

Exercise Recommendation for People With Bone Metastases: Expert Consensus for Health Care Providers and Exercise Professionals

Kristin L. Campbell, PT, PhD¹; Prue Cormie, PhD, AEP^{2,3}; Sarah Weller, MSc, CSEP-CEP^{1,4}; Shabbir M. H. Alibhai, MD, MSc⁵; Kate A. Bolam, PhD⁶; Anna Campbell, PhD, MBE⁷; Andrea L. Cheville, MD, MSCE⁸; Mary-Ann Dalzell, PT, MSc⁹; Nicolas H. Hart, PhD, AES^{10,11}; Celestia S. Higano, MD¹²; Kirstin Lane, PhD, CSEP-CEP¹³; Sami Mansfield, BA¹⁴; Margaret L. McNeely, PT, PhD¹⁵; Robert U. Newton, PhD, DSc, AEP¹⁰; Morten Quist, PT, PhD¹⁶; Jennifer Rauw, MD⁴; Friederike Rosenberger, PhD¹⁷; Daniel Santa Mina, PhD, CSEP-CEP¹⁸; Kathryn H. Schmitz, PhD¹⁹; Kerri M. Winters-Stone, PhD²⁰; Joachim Wiskemann, PhD¹⁷; and Jennifer Goulart, MD²¹

QUESTION ASKED: What are the best practice recommendations for exercise programming for people with bone metastases?

SUMMARY ANSWER: People with bone metastases should be supported and encouraged to engage in regular physical activity, including structured exercise, to obtain the well-established general health benefits and as a strategy to manage side effects related to cancer and treatments. Perceived risks of skeletal complications should be weighed against the potential health benefits in consultation between the person with bone metastases, health care team, and exercise professional.

WHAT WE DID: The International Bone Metastases Exercise Working Group (IBMEWG) developed best practice recommendations on the basis of published research, clinical experience, and expert opinion using (1) *modified Delphi survey*, (2) *systematic review*, (3) *cross-sectional survey* to physicians and nurse practitioners, (4) *in-person meeting*, and (5) *stakeholder engagement*.

WHAT WE FOUND: On the basis of the review of available evidence and expert consensus, the IBMEWG developed five key recommendations: (1) Before exercise testing or training, perform a risk assessment to inform the likelihood of a skeletal complication from exercise. (2) Consultation with the medical team is strongly encouraged to obtain key medical information and establish bidirectional communication. (3) Exercise professionals best suited for this population are physical therapists and clinical exercise physiologists (or equivalent) who have additional cancer exercise training. (4) Professional judgement should be used to consider if exercise testing is necessary. (5) Exercise prescription

should follow the standard exercise recommendations as outlined by the International Exercise Guidelines for Cancer Survivors, with greater emphasis on postural alignment, controlled movement, proper technique, and consideration of the bone lesion location and presentation.

BIAS, CONFOUNDING FACTORS: Some authors of this paper are employed by entities that provide physical activity programming for people with cancer, are involved in professional organizations that promote the role of exercise professionals within health care settings, and/or were authors for the International Exercise Guidelines for Cancer Survivors. Although these are strengths in terms of expertise, they may also lead to bias.

REAL-LIFE IMPLICATIONS: Exercise has been underutilized in people with advanced or incurable cancer despite the potential to improve physical function and reduce psychosocial morbidity, especially for people with bone metastases because of concerns over skeletal complications. These recommendations provide a framework and starting point for members of the medical team and exercise professionals to improve the integration of physical activity into the care of people with bone metastases. It is anticipated that the recommendations provided here will continue to evolve as more literature is available. Fundamental limitations remain around a lack of definitive literature on standardized approaches to predict the risk of skeletal complications and a paucity of data on the safety and efficacy of exercise for specific people that may be at increased risk of skeletal complications with exercise (ie, elderly individuals with multiple myeloma).

ASSOCIATED CONTENT

Appendix

Author affiliations and disclosures are available with the complete article at ascopubs.org/journal/op.

Accepted on November 18, 2021 and published at ascopubs.org/journal/op on January 6, 2022: Full-length article available online at DOI <https://doi.org/10.1200/JCO.21.00454>

CORRESPONDING AUTHOR

Kristin L. Campbell, PT, PhD, 212, 2177 Westbrook Mall, Department of Physical Therapy, Faculty of Medicine, University of British Columbia, Vancouver, British Columbia, Canada V6T 1Z3; e-mail: kristin.campbell@ubc.ca.

Exercise Recommendation for People With Bone Metastases: Expert Consensus for Health Care Providers and Exercise Professionals

Kristin L. Campbell, PT, PhD¹; Prue Cormie, PhD, AEP^{2,3}; Sarah Weller, MSc, CSEP-CEP^{1,4}; Shabbir M. H. Alibhai, MD, MSc⁵; Kate A. Bolam, PhD⁶; Anna Campbell, PhD, MBE⁷; Andrea L. Cheville, MD, MSCE⁸; Mary-Ann Dalzell, PT, MSc⁹; Nicolas H. Hart, PhD, AES^{10,11}; Celestia S. Higano, MD¹²; Kirstin Lane, PhD, CSEP-CEP¹³; Sami Mansfield, BA¹⁴; Margaret L. McNeely, PT, PhD¹⁵; Robert U. Newton, PhD, DSc, AEP¹⁰; Morten Quist, PT, PhD¹⁶; Jennifer Rauw, MD⁴; Friederike Rosenberger, PhD¹⁷; Daniel Santa Mina, PhD, CSEP-CEP¹⁸; Kathryn H. Schmitz, PhD¹⁹; Kerri M. Winters-Stone, PhD²⁰; Joachim Wiskemann, PhD¹⁷; and Jennifer Goulart, MD²¹

PURPOSE Exercise has been underutilized in people with advanced or incurable cancer despite the potential to improve physical function and reduce psychosocial morbidity, especially for people with bone metastases because of concerns over skeletal complications. The International Bone Metastases Exercise Working Group (IBMEWG) was formed to develop best practice recommendations for exercise programming for people with bone metastases on the basis of published research, clinical experience, and expert opinion.

METHODS The IBMEWG undertook sequential steps to inform the recommendations: (1) *modified Delphi survey*, (2) *systematic review*, (3) *cross-sectional survey* to physicians and nurse practitioners, (4) *in-person meeting* of IBMEWG to review evidence from steps 1-3 to develop draft recommendations, and (5) *stakeholder engagement*.

RESULTS Recommendations emerged from the contributing evidence and IBMEWG discussion for pre-exercise screening, exercise testing, exercise prescription, and monitoring of exercise response. Identification of individuals who are potentially at higher risk of exercise-related skeletal complication is a complex interplay of these factors: (1) lesion-related, (2) cancer and cancer treatment-related, and (3) the person-related. Exercise assessment and prescription requires consideration of the location and presentation of bone lesion(s) and should be delivered by qualified exercise professionals with oncology education and exercise prescription experience. Emphasis on postural alignment, controlled movement, and proper technique is essential.

CONCLUSION Ultimately, the perceived risk of skeletal complications should be weighed against potential health benefits on the basis of consultation between the person, health care team, and exercise professionals. These recommendations provide an initial framework to improve the integration of exercise programming into clinical care for people with bone metastases.

JCO Oncol Pract 18:e697-e709. © 2022 by American Society of Clinical Oncology

Creative Commons Attribution Non-Commercial No Derivatives 4.0 License 

INTRODUCTION

People living with advanced or incurable cancers are treated with sequential cancer therapies to improve survival and quality of life, but treatment burden can be high, including fatigue, reduced physical function, and psychosocial morbidity.¹ In this context, people with advanced or incurable cancer highlight that maintaining functional independence and managing symptom burden are top priorities.^{2,3}

Exercise (ie, planned and structured physical activity aimed to improve health) has been shown to improve fatigue, physical function, and psychosocial morbidity

in people with early-stage cancers.⁴ In the advanced or incurable cancer setting, the presence of bone metastases complicates prescribing exercise and promoting physical activity because of concerns about potential skeletal complications such as pathologic fracture, hypercalcemia, or spinal cord compression.⁵ Although people with bone metastases regularly express an interest in information on exercise,⁶⁻⁸ health care professionals report uncertainties regarding risk management.⁹⁻¹¹ Recent systematic reviews in advanced or incurable cancer generally show exercise to be safe, feasible, and beneficial for quality of life, physical function, and fatigue.¹²⁻¹⁸ However, these

Author affiliations and support information (if applicable) appear at the end of this article.

Accepted on November 18, 2021 and published at ascopubs.org/journal/op on January 6, 2022; DOI <https://doi.org/10.1200/JCO.2021.00454>

systematic reviews have not focused specifically on the safety or efficacy of exercise for people with bone metastases.

The International Bone Metastases Exercise Working Group (IBMEWG) was formed on the basis of the recognition that people with bone metastases could potentially benefit from exercise and are not receiving direction from the health care team, as they may be reticent because of lack of guidance in the literature or clinical practice. This group aimed to develop best practice recommendations on the basis of existing research evidence, clinical experience, and expert opinion.

METHODS

The IBMEWG is a multidisciplinary, international panel of physicians, physical therapists, clinical exercise physiologists, and researchers. Sequential steps (Fig 1) were taken to inform the recommendations: (1) *modified Delphi survey* to ascertain the practical considerations of implementing exercise for people with bone metastases in the outpatient oncology setting¹⁹ (all participants provided informed consent, Research Ethics Board approval, University of British Columbia; H19-00379); (2) *systematic review* to assess the safety, feasibility, and efficacy of exercise in controlled trials that included people with bone metastases (International Prospective Register of Systematic Reviews: CRD42019121958)²⁰; (3) *cross-sectional survey* to physicians and nurse practitioners to understand the attitudes toward exercise for people with bone metastases and components required to promote exercise referral²¹ (all participants provided informed consent, Research Ethics Board approval, University of British Columbia; H19-00379); (4) *in-person meeting* of IBMEWG to review evidence from steps 1-3 to develop recommendations; and (5) *stakeholder engagement*, first with people with bone metastases (draft recommendations) and second with clinician peers (penultimate recommendations).

RESULTS

Recommendation 1

Before exercise testing or training, perform a risk assessment to inform the likelihood of a skeletal complication from exercise.

The Delphi identified consensus on information that respondents deemed key to determine exercise suitability (Table 1). However, reliance on an individual's *self-reported* bone lesion details did not reach consensus. The systematic review showed that randomized controlled trials of exercise involving people with bone metastases commonly exclude people deemed to have structurally unstable bone lesion(s) or pain associated with bone lesion(s).²⁰ Determination of lesion stability was either undefined^{22,23} or two randomized controlled trials used Taneichi's subtype A-C scoring for osteolytic thoracic and lumbar spine lesions, with computed tomography or magnetic resonance

imaging assessed independently by a radiologist and orthopedic surgeon.^{24,25} In the survey, most respondents agreed that exercise for people with bone metastases was safe (82%) and these individuals look to their health care providers to provide exercise referral and recommendations (74%). To facilitate respondents providing an exercise recommendation to individuals, the most frequently cited resource identified was a set of clinical guidelines for exercise in this population (25%), an easy-to-use screening scale (20%), and a consult with a qualified exercise professional (13%).²¹

The IBMEWG acknowledged that in the absence of literature, all people with bone metastases can be at risk of an exercise-related skeletal complication, but this should not preclude prescribing exercise. Identification of individuals who are potentially at higher risk of exercise-related skeletal complication is a complex interplay of these factors: (1) lesion-related, (2) cancer and cancer treatment-related, and (3) person-related (Table 2). Furthermore, it was acknowledged that bone scan reports may not consistently provide information on lesion volume and that a computed tomography and magnetic resonance imaging may be more reliable for structural qualities of the bone and preferable for people deemed higher risk. Finally, more research is required to confirm the utility of pre-exercise skeletal assessment scales to guide risk assessment. Stakeholders with bone metastases reported that they were keen to exercise but fearful, lacking in confidence for self-guidance, and uncertain where to look for exercise advice. They confirmed that discussion with the health care team on how to manage risk was of key interest to people with bone metastases.

Recommendation 2

Consultation with the medical team is strongly encouraged before an exercise professional provides structured exercise for a person with bone metastases, to obtain key medical information and establish bidirectional communication for initial assessment and exercise training throughout care.

The primary reason reported by exercise professionals to seek medical clearance or guidance was to obtain key medical information, such as results of bone scan reports to guide exercise prescription and to establish two-way communication (ie, to allow for information sharing with the goal of better safety and overall care). When asked if a primary reason for seeking medical clearance or guidance was a requirement for professional liability (ie, signed approval by a physician), only 39% of exercise professionals strongly agreed or agreed (Table 1). In the systematic review, 24% of trials required medical clearance by a physician. For the remainder, exclusion criteria specific to lesion characteristics of bone metastases were used, such as excluding people with unstable bone metastases (24%) or pain associated with the bone lesion (41%).²⁰ Most

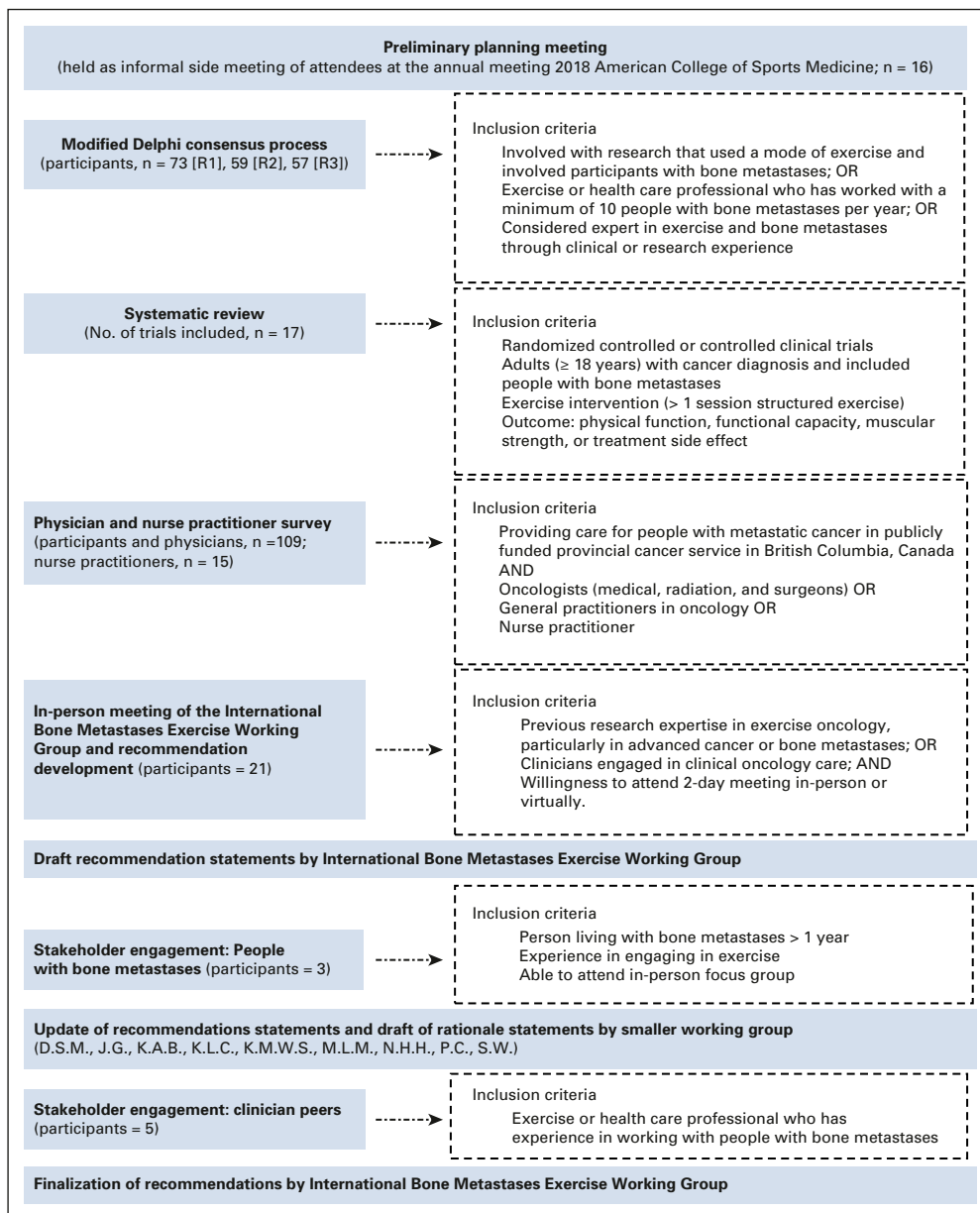


FIG 1. Information gathering and recommendation development process.

survey respondents agreed that people with bone metastases expected their physician to provide physical activity recommendations (74%), and these recommendations would be well received (66%) and followed (58%). However, less than half of the physicians and nurse practitioners (43%) felt confident to recommend exercise to people with bone metastases.²¹

The IBMEWG agreed that the term medical consultation versus clearance was the most appropriate term for communication between the exercise professional and health care provider. The goal of such medical consultation is to establish two-way communication to assess the cost to benefit-risk of an exercise prescription, as it can be difficult

for health care providers to feel that they have enough understanding of exercise to provide medical clearance and for exercise professionals to obtain or interpret all the desired clinical information to assess risk, especially without access to the medical chart (Appendix Table A1, online only).

Recommendation 3

Exercise professionals best suited to prescribe exercise to people with bone metastases are physical therapists and clinical exercise physiologists (or equivalent), who have additional cancer exercise training and appropriate experience in working with people with a cancer diagnosis.

TABLE 1. Modified Delphi Survey Results and Future Research Directions

DR	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Consensus (%)
A. Pre-exercise screening questions (Recommendation 1)						
DR2	When performing a pre-exercise screening on an individual with MBD, it is STRONGLY RECOMMENDED that an exercise professional uses the following information to determine exercise suitability: (1) bone lesion details, ideally from a diagnostic report that includes lesion location, type, progression, and history; (2) bone pain details (during rest, ADLs, or physical activity); (3) any medical treatment for bone pain within the past 3 months; (4) symptoms associated with the bone lesions					
	91%	9%	0%	0%	0%	100% agree
DR2	In addition to the above items, when performing a pre-exercise screening on an individual with MBD, it is STRONGLY RECOMMENDED that an exercise professional also uses the following information to determine exercise suitability: (1) detailed medical history, (2) current medications or treatments specific to MBD or pain, (3) history of fractures and falls, (4) bone mineral density report, (5) the individuals' physical activity goals, and (6) current physical activity levels					
	86%	12%	2%	0%	0%	98% agree
DR2	In the absence of a bone scan report (or a similar diagnostic report or letter from medical doctor), an individual's self-reported details of the bone lesion(s) ARE SUFFICIENT					
	2%	14%	23%	35%	26%	No consensus reached
B. Medical clearance and Medical guidance (Recommendation 2)						
DR3	As an exercise professional, the primary objective when seeking a medical clearance or medical guidance from a physician, in relation to an individual with MBD is					
	a. Medical information (eg, reports from recent scans or tests and any upcoming treatments)					
	65%	28%	5%	0%	2%	93% agree
	b. Establish two-way communication					
	53%	23%	7%	16%	2%	76% agree
	c. Recommendations for exercise prescription					
	10%	23%	23%	33%	11%	No consensus reached
	d. Professional liability					
	12%	27%	12%	33%	16%	No consensus reached
DR3	Individuals with MBD who meet any of the following conditions REQUIRE medical guidance from the individual's medical professional prior to commencing a structured exercise program with a clinical exercise professional: (1) bone lesions that are unstable or of unknown stability, (2) bone pain or medical treatment of bone pain in the past 3 months, and (3) history of disease-related fractures within the past 12 months					
	63%	26%	2%	5%	4%	89% agree
C. Suitable exercise professionals (Recommendation 3)						
DR2	Please select all the exercise professionals that you feel are suitable to safely prescribe exercise to an individual with metastatic bone disease who is deemed HIGHER RISK OF FRACTURE (eg, multiple bone lesion locations, unknown stability, and symptomatic)					
	a. Physical therapist					39
	b. Physical therapist with cancer exercise training					95
	c. Exercise physiologist					20
	d. Exercise physiologist with cancer exercise training					85
	e. Kinesiologist or exercise or sports scientist or exercise therapist					13
	f. Kinesiologist or exercise sports scientist or exercise therapist with cancer exercise training					52
	g. Personal trainer					0
	h. Personal trainer with cancer exercise training					13
	i. Fitness instructor					0
	j. Fitness instructor with cancer exercise training					7
(continued on following page)						

TABLE 1. Modified Delphi Survey Results and Future Research Directions (continued)

DR	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Consensus (%)
D. Exercise testing (Recommendation 4)						
DR2	In an individual with MBD who is at a LOWER risk of fracture, I recommend exercise testing, but there are some tests that are contraindicated					
	70%				30%	70% agree
	In an individual with MBD who is at a HIGHER risk of fracture, I recommend exercise testing, but there are some tests that are contraindicated					
	88%				12%	88% agree
DR3	When considering strength testing for a person with bone metastases, I would					
	a. Avoid any strength testing (7%)					
	b. Avoid any strength testing that places stress on the lesion site (44%)					
	c. Use caution with any testing that places stress on the lesion site (37%)					
	d. Not make any considerations (7%)					
	e. I am not an exercise professional and do not feel I can answer this question (2%)					
E. Exercise prescription (Recommendation 5)						
DR2	If an individual is deemed UNSAFE TO EXERCISE (aka “high” risk), it is appropriate for an exercise professional to provide physical activity education or movement prescription that is modified to specifically suit the individual and is provided in collaboration with the individuals’ medical team					
	65%	26%	2%	4%	4%	91% agree
DR3	Once an individual with MBD has received an exercise prescription from a highly qualified exercise professional (eg, Physiotherapist or Exercise Physiologist with cancer exercise training), referral to a less qualified exercise professional (eg, Personal Trainer or Fitness Instructor) may be appropriate. The less qualified exercise professional would administer and monitor the specific exercise program established by the Physiotherapist or Exercise Physiologist					
	16%	49%	12%	16%	7%	No consensus reached
DR3	For individuals with lower risk MBD (eg, stable and asymptomatic), exercise prescription is normally safe if it USES CAUTION with exercises that place stress on the bone lesion site					
	54%	39%	5%	0%	2%	93% agree
DR3	What does the term “use caution” mean to you, in the context of the question above?					
	a. Start by avoiding any exercises that place stress on the lesion site (14%)					
	b. For exercises that target the lesion site, start with active movement and no load or weight and progress slowly, provided there is no exacerbation of pain or adverse symptoms (47%)					
	c. For exercises that target the lesion site, start with low loads (eg, theraband or light dumbbells) and progress slowly, provided there is no exacerbation of pain or symptoms (28%)					
	d. Other (10%)					
F. Direction for future exercise research for people with bone metastases						
Clinical prediction models for adverse event risk during physical activity						
In exercise studies of people with advanced cancer, report in detail for people with bone metastases						
a. Numbers of participants						
b. Lesion(s) details: type, location, size, and treatments						
c. Screening procedures, tools, or decision-making process						
d. Adaptations to testing and exercise protocols						
e. Adverse events related and unrelated to exercise						
Conduct studies of safety and efficacy that test						
a. Different exercise prescription approaches						
b. Use of established scales or tools to screen or inform exercise prescription						
c. Exercise dose that optimizes maintenance or improvement on target outcome						
d. Exercise for individuals with unstable or painful bone lesion(s)						
Qualitative analysis of people with bone metastases perceptions of exercise, particularly safety, benefit, and worry						

Abbreviations: ADL, activity of daily living; DR, Delphi Round; MBD, metastatic bone disease.

TABLE 2. Recommendation for Team-Based Approach to Provision of Exercise Programming to People Living With Bone Metastases

Medical communication	
Communication with current medical team (eg, Oncologist) is recommended to	Obtain any necessary medical guidance or additional information (eg, specific bone lesion details, previous and current cancer therapies, etc)
	Establish and maintain a two-way communication pathway to share information on
	New presentation of pain
	Other symptoms
Access to information on <i>lesion-specific factors</i>	Functional concerns
	Most recent bone scan report or other diagnostic report that describes the following:
	Type of lesion (osteolytic, sclerotic, or mixed)
	Number of lesion (s)
	Location of lesion(s) (ie, load-bearing areas such as femur, spine, pelvic ring, acetabulum, and tibial plateau)
	Size of lesion(s) (ie, small v large)
Pre-exercise history	
Cancer and cancer treatment–related factors to consider	
Cancer diagnosis	Prognosis or progression of disease
	Metastases to other organ systems (ie, brain and lung)
	History of fractures since cancer diagnosis
Management of bone metastases	Planned or prior treatment approach to management of bone metastases (ie, surgical, radiation, and medical)
	Planned or prior treatment approach to management or for SSE (ie, surgical, radiation, and medical)
	Current use of bone agents (eg, denosumab and bisphosphonates > 6 months)
	Current use of agents that may increase risk of SSE (ie, corticosteroids, hormonal therapy, and anticoagulants)
General bone health	Bone health risk factors (ie, smoking and family history of osteoporosis)
	Diagnosis and severity of osteoporosis
	Pharmaceutical management of osteoporosis (eg, bisphosphonates)
Pain	Severity
	Location
	Use of pain medication related to site of lesion(s)
	Triggers (eg, functional pain, during ADLs, loading, at rest, and at night)
	Change in quality or location of pain (ie, new pain with weight bearing, transitional pain when performing ADLs, and pain worsening at night)
Neurologic	Sudden or recent muscle weakness in any region
	Sudden, new or recent change in bowel and/or bladder control (ie, progressive urinary retention, bladder or bowel incontinence)
	New or progressive gait or balance impairment
	Loss of sensation or reflexes in any region
Falls	Occurrence within the past 12 months
	If positive, number of falls
	If positive, injuries consequent to fall
Person-related factors to consider	
Overall medical and symptom profile (eg, comorbid condition, fatigue, and cachexia)	
Worse ECOG PS	
Limitations in ADLs or instrumental ADLs	
Cognitive impairment (eg, making adherence to precautions unreliable)	
Exercise history	

Abbreviations: ADL, activity of daily living; ECOG PS, Eastern Cooperative Oncology Group Performance Status; SSE, symptomatic skeletal event.

The Delphi showed consensus that the exercise professionals best suited to prescribe exercise to people with bone metastases were university qualified with clinical expertise, namely, physical therapists (95% agree) and clinical exercise physiologists (85% agree), provided that each has additional cancer exercise education and training (Table 1). In the systematic review, exercise supervision was provided predominantly by university-trained exercise professionals, including physical therapists and clinical exercise physiologists. All but one trial included at least one session of in-person supervised exercise instruction (ie, individualized demonstration and practice).²⁰

The IBMEWG recommended that all people are assessed by a physical therapist or clinical exercise physiologist, with additional cancer exercise education and ideally experience in working with people who have bone metastases (Appendix Table A1). This may necessitate that exercise professionals initially are advised or supervised by a more experienced colleague, and these recommendations may need to be adapted in different jurisdictions and clinical settings. Stakeholders with bone metastases endorsed the importance of members of the health care team being able to guide people to qualified professionals. The IBMEWG highlighted that considerable work is needed to establish a referral pathway to improve equitable access to qualified exercise professionals. Each exercise professional must consider their own training and experience, as well as the setting in which they work, to determine if it is appropriate to work with that client or to refer. Finally, the results of the systematic review suggest that an element of supervised exercise instruction should be initially included before the addition of unsupervised exercise for individuals with bone metastases. Although this supports the potential feasibility of delivering supervised virtual exercise programs in light of the COVID-19 pandemic, research is needed to determine the overall safety profile of virtual exercise for individuals with bone metastases.²⁶

Recommendation 4

Professional judgment should be used to consider if exercise testing at baseline and follow-up is necessary by weighing the risks and benefits of including the test or if the testing protocols may need to be modified.

In the Delphi, for lower and higher risk examples, the statement that “exercise testing was recommended but there were some tests that were contraindicated” met consensus. Specific to strength testing, there was consensus to avoid tests or use caution with a test that places stress on a lesion site (Table 1). In the systematic review, few studies provided sufficient details on which participants completed the tests outlined in the methods and why a test may or may not be used for select participants. For the four studies exclusively in people with bone metastases, all

outlined specific adjustments to the testing protocol.²⁰ For example, Galvao et al²⁷ excluded people with metastatic bone lesion(s) in the proximal femur from completing the 1-RM leg press and 400-m walk tests, and people with lesions in ribs, thoracic spine, or humerus were excluded from completing the 1-RM chest press and 1-RM seated row.

The IBMEWG assessed that there was insufficient evidence to guide specific recommendations on a standardized approach for safe exercise testing. To provide additional expert guidance, the recommendation is to focus on the goal of exercise testing and to follow the testing guidance in the International Exercise Guidelines for Cancer Survivors⁴ until further evidence is available to update this approach (Appendix Table A1). In addition, exercise practitioners should use professional judgment to consider if a test is necessary and consistent with the person’s goals, while providing written justification for inclusion of the test as part of the treatment plan in an appropriate charting location.

Recommendation 5

Exercise prescription should follow the standard exercise recommendations as outlined by the International Exercise Guidelines for Cancer Survivors, with greater emphasis on postural alignment, controlled movement, and proper technique, as well as consideration given to the location and presentation of the bone lesion(s). Formal monitoring of exercise response and adjustment of exercise prescription should be ongoing.

The Delphi shows a 91% consensus that education and advice on safe movement patterns for activities of daily living is important for all people with bone metastases (Table 1). Specific to prescribing an exercise that could directly place stress on the lesion site, most respondents agreed that the correct approach was to use caution. Respondents defined this as “start with active movement and no load or weight and progress slowly, provided there is no exacerbation of pain or adverse symptoms” (47%) or “start with low loads and progress slowly, provided there is no exacerbation of pain or adverse symptoms (28%).” This is a notable departure from approaches outlined originally by Cormie et al²⁸ and Galvao et al,²⁷ in which exercise involving the affected bone region was avoided altogether. In the systematic review, exercise prescription modifications specific to the presence of bone metastases were included in 41% of trials, whereas the remainder of trials did not report exercise modifications specific to bone metastases. How a participant’s response to exercise was monitored and the related adjustments made to the exercise prescription were not uniformly reported.²⁰

The IBMEWG discussed the available literature that could be used to inform specific guidance around exercise prescription approaches. Exercise prescription for resistance exercises that prevent direct stress on the site of bone lesions has been published by IBMEWG members (P.C.,

N.H.H., and R.U.N.).^{27,28} It was acknowledged that these previously published approaches were conservative and provided a starting point, while evidence regarding safety continued to emerge. The challenge in applying these generic prescription approaches is that individuals with widespread metastatic disease may be recommended to engage in limited exercise options that do not target the overall function or the goals of the individual. The approved movements can also be more restrictive than many activities of daily living that place considerable load on the body, including sites of bone metastases, such as descending stairs.

The IBMEWG recommendation aims to move beyond the initial and restrictive approaches to exercise testing and prescription with the goal better informing the development of efficacious exercise prescriptions for people with bone metastases in the clinical setting. The standard approach to exercise prescription for people living with and beyond cancer as outlined by the International Exercise Guidelines for Cancer Survivors from the American College of Sports Medicine⁴ should be used, with ongoing monitoring of individual response to adjust the exercise prescription or to send the person for further review. It was also deemed important to take additional guidance from exercise literature in osteoporosis that has sought to reduce the risk of skeletal-related complications, especially in vertebral bodies and hip.^{29,30} This includes an emphasis on correct technique and postural alignment with all exercises; avoidance of rapid or loaded end-range movements, such as rotation, flexion, or extension movements that involve the area of the lesions; consideration of impact loading of an exercise along with the type of movement (ie, concentric, eccentric, and plyometric) in the area of the bone lesion(s); and education and precautions to minimize the risk of falls. An additional consideration is that people with bone metastases may be deconditioned, because of treatment or higher symptom burden, and exercise volume should be adjusted accordingly.

Overarching Recommendation

Regular exercise has the potential to maintain or improve physical function and health-related quality of life in people with bone metastases, and the perceived risk of skeletal complication should be weighed against the potential health benefits.

On the basis of the review of available evidence and expert consensus, the IBMEWG has concluded that people with bone metastases should be supported and encouraged to engage in physical activity, including structured exercise, to obtain the well-established general health benefits, as a strategy to manage side effects related to cancer and treatments.⁴ Overall, the perceived risk of skeletal complications should be weighed against the potential health benefits of regular physical activity, including prevention of further loss of functional capacity. Exercise professionals

should communicate with the health care team to minimize participant risk while providing sufficient exercise stimulus to improve or maintain function or to slow decline, while prioritizing the goals of the person. The IBMEWG also identified research priorities to allow for the continuous evolution of evidence-based guidelines (Table 1).

This recommendation was strongly endorsed by our stakeholders, both people with bone metastases and clinician peers, who felt it essential for members of the health care team to initiate a conversation about exercise, explain why exercise is important for people with bone metastases, and frame exercise as a range of activities, spanning from activities of daily living to sports. Stakeholders with bone metastases also highlighted the need to increase the availability of exercise services led by qualified exercise professionals and the provision of more information on how to access services.

DISCUSSION

These recommendations aim to provide a framework for improved integration of exercise programming into the care of people with bone metastases. The overarching recommendation is that routine exercise has the potential to improve or maintain physical function and quality of life and reduce treatment side effects, while also potentially increasing resilience for future treatments. To achieve provision of exercise programming, a collaborative relationship between the health care team and qualified exercise professionals is optimal. This approach is intended to improve the health care team's confidence in encouraging people with bone metastases to engage in regular exercise and provide navigation on how to access qualified exercise professionals who can develop appropriate and individualized exercise programming.

Determining the ideal approaches to pre-exercise screening, exercise testing, and exercise programming related to safety and skeletal-related events (SREs) remains a challenge. The IBMEWG recommends that exercise programming for people with bone metastases is administered by qualified exercise professionals, namely, physical therapists and clinical exercise physiologists, who have additional training and experience in working with people with a cancer diagnosis. These exercise professionals have university-level training (or equivalent) in most countries and a scope of practice that includes working with individuals with complex medical conditions.

A specific risk stratification tool to evaluate the appropriateness of exercise participation for an individual is desired by the health care team, exercise professionals, and people with bone metastases. However, the utility to apply existing screening tools used to predict the risk of fracture or guide decisions on prophylactic surgical fixation (ie, Taneichi, Mirels, and Spinal Instability Neoplastic Score³¹) within the exercise screening process for people with bone metastases

is unknown. These have not been trialed extensively as part of the pre-exercise screening process to date and cannot be scored independently by an exercise professional. More research into the practical use of such a screening tool or newly developed tool is needed to determine if a standardized approach is feasible. Confounding this issue, the initial detection of bone metastasis is evolving with the advent of new imaging modalities. Unlike soft tissue tumors where Response Evaluation Criteria in Solid Tumors are clear, the response of bone metastasis to cancer treatment remains poorly understood.³² A recently proposed algorithm for the investigation of bone metastasis was proposed by the European Society for Medical Oncology in 2020, and this could be considered for future exercise studies.³²

The impact of cancer therapy and bone-modifying agents (BMA) on bone remodeling remains an area of intense study. With respect to BMA, zoledronic acid remains to date the only bisphosphonate to show broad efficacy in reducing SREs in people with bone metastases from almost all malignancies (including lung carcinoma and other solid tumor types: prostate, breast, thyroid, head and neck, thyroid, and renal cell).³² Data also show decreased SREs with the use of RANK ligand inhibitors (denosumab) for cancers of the prostate, breast, and renal cell, non-small-cell lung cancer, and multiple myeloma.³² In the future, the use of BMA should be clearly documented in exercise studies to develop a better understanding of their potential influence on bone remodeling. Furthermore, future studies should explore the use of bone biomarkers and imaging, especially positron emission tomography in exploring

potential risk indicators and treatment response of exercise interventions.

A key strength of the IBMEWG was the process to merge a systematic understanding of the current literature with a formalized Delphi process and stakeholder input. The IBMEWG recommendations are consistent with two existing publications. Sheill et al³³ published a narrative review of considerations for exercise prescription for people with bone metastases, and the support organization Macmillan Cancer Support in the United Kingdom developed a user-friendly guidance document for health care professionals.³⁴ The IBMEWG aimed to address gaps in these documents by documenting the specific information gathering and decision-making processes used to generate the recommendations.

A fundamental limitation is a lack of definitive literature on standardized approaches to safety screening, exercise testing and prescription, and safety reporting of minor or major complications with exercise, including between exercise sessions (ie, pain, disability, and need for analgesia). In addition, there is a paucity of data on specific individuals that may be at increased risk of fracture with exercise (ie, elderly individuals with multiple myeloma).

In conclusion, these recommendations provide a framework and starting point for exercise professionals and members of the health care team to improved integration of physical activity into the care of individuals with bone metastases. It is anticipated that the recommendations provided here will continue to evolve as more literature is available.

AFFILIATIONS

¹Department of Physical Therapy, University of British Columbia, Vancouver, British Columbia, Canada

²Australian Catholic University, Melbourne, Australia

³Peter MacCallum Cancer Centre, East Melbourne, Australia

⁴BC Cancer, Vancouver, British Columbia, Canada

⁵Toronto General Hospital and University of Toronto, Toronto, Ontario, Canada

⁶Karolinska Institute, Stockholm, Sweden

⁷Edinburgh Napier University, Edinburgh, Scotland

⁸Mayo Clinic, Rochester, NY

⁹Oncology Division of the Canadian Physiotherapy Association, Montreal, Quebec, Canada

¹⁰Edith Cowan University, Joondalup, Australia

¹¹Queensland University of Technology, Brisbane, Australia

¹²Vancouver Prostate Centre, Vancouver, British Columbia, Canada

¹³University of Victoria, Victoria, British Columbia, Canada

¹⁴University of Kansas Cancer Center, Kansas City, MO

¹⁵University of Alberta, Edmonton, Alberta, Canada

¹⁶University of Copenhagen, Copenhagen, Denmark

¹⁷National Center for Tumor Diseases, Heidelberg, Germany

¹⁸University of Toronto, Toronto, Ontario, Canada

¹⁹Penn State University, Hershey, PA

²⁰Oregon Health and Sciences University, Portland, OR

²¹BC Cancer, Victoria, British Columbia, Canada

CORRESPONDING AUTHOR

Kristin L. Campbell, PT, PhD, 212, 2177 Wesbrook Mall, Department of Physical Therapy, Faculty of Medicine, University of British Columbia, Vancouver, British Columbia, Canada V6T 1Z3; e-mail: Kristin.campbell@ubc.ca.

PRIOR PRESENTATION

Presented in part orally at annual meeting of the American College of Sports Medicine, June 4, 2021 and the International Conference of Physical Therapy in Oncology, May 4, 2021.

SUPPORT

Funded through Astellas Pharma Canada Inc.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Disclosures provided by the authors are available with this article at DOI <https://doi.org/10.1200/OP.21.00454>.

AUTHOR CONTRIBUTIONS

Conception and design: Kristin L. Campbell, Prue Cormie, Sarah Weller, Shabbir M. H. Alibhai, Anna Campbell, Andrea L. Cheville, Nicolas H.

Hart, Celestia S. Higano, Margaret L. McNeely, Robert U. Newton, Jennifer Rauw, Kerri M. Winters-Stone, Jennifer Goulart

Financial support: Jennifer Goulart

Administrative support: Jennifer Goulart

Provision of study materials or patients: Jennifer Rauw, Jennifer Goulart

Collection and assembly of data: Kristin L. Campbell, Prue Cormie, Sarah Weller, Kate A. Bolam, Mary-Ann Dalzell, Nicolas H. Hart, Celestia S. Higano, Kirstin Lane, Sami Mansfield, Robert U. Newton, Morten Quist, Jennifer Rauw, Daniel Santa Mina, Jennifer Goulart

Data analysis and interpretation: Kristin L. Campbell, Prue Cormie, Sarah Weller, Shabbir M. H. Alibhai, Kate A. Bolam, Andrea L. Cheville, Mary-Ann Dalzell, Nicolas H. Hart, Celestia S. Higano, Kirstin Lane, Robert U. Newton, Friederike Rosenberger, Daniel Santa Mina, Kathryn H. Schmitz, Kerri M. Winters-Stone, Joachim Wiskemann, Jennifer Goulart

Manuscript writing: All authors

Final approval of manuscript: All authors

Accountable for all aspects of the work: All authors

ACKNOWLEDGMENT

We would like to thank our stakeholders with bone metastases for their participation and peers external to the working group who provided feedback before submission (Alysa Fairchild, David Langelier, Grainne Sheill, Martijn Stuiver, and Shelley Kay).

This work was endorsed by the Oncology Division of the Canadian Physiotherapy Association (CPA), the Canadian Society for Exercise Physiology (CSEP), and the International Physical Therapists for HIV/AIDS, Oncology, Hospice and Palliative Care World Physiotherapy Subgroup (IPT-HOPE).

REFERENCES

- Cheville AL, Troxel AB, Basford JR, et al: Prevalence and treatment patterns of physical impairments in patients with metastatic breast cancer. *J Clin Oncol* 26:2621-2629, 2008
- Axelsson B, Sjoden PO: Quality of life of cancer patients and their spouses in palliative home care. *Palliat Med* 12:29-39, 1998
- Gralla RJ, Hollen PJ, Msaouel P, et al: An evidence-based determination of issues affecting quality of life and patient-reported outcomes in lung cancer: Results of a survey of 660 patients. *J Thorac Oncol* 9:1243-1248, 2014
- Campbell KL, Winters-Stone KM, Wiskemann J, et al: Exercise guidelines for cancer survivors: Consensus statement from International Multidisciplinary Roundtable. *Med Sci Sports Exerc* 51:2375-2390, 2019
- Coleman RE: Clinical features of metastatic bone disease and risk of skeletal morbidity. *Clin Cancer Res* 12:6243s-6249s, 2006
- Lowe SS, Watanabe SM, Baracos VE, et al: Physical activity interests and preferences in palliative cancer patients. *Support Care Cancer* 18:1469-1475, 2009
- Ten Tusscher MR, Groen WG, Geleijn E, et al: Physical problems, functional limitations, and preferences for physical therapist-guided exercise programs among Dutch patients with metastatic breast cancer: A mixed methods study. *Support Care Cancer* 27:3061-3070, 2019
- Delrieu L, Vallance JK, Morelle M, et al: Physical activity preferences before and after participation in a 6-month physical activity intervention among women with metastatic breast cancer. *Eur J Cancer Care (Engl)* 29:e13169, 2020
- Sheill G, Guinan E, Neill LO, et al: Physical activity and advanced cancer: The views of chartered physiotherapists in Ireland. *Physiother Theory Pract* 34:534-541, 2018
- Sheill G, Guinan E, Neill LO, et al: Physical activity and advanced cancer: The views of oncology and palliative care physicians in Ireland. *Ir J Med Sci* 187:337-342, 2018
- Ten Tusscher MR, Groen WG, Geleijn E, et al: Education needs of Dutch physical therapists for the treatment of patients with advanced cancer: A mixed methods study. *Phys Ther* 100:477-486, 2020
- Dittus KL, Gramling RE, Ades PA: Exercise interventions for individuals with advanced cancer: A systematic review. *Prev Med* 104:124-132, 2017
- Beaton R, Pagdin-Friesen W, Robertson C, et al: Effects of exercise intervention on persons with metastatic cancer: A systematic review. *Physiother Can* 61:141-153, 2009
- Albrecht TA, Taylor AG: Physical activity in patients with advanced-stage cancer: A systematic review of the literature. *Clin J Oncol Nurs* 16:293-300, 2012
- Nadler MB, Desnoyers A, Langelier DM, et al: The effect of exercise on quality of life, fatigue, physical function and safety in advanced solid tumor cancers: A meta-analysis of randomized control trials. *J Pain Symptom Manage* 58:899-908.e7, 2019
- Heywood R, McCarthy AL, Skinner TL: Safety and feasibility of exercise interventions in patients with advanced cancer: A systematic review. *Support Care Cancer* 25:3031-3050, 2017
- Heywood R, McCarthy AL, Skinner TL: Efficacy of exercise interventions in patients with advanced cancer: A systematic review. *Arch Phys Med Rehabil* 99:2595-2620, 2018
- Chen YJ, Li XX, Ma HK, et al: Exercise training for improving patient-reported outcomes in patients with advanced-stage cancer: A systematic review and meta-analysis. *J Pain Symptom Manage* 59:734-749.e10, 2020
- Hsu CC, Sandford BA: The Delphi technique: Making sense of consensus. *Pract Assess Res Eval* 12, 2007
- Weller S, Hart NH, Bolam KA, et al: Exercise in individuals with bone metastases: A systematic review. *Crit Rev Oncol Hematol* 166:103433, 2021
- Adams J, Rauw J, Weller S, et al: Physical activity recommendations for cancer survivors living with bony metastases: Views of oncologic healthcare providers. *J Cancer Surviv* 15:414-417, 2021
- Bourke L, Doll H, Crank H, et al: Lifestyle intervention in men with advanced prostate cancer receiving androgen suppression therapy: A feasibility study. *Cancer Epidemiol Biomarkers Prev* 20:647-657, 2011
- Bourke L, Gilbert S, Hooper R, et al: Lifestyle changes for improving disease-specific quality of life in sedentary men on long-term androgen-deprivation therapy for advanced prostate cancer: A randomised controlled trial. *Eur Urol* 65:865-872, 2014
- Sprave T, Rosenberger F, Verma V, et al: Paravertebral muscle training in patients with unstable spinal metastases receiving palliative radiotherapy: An exploratory randomized feasibility trial. *Cancers (Basel)* 11:1771, 2019
- Rief H, Petersen LC, Omlor G, et al: The effect of resistance training during radiotherapy on spinal bone metastases in cancer patients—A randomized trial. *Radiother Oncol* 112:133-139, 2014
- Bland KA, Bigaran A, Campbell KL, et al: Exercising in isolation? The role of telehealth in exercise oncology during the COVID-19 pandemic and beyond. *Phys Ther* 100:1713-1716, 2020

27. Galvao DA, Taaffe DR, Spry N, et al: Exercise preserves physical function in prostate cancer patients with bone metastases. *Med Sci Sports Exerc* 50:393-399, 2018
28. Cormie P, Galvao DA, Spry N, et al: Functional benefits are sustained after a program of supervised resistance exercise in cancer patients with bone metastases: Longitudinal results of a pilot study. *Support Care Cancer* 22:1537-1548, 2014
29. Giangregorio LM, McGill S, Wark JD, et al: Too fit to fracture: Outcomes of a Delphi consensus process on physical activity and exercise recommendations for adults with osteoporosis with or without vertebral fractures. *Osteoporos Int* 26:891-910, 2015
30. Giangregorio LM, Papaioannou A, Macintyre NJ, et al: Too fit to fracture: Exercise recommendations for individuals with osteoporosis or osteoporotic vertebral fracture. *Osteoporos Int* 25:821-835, 2014
31. Fourney DR, Frangou EM, Ryken TC, et al: Spinal instability neoplastic score: An analysis of reliability and validity from the spine oncology study group. *J Clin Oncol* 29:3072-3077, 2011
32. Coleman R, Hadji P, Body JJ, et al: Bone health in cancer: ESMO clinical practice guidelines. *Ann Oncol* 31:1650-1663, 2020
33. Sheill G, Guinan EM, Peat N, et al: Considerations for exercise prescription in patients with bone metastases: A comprehensive narrative review. *PM R* 10: 843-864, 2018
34. MacMillan Cancer Support: Physical Activity for People with Metastatic Bone Disease: Guidelines for Healthcare Professionals. 2018. <https://www.macmillan.org.uk/healthcare-professionals/news-and-resources/guides/physical-activity-for-people-with-metastatic-bone-disease>
35. American Physical Therapy Association: Specialist certification in oncology from the American Physical Therapy Association, <https://specialization.apta.org/become-a-specialist/oncology>
36. Canadian Physiotherapy Association: Clinical specialty program, <https://physiotherapy.ca/clinical-specialist-program>
37. American College of Sports Medicine: ACSM/ACS certified cancer exercise trainer, <https://www.acsm.org/get-stay-certified/get-certified/specialization/cet>
38. CanRehab: Fitness workshops, <http://canrehab.co.uk/fitness-workshops/>
39. Thrive Health: Cancer & exercise training for health & fitness professionals by Thrive, <https://thrivehealthservices.com/professionals/certification/>
40. EX-MED Cancer: EX-MED Cancer professional development, <https://exmedcancerpd.learnbook.com.au/>
41. Exercise Medicine Research Institute: Professional development: Exercise Oncology at ECU, <https://www.exercisemedicine.org.au/professional-development/exercise-oncology-at-ecu>



AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST**Exercise Recommendation for People With Bone Metastases: Expert Consensus for Health Care Providers and Exercise Professionals**

The following represents disclosure information provided by authors of this manuscript. All relationships are considered compensated unless otherwise noted. Relationships are self-held unless noted. I = Immediate Family Member, Inst = My Institution. Relationships may not relate to the subject matter of this manuscript. For more information about ASCO's conflict of interest policy, please refer to www.asco.org/rwc or ascopubs.org/op/authors/author-center.

Open Payments is a public database containing information reported by companies about payments made to US-licensed physicians ([Open Payments](#)).

Kristin L. Campbell

Honoraria: Astellas Pharma

Prue Cormie

Stock and Other Ownership Interests: Exercise Oncology EDU Pty Ltd

Other Relationship: EX-MED Cancer Ltd

Sarah Weller

Research Funding: Astellas Pharma

Shabbir M. H. Alibhai

Stock and Other Ownership Interests: ResMed

Honoraria: Astellas Scientific and Medical Affairs Inc

Kate A. Bolam

Stock and Other Ownership Interests: Novo Nordisk

Celestia S. Higano

Employment: CTI BioPharma Corp (I)

Stock and Other Ownership Interests: CTI BioPharma Corp (I)

Honoraria: Astellas Pharma

Consulting or Advisory Role: Bayer, Ferring, Clovis Oncology, Blue Earth Diagnostics, Janssen, Hinova Pharmaceuticals, Pfizer, AstraZeneca, Carrick Therapeutics, Novartis, Merck Sharp & Dohme, Astellas Pharma, Myovant Sciences, Genentech, Menarini

Research Funding: Aragon Pharmaceuticals (Inst), AstraZeneca (Inst), Medivation (Inst), Emergent BioSolutions (Inst), Bayer (Inst), Pfizer (Inst), Roche (Inst), Astellas Pharma (Inst), Clovis Oncology (Inst), Ferring (Inst), eFFECTOR Therapeutics (Inst)

Travel, Accommodations, Expenses: Pfizer, Janssen Oncology, Novartis, Merck Sharp & Dohme, Carrick Therapeutics

Kirstin Lane

Stock and Other Ownership Interests: Moderna Therapeutics

Travel, Accommodations, Expenses: Astellas Pharma

Robert U. Newton

Honoraria: GenesisCare

Research Funding: Ipsen

Travel, Accommodations, Expenses: Genesis Cancer Care

Morten Quist

Employment: Zealand Pharmaceuticals (I)

Honoraria: AstraZeneca

Jennifer Rauw

Honoraria: AstraZeneca

Speakers' Bureau: GlaxoSmithKline

Travel, Accommodations, Expenses: AstraZeneca

Friederike Rosenberger

Stock and Other Ownership Interests: BioNTech, Bristol Myers Squibb, AstraZeneca

Honoraria: Bristol Myers Squibb, Hexal

Kathryn H. Schmitz

Patents, Royalties, Other Intellectual Property: Fees from the educational program I developed that are now offered through Klose Training and Consulting

Joachim Wiskemann

Honoraria: Pfizer, Lilly, Novartis

Jennifer Goulart

Research Funding: Astellas Pharma (Inst)

No other potential conflicts of interest were reported.

APPENDIX

TABLE A1. Guidance for Exercise Testing Approach and Monitoring Exercise Response With Examples of Qualified Exercise Professionals

Guidance for exercise testing approach		
Is the test necessary?	Consideration should be given to why the test is being conducted, weighing the risks against the benefits, in discussion with patient and healthcare team	
Criteria for specific test selection:	Testing should inform clinical decision making and exercise prescription	
	Testing should be adapted according to patient goals	
	Individuals must be informed and feel comfortable to perform the test safely	
Practical considerations	Avoid tests that place high loads on site(s) of bone metastasis (ie, 1-RM leg press for individual with lesion in proximal femur or vertebrae) ⁴	
	Consider potential of fall risk when using treadmill or other ambulatory machines (ie, handrails must be available and blood pressure monitoring should be done with consideration of not compromising balance)	
	Consider forces testing approach on site(s) of bone metastasis (ie, eccentric concentric, or isometric, including open v closed chain)	
	Consider the compressive forces of testing approach (ie, pressure on lumbar spine from backrest of leg press machine or repeated chair rise causing rapid/forceful impact onto the chair)	
	Be mindful of movement and forces needed to get into position for tests not just the test itself (ie, range of hip flexion needed to get into position for leg press in a leg press machine) as this can inadvertently cause unsafe movement related to risk of skeletal complication	
Guidance for monitoring response to exercise training		
Observation	Exercise professionals should continuously monitor overall response to each exercise prescribed and adjust prescription as appropriate to reduce potential risk of exercise-related adverse event	
Self-reported response	Exercise professionals must ask the individual before and after each session about	
	Pain ^a	New or increased pain; or Change in quality or location of pain; or Unexplained pain; or Change in pain medication (dose and/or type) prior to or following an exercise session Ideally using a standardized tool, such as a visual analog scale
	Neurological symptoms ^a	New symptom or change in symptom (eg, muscle weakness, loss of sensation or change in bladder/bowel function, balance or gait)
	ADL	New limitation or change in limitations
Examples of qualified exercise professionals and cancer certifications		
Professional title ^b	Regulatory or professional body	Examples of additional cancer training or certifications
Licensed or registered physical therapist or physiotherapist	Colleges of Physical Therapy (State, Province, or National)	Specialist Certification in Oncology from the American Physical Therapy Association ³⁵
		Clinical Specialist from Canadian Physiotherapy Association ³⁶
ACSM-CEP	ACSM	ACSM Cancer Exercise Trainer ³⁷
		CanRehab ³⁸
CSEP-CEP	CSEP	Thrive Cancer and Exercise Training ³⁹
ESSA-AEP	ESSA	ExMedCancer ⁴⁰
		Exercise Medicine Research Institute ⁴¹

Or equivalent in a given jurisdiction

Abbreviations: ACSM, American College of Sports Medicine; ADL, activity of daily living; AEP, Accredited Exercise Physiologist; CEP, Clinical Exercise Physiologist; CSEP, Canadian Society for Exercise Physiology; ESSA, Exercise and Sport Science Australia; RM, repetition maximum.

^aFor individuals with complex presentation, exercise professional should consider asking the individual before and after each exercise performed, especially if it is a new exercise.

^bThere is currently no single standardized licensing examination or number of clinic hours identified as optimal credentials for exercise professionals, specific to working with people with bone metastases.