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The Exercise and Sports Science Australia position statement: Exercise medicine in cancer management

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Review

The Exercise and Sports Science Australia position statement: Exercise medicine in cancer management

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ABSTRACT

Objectives: Since Exercise and Sports Science Australia (ESSA) first published its position statement on exercise guidelines for people with cancer, there has been exponential growth in research evaluating the role of exercise pre-, during and post-cancer treatment.
Design and Methods: The purpose of this report is to use the current scientific evidence, alongside clinical experience and exercise science principles to update ESSA's position statement on cancer-specific exercise prescription.
Results: Reported in this position statement is a summary of the benefits accrued through exercise following a cancer diagnosis and the strengths and limitations of this evidence-base. An exercise prescription framework is then proposed to enable the application of cancer-specific considerations for individualisation, specificity, safety, feasibility and progression of exercise for all patients. Additional specific exercise prescription considerations are provided for the presence of haematological, musculoskeletal, systemic, cardiovascular, lymphatic, gastrointestinal, genitourinary and neurological disease- and treatment-related concerns, as well as presence of co-morbid chronic disease. Further, we also identify and discuss cancer-specific pragmatic issues and barriers requiring consideration for exercise prescription.
Conclusions: While for the majority, multimodal, moderate to high intensity exercise will be appropriate, there is no set prescription and total weekly dosage that would be considered evidence-based for all cancer patients. Targeted exercise prescription, which includes the provision of behaviour change advice and support, is needed to ensure greatest benefit (as defined by the patient) in the short and longer term, with low risk of harm.

Practical implications

- This document represents ESSA's exercise and cancer position statement and has the purpose of guiding individualised, targeted exercise prescription to cancer patients through the application of evidence, clinical experience and exercise principles.
- The exercise prescription that works best for whom and when will be determined by patient assessment, identification and consideration of general and cancer-specific health issues and their contribution to risk of morbidity and/or mortality, and subsequent patient-driven goals.
- While for the majority, multimodal, moderate to high intensity exercise will be appropriate, there is no set prescription and total weekly dosage that would be considered evidence-based for all cancer patients.
- Targeted exercise prescription, which includes the provision of behaviour change advice and support, is needed to ensure greatest benefit (as defined by the patient) is achieved in the short and longer term, with very low risk of harm.

1. Introduction

In 2009, Exercise and Sports Science Australia (ESSA) published its first position statement on optimising cancer outcomes through exercise.[1] Since that time, the position statement has been used by health professionals to guide exercise prescription to cancer patients pre-, during and post-treatment, and has provided the foundation for continuing education courses in upskilling the workforce. In the past decade, cancer incidence in Australia has increased and cancer survival has continued to improve,[2] ensuring

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a rapidly expanding number of people living with a cancer diagnosis (>400,000 Australians are currently living with a cancer diagnosis in the previous five years). Further, there has been exponential growth in published high quality, randomised, controlled trials that have evaluated the effect of exercise on a range of cancer-related outcomes across the cancer trajectory, from diagnosis through to end of life. In recognition that Accredited Exercise Physiologists (AEPs) require and seek assistance in translating this evidence to their exercise prescription practice for people with cancer, who represent a growing population with diverse and cancer-specific health needs and priorities, we present a new ESSA exercise and cancer position statement. The purpose of this position statement is to: (1) provide a contemporary overview of the exercise and cancer evidence-base; and (2) present a framework for exercise prescription to patients, with cancer-specific considerations for individualisation, specificity, safety, feasibility and progression.

2. Evidence of exercise benefit following a cancer diagnosis

Benefits accrued through exercise during and beyond treatment for cancer have been extensively reviewed. Specifically, a recent publication reported that 140 meta-analyses have been published to date, with the majority (75%) showing statistically significant and clinically relevant benefit through exercise on a range of treatment-related side effects, physical, functional, and psychosocial outcomes.[3] Our own review (date: 18/7/17; search terms: ((“exercise”[MeSH Terms] OR “exercise”[All Fields]) AND (“neoplasms”[MeSH Terms] OR “neoplasms”[All Fields])) AND (“2009”[PDAT] AND Review[ptyp])) identified more than 140 systematic reviews or meta-analyses and more than 90 non-systematic reviews on new or emerging topics. There now exists evidence of varying strength on the safety, feasibility and/or efficacy of exercise throughout the cancer continuum in a range of cancers, including but not limited to, more common cancers such as breast,[4] prostate,[5] colorectal[6] and lung[7] cancer, as well as other cancers including haematological,[8] head and neck,[9] cancers of childhood and adolescence,[10] and gynaecological cancers,[11,12] and less common cancers such as brain,[13] testicular[14] and pancreatic.[15] Some studies have specifically targeted patient cohorts with more advanced disease,[16,17] providing initial evidence beyond patients with early-stage disease, generally considered ‘well’.

Outcomes evaluated in trials have also broadened. There is now trial evidence (again of varying strength) regarding the potential positive effect of exercise for more contemporary treatment-related side effects, such as chemotherapy-induced peripheral neuropathy,[18] myalgia and arthralgias,[19,20] lymphoedema (upper- and lower-limb),[21,22] bone health,[23–25] sarcopenia[26,27] and metabolic syndrome,[28] sleep quality,[29] cachexia,[30] cognitive impairment[31] and cardiotoxicity,[32,33] as well as outcomes particularly relevant to the clinical and public health setting, such as treatment adherence or completion[34–36] and cost-effectiveness.[37] In the past five years, preliminary findings have also become available from phase 2 exploratory studies that have reported the effect of exercise on survival outcomes.[38–41]

Despite the exponential growth in the number and quality of clinical trials contributing to the broader evidence-base supporting exercise in oncology, there remains a preponderance of studies in the breast cancer setting and/or involving ‘healthier, more active’ cancer patients,[42] which is disproportionate to the characteristics of the wider cancer population. Further, there are varying levels of evidence in support of exercise as being safe, feasible and effective for various cancer cohorts, cancer subtypes, stages of disease and outcomes of interest. For example within the breast cancer setting, there is strong evidence to support exercise as being safe, feasible and effective at improving cardiorespiratory fitness, neuromuscular strength and quality of life during and post-breast cancer treatment (particularly for those diagnosed with early stage disease).[43] In contrast, the evidence to support exercise as being effective at improving survival outcomes for any cancer cohort is weak (findings come from underpowered, exploratory analyses).[38–41] There is strong evidence that exercise leads to benefits when integrated during active treatment for a range of cancers,[43] but no evidence to suggest that the specific timing of an exercise session matters (e.g., evidence showing exercise during chemotherapy infusion is more or less effective at improving survival outcomes versus before or after infusion is lacking). Following a review of this literature, a forthcoming American College of Sports Medicine publication (to be published in *Medicine and Science in Sports and Exercise,* 2019) will provide exercise prescription guidelines specific to cancer-outcomes with a sufficient evidence-base to do so. The ESSA exercise and cancer guideline update presents a process that can guide the practical application of this evidence.

3. Recommended process for targeted, exercise prescription for cancer patients

When the evidence base for all cancer types, cancer-specific outcomes and different exercise prescriptions evaluated is reviewed in light of its strengths and limitations and applied in practice alongside generic exercise prescription principles, it provides a powerful foundation from which exercise can be used to improve the lives of those diagnosed with cancer. Fig. 1, represents a recommended process that can guide individualised, evidence-based assessment, exercise prescription and follow-up to cancer patients (defined from herein as a person who has been diagnosed with cancer). It incorporates cancer-specific considerations to all aspects of patient care, including assessment and initial exercise prescription, as well as exercise principles of progressive overload, periodisation and autoregulation. Further, it incorporates the use of behaviour change strategies, education and monitoring, to ensure a patient-centred approach to the provision of care (specificity), while enabling patients to develop the necessary skills to ensure exercise can benefit their health in the longer term. The process is as follows:

1) *Patient assessment*, including patient and family health history (presence of comorbidities/additional chronic disease and related treatment); cancer diagnosis (previous and current); cancer treatment (previous, current and planned); risk, presence and severity of treatment-related toxicities (acute, persistent and late side effects); and physical activity and exercise history.
2) *Determine health issues* and prioritise contribution of these to risk of morbidity and/or mortality. Exercise prescription following cancer diagnosis typically seeks to influence any one or more of a range of outcomes, including but not limited to prevention or management of disease- and treatment-related toxicities. The exercise prescription must be focussed on ameliorating issues with greatest impact on health and survival.
3) *Identify patient capacity and intervention suitability* determined by considering economic, psychosocial and physiological constraints (including contraindications), accessibility, preferences, self-efficacy, barriers and facilitators to exercise, and potential benefit.
4) *Prescribe exercise* according to patient-driven exercise-related goals.
5) *Reassessment and prescription modification* by following points 1–4.

Screening tools and guidelines, such as the ESSA Adult Pre-Exercise Screening tool,[44] Physical Activity Readiness Questionnaire,[45] or the American College of Sports Medicine

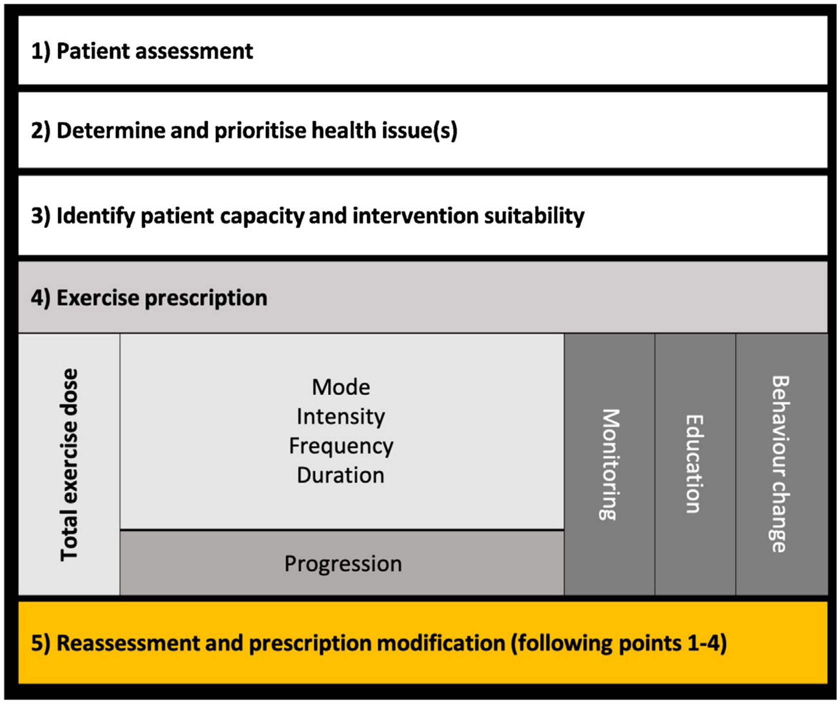

Fig. 1. Recommended process for targeted exercise prescription for cancer patients.

(ACSM) guidelines for exercise testing and prescription[46,47] are useful for developing an initial health and risk profile for an individual. However, these tools are not designed to collect the necessary additional information required to enable safe and feasible exercise prescription for cancer patients. Instead, information needs to be collected on all issues specified in *point 1* above, most of which can be sourced directly from the patient. However, patient-derived information, particularly with respect to risk of developing acute, persistent or late treatment-related side effects, needs to be supplemented with information derived from reputable sources. The Australian Government online resource of cancer treatment protocols (https://www.eviq.org.au) may be useful in this regard. This information (*point 1 above*) could be supplemented with questionnaires typically used in cancer research and clinical management to measure and track changes in patient-reported outcomes including quality of life (e.g., Functional Assessment of Cancer Therapy (FACT) – General,[48] Patient-reported Outcomes Measurement Information System (PROMIS)[49]), treatment-related side effects (e.g., PROMIS,[49] FACT-Breast[50]) and exercise self-efficacy.[51] The initial assessment could also include a battery of physical/functional tests including assessments (or surrogate measures) of cardiorespiratory fitness, function, strength, balance, body composition and bone health.

Responses to screening tools, AEP-derived template of questions, externally-sourced treatment-related information, patient-completed questionnaires, and results from physical assessment will allow an AEP and cancer patient to discuss *point 2* above, and can aid the clinical judgement as to whether further testing, medical investigation or medical clearance is needed prior to commencing an exercise program. While there is no 'correct' or 'optimal' number and type of patient-reported or objectively-measured outcomes included in an initial assessment, patient test burden must be considered and limited. What *must* be measured are the minimum parameters necessary to prescribe a safe, feasible and effective exercise program. The inclusion of additional assessments should only occur when benefit of the information collected outweighs the burden of its assessment. Overall, research findings can only suggest potential components of the initial assessment; in the end, clinical judgement that is based on the patient's circumstances and exercise-related goals will dictate what is (and is not) assessed and why.

For a patient in the active treatment phase,[52] it is best practice to contact the treating clinician, informing them that exercise prescription is being integrated into cancer care and providing opportunity for comment or concerns. During treatment, the most appropriate clinician to liaise with will depend on the type and stage of cancer and treatment being received. For example, a urologist, medical oncologist or radiation oncologist may be the most appropriate clinician for those receiving treatment for prostate cancer, chemotherapy for colorectal cancer or radiation therapy for head and neck cancer, respectively. A general practitioner will likely be the most relevant clinician to liaise with during the post-treatment survivorship phase. Discussions with a patient during the initial assessment (*point 1* above) will allow an AEP to identify the most appropriate clinician to communicate with and to establish consent to discuss patient information with this clinician.

The need for medical clearance prior to exercise testing and prescription for cancer patients is a topic of debate. Endorsing a blanket requirement for medical clearance for all cancer patients creates an additional barrier to the provision of exercise prescription.[53] Further, given the known harm of inactivity, only in rare circumstances would a targeted, exercise prescription be contraindicated. Yet the potential benefits of targeted exercise prescription prior, during and post-cancer treatment may not be recognised by all treating clinicians and may contribute to a situation whereby those patients most in need are the least likely to receive medical clearance (i.e., AEPs receive medical clearance and subsequent referral for only the 'well' cancer patient). However, requesting medical clearance can instigate communication between the AEP and a treating clinician, and the subsequent transfer of relevant exercise considerations that a patient may or may not be aware of. Therefore, the need for medical clearance should be considered on a case by case basis, but direct communication with at least one member of the treating team who can provide clinical guidance when needed[53] is recommended for all patients.

Following initial assessment (*point 1* above), the next task is to assist a cancer patient to identify their specific health (psychological and/or physiological), quality of life and survival concerns (*point 2* above) and to discuss potential benefit through exercise. Goals of exercise need to be prioritised according to what is of most value to the patient (e.g., symptom management, improving mood, minimising declines in cardiorespiratory fitness, reversing loss of muscle mass, survival), noting that some may prioritise long-term over short-term goals, psychosocial benefits over physiological or functional benefits, and that goals and priorities for all will likely change over time. A targeted exercise prescription is one that seeks to achieve these goals. Patient-factors that may influence adherence to this targeted prescription then need to be identified and discussed (*point 3* above). This includes understanding patient circumstances (including current functional capacity, physical limitations/constraints) and preferences pertaining to type, frequency, intensity and duration, available finances to support exercise participation (which will influence degree to which the exercise is supervised and where), health literacy, exercise self-efficacy, ability to identify and problem solve exercise-related barriers (which may be cancer-specific or general), the support network available to assist integrating exercise during and beyond cancer management, and motivation to achieve goals via exercise.

It will also be necessary to educate the patient about what constitutes realistic exercise-related goals (e.g., maintenance of function, slowing declines or improvements in function), with the patient's current cancer survivorship phase (pre-, during, post-treatment with treatment aim being cure, substantive remission or palliation[52]) influencing expectations. Further, educating the patient about what exercise components will be necessary for achieving specific goals, particularly when patient exercise preferences fail to align with achieving their desired goal(s), will be relevant and important. In these instances, an AEP will need to help guide the patient in recognising what they are willing to do to achieve a goal (even if not enjoyable) versus what they are not willing to do. The final exercise prescription (*point 4* above) represents one that considers exercise goals alongside health priorities, and ensures the patient is central to the discussion and decisions made.

Frequency and components of reassessment and prescription modification (*point 5* above) will be influenced by the exercise prescription goals, whether the patient is in an active treatment phase, likelihood of changes in disease- and treatment-related toxicities that may influence or be influenced by the exercise prescription and access to AEP services. Of note, when the process of targeted exercise prescription is followed, AEPs can readily identify when a patient may benefit from referral to another allied health professional. For example, referral to a dietitian for those in need of nutritional advice, referral to supportive services (e.g., peer support connections) and health professionals including a psychologist, specialist oncology nurse or counsellor for those reporting concerns with fear of recurrence, or referral to a physiotherapist for those with acute or persistent musculoskeletal or neurological issues. Further, an AEP may play a pivotal role in referring a patient back to the treating team for clinical review of new or changing disease- and treatment-related toxicities or side effects, which may or may not be associated with progression of disease.

While it is not possible to provide a specific exercise prescription based on an individual's diagnosis (and likely never will be), there are some general exercise prescription guidelines that will be appropriate for the majority of cancer patients, including children through to geriatric patients (Table 1). Also, the growing body of evidence suggests beneficial prescription parameters for a number of side effects and treatment-related outcomes (Table 2). In some cases, it will be appropriate to look to other disease states or chronic conditions for exercise principles and guidelines targeting similar outcomes (e.g., exercise and obesity guidelines for obese women receiving treatment for endometrial cancer; exercise and osteoporosis guidelines for osteopenic women receiving aromatase inhibitors for breast cancer or men receiving androgen deprivation therapy for prostate cancer; Table 2). However, appropriate caution is necessary given that the generalisability of safety, feasibility and efficacy findings among comorbidities is unknown. Further, as the benefits of exercise following cancer are better elucidated, it is prudent for exercise professionals to remain cognisant of potential harm through exercise, to educate patients about, and monitor presence of, contraindications, which largely relate to the presence of *new* or *unusual changes* to existing signs and symptoms (Table 2). Our approach of placing strong emphasis on using changes in signs and symptoms to guide exercise prescription (and exercise prescription modifications), while continuing to acknowledge the relative risks associated with abnormal haematological or other markers (e.g., oxygen saturation levels at rest), when known, is similar to that recently suggested by others.[54]

3.1. Core components of exercise prescription: mode, intensity, frequency, duration, total exercise dosage, progression, periodisation and autoregulation

Exercise mode: A multimodal exercise program, comprising aerobic and resistance (targeting large and specific muscle groups) exercise should be included in a patient's exercise prescription (Table 1). However, the focus or emphasis of aerobic versus resistance exercise must be determined by a patient's needs and goals. For example, a woman with endometrial cancer advised to lose weight through dietary change, will need to increase emphasis on resistance training to ensure preservation of lean tissue during periods of weight loss, whereas a lung cancer patient who needs to improve cardiorespiratory fitness will need to increase emphasis on aerobic exercise. Exercise prescription emphasis requirements based on specific considerations are presented in Table 2. While there is cross-over in exercise benefit (i.e., resistance exercise can produce a cardiorespiratory adaptation and aerobic exercise can produce a neuromuscular strength and endurance adaptation in cancer patients[55,56]), the magnitude of benefit will be influenced by training specificity.[56] As such, it is appropriate to consider patient preferences and resources when prescribing exercise mode, particularly during the early stages of exercise prescription in deconditioned patients. However, a patient also needs to be educated with respect to optimal exercise mode for achieving their defined exercise goals. Further, the specific modes chosen within aerobic and resistance exercise (e.g., water-based exercise versus use of ergometers versus walking, or free-weights versus machine-weights versus therabands) should be influenced by cancer-specific factors (Table 2), as well as patient preferences.

The inclusion of balance and flexibility training may improve the ability to undertake daily activities with reduced falls risk, discomfort, pain or concerns.[57] Yoga and Tai chi, which have been shown to improve quality of life and other cancer-related outcomes[58–60] (Table 2), are potentially time efficient and beneficial means for incorporating balance training into exercise prescription for those in need. The inclusion of pelvic floor exercises is also particularly important for patients with or at high-risk of urinary and faecal incontinence (such as those treated for genitourinary, colorectal or gynaecological cancers), but likely appropriate for the majority of adult and geriatric patients.[61] Further, for highly deconditioned patients or patients nearing end of life, exercise prescription

Table 1
Foundation exercise prescription guidelines for cancer patients.

Weekly exercise prescription: Multimodal, moderate to high intensity exercise	
Mode	Aerobic and resistance exercise. Priority and focus for type will be influenced by patient-driven exercise goals (Table 2).
Intensity	At least moderate intensity.
Frequency and duration	Weekly duration accrued through varying frequency of bouts per day or week of varying durations (frequency and duration to be informed by patient-driven goals of exercise and exercise considerations; see Tables 2 and 3).
Progression, periodisation and autoregulation	• Exercise mode, intensity and volume can be varied within a given week, over time and/or across cycles (e.g., 3-4 week cycles), with transitioning in emphasis leading up to specific events (e.g., surgery), in preparation for subsequent survivorship phases (e.g., commencement of second-line therapy) or introduction of new exercise modes (e.g., impact loading). • For those patients with no contraindications, progressive overload can occur as recommended for the general population. However, progressive overload may need to be slower and more gradual for deconditioned patients or those who are considered at risk of exacerbating existing or developing new treatment-related concerns such as lymphoedema, fatigue, nausea. Of note, doing too much too quickly brings with it the risk of disengaging the patient and/or injury/harm (e.g., worsening treatment-related toxicities). • The exercise prescription should be sufficiently flexible to allow patients to autoregulate prescription parameters (mode, intensity, frequency or duration) based on cancer-specific considerations during any given exercise session.

Aerobic exercise
Mode: Exercises involving large muscle groups that allow for variation in intensity. While the majority of patients tend to choose walking, patients do not need to be restricted to this type, and as function and fitness improves, variations in aerobic exercise mode will likely be needed to achieve physiological and functional benefits.
Frequency and duration: For patients who can accrue a minimum of approximately 20 continuous min per exercise bout, exercise sessions should be spread across the week, avoiding two consecutive days with no planned exercise. For deconditioned patients and patients with functional issues, undertaking bouts of at least 20 min duration may be difficult, and as such multiple bouts per day (of <20 min duration), *each and every* day, is recommended.
Intensity: Whether considered deconditioned or high functioning, exercise of at least moderate intensity is advised, unless patient preference is to exercise at low intensity or presence of symptoms prevents moderate or higher intensity (see Table 2). When low intensity is preferred, total duration of each exercise bout needs to be extended. All patients need to be educated with respect to specific intensity effects and how intensity influences total dosage and total dosage will influence expected outcome.
Progression: To occur via modifying mode, frequency (per day and/or across the week), duration and/or intensity of exercise bouts.

Resistance exercise
Mode: Dynamic exercises, using both concentric and eccentric muscle contractions, or combination of dynamic and isometric exercises recommended. Use of machine-weight, free-weights, body weight and/or exercises using resistance bands that involve major, lower- and upper-body muscle groups are appropriate, and/or exercises that target specific muscle groups adversely influenced by treatment (most likely surgical treatment) and are now interfering with activities of daily living.
Frequency, intensity, and volume: Resistance exercise to be performed at least 2 sessions per week, with at least 48 h recovery before exercising the same muscle group again. When performed more regularly (i.e., ≥3 sessions per week), split programming will be required to accommodate necessary rest period. Moderate to high intensity is recommended, with higher volume load (sets × repetitions × load) to optimise muscle hypertrophy.
Progression: Through modifications to number and type of exercises and load, sets and/or repetitions.

Table 2
Acute or chronic cancer-related concerns requiring specific exercise prescription consideration[a,b].[77–99]

[a] These recommendations are to be considered alongside standard exercise prescription and safety considerations; e.g., relative and absolute contraindications for exercise as presented in ACSM's guidelines for exercise testing and prescription.[47]
[b] References provided throughout the table represent supplementary references to those provided within the main text of the paper, and do not reflect an exhaustive list of studies contributing to the evidence base. Further, the below recommendations are derived from evidence (when available) in conjunction with the clinical judgement of experts who have authored or contributed to the paper (see acknowledgements section).

Acute and chronic cancer-related concerns	***Recommendations including exercise prescription <u>emphasis</u> (F=frequency and duration, I=intensity)***	***Considerations and cautions***
Haematological:		
Anaemia: Anaemia (too few red blood cells or low haemoglobin) leads to reduced oxygen transport capacity. Symptoms include weakness, fatigue, shortness of breath, dizziness, pale in colour, lack of appetite, sleeping issues.		
	Resistance training: Table 1. *Aerobic exercise:* F: multiple bouts daily likely appropriate, starting with shorter sessions, building to >20 min at least 3–4 days per week. I: Table 1. • Supervision recommended.	• Rating of perceived exertion or breathlessness scales likely more useful than heart rate in monitoring intensity. • Long continuous aerobic exercise may be unpleasant and lead to low adherence. • Lower absolute exercise intensity according to symptoms.
Thrombocytopenia: Thrombocytopenia (low platelet count) reduces blood clotting ability and therefore may increase risk of serious bleeding.		
	Multimodal exercise: Table 1. • Exercise modes such as water-based activities, use of machine-weights versus free-weights and stationary cycling, may be considered safer than other modes. • Supervision recommended. *(continues over next page)*	• The risk that exercise could result in a serious bleeding episode is unclear, although was reported as 'minor and relatively rare' in paediatric patients with severe thrombocytopenia undergoing stem cell transplant.[77] Also, risk of severe exercise-related bleeding events was found to be low during a supervised inpatient program for haematologic malignancy patients with severe thrombocytopenia.[78] • For patients on anticoagulant therapy (e.g., warfarin, direct oral anticoagulants, enoxaparin), discussions regarding exercise safety with treating clinician, as well as applying additional caution when determining the starting exercise dosage and increments of progression, is recommended. • Avoid exercise that is associated with increased risk of falls or blunt-force trauma; e.g., contact sports, activities requiring balance and/or coordination (e.g., treadmill walking or cycling for elderly/those with peripheral neuropathy).

Table 2 (*Continued*)

		• Avoid risk of impact or point pressure when using equipment, and excessive blood pressure elevation (Valsalva manoeuvre). • Monitor signs of bleeding.
Neutropenia: Neutropenia (insufficient neutrophils, which are a type of white blood cell) may cause compromised immunity and increased susceptibility to certain types of infection (opportunistic, reactivation).		
	Multimodal: F: Table 1. I: moderate.	• Encourage good hygiene practices, such as regular hand washing, cleaning exercise equipment before use, use of personal exercise mats, choosing times to exercise in public places that may be less busy and staying away from unwell people. • For patients who have specifically been advised by their medical team to avoid crowded or high-use locations (e.g., public fitness facilities) due to neutropenia, provision of a home-based exercise prescription can accommodate these periods. • Avoiding high intensity exercise during neutropenic periods is recommended, as high intensity exercise has been associated with declines in white blood cell count or function.
Musculoskeletal		
Arthralgia/Aromatase inhibitor-associated (AIA) musculoskeletal syndrome: Arthralgia usually presents with symmetrical joint pains, most commonly affecting the wrists, hands and knees; AIA musculoskeletal syndrome encompasses muscular and joint signs and symptoms.		
	Multimodal: Table 1.[79]	• Mode and intensity to be guided by symptom response. • The presence of arthralgia has been associated with non-compliance and premature discontinuation of therapy.[80]
Cachexia: Cachexia represents involuntary body weight loss (>5%, or weight loss >2% in patients already showing depletion according to current BMI <20 or muscle mass depletion), which may adversely influence functional capacity, quality of life, responsiveness and side effects to treatment, and survival in advanced cancer patients.		
	Emphasis on *resistance exercise* with high total volume load, as tolerated to stimulate hypertrophy. F & I: Table 1. *Aerobic exercise*: Table 1.	• Consider underlying known or possible cause(s). For example, reduced caloric intake due to persistent nausea, in conjunction with an increased catabolic drive due to disease, may necessitate a reduction in high-energy cost exercise. Referral to a dietitian for nutritional and high calorie supplementation may be appropriate. • Progressive and uncontrollable cachexia may be a sign of transition to the end of life period. This may change the priorities and goals of the exercise.

Table 2 (*Continued*)

Sarcopenia: Loss of skeletal muscle mass can be substantial in patients undergoing cancer treatment, or may be a consequence of planned weight loss. Increasingly cancer patients are being diagnosed with existing sarcopenia and emerging research indicates increased treatment-related side effects and reduced survival in patients with low muscle mass.		
	Emphasis on *resistance exercise:* major muscle groups, with high total volume load, as tolerated to stimulate hypertrophy. F: at least 2 times per week for each muscle group. I: moderate to high – maximise volume load (sets x reps x weight) as patient tolerated, as this is the predominant driver for muscle growth. *Aerobic exercise*: Table 1.	• Preventing further skeletal muscle mass loss should initially be addressed, followed by a progression towards prescriptions aimed at increasing skeletal muscle mass. • Consider referral to dietitian for nutritional and high calorie supplementation advice. • Consider potential for aerobic exercise to interfere with muscle accrual, and balance aerobic and resistance exercise emphasis accordingly.
Bone loss: Treatment-induced bone loss is associated with therapy for a range of cancers, but in particular cancers treated with hormone therapies (e.g., androgen-deprivation therapy, aromatase inhibitors). Moderate risk (osteopenia) = T-score −1.0 to −2.5 SD; High risk (osteoporosis) = T-score <−2.5 SD.		
	Emphasis on *resistance exercise.* F: 2 times per week. I: moderate to high. • Inclusion of *impact loading:* vertical and multidirectional, bounding, hopping, skipping rope, drop jumps and bench stepping. [Refer to ESSA Position Statement on exercise prescription for the prevention and management of osteoporosis.[81]] *Aerobic exercise:* Table 1.	• Impact loading is contraindicated for patients with bone metastasis. • Consider period of moderate to high intensity resistance exercise before introducing impact loading. • Consider inclusion of balance exercises to reduce falls risk.
Cancerous bone tumours: Malignant bone lesions can be primary lesions (cancer originated in the bone, e.g., as seen in those diagnosed with Multiple Myeloma or Osteosarcoma) or secondary lesions (cancer originated at another primary site, e.g., as seen in metastatic bone disease, most commonly in advanced lung, breast or prostate cancers). Common sites for bone tumours include the spine, pelvis and ribs but may also occur in the skull or long bones of upper arms and legs. Bone tumours often lead to a weakening of the bone, increased risk of fracture and pain at night or during activity.		
	Resistance exercise: avoid exercises that load the malignant bone lesion site(s).[82] F & I: Table 1. *Aerobic exercise:* weight bearing or non-weight bearing based on malignant bone lesion site(s) and symptoms.[82] F & I: Table 1. *(continues over next page)*	• Those with bone tumours are at risk of developing pathological fractures, hypercalcemia, bone marrow suppression, and nerve and spinal cord compression that results in significant morbidity and limited function.[83] • AEP to be aware of site(s) of known malignant bone lesion(s), and progression of lesions over time. • Tailor exercise prescription to limit loading of the malignant bone lesion(s) site.

Table 2 (*Continued*)

		• Impact loading (e.g., jumping exercises) may be contraindicated for patients with malignant bone legions (dependent on location of lesion(s)). • Exercise intensity will likely be determined by symptom tolerability (in particular, pain).
Pain: Localised and generalised pain represents a common symptom associated with a range of cancers and their treatments.		
	Multimodal exercise: Table 1. • Exercise response may influence frequency: experiencing benefit from exercise = daily; no change = Table 1.	• Pain may ultimately dictate exercise capacity and tolerability. • For localised pain — begin by choosing a mode that avoids the area. Progress to include exercises (of low dosage) that involve the area of pain and progress when there is no association between exercise and worsening pain. • For generalised pain — commence with a low dosage of *aerobic* and *resistance* exercise and progress in small increments when there is no association between exercise and worsening pain. • New or worsening pain requires referral back to the treating clinician for investigation. • Keeping a pain diary (including details of location, severity, fluctuations and activities associated with fluctuations) may be helpful with informing exercise prescription and progression. • Need to consider pain medication taken and potential acute or persistent side effects (such as drowsiness, nausea, low motivation, psychosis), which may influence exercise prescription or response.
Post-surgical wound healing: Physical loading of surgical sites should be avoided to permit wound healing and reduce the risk of damage.		
	Multimodal exercise: Table 1.	• While minimally-invasive surgery (e.g., keyhole) is becoming more common, radical and open surgeries are still common for the removal of solid organ tumours. Duration of time required for wound healing after surgery will vary between location, invasiveness of surgery and patient recovery response. • When medical clearance is given to return to normal activities of daily living it is generally also appropriate to commence or return to exercise, taking into consideration any changes to function or new issues. Most surgeons will instruct patients about wound healing related limitations and when they may resume normal activities (often a graduated reintroduction to certain physical activities will be stressed). • Additional exercise prescription considerations relating to wound healing may include the site and strength of the scar, associated pain, reduced range of motion related to the surgical site, and also the possibility of further surgeries at the same site (e.g., for reconstruction or inadequate margins). • Exercising non-effected parts of the body allows for an earlier return to exercise and may assist wound healing and limit structural and functional decline.

Table 2 (*Continued*)

Systemic		
Fatigue: Cancer-related fatigue is "a distressing persistent, subjective sense of physical, emotional and/or cognitive tiredness or exhaustion related to cancer or cancer treatment that is not proportional to recent activity and interferes with usual functioning".[84]		
	Multimodal exercise: Table 1.	• A consistent and strong body of evidence supports exercise as one of the most effective non-pharmacological treatments for cancer-related fatigue.[85] • Various exercise modes are effective in reducing fatigue.[86] • Low intensity exercise may be as effective as high intensity, possibly because it avoids over-exertion and rebound fatigue. However, short bouts of high intensity *aerobic* or *resistance* exercise may be better tolerated in some patients. • Assess whether reduced skeletal muscle mass and strength or cardiorespiratory capacity may be contributing to fatigue, and use this information to determine prescription emphasis for *resistance* and *aerobic exercise*, respectively. • Motivation and adherence to the prescription is essential. Pathophysiological or mental barriers, or fatigue in itself may hinder patients from becoming (more) active. • Important to avoid total rest (i.e., no exercise) as this will exacerbate fatigue. • Consider participation in other daily activities and assess how these contribute to fatigue.
Fever: Fever is frequently seen in patients with cancer and can be associated with a variety of infectious and non-infectious causes. Fever in conjunction with neutropenia (known as febrile neutropenia) is a common and potentially life-threatening complication of many cancers (as a result of the disease process) and its treatments (side effects). Almost all patients are admitted to hospital for investigation and management, including the commencement of empiric broad-spectrum intravenous antimicrobials while tests are undertaken to identify the potential cause. Common causes include bacteria (gram positive bacteria including *Staphylococcus* species; gram negative bacteria including *Escherichia coli*), however many episodes of febrile neutropenia have no cause identified, and may simply be related to the disease process and its treatment (e.g., induction of a cytokine storm).		
	• Exercise is contraindicated.	
Infection, including cellulitis: Infection is the effect of a foreign organism (e.g., bacterial, fungal, viral, protozoa or worms) in the body, which leads to an adverse response including fevers, chills, changes in heart rate and pain. Cellulitis is an acute bacterial skin infection of the dermis and underlying soft tissue that manifests with spreading skin redness, warmth, swelling and pain. Immunocompromised patients (most cancer patients during periods of active treatment) and those with disrupted lymphatics (e.g., those with lymphoedema), are more prone to recurrent episodes of cellulitis.		
	• Exercise is contraindicated until infection or cellulitis has responded to antibiotic treatment, or if there are cardiovascular or other physiological concerns as a consequence of the infection. *(continues over next page)*	• While exercise is beneficial for lymphoedema, cellulitis is an acute infection which must be treated before a patient may return to their usual exercise prescriptions. Depending on the site and severity of the cellulitis, a temporary modification to the exercise prescription may allow for the affected limb, for example, to be rested while the other corresponding limb is exercised (e.g., single leg stationary bicycling). Low intensity or passive limb exercises that encourage lymphatic circulation and drainage are to be encouraged.

Table 2 (*Continued*)

		• Once infection is controlled, patients should be encouraged to return to exercise as soon as possible, with appropriate modification to exercise dosage when needed.
Sleep: Disordered sleep patterns including insomnia, difficulty falling asleep, frequently waking overnight, early morning awakenings, and an inability to get back to sleep, are common problems for people with cancer.		
	Multimodal exercise: Table 1.	• Consider individual response to exercise with respect to sleep (e.g., influence of timing of exercise).
Sexual dysfunction: Sexual dysfunction can encompass physical changes (vaginal atrophy, dryness or tightness; erectile dysfunction), decreases in sexual desire or arousal, pain during sex, or absent or muted orgasms, and is associated with anxiety, fatigue, depression, poor body image and reduced quality of life.[87]		
	Multimodal exercise: Table 1. • Inclusion of pelvic floor exercises.	• Potential benefits to sexual health through exercise may be via improvements to vascular function and structure, hormone profile and other concerns (e.g., body image, fatigue, mood).
Cardiovascular and Respiratory		
Dyspnoea: Dyspnoea (perceived shortness of breath) is particularly common in those with lung cancer, especially patients who are previous or current smokers, patients with lung-specific diseases (e.g., chronic obstructive pulmonary disease and bronchiectasis) or patients who have received radiation (causing fibrosis or pneumonitis) or surgery to the lungs or thorax more generally.		
	Aerobic exercise: F: daily. I: moderate to high. Interval training may be required.[7] *Resistance exercise:* Table 1. • Supervision recommended.	• Emerging evidence supporting exercise in prehabilitation, although no evidence to delay surgery for exercise training.[64]
Chest pain:		
	Exercise is contraindicated.	Sudden onset chest pain or worsened by exertion: exercise is contraindicated (refer to clinician).
Cardiovascular toxicity: Anticancer therapies including chemotherapy, immunotherapy and radiation therapy can cause changes in resting myocardial function (both systolic and diastolic), such as left ventricular ejection fraction, and the development of heart failure, resulting in impairments to cardiorespiratory fitness.[88]		
	Multimodal exercise: Table 1. • Supervision recommended.	• When risk of cardiovascular toxicity is linked with treatment, particular care is required in identifying appropriate starting exercise prescription, and increments for progression should be small. • Be aware of contraindications and signs for cessation of exercise training. • To date, effect of aerobic exercise has been commonly investigated compared with resistance exercise.

Table 2 (*Continued*)

Lymphatic		
Lymphoedema[89]: Lymphoedema is the accumulation of protein-rich fluid resulting in swelling of one or more regions of the body.		
	Multimodal exercise: F: Table 1. I: moderate to high; starting at lower intensities/loads with smaller/slower progression recommended. • Supervision recommended, at least initially.	• For those at risk of developing lymphoedema (risk factors: more extensive surgical procedures, including removal of lymph nodes, chemotherapy and/or radiation therapy, higher body mass index and physical inactivity/being sedentary[90]) or with lymphoedema, and who are also overweight, exercise will be an important component of influencing energy balance that may lead to positive weight changes while also influencing lymphoedema outcomes. • Lymphatic flow is supported by respiration, blood flow and skeletal muscle contractions. Therefore, mixed exercise including both *aerobic* and *resistance* exercise is recommended. • Wearing compression garments during exercise (unless performed in water) is typically recommended. However, if wearing a compression garment presents as a barrier to exercise, exercise at low intensity without garment while under close supervision and monitoring lymphoedema response is recommended. If no worsening, progress from there.[89] • Water-based exercise provides compression (a common treatment for lymphoedema) while training the muscular and cardiorespiratory systems.
Gastrointestinal and genitourinary		
Vomiting, nausea and loose bowel motions (faecal incontinence and diarrhoea): These symptoms may have led to a cancer diagnosis and/or represent treatment-related side effects that may present at certain times during treatment cycles, or be present throughout the entire treatment period.		

	Multimodal exercise: Table 1.
	• The presence (particularly cyclical presence) of these side effects may benefit from a 'bad day' exercise prescription that would likely include modification of the 'good day' exercise prescription in one or more of the following ways:
	  • Removal of modes (or specific exercises) that exacerbate side effect.
	  • Reduce intensity and/or duration of session and increase bouts per day.
	• Supervision recommended.
		• Consider risk of dehydration and malnutrition and manage accordingly (e.g., management may be exercise-related – resistance exercise may take priority over aerobic exercise, indoor exercise may take priority over exercise outdoors, etc, or may relate to increasing frequency of drinking during exercise session).
		• The key for determining exercise maintenance or suspension is whether presence or severity of the side effect is *unusual* (e.g., increased frequency of vomiting, increased severity of nausea, or sudden onset of diarrhoea represent a time to suspend exercise and refer to clinician).
		• Maintaining habit of exercise (even at levels which may not provide physiological benefit) could be an appropriate short term goal when these symptoms are present.
		• Emphasising participation in physical activity over adhering to a specific exercise prescription should take priority during periods of these symptoms.

Table 2 (*Continued*)

Urinary incontinence: Urinary incontinence is a common but often unrecognised complication of cancer (in particular, prostate, gynaecological and colorectal cancers) and its therapies (e.g., disruption to surrounding structures including nerves and blood supply), with the risk and severity of incontinence exacerbated by other conditions, such as anxiety and depression.		
	Multimodal exercise: Table 1. • Inclusion of pelvic floor exercises and resistance training of the large muscle groups of the pelvis, abdomen and spine region.	• The impact of incontinence on quality of life is significant and unless discussed and addressed may be a silent barrier to exercise adherence.[91] • Depending on the severity of incontinence, high impact activities may need to be avoided. • Consider the influence of hydration and timing of toileting with respect to exercise and continence control. • Consider the need for ensuring proximity to bathroom facilities, incontinence pads or change of clothing. • Educate about the influence of other exercise benefits on continence (e.g., weight loss).
Neurological		
Peripheral neuropathy: Peripheral neuropathy in cancer patients is more commonly associated with chemotherapy (and therefore often termed chemotherapy-induced peripheral neuropathy, CIPN), in particular, taxane- and platinum-based treatments. Symptoms vary, but may include numbness, 'pins and needles' or stabbing pain in hands or feet, difficulty picking things up, loss of balance or trouble walking. CIPN can also lead to reduced quality of life and treatment interruptions or early cessation. Other causes of peripheral neuropathy include damage to nerves caused by surgery or radiation and non-cancer risk factors including pre-existing conditions, such as diabetes.		
	Multimodal exercise: low impact exercises, such as swimming or cycling, may be less painful. F: Table 1. I: moderate. • Supervision recommended unless deemed safe. • Include balance/proprioception exercise.	• If peripheral neuropathy makes the patient unstable then appropriate modifications to exercise mode will be required (e.g., supported treadmill walking, seated versus standing resistance exercises).
Dizziness:		
	Multimodal exercise: I: low to moderate. • Include balance/proprioception training.	• If symptom severity makes the patient unable to, or unsafe to, stand or walk then seated exercise should be considered. • If this is a new or changing symptom (i.e., difference in severity, frequency, timing; presentation is *unusual*) or has an acute onset during exercise, the exercise should be ceased and the symptom evaluated by the patient's medical team. • Monitor closely to evaluate the safety of exercises and adjust accordingly. • Home-based programs may be particularly important for patients with neurological symptoms that restrict mobility (i.e., the ability to drive or use public transport). • Be mindful of carer load and to what extent the exercise prescription impacts others.

Table 2 (*Continued*)

Cognition: Cancer and its treatment (in particular chemotherapy) have been associated with cognitive impairment, sometimes referred to as "chemo-brain" or "chemo-fog" (although it can occur in the absence of chemotherapy). Severity is typically mild to moderate and involves impairments to memory, attention, executive functioning and processing speed. The impairments may continue (and even emerge) from diagnosis to years post-treatment. Cognitive impairments are also common in the presence of primary and secondary brain tumours.		
	Multimodal exercise: Table 1. • Traditional Asian exercises, such as Tai chi, Qigong and yoga may also provide benefit.[92]	• While cognitive impairment is a common issue in cancer patients, new or unusual changes in cognition should be reported to the patient's treating team. • Being physically active is associated with reduced cognitive decline in general and cancer populations. • Combining physical and cognitive exercises (e.g., exercises that require coordination, sequence of exercises to be undertaken without prompting, ancillary memory and cognitive activities, etc) within the session may have additional potential for benefit.
Presence of other chronic disease (presenting either pre- or post-diagnosis) Depending on treatment-related side effects, as well as other patient considerations, it is possible that the signs, symptoms and side effects associated with a patient's chronic disease (or risk of chronic disease) may supersede cancer as the priority of the exercise prescription.		
Obesity: Obesity is defined as a BMI $\geq$30 kg/m^2. Obesity is a risk factor for many cancers (in particular endometrial cancer), and is therefore more prevalent in specific cancer groups, compared with the general population. Obesity is also associated with increased treatment-related side effects, and poorer quality of life and prognosis. Some cancers and cancer treatments contribute to weight gain (directly or indirectly, via reduced physical activity), thus increasing risk of other comorbidities (e.g., cardiovascular disease and diabetes).		
	Multimodal exercise: *Aerobic exercise*: F: daily. I: high intensity interval exercise is considered particularly effective at improving cardiorespiratory fitness and reducing % body fat in obese individuals, and should be considered as a means to achieve higher exercise volume with time efficiency.[93] *Resistance exercise:* major muscle groups F: >2 times/week. I: Table 1. • Consider higher amounts of exercise volume (through combined resistance and aerobic exercise; i.e., >250 min per week) in achieving short and longer term weight control.	• Weight loss may be clinically indicated to: reduce the risks associated with tumour-removal during surgery; address ineligibility for reconstructive surgery; reduce the risk of cancer recurrence, new cancers, or other chronic diseases; or to reduce the risk of treatment-related side effects (e.g., lymphoedema). It may also represent a patient-driven goal. Irrespective, it is important to acknowledge the role of exercise in weight control but also explain the primary role of diet, in order to avoid unrealistic exercise expectations. • Water-based exercise or swimming may be helpful for patients with weight-related joint problems that limit movement on land. However, slow progression towards the inclusion of land-based exercise will aid achievement of weight loss goals. • Consider and discuss the importance of preserving lean tissue through resistance exercise while achieving fat loss.

Table 2 (*Continued*)

Type 2 diabetes mellitus: Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder that is characterised by high blood glucose levels, insulin resistance and a relative lack of insulin. T2DM is associated with an increased risk of liver, pancreas, endometrium, colon and rectum, breast, and bladder cancers, and may therefore be more common in patients with these cancers. Shared lifestyle risk factors between these cancers and T2DM include poor diet, physical inactivity and insulin resistance. Some cancer treatments, such as corticosteroids, hormone suppression, and some chemotherapy and immunotherapy agents increase the risk of T2DM.		
	Multimodal exercise: *Aerobic exercise*: F: daily; no more than 2 consecutive days without aerobic exercise. *Resistance exercise:* major muscle groups. F: >2 times/week. I: moderate to high. • Consider higher amounts of exercise volume (through combined resistance and aerobic exercise; i.e., >200 min of moderate intensity [or equivalent] exercise per week). • If weight loss is indicated, see recommendations for Obesity. [Also see ESSA position statement].[94]	• Be aware of the impact changes in treatments, activity levels, gastrointestinal issues and diet may have on T2DM management. • Encourage the patient to monitor blood glucose levels at an appropriate time before, during and after exercise. It can be helpful to schedule exercise at a similar time of day and time post-meal (e.g., 1–2 h post-meal) to standardise response and reduce the risk of a hypoglycaemic event. • Avoid prolonged periods of sedentary behaviour due to the impact on glycaemic control.
Osteoporosis: Osteoporosis is a condition in which bone tissue loses mass or density and the resultant reduction in strength leads to an increased risk of bone fractures. Specific treatments for cancer (e.g., certain chemotherapies, hormone treatment that reduces levels of oestrogen or testosterone, and corticosteroid therapy) and specific cancers (e.g., multiple myeloma) increase the risk of osteoporosis, alongside other risk factors including family history and lifestyle factors (e.g., heavy smoking, excessive alcohol consumption, physical inactivity and prolonged bed rest).		
	• See bone loss above. [Also see ESSA position statement].[81]	• As falls are a major cause of fractures, particular attention should be given to evaluating (or referral for evaluation of) issues that may increase risk of falls (e.g., gait, range of motion, vision) or specific exercise modes (e.g., treadmill walking, walking on uneven surfaces).
Arthritis: Arthritis is a chronic disorder of the joints (with >100 subtypes), causing pain and restricted movement. In osteoarthritis (the most common form of arthritis) the cartilage of the affected joint wears down causing bones to come in direct contact. Increasing age and being overweight/obese are associated with increased prevalence of arthritis. Age and higher body weight are shared risk factors for cancer, and therefore arthritis is common pre- and post-cancer diagnosis. There appears to be a relationship between chronic inflammation in rheumatoid arthritis (an autoimmune disease causing joint inflammation, pain and destruction) and the risk of developing some cancers. Certain cancer treatment (e.g., aromatase inhibitors) increases prevalence of arthritis or severity of those who had the condition pre-cancer.		
	Multimodal exercise: F: Regular (up to daily). I: moderate. *(continues over next page)*	• General exercise guidelines may need to be adjusted to accommodate pain, instability and functional limitations.

Table 2 (*Continued*)

	• Resistance exercise including of the affected joints is indicated. • Addition of traditional Asian exercises, such as Tai chi and yoga, may be considered useful. • Low-impact exercises (e.g., stationary or recumbent cycling) and water-based exercises (swimming, hydrotherapy, water aerobics) may be preferred by patients, particularly those who are also overweight or have advanced arthritis. • Including flexibility exercises to counteract stiffness that typically presents with arthritis is indicated. [Also see ESSA endorsed review of exercise and osteoarthritis].[95]	• Some pain in the affected joints is not unusual during exercise, but substantial increases in pain or swelling during or following exercise may indicate need for exercise prescription modification. • Patients may need to modify or rest from exercise during an acute period when symptoms "flare" (often indicated by the affected joint being red, hot and/or swollen). • For those who have muscle atrophy as a consequence of arthritis, greater emphasis may need to be given to resistance exercise.
Depression and Anxiety: Depression is a common, potentially debilitating condition characterised by sadness, loss of interest or pleasure, and feelings of guilt and low self-worth. Depression may also manifest as disturbances in sleep, concentration, appetite, or as persistent fatigue. Signs of anxiety include constantly feeling agitated or angry, sleeping difficulties, difficulty concentrating, avoiding distressing issues, and feeling a constant need for reassurance. Anxiety and depression are common feelings after diagnosis and treatment for cancer, affecting >10% of cancer patients, with rates of clinical depression estimated to be three times higher in cancer patients than in the general population.		
	Multimodal exercise: *Aerobic exercise:* walking most commonly studied in cancer patients, but identifying patient preference in type should be the emphasis.[96] F: regular; most days of the week. I: low to moderate. Total dosage: dose-response relationship has been observed whereby higher dosage (including >150 min/week) of aerobic exercise has been associated with greater reductions in depression and anxiety. *Resistance exercise:* Table 1. [Also see ESSA joint position statement on mental health].[97]	• AEPs need to avoid adding unnecessary burdens or pressures through exercise prescription. Carefully planned goals, developed in conjunction with the cancer patient, may help increase adherence, without increasing the patient's experience of undue pressure, stress or guilt. This may be particularly important for cancer patients in the end of life stage.

Table 2 (*Continued*)

Cardiovascular disease (CVD): Cardiovascular disease (e.g., heart failure, heart attack, coronary artery disease, ischaemic heart disease, stroke, hypertension) may be pre-existent (prevalence increased in many cancers due to shared risk factors, e.g., poor diet, obesity, inactivity, tobacco smoking) or secondary to cancer treatment-related side effects (in particular, radiation to the chest and cardiotoxic chemotherapies). Some cancer groups (e.g., older women diagnosed with breast cancer) are more likely to die from CVD than cancer. Survivors of childhood cancers may experience early adult-onset CVD caused by treatments.		
	Multimodal exercise: Table 1. *For those with hypertension:* avoid valsalva (particularly during resistance training). *For those on anti-hypertensive medication:* extend and monitor the warm-up and cool-down periods. *For those with chronic heart failure:* When applicable, exercise intensity should be below myocardial ischaemic threshold. [Also see ESSA position statements on hypertension and chronic heart failure].[98,99] • Consider need for supervision. • See notes on cardiovascular toxicity.	• CVD is a large group of diseases and prescription varies greatly between conditions. Overall, prescription depends on functional capacity, presence of CVD risk factors alone versus a diagnosed CVD, and whether there has been a recent CV event (e.g., acute rehabilitation following a heart attack or stroke). Evaluation of exercise risk is specific to conditions and should be carefully evaluated prior to exercise prescription. • High prevalence of CVD and risk factors likely correlates to a high prevalence of related medications, such as angiotensin converting enzyme (ACE) inhibitors, beta blockers and statins. Use of these medications may influence exercise prescription, in particular the tools and methods used for prescribing and monitoring exercise intensity. Rating of perceived exertion is likely more appropriate than heart rate in assessing intensity. • Be aware of absolute and relative contraindications, including signs for cessation of exercise testing and training.

emphasis may need to be placed on 'mobility' exercises (e.g., a range of specific upper- and lower-body exercises undertaken with low/no load) to accommodate and progress (when relevant) cardiovascular and respiratory function, neuromuscular strength and endurance, and flexibility capabilities.

While focus should be given to targeted exercise prescription to address priority health issues, any kind of activity that a patient considers enjoyable or perceives as positively influencing cancer-related outcomes (e.g., pain, quality of life) should be permitted or even encouraged. These activities (e.g., low-intensity yoga, Tai chi, meditation) can supplement the exercise prescription and will enhance adherence while providing additional physiological and psychological benefit. The exception to this recommendation is when a specific activity is considered contraindicated or risk of harm outweighs benefit (e.g., a brain cancer patient with balance concerns who wants to keep road cycling, a paediatric cancer patient with thrombocytopenia who wants to continue playing competitive rugby, an osteoporotic breast cancer patient who is taking aromatase inhibitors and wants to only do water-based exercise). When this is the case, patient education around benefit versus risk, and revisiting short and long term goals and priorities may help in steering the patient towards safe, feasible and effective exercise (e.g., advising use of a road bike on a wind-trainer for the brain cancer patient, encouraging participation in certain components of training but not game play for the paediatric cancer patient with thrombocytopenia; doing two water-based sessions per week, supplemented with two land-based strength sessions, including appropriate impact loading, per week for the osteoporotic breast cancer patient).

Intensity: Patients should not be restricted to low-intensity exercise, nor is high-intensity exercise contraindicated for all. However, there will be times when low-intensity exercise is recommended (e.g., a patient with nausea that worsens with moderate intensity exercise) and when high intensity exercise may need to be avoided (e.g., immediate weeks post-surgery to avoid adversely influencing wound healing; presence of a blood clot related to a peripherally-inserted central catheter). Helping patients understand what constitutes low, moderate and high intensity exercise through the use of one or more tools, including rating of perceived exertion scale, heart rate and repetition maximum, is recommended. Self-reported methods of assessing intensity are considered particularly useful for those at risk of their heart rate response being influenced by treatment-induced cardiac changes or certain treatments (e.g., specific chemotherapeutic agents or HER2 targeting drugs). Self-reported methods are also considered useful for those experiencing 'good' and 'bad' days/weeks during an active treatment period. Further, helping patients understand what constitutes a normal physiological response to exercise and that they are in the best position to measure and monitor exertion (either by rating perceived exertion with or without objective measurement of heart rate) may improve exercise self-efficacy.[62]

The intensity of exercise sessions, including whether interval training, impact loading, explosive dynamic training or other, is included should be determined by patient-driven factors (short and long term goals and interests) and cancer-specific factors (indications and contraindications, see Table 2). Evidence to support for example, high intensity interval training over moderate intensity continuous duration training for improving cardiorespiratory fitness in the longer term in cancer patients is currently unclear.[6,63] However, for a patient who needs to improve fitness in a specific and short time frame (e.g., lung cancer patient with only 4 weeks prior to surgery),[64] there may need to be greater emphasis on undertaking exercise at high intensity.

Frequency and duration: Duration of any given exercise session will influence frequency of exercise bouts per day or week. For deconditioned patients, immediately post-surgery and/or for those with advanced stage disease, a starting exercise prescription may need to involve multiple short bouts (5–10 min duration) daily, to accumulate at least 20 min on any given day. As exercise capacity improves, progression towards longer sessions of at least 20 min duration on most days of the week is recommended. The 20 min cut-point being proposed (which has also been suggested by others previously[65]) is not distinct and less duration per day may be more optimal for some patients (e.g., palliative patients with lung cancer). Instead this suggested cut-point reflects a pragmatic exercise duration whereby there is sufficient time for an exercise prescription that allows for a warm-up and cool-down component, sufficient disruption to cardiovascular, respiratory, neuromuscular, endocrine and immune homeostasis, and requires patients to actively plan/schedule their exercise, which in turn will aid longer term positive behaviour change.[66] Further, sessions of a minimum of 20-min duration could allow for sufficient weekly exercise dose while incorporating rest days (noting that rest days may be purposely scheduled into the exercise prescription due to pragmatic reasons or preferences, or be unplanned and occur due to the presence of one or more barriers).

Total exercise dosage: Intensity, frequency and duration combine to produce total dosage of exercise prescription over a defined period (e.g., week or month). Information gathered during the initial assessment, with particular attention to current and previous exercise, will enable an AEP to determine the appropriate starting exercise dosage. Erring on the side of caution (that is, prescribe less than more) in the initial phases of an exercise program, particularly for sedentary or deconditioned patients is recommended. Note, the targets promoted in physical activity guidelines for cancer patients (that is, >150 min of moderate intensity aerobic activity/>75 min of vigorous intensity aerobic activity plus 2 resistance exercise sessions, per week[67]) may not represent an appropriate starting weekly exercise dosage for the majority of cancer patients, nor may they ever be achievable for specific patients. Studies involving women with either ovarian or metastatic breast cancer, and patients with either lung or pancreatic cancer, have specifically shown that while some may be able to achieve physical activity targets through exercise prescription at least some of the time, others were never able to achieve the target during the intervention period assessed.[30,68,69] Further, for some, the target may be unnecessary for accruing benefit (that is, benefits have been observed with lower dosages).[63]

It will be important for patients to have an understanding of what constitutes their ideal weekly exercise dosage, and whether there is need for this dosage to be modified over time. The known dose-response relationship between exercise and physical and psychosocial outcomes is relevant for patients with cancer. Evidence from a large, systematic review of cohort studies evaluating the association between physical activity post-cancer and survival outcomes suggest that a weekly exercise dosage of *around* 150 min of moderate intensity (or equivalent volume) exercise per week represents the approximate dosage beyond which there may be diminishing benefits gained through undertaking higher dosages.[70] Nonetheless, there is some evidence to suggest that exercising at higher dosages may contribute to additional benefit in specific outcomes (e.g., fitness) for specific cohorts (e.g., patients with colon cancer).[71] While future research continues to improve our understanding about what constitutes minimum and maximum exercise dosage thresholds and for whom, it is reasonable to suggest that the majority of cancer survivors can safely undertake regular exercise, when commenced at conservative dosages, progressed gradually and appropriately modified for the presence of disease- and treatment-related side effects and co-morbidities (Table 2).

There is potential for benefit in the translation of research into periodisation to exercise prescription for cancer patients and several exercise oncology trials have incorporated various periodi-

Table 3
Cancer-specific pragmatic issues and barriers requiring consideration for exercise prescription[a].

[a] *The below recommendations are derived from evidence (when available) in conjunction with clinical judgement of experts who have authored or contributed to the paper (see acknowledgements section).*

Pragmatic Issues
Presence of a PICC or portacath: A peripherally-inserted central catheter (PICC) is a thin flexible plastic tube that is inserted into a vein in the upper arm and threaded into a large vein above the right side of the heart (superior vena cava), with the tip usually sitting just above the right atrium. It is used to give intravenous fluids, blood transfusions, chemotherapy and other drugs and can be used for taking blood samples. A PICC can remain in place for weeks or even months. Other central venous access devices, such as a Hickman line or portacath (more permanent than PICC or Hickman line) have similar purposes to the PICC but enter the body at the trunk, rather than limbs.
• The primary clinical concern around exercising with a PICC is damage to the PICC material: a fracture in the plastic tube causing a leakage, a segment of the PICC breaking off and lodging in a distant blood vessel (e.g., heart, lung, brain), or the dislodgement of the PICC, either partially (the tip of the PICC is no longer in the correct location and the infused fluid can damage the surrounding tissue) or completely (the PICC completely leaves the vein, requiring the insertion of a new PICC). However, pain on movement of arm with the inserted PICC is also possible. When the arm with the PICC is raised directly above the head, the total distance between the insertion site and the heart is reduced, pushing the PICC tip further along, potentially into the right atrium. For many, this does not provoke any problems, however a small but significant minority of patients may experience an unpleasant sensation caused by the PICC tip coming into contact with the right atrial wall or tricuspid heart valve. The unpleasant sensation promptly abates upon lowering the arm. • There are no available data on the risk of PICC damage or dislodgement during exercise and the recommendations a patient may receive or read may be based on anecdotal information, hypothetical situations or mechanistic theories, and include: limit lifting to <2-5 kg and avoid repetitious movements (scrubbing, vacuuming, upper-limb strength exercise repetitions). • Safety considerations to discuss with patient: (1) recommend dressings are changed if they become impaired or soiled from exercise; and (2) if PICC is not fully covered and secured, the patient should take care to ensure it does not catch on anything (e.g., clothing, edge of a chair) as this could dislodge or damage the PICC. Acknowledge any concerns a patient may have regarding the safety of exercise (e.g., fear of pain) or conflicting advice (or risk-averse educational material) that the patient may have received about the safety of exercise. • The risk of an exercise-related adverse event should be balanced against the harm of avoiding activity. Explain that there is no evidence of risk from lower-body exercise, but there are known adverse effects from avoiding activity. Support the patient's decision about what exercise they feel comfortable doing. • When a patient is fearful of damage to their PICC or experiences pain or discomfort from the PICC while exercising, emphasise lower-body aerobic and resistance exercise. • Slowly introduce upper-body mobility exercises (e.g., walking with intent to swing arms, mobility upper-body arm exercises with no weight in seated or standing position), followed by slow introduction of resistance exercise. • Encourage arm movement outside of exercise (e.g., hanging clothes on the line), which will in turn improve confidence of arm movement as part of exercise routines.

Table 3 (*Continued*)

- Exercise the contralateral limb, when deemed appropriate.
- Keep things in perspective – meaning, that for most having a PICC is short term. Therefore, for patients with low exercise self-efficacy while having a PICC, the emphasis can be on maintaining a lower-body exercise program and to work on progression once PICC is removed.
- While central venous access devices (e.g., Hickman line or portacath) are less influenced by heavy or repetitious movement of the upper limb, choice of exercise may be limited by pain or discomfort on specific movement (e.g., exercises that may move the catheter, which enters near the clavicle).

Presence of a urinary catheter: A catheter is a thin hollow flexible plastic tube that is used to drain urine from the bladder. It is either inserted into the urethra, or through a surgical incision in the abdomen wall (called a supra-pubic catheter). A urinary catheter may be necessary because of the location of a tumour or the side effects of treatment (surgery or radiation). It is most common in urological cancers and during end of life care. The catheter may be temporary (while the body heals) or permanent (being changed every 4-6 weeks). Some patients will self-insert a urinary catheter each time they need to void their bladder; this is called intermittent self-catheterisation.

- No limitations to exercise due to the catheter.
- Depending on the urinary issue, some individuals find that high impact sport or ground impact activities (e.g., through running or jumping) can cause urinary leakage and choose to either avoid these activities or to wear an incontinence pad.
- The catheter bag (which collects the urine; not all patients will have a bag as they may use a valve to empty the bladder through the catheter as needed) is not changed daily and therefore some patients may be conscious of the bag becoming soiled or smelly due to sweating during exercise. Suggestions to address this issue include wrapping the bag in a thin towel or putting it in a ziplock bag during exercise.
- Some patients will want to attach the catheter bag to themselves more securely for exercise. Options include a waist belt, a mesh "sleeve" that goes over the entire leg, or using additional straps.

Ostomies (e.g., stoma bag): An ostomy or stoma is a surgical opening made in the skin that allows waste to leave the intestines (ileostomy or colostomy) or from the bladder (urostomy). A stoma may be temporary (while the body heals) or permanent. The waste that passes out of the stoma is collected in an external pouching system (generally called a stoma bag) that requires regular, manual emptying. In cancer patients, intestinal stomas are most common after surgery on the intestines, either due to primary colon cancer or other cancers, such as ovarian cancer, which have spread to the intestine or the area around the intestine. Urostomies are most common in bladder cancer patients (see *presence of a urinary catheter* above).

- Compression garments or high-waisted underwear/ tight exercise garments can help support the weakened abdominal wall. These can also help to reduce movement of the bag during exercise. Alternatively, there are stoma-specific products such as belts or guards (recommended if the bag may be bumped or rubbed, e.g., contact sport, rock climbing) for use during sport.
- Swimming is safe once the stoma has healed. Ensure the bag is well sealed and consider ensuring attachment with additional support or waterproof dressings. Choosing high-waisted or firm fitting swimwear may help to secure (and hide/disguise) the pouch.
- Avoid excessive abdominal pressure (e.g., Valsalva) due to risk of peristomal hernia.
- Exercise can cause pressure on or pulling of stitches around stoma site – if the site is not visible to the individual then recommend that someone checks the stoma site and that the bag is not moving or leaking after attempting new exercise or movements.

Table 3 (*Continued*)

	• Consider nutritional requirements: individuals with a stoma are at increased risk of dehydration and may need to increase fluid intake when exercising. Individuals may need to trial eating at different intervals prior to exercise to optimise comfort and hydration (asking for advice from the stoma nurse and being prepared for trial and error are important). • Hygiene: follow the general advice and be aware that exercise may cause increased perspiration, or exposure to environmental contaminants (e.g., water from swimming, dirt from outside activities) and consider the need to change the bag more frequently.
Cancer-related barriers to exercise	
Alopecia (hair loss) and wigs: Hair loss is a side effect of some, but not all, types of chemotherapy.	
	• Understanding a patient's views and concerns regarding hair loss (as well as other options such as wearing a hat or scarf), is an important first step in ensuring appropriate exercise prescription, support and advice is provided (e.g., exercising at home may be the only option for those who find wigs too hot while exercising but who are also not comfortable in public without a wig). • Exercising with a wig may be uncomfortable and may interfere with heat transfer. However, some are not comfortable being in the presence of others without a wig. • The absence of hair (including eyebrows) or fabric on the head can lead to increased sweat running from the head to the face and eyes. A sweat band or exercising in a cooler environment can be helpful.
Time and scheduling:	
	• Understanding a patient's commitments and priorities is a necessary step to feasible exercise prescription. • Having an exercise prescription that can be implemented when available time is reduced unexpectedly can help patients to maintain habit of exercise, remember the importance of scheduling in exercise and ensure some exercise is undertaken versus no exercise. • Time-barriers during treatment may be less for those who cease work during their treatment period and therefore this cancer survivorship phase may represent an ideal time to integrate exercise into cancer care. Alternatively, if treatment needs to be scheduled without removing any daily activities the active treatment period may be the most difficult time to influence exercise behaviour. • Understanding, reviewing and reminding patients of their motivators of exercise and priority of exercise goals (short and longer term) versus day to day priorities will help patients to prioritise their time accordingly. • Consideration of behaviour change strategies aligned with the patient's goal(s) to optimise exercise uptake and adherence (noting that strategies to achieve uptake may differ to those useful for adherence).
Fear of causing or exacerbating treatment-related side effect(s):	
	• Keeping a daily logbook of presence of treatment-related side effects, in the absence of exercise, will help patients to develop an understanding of what constitutes normal fluctuations. Next step is to introduce exercise, while maintaining this logbook. This will help a patient to understand what symptoms may change with exercise (including type, intensity, duration and frequency) and how. This strategy provides extremely useful information from which an AEP and patient can work together in understanding what works best and when. • Being sedentary and avoidance of activity is associated with exacerbation of existing treatment-related toxicities and increased risk of developing new toxicities. In contrast, being regularly active, and planned, progressive exercise is associated with decreased risk of new toxicities and better management (including reductions) of existing treatment-related toxicities. • The presence of an *unusual* symptom (that is, new or worsening) indicates need for referral for clinical examination.

Table 3 (*Continued*)

Skin irritations or discomfort:
• Identify factors that may make skin irritations worse (e.g., types of fabric, tightness of clothing around a particular area, temperature, smoothness of weights, etc) and problem solve accordingly (e.g. suggest trying a singlet top with a shelf bra to women who find wearing a bra to be uncomfortable or painful during radiation treatment to the chest wall). • Promote good skin hygiene and care.
End of life period/ nearing death: The duration of this period is usually only days to weeks. Anticipated length of survival, if known or given, represents an estimate only and a patient may or may not understand (or want to know) their estimated survival time.
• Moving from a period of treatment with curative intent to palliative treatment or cessation of all treatment can represent a time of significant change to the medical team surrounding the patient. Maintaining continuous contact with an AEP during this period could have important and positive psychosocial and physical ramifications. • Anticipated duration of the palliative care period will influence exercise-related goals which may be to gain, maintain or prevent declines in fitness and function, through to maintaining dignity (e.g., ability to self-care for as long as possible). Whether you understand approximate duration of survival or not, ensure the patient guides the goals. • At all times, an AEP must be highly cognisant of balancing any burden associated with exercise prescription and its perceived benefit – ensure the benefit (physiological or psychosocial) outweighs the burden (e.g., patient would prefer spending time doing something else).

sation models.[25,72] Variation in volume and intensity across the week or within treatment cycles may stimulate greater physiological adaptation, and reduce boredom and risk of over-training. Further, periodised plans designed for optimal preparation for specific events, such as surgery or commencement of chemotherapy or radiation therapy, or to specifically address particular health issues should be considered. This may include sequential and cycling phases of emphasis on specific exercise modes such as resistance, aerobic, balance, and impact training. For example, the prescription of an extended phase of heavy resistance training before progressing to impact loading for maintaining bone density[25]; planned emphasis on low intensity exercise when treatment-related symptoms are severe, and high intensity exercise when symptoms are mild; or emphasis on high load resistance training with water-based aerobic exercise during the initial weeks of exercise prescription for obese patients (Table 2).

In recognition that cancer patients experience marked fluctuations in exercise tolerance, capacity and self-efficacy, particularly during the active treatment phase, it is paramount to ensure flexibility is built into the exercise prescription. The prescription should enable patients to *autoregulate* session, weekly and monthly exercise dosage to accommodate 'good days/weeks' (whereby higher intensity and/or dosage may be undertaken) and 'bad days/weeks' (whereby reduced intensity and/or total dosage may be required to accommodate symptoms). Autoregulation can occur, when necessary, through modifications to mode, intensity, frequency, duration and/or total volume, guided by objective (e.g., heart rate, repetitions completed) and/or subjective (e.g., rating of perceived exertion) measures. Examples of the implementation of autoregulation in the oncology setting have been previously published for aerobic[73] and resistance[74] exercise. Overall, the total exercise dosage for a defined period should seek to achieve the desired physical and mental health benefit(s), while balancing risks of overtraining, maladaptation, suboptimal, low priority or unnecessary exercise.

Progression: How to approach the progression of exercise prescription will differ depending on whether the patient is in the pre-, during or post-treatment cancer survivorship phase.[52] For example, physical and physiological declines are typically observed during active treatment periods, and also during periods of disease progression. Consequently, an exercise intensity that is moderate in the early weeks of treatment may elicit a physiological response indicative of vigorous intensity exercise in the final weeks of chemotherapy or when the disease has advanced. As such, minimising regression of total exercise dosage and relative intensity, or maintaining these parameters throughout the treatment period could be considered appropriate progression and incorporates patient autoregulation as discussed above.

For those who have completed treatment with a curative intent, it is generally reasonable to expect that exercise can be progressed steadily through increased overall dosage via modifications to mode, frequency, intensity and duration. However, it remains important to consider the influence of any persistent treatment-related toxicities or co-morbidities and the risk of new issues, as well as the potential challenge of returning to daily activities including work, on how progression should and could be defined. For example, returning to domestic chores, paid employment, volunteering or family responsibilities after treatment, while maintaining previous weekly exercise dosage could be considered appropriate progression in the first 3–6 months post-treatment.

In all cases, the goal of progression is to facilitate and maintain benefits derived through exercise prescription in the short and longer term. Those who are already meeting or exceeding public health physical activity guidelines or conversely, those who are sedentary at time of diagnosis, may require more assistance with understanding what appropriate progression means and how it can be defined. For example, helping regular exercisers to modify expectations around physical response to exercise and to appreciate that minimising declines in function during active treatment periods is indicative of exercise benefit. For those who are sedentary at diagnosis, helping them to overcome fears associated with 'doing too much' and learning differences between treatment-related side effects and normal, short term physiological responses to exercise overload, will likely be an important part of provision of exercise prescription and support. However, it will also be necessary to help patients avoid overtraining, which *may* bring with it higher risk of physical stress, injury, and compromised immune function, with unknown effect on key cancer-outcomes, such as quality of life, treatment tolerance and effectiveness, and even survival. Signs of overtraining would include the presence of unusual symptoms, increased severity of symptoms and changes in symptom trajectory (e.g., persist longer than expected). Overall, a key role of an AEP is to assess the safety, feasibility and effect of specific exercises, weekly dosage and pace of progression within the framework of an individual cancer patient's risk profile and exercise-related goals.

3.2. Behaviour change strategies — an important component of exercise prescription

Through the implementation of behaviour change techniques including goal setting, self-monitoring, individualised education, exercise prescription and feedback, and social support, exercise adherence can be improved.[75] This, in turn, facilitates achieving predefined exercise goals. Identifying and helping a patient problem-solve general and cancer-specific issues and barriers to exercise also forms an essential component of exercise prescription (Table 3). Finally, incorporating behaviour change strategies as part of the routine provision of exercise prescription will improve patient exercise self-efficacy,[76] and as such, provide them with the tools to use exercise to benefit their longer term health.

Education and monitoring of exercise prescription: In addition to standard exercise-related education topics, including appropriate clothing and footwear, hydration, and safe and appropriate use of equipment, a patient needs to be equipped to monitor the presence and severity of treatment-related side effects before, during and following exercise sessions and to be able to report on exercise response to the AEP. This represents important information that will enable appropriate modification to exercise prescription parameters for the purpose of autoregulation, periodisation and progression. Further, this information also allows for an adverse event or contraindication to exercise to be readily identified and managed accordingly. The presence of an unusual symptom or an unusual change to an existing symptom, rather than the presence of a persistent treatment-related side effect or symptom in itself, is more likely to represent an exercise contraindication. To detect the 'unusual', it is first necessary to have a clear understanding of what constitutes 'normal' or 'expected' for any given patient.

4. Conclusion

Overall, evidence supports that the implementation of exercise prescription brings with it reduced morbidity, improved function and quality of life, and potential for improved survival, with very low risk of harm. However, the strength of the evidence in support of exercise safety, feasibility and benefit is dependent on cancer type and outcome of interest. While for the majority, multimodal, moderate to high intensity exercise will be appropriate, there is no set prescription and total weekly dosage that would be considered evidence-based for all cancer patients. Appropriate exercise prescription for cancer patients needs to be targeted and individualised according to patient- and cancer-specific considerations.

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References

1. Hayes SC, Spence RR, Galvao DA et al. Australian Association for Exercise and Sport Science position stand: optimising cancer outcomes through exercise. *J Sci Med Sport* 2009; 12(4):428–434.
2. Australian Institute of Health and Welfare. Cancer survival and prevalence in Australia: period estimates from 1982 to 2010, In: *AIHW, ed. Vol Cancer Series no. 69. Cat. no. CAN 65.* Canberra, Australia, AIHW, 2012.
3. Fuller JT, Hartland MC, Maloney LT et al. Therapeutic effects of aerobic and resistance exercises for cancer survivors: a systematic review of meta-analyses of clinical trials. *Br J Sports Med* 2018; 52(20):1311.
4. Hayes SC, Rye S, Disipio T et al. Exercise for health: a randomized, controlled trial evaluating the impact of a pragmatic, translational exercise intervention on the quality of life, function and treatment-related side effects following breast cancer. *Breast Cancer Res Treat* 2013; 137(1):175–186.
5. Crawford-Williams F, March S, Goodwin BC et al. Interventions for prostate cancer survivorship: A systematic review of reviews. *Psychooncology* 2018; 27(10):2339–2348.
6. Devin JL, Jenkins DG, Sax AT et al. Cardiorespiratory fitness and body composition responses to different intensities and frequencies of exercise training in colorectal cancer survivors. *Clin Colorectal Cancer* 2018; 17(2):e269–e279.
7. Edvardsen E, Skjonsberg OH, Holme I et al. High-intensity training following lung cancer surgery: a randomised controlled trial. *Thorax* 2015; 70(3):244–250.
8. Wiskemann J, Dreger P, Schwerdtfeger R et al. Effects of a partly self-administered exercise program before, during, and after allogeneic stem cell transplantation. *Blood* 2011; 117(9):2604–2613.
9. Jackson C, Dowd AJ, Capozzi LC et al. A turning point: Head and neck cancer patients' exercise preferences and barriers before and after participation in an exercise intervention. *Eur J Cancer Care (Engl)* 2018; 27(2):e12826.
10. Morales JS, Valenzuela PL, Rincon-Castanedo C et al. Exercise training in childhood cancer: A systematic review and meta-analysis of randomized controlled trials. *Cancer Treat Rev* 2018; 70:154–167.
11. Zhou Y, Cartmel B, Gottlieb L et al. Randomized trial of exercise on quality of life in women with ovarian cancer: women's activity and lifestyle study in connecticut (WALC). *J Natl Cancer Inst* 2017; 109(12).
12. Basen-Engquist K, Carmack C, Brown J et al. Response to an exercise intervention after endometrial cancer: differences between obese and non-obese survivors. *Gynecol Oncol* 2014; 133(1):48–55.
13. Capozzi LC, Boldt KR, Easaw J et al. Evaluating a 12-week exercise program for brain cancer patients. *Psychooncology* 2016; 25(3):354–358.
14. Adams SC, DeLorey DS, Davenport MH et al. Effects of high-intensity aerobic interval training on cardiovascular disease risk in testicular cancer survivors: a phase 2 randomized controlled trial. *Cancer* 2017; 123(20): 4057–4065.
15. Yoh K, Nishikawa H, Enomoto H et al. Effect of exercise therapy on sarcopenia in pancreatic cancer: a study protocol for a randomised controlled trial. *BMJ Open* 2018; 7(5):1.
16. Dittus KL, Gramling RE, Ades PA. Exercise interventions for individuals with advanced cancer: a systematic review. *Prev Med* 2017; 104:124–132.
17. Heywood R, McCarthy AL, Skinner TL. Efficacy of exercise interventions in patients with advanced cancer: a sstematic review. *Arch Phys Med Rehabil* 2018; 99(12):2595–2620.
18. Duregon F, Vendramin B, Bullo V et al. Effects of exercise on cancer patients suffering chemotherapy-induced peripheral neuropathy undergoing treatment: a systematic review. *Crit Rev Oncol Hematol* 2018; 121:90–100.
19. Irwin ML, Cartmel B, Gross CP et al. Randomized exercise trial of aromatase inhibitor-induced arthralgia in breast cancer survivors. *J Clin Oncol* 2015; 33(10):1104–1111.
20. Nyrop KA, Callahan LF, Cleveland RJ et al. Randomized controlled trial of a home-based walking program to reduce moderate to severe aromatase inhibitor-associated arthralgia in breast cancer survivors. *Oncologist* 2017; 22(10):1238–1249.
21. Bloomquist K, Oturai P, Steele ML et al. Heavy-load lifting: acute response in breast cancer survivors at risk for lymphedema. *Med Sci Sports Exerc* 2018; 50(2):187–195.
22. Iyer NS, Cartmel B, Friedman L et al. Lymphedema in ovarian cancer survivors: Assessing diagnostic methods and the effects of physical activity. *Cancer* 2018; 124(9):1929–1937.
23. Taaffe DR, Galvao DA, Spry N et al. Immediate versus delayed exercise in men initiating androgen deprivation: effects on bone density and soft tissue composition. *BJU Int* 2018.
24. Winters-Stone KM, Dobek JC, Bennett JA et al. Skeletal response to resistance and impact training in prostate cancer survivors. *Med Sci Sports Exerc* 2014; 46(8):1482–1488.
25. Newton RU, Galvao DA, Spry N et al. Exercise mode specificity for preserving spine and hip BMD in prostate cancer patients. *Med Sci Sports Exerc* 2018.
26. Adams SC, Segal RJ, McKenzie DC et al. Impact of resistance and aerobic exercise on sarcopenia and dynapenia in breast cancer patients receiving adjuvant chemotherapy: a multicenter randomized controlled trial. *Breast Cancer Res Treat* 2016; 158(3):497–507.
27. Galvao DA, Taaffe DR, Spry N et al. Combined resistance and aerobic exercise program reverses muscle loss in men undergoing androgen suppression therapy for prostate cancer without bone metastases: a randomized controlled trial. *J Clin Oncol* 2010; 28(2):340–347.
28. Dieli-Conwright CM, Courneya KS, Demark-Wahnefried W et al. Effects of Aerobic and resistance exercise on metabolic syndrome, sarcopenic obesity, and circulating biomarkers in overweight or obese survivors of breast cancer: a randomized controlled trial. *J Clin Oncol* 2018; 36(9):875–883.
29. Rogers LQ, Courneya KS, Oster RA et al. Physical activity and sleep quality in breast cancer survivors: a randomized trial. *Med Sci Sports Exerc* 2017; 49(10):2009–2015.
30. Solheim TS, Laird BJA, Balstad TR et al. A randomized phase II feasibility trial of a multimodal intervention for the management of cachexia in lung and pancreatic cancer. *J Cachexia Sarcopenia Muscle* 2017; 8(5):778–788.
31. Hartman SJ, Nelson SH, Myers E et al. Randomized controlled trial of increasing physical activity on objectively measured and self-reported cognitive functioning among breast cancer survivors: The memory & motion study. *Cancer* 2018; 124(1):192–202.
32. Jones LW, Fels DR, West M et al. Modulation of circulating angiogenic factors and tumor biology by aerobic training in breast cancer patients receiving neoadjuvant chemotherapy. *Cancer Prev Res (Phila)* 2013; 6(9):925–937.
33. Scott JM, Nilsen TS, Gupta D et al. Exercise therapy and cardiovascular toxicity in cancer. *Circulation* 2018; 137(11):1176–1191.
34. Courneya KS, McKenzie DC, Mackey JR et al. Effects of exercise dose and type during breast cancer chemotherapy: multicenter randomized trial. *J Natl Cancer Inst* 2013; 105(23):1821–1832.
35. Courneya KS, Segal RJ, Mackey JR et al. Effects of aerobic and resistance exercise in breast cancer patients receiving adjuvant chemotherapy: a multicenter randomized controlled trial. *J Clin Oncol* 2007; 25(28):4396–4404.
36. van Waart H, Stuiver MM, van Harten WH et al. Effect of low-intensity physical activity and moderate- to high-intensity physical exercise during adjuvant chemotherapy on physical fitness, fatigue, and chemotherapy completion rates: results of the paces randomized clinical trial. *J Clin Oncol* 2015; 33(17):1918–1927.
37. Gordon LG, DiSipio T, Battistutta D et al. Cost-effectiveness of a pragmatic exercise intervention for women with breast cancer: results from a randomized controlled trial. *Psychooncology* 2017; 26(5):649–655.
38. Courneya KS, Segal RJ, McKenzie DC et al. Effects of exercise during adjuvant chemotherapy on breast cancer outcomes. *Med Sci Sports Exerc* 2014; 46(9):1744–1751.
39. Courneya KS, Friedenreich CM, Franco-Villalobos C et al. Effects of supervised exercise on progression-free survival in lymphoma patients: an exploratory follow-up of the HELP Trial. *Cancer Causes Control* 2015; 26(2):269–276.
40. Wiskemann J, Kleindienst N, Kuehl R et al. Effects of physical exercise on survival after allogeneic stem cell transplantation. *Int J Cancer* 2015; 137(11): 2749–2756.
41. Hayes SC, Steele ML, Spence RR et al. Exercise following breast cancer: exploratory survival analyses of two randomised, controlled trials. *Breast Cancer Res Treat* 2018; 167(2):505–514.
42. Spence R, DiSipio T, Schmitz K et al. Is unsupervised exercise following breast cancer safe for all women? *Int J Phys Med Rehabil* 2014; 2(3).
43. Speck RM, Courneya KS, Masse LC et al. An update of controlled physical activity trials in cancer survivors: a systematic review and meta-analysis. *J Cancer Surviv* 2010; 4(2):87–100.

44. Norton K, Norton L. *Pre-Exercise Screening: Guide to the Australian Adult Pre-Exercise Screening System, Australia*, Exercise and Sport Science Australia Fitness Australia and Sports Medicine Australia, 2011.
45. Thomas S, Reading J, Shephard RJ. Revision of the physical activity readiness questionnaire (PAR-Q). *Can J Sport Sci* 1992; 17(4):338–345.
46. Riebe D, Franklin B, Thompson P et al. Updating ACSM's recommendations for exercise preparticipation health screening. *Med Sci Sports Exerc* 2015; 47(11):3473–3479.
47. Riebe D, Ehrman J, Liguori G et al. *ACSM's Guidelines for Exercise Testing and Prescription*, tenth edition Philadelphia, Wolters Kluwer, 2018.
48. Webster K, Cella D, Yost K. The Functional Assessment of Chronic Illness Therapy (FACIT) Measurement System: properties, applications, and interpretation. *Health Qual Life Outcomes* 2003; 1:79.
49. Cella D, Riley W, Stone A et al. The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005–2008. *J Clin Epidemiol* 2010; 63(11):1179–1194.
50. Brady MJ, Cella DF, Mo F et al. Reliability and validity of the Functional Assessment of Cancer Therapy-Breast quality-of-life instrument. *J Clin Oncol* 1997; 15(3):974–986.
51. Rogers LQ, Courneya KS, Verhulst S et al. Exercise barrier and task self-efficacy in breast cancer patients during treatment. *Support Care Cancer* 2006; 14(1):84–90.
52. Courneya KS, Friedenreich CM. Physical activity and cancer control. *Semin Oncol Nurs* 2007; 23(4):242–252.
53. Maiorana AJ, Williams AD, Askew CD et al. Exercise professionals with advanced clinical training should be afforded greater responsibility in pre-participation exercise screening: a new collaborative model between exercise professionals and physicians. *Sports Med* 2018; 48(6):1293–1302.
54. Santa Mina D, Langelier DM, Adams S et al. Exercise as part of routine cancer care. *Lancet Oncol* 2018; 19(9):e433–e436.
55. Buchan J, Janda M, Box R et al. A randomized trial on the effect of exercise mode on breast cancer-related lymphedema. *Med Sci Sports Exerc* 2016; 48(10):1866–1874.
56. Buffart LM, Sweegers MG, May AM et al. Targeting exercise interventions to patients with cancer in need: an individual patient data meta-analysis. *J Natl Cancer Inst* 2018; 110(11):1190–1200.
57. Chang JT, Morton SC, Rubenstein LZ et al. Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials. *BMJ* 2004; 328(7441):680.
58. Danhauer SC, Addington EL, Sohl SJ et al. Review of yoga therapy during cancer treatment. *Support Care Cancer* 2017; 25(4):1357–1372.
59. Chandwani KD, Perkins G, Nagendra HR et al. Randomized, controlled trial of yoga in women with breast cancer undergoing radiotherapy. *J Clin Oncol* 2014; 32(10):1058–1065.
60. Kiecolt-Glaser JK, Bennett JM, Andridge R et al. Yoga's impact on inflammation, mood, and fatigue in breast cancer survivors: a randomized controlled trial. *J Clin Oncol* 2014; 32(10):1040–1049.
61. Chang JI, Lam V, Patel MI. Preoperative pelvic floor muscle exercise and post-prostatectomy incontinence: a systematic review and meta-analysis. *Eur Urol* 2016; 69(3):460–467.
62. Michie S, Abraham C, Whittington C et al. Effective techniques in healthy eating and physical activity interventions: a meta-regression. *Health Psychol* 2009; 28(6):690–701.
63. Scott JM, Zabor EC, Schwitzer E et al. Efficacy of exercise therapy on cardiorespiratory fitness in patients with cancer: a systematic review and meta-analysis. *J Clin Oncol* 2018; 36(22):2297–2305.
64. Licker M, Karenovics W, Diaper J et al. Short-term preoperative high-intensity interval training in patients awaiting lung cancer surgery: a randomized controlled trial. *J Thorac Oncol* 2017; 12(2):323–333.
65. Jones LW, Eves ND, Peppercorn J. Pre-exercise screening and prescription guidelines for cancer patients. *Lancet Oncol* 2010; 11(10):914–916.
66. Williams S, French D. What are the most effective intervention techniques for changing physical activity self-efficacy and physical activity behavior and are they the same? *Health Educ Res* 2011; 26(2):308–322.
67. COSA Exercise Cancer Group Executive Committee. Clinical Oncology Society of Australia position statement on exercise in cancer care. *Med J Aust* 2019; 210(1), 54-54 e51.
68. Newton MJ, Hayes SC, Janda M et al. Safety, feasibility and effects of an individualised walking intervention for women undergoing chemotherapy for ovarian cancer: a pilot study. *BMC Cancer* 2011; 11:389.
69. Scott JM, Iyengar NM, Nilsen TS et al. Feasibility, safety, and efficacy of aerobic training in pretreated patients with metastatic breast cancer: a randomized controlled trial. *Cancer* 2018; 124(12):2552–2560.
70. Li T, Wei S, Shi Y et al. The dose–response effect of physical activity on cancer mortality: findings from 71 prospective cohort studies. *Br J Sports* 2016; 50:339–345.
71. Brown J, Damjanov N, Courneya KS et al. A randomized dose-response trial of aerobic exercise and health-related quality of life in colon survivors. *Psychooncology* 2018; 27(4):1221–1228.
72. Newton RU, Kenfield SA, Hart NH et al. Intense Exercise for Survival among Men with Metastatic Castrate-Resistant Prostate Cancer (INTERVAL-GAP4): a multicentre, randomised, controlled phase III study protocol. *BMJ Open* 2018; 8(5):e022899.
73. Kirkham AA, Bonsignore A, Bland KA et al. Exercise prescription and adherence for breast cancer: one size does not FITT All. *Med Sci Sports Exerc* 2018; 50(2):177–186.
74. Fairman CM, Zourdos MC, Helms ER et al. A scientific rationale to improve resistance training prescription in exercise oncology. *Sports Med* 2017; 47(8):1457–1465.
75. Turner RR, Steed L, Quirk H et al. Interventions for promoting habitual exercise in people living with and beyond cancer. *Cochrane Database Syst Rev* 2018; 9:CD010192.
76. Craike MJ, Gaskin CJ, Mohebbi M et al. Mechanisms of physical activity behavior change for prostate cancer survivors: a cluster randomized controlled trial. *Ann Behav Med* 2018; 52(9):798–808.
77. Ibanez K, Espiritu N, Souverain RL et al. Safety and feasibility of rehabilitation interventions in children undergoing hematopoietic stem cell transplant with thrombocytopenia. *Arch Phys Med Rehabil* 2018; 99(2): 226–233.
78. Fu JB, Tennison JM, Rutzen-Lopez IM et al. Bleeding frequency and characteristics among hematologic malignancy inpatient rehabilitation patients with severe thrombocytopenia. *Support Care Cancer* 2018; 26(9):3135–3141.
79. Nahm N, Mee S, Marx G. Efficacy of management strategies for aromatase inhibitor-induced arthralgia in breast cancer patients: a systematic review. *Asia Pac J Clin Oncol* 2017:1–9.
80. Beckwee D, Leysen L, Meuwis K et al. Prevalence of aromatase inhibitor-induced arthralgia in breast cancer: a systematic review and meta-analysis. *Support Care Cancer* 2017; 25(5):1673–1686.
81. Beck B, Day R, Singh M et al. Exercise and Sports Science Austrlalia (ESSA) position statement on exercise prescription for the prevention and management of osteoporosis. *J Sci Med Sport* 2017; 20(5):438–445.
82. Galvao DA, Taaffe DR, Spry N et al. Exercise preserves physical function in prostate cancer patients with bone metastases. *Med Sci Sports Exerc* 2018; 50(3):393–399.
83. Carlin BI, Andriole GL. The natural history, skeletal complications, and management of bone metastases in patients with prostate carcinoma. *Cancer* 2000; 88(12 Suppl):2989–2994.
84. Berger AM, Mooney K, Alvarez-Perez A et al. Cancer-Related Fatigue, Version 2.2015. *J Natl Compr Canc Netw* 2015; 13(8):1012–1039.
85. Mustian KM, Alfano CM, Heckler C et al. Comparison of pharmaceutical, psychological, and exercise treatments for cancer-related fatigue: a meta-analysis. *J Am Med Assoc* 2017; 3(7):961–968.
86. Taaffe DR, Newton RU, Spry N et al. Effects of different exercise modalities on fatigue in prostate cancer patients undergoing androgen deprivation therapy: a year-long randomised controlled trial. *Eur Urol* 2017; 72(2): 293–299.
87. Zdenkowski N, Tesson S, Lombard J et al. Supportive care of women with breast cancer: key concerns and practical soluations. *Med J Aust* 2016; 205(10):471–475.
88. Lenneman CG, Sawyer DB. Cardio-oncology: an update on cardiotoxicity of cancer-related treatment. *Circ Res* 2016; 118(6):1008–1020.
89. Singh B, DiSipio T, Peake J et al. Systematic review and meta-analysis of the effcts of exercise for those with cancer-related lymphoedema. *Arch Phys Med Rehabil* 2016; 97(2):302–315.
90. DiSipio T, Rye S, Newman B et al. Incidence of unilateral arm lymphoedema after breast cancer: a systematic review and meta-analysis. *Lancet Oncol* 2013; 14(6):500–515.
91. Lindgren A, Dunberger G, Enblom A. Experiences of incontinence and pelvic floor muscle training after gynaecologic cancer treatment. *Support Care Cancer* 2017; 25(1):157–166.
92. Zimmer P, Baumann FT, Oberste M et al. Effects of exercise interventions and physical activity behavior on cancer related cognitive impairments: a systematic review. *Biomed Res Int 2016* 2016:1820954.
93. Türk Y, Theel W, Kasteleyn MJ et al. High intensity training in obesity: a meta-analysis. *Obesity Sci Pract* 2017; 3(3):258–271.
94. Hordern MD, Dunstan DW, Prins JB et al. Exercise prescription for patients with type 2 diabetes and pre-diabetes: a position statement from Exercise and Sport Science Australia. *J Sci Med Sport* 2012; 15(1):25–31.
95. Bennell KL, Hinman RS. A review of the clinical evidence for exercise in osteoarthritis of the hip and knee. *J Sci Med Sport* 2011; 14(1):4–9.
96. Craft LL, VanIterson EH, Helenowski IB et al. Exercise Effects on Depressive Symptoms in Cancer Survivors: A Systematic Review and Meta-Analysis. *Cancer Epidemiol Biomarkers Prev* 2012; 21(1):3–19.
97. Stubbs B, Vancampfort D, Hallgren M et al. EPA guidance on physical activity as a treatment for severe mental illness: a meta-review of the evidence and Position Statement from the European Psychiatric Association (EPA), supported by the International Organization of Physical Therapists in Mental Health (IOPTMH). *Eur Psychiatry* 2018; 54:124–144.
98. Selig SE, Levinger I, Williams AD et al. Exercise & Sports Science Australia Position Statement on exercise training and chronic heart failure. *J Sci Med Sport* 2010; 13(3):288–294.
99. Sharman JE, Stowasser M. Australian association for exercise and sports science position statement on exercise and hypertension. *J Sci Med Sport* 2009; 12(2):252–257.