physical activity professional, in particular, those patients with barriers to practice (sarcopenia, comorbidities, metastatic disease, intense fatigue, negative belief/fear in exercise). *For motivational aspects* ■ Not mentioned.
American Society of Clinical Oncology (Ligibel et al., 2022)	2022	*For testing* ■ Not mentioned. *For programming/prescription* ■ Not mentioned. *For referring* ■ Encourage clinicians to make appropriate referrals to oncology rehabilitation, cancer-certified fitness professionals, etc. *For motivational aspects* ■ Clinicians should introduce the importance of exercise to their patients. ■ Incorporation of motivational strategies, identification of barriers, and creative approaches to support behavior change.

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Institution/ Scientific Society	Year	Recommendations/precautions
Exercise for people with cancer guideline development group (Segal et al., 2017)	2017	*For testing* ■ Is recommended a pre-exercise assessment to evaluate for any effects of disease, treatments, and comorbidities. *For programming/prescription* ■ Is recommended a group-based or supervised setting since that environment may provide superior benefits. *For referring* ■ Not mentioned. *For motivational aspects* ■ Not mentioned.

three, those released by ESSA in 2019, the French Oncology Intergroup, and the Cancer Care Ontario, reported general indications for testing, including the health history, symptoms, and physical fitness assessments (Hayes et al., 2019; Neuzillet et al., 2021; Segal et al., 2017); the others published by ACSM in 2010 and 2019 and International Bone Metastases Exercise Working Group (IBMEWG), appeared to detail more the instructions for medical assessment/clearance, including the use of specific health assessments tools, as well as for exercise testing, such as contraindications or potential risks to be aware of (Campbell et al., 2022; Campbell et al., 2019; Schmitz et al., 2010).

Regarding programming adaptations, nine recommendations provided indications/precautions to be implemented for patients with cancer (Campbell et al., 2022; Campbell et al., 2019; Cormie et al., 2018; Hayes et al., 2019; Hayes et al., 2009; Neuzillet et al., 2021; Rock et al., 2012; Schmitz et al., 2010; Segal et al., 2017). Six of these reported precautions in light of cancer-specific symptoms or treatment sequelae, such as anemia, immune function impairment, peripheral neuropathy, skin rash, severe fatigue, bone metastases, indwelling catheters, or ostomy (Campbell et al., 2019; Hayes et al., 2019; Hayes et al., 2009; Neuzillet et al., 2021; Rock et al., 2012; Schmitz et al., 2010), one focused only on precautions for bone metastases (Campbell et al., 2022) and two general indications (Cormie et al., 2018; Segal et al., 2017).

Instructions for referring were reported in seven out of 11 recommendations and included a referral to rehabilitation (e.g., physiotherapists) or exercise (e.g., exercise physiologists or adapted physical activity professionals) specialists (Campbell et al., 2022; Campbell et al., 2019; Cormie et al., 2018; Hayes et al., 2019; Ligibel et al., 2022; Neuzillet et al., 2021; Rock et al., 2022). Four guidelines included considerations or some degree of instructions for motivational aspects to increase patients' compliance and support the behavior change (Hayes et al., 2019; Hayes et al., 2009; Ligibel et al., 2022; Rock et al., 2012).

4. Discussion

The current systematic review has identified 11 recommendations dedicated to physical activity for adult patients affected by cancer published in the last 15 years and endorsed by recognized scientific societies. Overall, seven of 11 guidelines were judged to be high quality, whereas four, the oldest, were scored with a point $\leq$ 60 % according to the AGREE II tool. Among the domains, *Stakeholder involvement* (domain 2), *Rigor of Development* (domain 3)*, and Applicability* (domain 5) were the three main methodological pitfalls. These discrepancies in the quality of the recommendations could be related to the year of development; on one side, more guidance (e.g., Grading of Recommendations, Assessment, Development, and Evaluations) for guidelines development has been published in recent years, thus helping authors create more rigorous recommendations (Zeng et al., 2021). On the other hand, the research on physical activity in oncology has exponentially grown in the last 15 years, providing numerous and more consistent evidence to be summarized in the guidelines (Gu et al., 2023). What is certain is that the rigor of development is fundamental to increasing the trustworthiness of the recommendations, whereas incorporating stakeholder views and enhancing the applicability domain is crucial for expecting and obtaining an effective implementation of the recommendations, as highlighted by the previous literature. In this light, dissecting the barriers and facilitators to physical activity guidelines implementation could be paramount. Healthcare providers are crucial in recommending physical activity to their patients but often lack education, and healthcare system constraints (e.g., lack of time) are barriers to effectively promoting an active lifestyle. In addition to this, reimbursement issues, as well as the lack of services dedicated to oncological exercise, remain important obstacles to exercise therapy and referral (Baumann et al., 2024; Yang et al., 2024). Future developments might try to overcome these barriers by including interdisciplinary programs for oncologists and physiotherapists to improve exercise prescription knowledge and expanding the registries of dedicated exercise programs

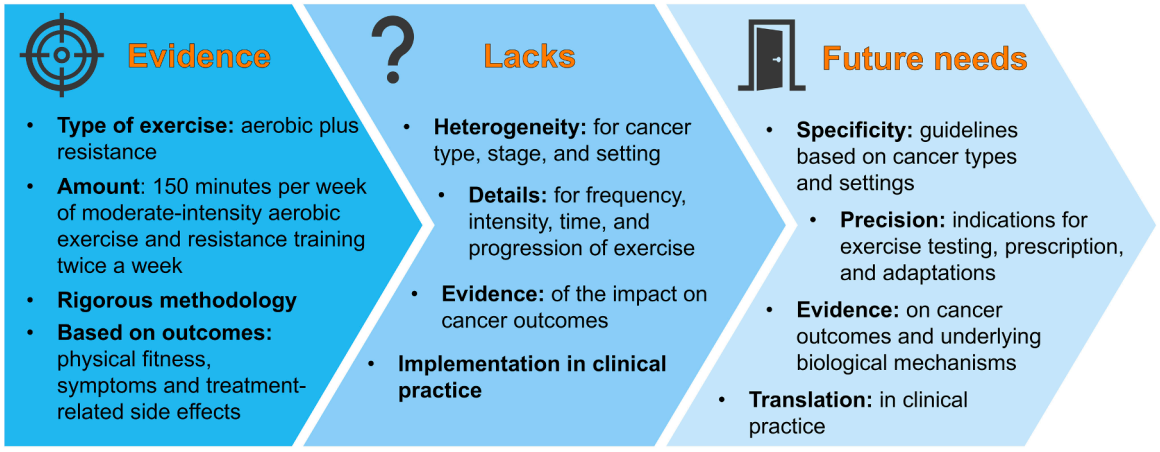

Fig. 2. "Current evidence, lacks, and future needs for guidelines in exercise oncology".

(Avancini, Belluomini, et al., 2023; Baumann et al., 2024; Yang et al., 2024). Additionally, the use of technology devices, such as wearables and telemedicine approach, has been demonstrated to be effective in enhancing physical activity in patients with cancer and offers a great opportunity to enhance implementation by breaking down logistic factors and the costs by a favorable ratio of patient-healthcare providers (Bergerot et al., 2024).

All the guidelines suggested combining aerobic and resistance training as the main activities that patients with cancer should perform (Campbell et al., 2022; Campbell et al., 2019; Cormie et al., 2018; Hayes et al., 2019; Hayes et al., 2009; Ligibel et al., 2022; Neuzillet et al., 2021; Rock et al., 2012; Rock et al., 2022; Schmitz et al., 2010; Segal et al., 2017). Regarding the *dosage* of physical activity, the majority reported 150 minutes per week of moderate-intensity or 75 minutes of vigorous-intensity aerobic training plus resistance training twice a week (19, 23–27) as the most common indications to address the major physical and psychological adverse events of cancer and its treatment. Although these recommendations are important, at the same time, they are general and rarely report detailed instructions about the frequency, intensity, duration, and progression. These principles are essential to guarantee the most appropriate prescription for maximizing the potential benefits and achieving the desired outcomes. In this sense, appear more exhaustive the guidelines endorsed by the ESSA in 2009 and 2019 and those of the ACSM 2019, which proposed aerobic training with a frequency of 3 times/week, a duration of 20–30 minutes per session, and an intensity of 60–80 % HRmax (or the equivalent of VO2max), and resistance training, involving 6–10 exercise 1–3 times/week, 1–4 sets of 8–15 repetitions performed at least 5–60 % of the 1RM (Campbell et al., 2019; Hayes et al., 2019; Hayes et al., 2009).

Additionally, since cancer is a heterogeneous disease, including different trajectories and treatment options, a final aim could be having precise recommendations considering all these aspects (Courneya et al., 2024). For instance, body composition is differently shaped by cancer types and stages (Caan et al., 2018). Patients affected by cancers of the head and neck, pancreatic, or lung have a higher risk of developing sarcopenia/cachexia (Avancini, Trestini, et al., 2021). On the contrary, breast, ovary, and prostate cancers typically lead to overweight/obesity phenotype (Caan et al., 2018). In this light, having instructions for balancing the dosage of aerobic and resistance exercises specific for cancer types could be extremely important in view of precision medicine based on the disease. Furthermore, physical activity plays an important role across the entire cancer continuum and may serve before treatments, during treatments, between treatments, immediately after successful treatments, during longer-term survivorship after successful treatments, and during the end of life after unsuccessful treatments. Indeed, as postulated by Courneya et al., with Exercise across the Postdiagnosis Cancer Continuum (EPiCC) framework, physical exercise has a specific role as a disease treatment and supportive care, depending on different treatment settings (Courneya et al., 2024). Following this perspective, a tentative to develop guidelines tailored for cancer type and setting has been made by Neuzillet et al. (Neuzillet et al., 2021), who have proposed physical activity guidelines for digestive cancers, including dedicated subsections for different treatment phases, even if they lack detailed physical activity recommendations (Neuzillet et al., 2021). Similarly, the guidelines published by ASCO focused on patients undergoing systemic treatments have included exercise prehabilitation intervention in their analysis, but also, in this case, dedicated exercise instructions were not drawn due to heterogeneity in the current evidence (Ligibel et al., 2022). A possible explanation for the lack of detailed guidelines based on cancer type and settings could be related to the relative *novelty* of physical activity research in oncology. Although a bibliometric analysis has established that over the past 20 years, research dedicated to physical activity and sedentary in the context of cancer has undergone a 10-fold increase, a large part of the evidence is focused on breast cancer and survivorship phase, making currently impossible summarizing and developing guidelines organized for cancer types and settings (Gu et al., 2023). This implies that in the future, huge efforts should be made to further increase the number of high-quality research, especially in areas with poor evidence.

The ACSM guidelines published in 2019, for the first time, have reported dedicated exercise prescriptions for specific endpoints, including anxiety, depression, fatigue, quality of life, lymphoedema, and physical function (Campbell et al., 2019). This is an incredible forward step to establishing exercise as an essential supportive care for patients with cancer, able to prevent and/or manage cancer and/or treatment-related side effects. Nevertheless, to confirm physical exercise as a possible adjunctive treatment for cancer and thus produce recommendations specific for cancer survival, evidence on cancer outcomes is necessary. Although observational data has suggested an inverse association between physical activity and mortality for patients with cancer (Friedenreich, Stone, et al., 2020) and preclinical data support the antitumor effect of exercise (Yang et al., 2021), data deriving from interventional trials are still limited (Morishita et al., 2020; Sanft et al., 2023). In this sense, some studies specifically designed to explore the effect of exercise on clinical endpoints are currently ongoing. For instance, the Intense Exercise for Survival among Men with Metastatic Prostate Cancer (INTERVAL-GAP4) trial is a randomized controlled study evaluating the impact of a 2-year tailored exercise program on overall survival in 866 patients affected by metastatic prostate cancer (Newton et al., 2018). The Colon Health and Life-Long Exercise Change (CHALLENGE) study, by applying a randomized controlled design, examines, on 962 patients with colon cancer stage II and III who have completed surgical resection and systemic treatment, the effect of a 3-year exercise program on disease-free survival (Courneya et al., 2008).

Moreover, our research group has just started a novel study, the PerSonalized nutrition and physical exercise for earLy-staGe NSCLC ouTcomes (STARLighT), investigating the impact of physical exercise and diet in patients affected by early-stage lung cancer (Avancini et al., 2025). The project applies an adapted master protocol design to simultaneously evaluate the intervention in the context of neoadjuvant chemoimmunotherapy through a single-arm study on 46 patients and pathological complete response and quality of life as co-primary endpoints, and in the adjuvant setting, after surgical resection, through a randomized controlled evaluating the impact on disease-free survival on 275 patients (AIRC, 2024). These studies will provide important information to address the current research gap in this area and a first step in developing dedicated recommendations. Moreover, to optimize exercise intervention further, it will soon be essential to explore the biological activity and working mechanisms by which exercise may act as anticancer therapy. Demonstrating the impact on cancer outcomes, as well as deciphering the underlying mechanisms of action, might guarantee an incredible step forward toward an effective implementation of physical activity in clinical routines. Approval of new current diagnostic and therapeutic opportunities options in oncology is based on the demonstration of significant impact in terms of hard endpoints (e.g., survival) as well as in tolerability and quality of life. A similar approach can be hypothesized for physical exercise as an adjunctive therapy. Specific instructions for testing/medical clearance are reported in half of the included guidelines, even if most of them report only general indications without specifying the assessments that might be performed (Campbell et al., 2022; Campbell et al., 2019; Hayes et al., 2019; Neuzillet et al., 2021; Schmitz et al., 2010; Segal et al., 2017). This will be a crucial point to clarify in the near future. Indeed, medical clearance for patients with cancer may have a double face. On one side, as reported by some authors, it may act as a barrier to participation, discouraging patients from starting an exercise program (Hayes et al., 2019). On the other, it could provide important indications for exercise prescription, e.g., by assessing the status of the cardiovascular system and/or skeleton in case of fragility, allowing to avoid unnecessary risks or identifying those patients for which exercise could be contraindicated (Jones, 2011). Similarly, adaptations/ precautions to be adopted during an exercise program have been illustrated in nine guidelines; even if the degree of detail is highly variable across them, those endorsed by ESSA in 2019 appear extremely comprehensive (Hayes et al., 2019). However, most of these instructions appear to be based more on best practices rather than scientific evidence. This does not necessarily mean that they are incorrect or invalid, but they need to be confirmed with an evidence-based approach since they could lead to under or over-estimations of the adaptations, proposing a more conservative approach or, on the other hand, a too-pioneering one, with potential consequence on the risks and benefits deriving from exercise. Only four guidelines illustrated some indications for motivational aspects, even in this case, with greater variability of details (Hayes et al., 2019; Hayes et al., 2009; Ligibel et al., 2022; Rock et al., 2012). Motivational aspects are essential to increase patients' uptake and adherence to exercise programs, and often, their impairments are indicated as the reasons for the small-moderate effects of exercise (Buffart et al., 2017). Several ways could positively influence motivation in patients with cancer, including their preferences (Avancini et al., 2020; Borsati et al., 2023), clinicians, and family support (Avancini et al., 2020; Borsati et al., 2023), as well as breaking the potential experienced barriers (Avancini et al., 2020; Borsati et al., 2023) and inserting tailored behavior change techniques (Courneya, 2010). This will be another important area of improvement for the future guidelines.

The current work presents strengths and limitations that should be noted. The "language" inclusion criteria represent the main limitation of this review. Indeed, we limited the search to those guidelines published in English, Italian, or Scandinavian languages, therefore limiting the comprehensive selection to those published in other languages. Regarding the strength of this work, we use the AGREE II instrument, which is a reliable and valid tool to evaluate the methodological quality of the guidelines and may address future areas of improvement. Additionally, we decided to select only guidelines endorsed by scientific societies, having a recognized role in cancer care, to ensure including those with a higher trustworthiness in the scientific landscape.

In conclusion, we found 11 guidelines dedicated to physical activity in patients with cancer. Although the most recent recommendations tried to provide indications regarding the physical activity dosage, most still resulted generic (Fig. 2). High-quality research will surely help to produce future and more detailed guidelines, including specific indications about the type, frequency, intensity, duration, and progression of the activities specific to cancer type, treatment type/phase, and outcomes (Fig. 2). To achieve this crucial goal, this review offers important insights to address the gaps in determinate areas.

Funding

This research was supported by the Associazione Italiana per la Ricerca sul Cancro (AIRC, Next Gen Clinician Scientist 2023n° 30204).

On behalf of the coauthors

LB received payment or honoraria for lectures, presentations, speaker's bureaus, manuscript writing or educational events from AstraZeneca, Merck Sharp & Dohme, and Roche, outside the submitted manuscript; travel fees from Takeda. MM personal honoraria from AstraZeneca and MSD; travel expenses from AstraZeneca, outside the submitted manuscript. SP received consulting fees from AstraZeneca, MSD, Eli Lilly, Roche, AMGEN, Pierre-Fabre, Daichii-Sankyo, Pfizer, Boehringer Ingelheim, Regeneron; payment or honoraria for lectures, presentations, speaker's bureaus, manuscript writing or educational events from AstraZeneca, MSD, Eli Lilly, Roche, AMGEN, Daichii-Sankyo, Boehringer Ingelheim, Johnson & Johnson, Novartis; support for attending meetings and/or travel from Roche, Johnson & Johnson, AMGEN, outside the submitted manuscript. The other authors declare no conflict of interest.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: LB received payment or honoraria for lectures, presentations, speaker's bureaus, manuscript writing or educational events from AstraZeneca, Merck Sharp & Dohme, and Roche, outside the submitted manuscript; travel fees from Takeda. MM personal honoraria from AstraZeneca and MSD; travel expenses from AstraZeneca, outside the submitted manuscript. SP received consulting fees from AstraZeneca, MSD, Eli Lilly, Roche, AMGEN, Pierre-Fabre, Daichii-Sankyo, Pfizer, Boehringer Ingelheim, Regeneron; payment or honoraria for lectures, presentations, speaker's bureaus, manuscript writing or educational events from AstraZeneca, MSD, Eli Lilly, Roche, AMGEN, Daichii-Sankyo, Boehringer Ingelheim, Johnson & Johnson, Novartis; support for attending meetings and/or travel from Roche, Johnson & Johnson, AMGEN, outside the submitted manuscript. The other authors declare no conflict of interest.

Acknowledgments

L.B. and A.A. are supported by grants from Associazione Pietro Casagrande ONLUS. S.P. is supported by the Associazione Italiana per la Ricerca sul Cancro (AIRC, Next Gen Clinician Scientist 2023n° 30204).

Appendix

Table. Search strategy

Database	Search terms
PubMed	(("physical activity"[Title/Abstract] OR exercise[Title/Abstract] OR "physical exercise"[Title/Abstract] OR "exercise therapy"[Title/Abstract] OR "resistance training"[Title/Abstract] OR walking[Title/Abstract] OR "circuit-based training"[Title/Abstract] OR "strength training"[Title/Abstract] OR "weight-bearing exercise"[Title/Abstract] OR "aerobic training"[Title/Abstract] OR "cardiorespiratory training"[Title/Abstract] OR fitness[Title/Abstract] OR "endurance training"[Title/Abstract] OR "exercise prescription"[Title/Abstract] OR "muscle strength"[Title/Abstract] OR bodybuilding[Title/Abstract] OR fitness[Title/Abstract] OR "Resistance exercise"[Title/Abstract] OR "Resistance training"[Title/Abstract] OR "Strength training"[Title/Abstract] OR "Total body training"[Title/Abstract] OR "Weight-bearing exercise"[Title/Abstract] OR "Weightlifting"[Title/Abstract] OR "Weight lifting"[Title/Abstract] OR "Weight-lifting"[Title/Abstract] OR "Weight training"[Title/Abstract] OR "cardiorespiratory fitness"[Title/Abstract] OR "physical capacity"[Title/Abstract]) AND (guideline*[Title/Abstract] OR "consensus statement*"[Title/Abstract] OR "recommendation"[Title/Abstract] OR "position statement*"[Title/Abstract] OR roundtable*[Title/Abstract] OR "expert statement*"[Title/Abstract] OR "expert consensus"[Title/Abstract] OR "position stand"[Title/Abstract])) AND (neoplasm*[Title/Abstract] OR cancer[Title/Abstract] OR carcinoma*[Title/Abstract] OR tumor*[Title/Abstract] OR malignanc*[Title/Abstract] OR "blood tumor*"[Title/Abstract])
Cochrane	"physical activity" OR exercise OR "physical exercise" OR "exercise therapy" OR "resistance training" OR walking OR "circuit-based training" OR "strength training" OR "weight-bearing exercise" OR "aerobic training" OR "cardiorespiratory training" OR fitness OR "endurance training" OR "exercise prescription" OR "muscle strength" OR bodybuilding OR fitness OR "Resistance exercise" OR "Resistance training" OR "Strength training" OR "Total body training" OR "Weight-bearing exercise" OR "Weightlifting" OR "Weight lifting" OR "Weight-lifting" OR "Weight training" OR "cardiorespiratory fitness" OR "physical capacity" in Title Abstract Keyword AND guideline* OR "consensus statement* " OR "recommendation" OR "position statement* " OR roundtable* OR "expert statement* " OR "expert consensus" OR "position stand" in Title Abstract Keyword AND neoplasm* OR cancer OR carcinoma* OR tumor* OR malignanc* OR "blood tumor* " in Title Abstract Keyword
Scopus	(TITLE-ABS-KEY ("physical activity" OR exercise OR "physical exercise" OR "exercise therapy" OR "resistance training" OR walking OR "circuit-based training" OR "strength training" OR "weight-bearing exercise" OR "aerobic training" OR "cardiorespiratory training" OR fitness OR "endurance training" OR "exercise prescription" OR "muscle strength" OR bodybuilding OR fitness OR "Resistance exercise" OR "Resistance training" OR "Strength training" OR "Total body training" OR "Weight-bearing exercise" OR "Weightlifting" OR "Weight lifting" OR "Weight-lifting" OR "Weight training" OR "cardiorespiratory fitness" OR "physical capacity") AND TITLE-ABS-KEY (guideline* OR "consensus statement*" OR "recommendation" OR "position statement*" OR roundtable* OR "expert statement*" OR "expert consensus" OR "position stand") AND TITLE-ABS-KEY (neoplasm* OR cancer OR carcinoma* OR tumor* OR malignanc* OR "blood tumor*"))

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