ASCO special articles

Exercise, Diet, and Weight Management During Cancer Treatment: ASCO Guideline

Jennifer A. Ligibel, MD[1]; Kari Bohlke, ScD[2]; Anne M. May, PhD[3]; Steven K. Clinton, MD, PhD[4]; Wendy Demark-Wahnefried, PhD, RD[5]; Susan C. Gilchrist, MD, MS[6]; Melinda L. Irwin, PhD, MPH[7]; Michele Late[8]; Sami Mansfield, BA[9]; Timothy F. Marshall, PhD, MS[10]; Jeffrey A. Meyerhardt, MD, MPH[1]; Cynthia A. Thomson, PhD, RD[11]; William A. Wood, MD, MPH[12]; and Catherine M. Alfano, PhD[13]

abstract

PURPOSE To provide guidance on exercise, diet, and weight management during active cancer treatment in adults.

METHODS A systematic review of the literature identified systematic reviews and randomized controlled trials evaluating the impact of aerobic and resistance exercise, specific diets and foods, and intentional weight loss and avoidance of weight gain in adults during cancer treatment, on quality of life, treatment toxicity, and cancer control. PubMed and the Cochrane Library were searched from January 2000 to May 2021. ASCO convened an Expert Panel to review the evidence and formulate recommendations.

RESULTS The evidence base consisted of 52 systematic reviews (42 for exercise, nine for diet, and one for weight management), and an additional 23 randomized controlled trials. The most commonly studied types of cancer were breast, prostate, lung, and colorectal. Exercise during cancer treatment led to improvements in cardiorespiratory fitness, strength, fatigue, and other patient-reported outcomes. Preoperative exercise in patients with lung cancer led to a reduction in postoperative length of hospital stay and complications. Neutropenic diets did not decrease risk of infection during cancer treatment.

RECOMMENDATIONS Oncology providers should recommend regular aerobic and resistance exercise during active treatment with curative intent and may recommend preoperative exercise for patients undergoing surgery for lung cancer. Neutropenic diets are not recommended to prevent infection in patients with cancer during active treatment. Evidence for other dietary and weight loss interventions during cancer treatment was very limited. The guideline discusses special considerations, such as exercise in individuals with advanced cancer, and highlights the critical need for more research in this area, particularly regarding diet and weight loss interventions during cancer treatment.

Additional information is available at www.asco.org/supportive-care-guidelines.

J Clin Oncol 40:2491-2507. © 2022 by American Society of Clinical Oncology

ASSOCIATED CONTENT

Appendix

Data Supplement

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

Accepted on April 4, 2022 and published at ascopubs.org/journal/jco on May 16, 2022: DOI https://doi.org/10.1200/JCO.22.00687

Evidence Based Medicine Committee approval: March 21, 2022.

INTRODUCTION

Obesity, physical inactivity, and low dietary quality are all known risk factors for more than a dozen malignancies.[1-3] The World Cancer Research Fund estimates that 18% of cancers in the United States—more than 300,000 cancer cases each year—are directly attributable to suboptimal diet, low physical activity, and/or excess adiposity.[3] Evidence from observational studies also suggests that these factors contribute to poor cancer outcomes, especially in individuals with early-stage breast, colon, and prostate cancers.[4-7] Although there are very limited data from randomized controlled trials (RCTs) testing the impact of weight loss, increased exercise, or changes in diet composition during cancer treatment on cancer recurrence or mortality, hundreds of randomized trials have demonstrated that these types of lifestyle changes lead to improvements in other end points, such as quality of life (QoL) and treatment-related side effects after cancer diagnosis.[8-12]

The growing body of observational data showing the relationship between diet, physical activity, body weight, and cancer risk and outcomes, as well as data from RCTs showing the benefit of healthy lifestyle change after cancer diagnosis, have led to the development of numerous diet and physical activity guidelines recommending the incorporation of physical activity,

THE BOTTOM LINE

Exercise, Diet, and Weight Management During Cancer Treatment: ASCO Guideline

Guideline Question

For adult patients with cancer undergoing active treatment with systemic antineoplastic therapy or radiotherapy, or who are in the perioperative period, do interventions involving exercise, diet, and/or weight control compared with no intervention lead to meaningful improvements in outcomes related to QoL, treatment toxicity, or cancer control?

Target Population

Adults with cancer receiving systemic antineoplastic therapy or radiotherapy, or who are in the perioperative period. Notably, this guideline does not include recommendations for individuals with breast cancer being treated with endocrine therapy, given the extensive representation of this population in other guidelines.

Target Audience

Clinicians who provide care to adults with cancer, as well as patients and caregivers.

Methods

An Expert Panel was convened to develop evidence-based recommendations on the basis of a systematic review of the medical literature. Evidence shaping this guidance is derived from systematic reviews of randomized trials of exercise, dietary modification, and weight management (weight loss or avoidance of weight gain) interventions administered during systemic antineoplastic therapy or radiotherapy, or during the perioperative period. The guideline does not address mind-body exercise (such as yoga), dietary supplements, cancer cachexia, malnutrition, enteral feeding, or parenteral nutrition.

Recommendations

Question 1: Does exercise during cancer treatment safely improve outcomes related to QoL, treatment toxicity, or cancer control?

Recommendation 1.1. Oncology providers should recommend aerobic and resistance exercise during active treatment with curative intent to mitigate side effects of cancer treatment (Type: evidence based, benefits outweigh harms; Evidence quality: moderate to low; Strength of recommendation: strong).

Note: Exercise interventions during active treatment reduce fatigue; preserve cardiorespiratory fitness, physical functioning, and strength; and in some populations, improve QoL and reduce anxiety and depression. In addition, exercise interventions during treatment have low risk of adverse events. Evidence was not sufficient to recommend for or against exercise during treatment to improve cancer control outcomes (recurrence or survival) or treatment completion rates.

Recommendation 1.2. Oncology providers may recommend preoperative exercise for patients undergoing surgery for lung cancer to reduce length of hospital stay and postoperative complications (Type: evidence based, benefits outweigh harms; Evidence quality: low; Strength of recommendation: weak).

Question 2: Does consuming a particular dietary pattern or food(s) during cancer treatment safely improve outcomes related to QoL, treatment toxicity, or cancer control?

Recommendation 2.1. There is currently insufficient evidence to recommend for or against dietary interventions such as ketogenic or low-carbohydrate diets, low-fat diets, functional foods, or fasting to improve outcomes related to QoL, treatment toxicity, or cancer control.

Recommendation 2.2. Neutropenic diets (specifically diets that exclude raw fruits and vegetables) are not recommended to prevent infection in patients with cancer during active treatment (Type: evidence based, harms likely to outweigh benefits; Evidence quality: low; Strength of recommendation: weak).

Question 3: Do interventions to promote intentional weight loss or avoidance of weight gain during cancer treatment safely improve outcomes related to QoL, treatment toxicity, or cancer control?

Recommendation 3. There is currently insufficient evidence to recommend for or against intentional weight loss or prevention of weight gain interventions during active treatment to improve outcomes related to QoL, treatment toxicity, or cancer control.

Note: The Expert Panel felt strongly that the current lack of evidence regarding diet and weight management interventions during cancer treatment should be a call to conduct more research in these critical areas. Diet and weight management strategies that provide health benefits to the general population could also provide important benefits to people who are undergoing cancer treatment. The Expert Panel is not discouraging clinicians from discussing healthy diet and weight[3,13] with their patients, but did refrain from making specific recommendations, given gaps in the evidence.

(continued on following page)

THE BOTTOM LINE (CONTINUED)

Additional Resources

Definitions for the quality of the evidence and strength of recommendation ratings are available in Appendix Table A1 (online only). More information, including slide sets, clinical tools and resources, and a supplement with evidence tables, is available at www.asco.org/supportive-care-guidelines. The Methodology Manual (available at www.asco.org/guideline-methodology) provides additional information about the methods used to develop this guideline. Patient information is available at www.cancer.net.

ASCO believes that cancer clinical trials are vital to inform medical decisions and improve cancer care, and that all patients should have the opportunity to participate.

weight management, and dietary modification as a part of cancer prevention and control.[3,11,12] To date, guidance has generally emphasized population-based public health guidelines, with a growing focus on at-risk individuals and cancer survivors. By contrast, there has been limited effort focused upon patients currently undergoing cancer treatment. This time period is critical, given that cancer treatment often leads to declines in cardiorespiratory fitness and physical functioning, unfavorable changes in body composition, and side effects such as neuropathy and fatigue. These side effects can not only adversely affect QoL and functional status after cancer diagnosis, but also predispose patients with cancer to comorbidities such as cardiovascular disease and diabetes.

Over the past decade, an increasing number of RCTs have tested the impact of exercise, diet, and, to a lesser extent, weight management interventions on QoL and treatment-related side effects in patients with cancer receiving a variety of systemic and local cancer treatments.[8-10,12] Assimilating these data into evidence-based recommendations is needed, both to best mitigate toxicities of cancer treatment and to provide oncology providers with a framework to help patients navigate the abundant, often contradictory, information regarding nutrition, exercise, and weight management for patients with cancer in the lay press.

This ASCO clinical practice guideline seeks to provide evidence-based recommendations regarding exercise, diet, and weight management interventions in adults undergoing active cancer treatment.

GUIDELINE QUESTIONS

This clinical practice guideline addresses three overarching clinical questions: (1) Does exercise during cancer treatment safely improve outcomes related to QoL, treatment toxicity, or cancer control? (2) Does consuming a particular dietary pattern or food(s) during cancer treatment safely improve outcomes related to QoL, treatment toxicity, or cancer control? (3) Do interventions to promote intentional weight loss or avoidance of weight gain during cancer treatment safely improve outcomes related to QoL, treatment toxicity, or cancer control?

METHODS

Guideline Development Process

This systematic review-based guideline was developed by a multidisciplinary Expert Panel, which included a patient representative and an ASCO guidelines staff member with health research methodology expertise (Appendix Table A2, online only). The Expert Panel met via webinar and corresponded through e-mail. Based upon the consideration of the evidence, the authors were asked to contribute to the development of the guideline, provide critical review, and finalize the guideline recommendations. The guideline recommendations were sent for an open comment period of two weeks, allowing the public to review and comment on the recommendations after submitting a confidentiality agreement. These comments were taken into consideration while finalizing the recommendations. The members of the Expert Panel were responsible for reviewing and approving the penultimate version of the guideline, which was then circulated for external review, and submitted to the *Journal of Clinical Oncology (JCO)* for editorial review and consideration for publication. All ASCO guidelines are ultimately reviewed and approved by the Expert Panel and the ASCO Evidence Based Medicine Committee before publication. All funding for the administration of the project was provided by ASCO.

The recommendations were developed by using a systematic review of evidence identified through online searches of PubMed and the Cochrane Library for the period from January 1, 2000, through May 17, 2021. Only data from RCTs were considered. Systematic reviews of RCTs and individual RCTs were selected for inclusion on the basis of the following criteria:

- Population: Adults with cancer who were receiving systemic antineoplastic therapy or radiotherapy, or who were in the perioperative period. Patients receiving adjuvant endocrine therapy for early-stage breast cancer were excluded because this literature is already summarized in several previous guidelines.[11,12] Patients with head and neck cancer were excluded from the diet systematic review because of their unique nutritional challenges.

- Interventions: Supervised or unsupervised aerobic and/or resistance exercise; dietary counseling, specific diets (eg, ketogenic), fasting, functional foods, or other changes to dietary composition; or interventions intended to promote weight loss or avoidance of weight gain. Mind-body exercises, dietary supplements (including immunonutrition), and enteral or parenteral nutritional support were excluded, as was management of malnutrition or cachexia.
- Comparisons: Usual care or a different or less intensive diet or exercise intervention.
- Outcomes: Cardiorespiratory fitness, muscle strength, physical functioning, QoL, fatigue, anxiety, depression, sleep, body weight, body composition, surgical complications, chemotherapy or radiotherapy adverse events, adverse effects of the diet or exercise interventions, and cancer outcomes such as recurrence and survival.
- Sample size: A minimum of 25 patients per arm in RCTs.

Articles were excluded from the systematic review if they were (1) conference abstracts not subsequently published in peer-reviewed journals; (2) editorials, commentaries, letters, news articles, case reports, and narrative reviews; (3) published in a non-English language, or (4) a systematic review that was replaced by a more comprehensive, subsequent systematic review. The guideline recommendations were crafted, in part, using the Guidelines Into Decision Support methodology and accompanying BRIDGE-Wiz software.[14] In addition, a review of the ability to implement the guideline was conducted. On the basis of the implementability review, revisions were made to the draft to clarify recommended actions for clinical practice. Ratings for type and strength of the recommendation, and evidence quality are provided with each recommendation. The quality of the evidence for each outcome was assessed using the Cochrane Risk of Bias tool and elements of the GRADE quality assessment and recommendations development process.[15,16] GRADE quality assessment labels (ie, high, moderate, low, and very low) were assigned for each outcome by the project methodologist in collaboration with the Expert Panel cochairs and reviewed by the full Expert Panel.

The ASCO Expert Panel and guidelines staff will work with cochairs to keep abreast of any substantive updates to the guideline. On the basis of formal review of the emerging literature, ASCO will determine the need to update. The ASCO Guidelines Methodology Manual (available at www.asco.org/guideline-methodology) provides additional information about the guideline update process. This is the most recent information as of the publication date.

Guideline Disclaimer

The Clinical Practice Guidelines and other guidance published herein are provided by ASCO to assist providers in clinical decision making. The information herein should not be relied upon as being complete or accurate, nor should it be considered as inclusive of all proper treatments or methods of care or as a statement of the standard of care. With the rapid development of scientific knowledge, new evidence may emerge between the time information is developed and when it is published or read. The information is not continually updated and may not reflect the most recent evidence. The information addresses only the topics specifically identified therein and is not applicable to other interventions, diseases, or stages of diseases. This information does not mandate any particular course of medical care. Further, the information is not intended to substitute for the independent professional judgment of the treating provider, as the information does not account for individual variation among patients. Recommendations specify the level of confidence that the recommendation reflects the net effect of a given course of action. The use of words like "must," "must not," "should," and "should not" indicates that a course of action is recommended or not recommended for either most or many patients, but there is latitude for the treating physician to select other courses of action in individual cases. In all cases, the selected course of action should be considered by the treating provider in the context of treating the individual patient. Use of the information is voluntary. ASCO does not endorse third party drugs, devices, services, or therapies used to diagnose, treat, monitor, manage, or alleviate health conditions. Any use of a brand or trade name is for identification purposes only. ASCO provides this information on an "as is" basis and makes no warranty, express or implied, regarding the information. ASCO specifically disclaims any warranties of merchantability or fitness for a particular use or purpose. ASCO assumes no responsibility for any injury or damage to persons or property arising out of or related to any use of this information, or for any errors or omissions.

Guideline and Conflicts of Interest

The Expert Panel was assembled in accordance with ASCO's Conflict of Interest Policy Implementation for Clinical Practice Guidelines ("Policy," found at https://www.asco.org/guideline-methodology). All members of the Expert Panel completed ASCO's disclosure form, which requires disclosure of financial and other interests, including relationships with commercial entities that are reasonably likely to experience direct regulatory or commercial impact as a result of promulgation of the guideline. Categories for disclosure include employment; leadership; stock or other ownership; honoraria, consulting or advisory role; speaker's bureau; research funding; patents, royalties, other intellectual property; expert testimony; travel, accommodations, expenses; and other relationships. In accordance with the Policy, the majority of the members of the Expert Panel did not disclose any relationships constituting a conflict under the Policy.

RESULTS

Characteristics of Studies Identified in the Literature Search

The literature search of exercise RCTs identified a 2017 systematic review of systematic reviews,[8] which formed the starting point for the exercise evidence base. A total of 652 additional exercise systematic reviews were identified for the period from January 1, 2017, to June 17, 2021. Forty-two met eligibility criteria and were included in the review.[8-10,17-55] The most commonly studied types of cancer were breast, prostate, lung, and colorectal. The literature search of diet identified 742 systematic reviews; nine met eligibility criteria and were included in the review.[56-64] The literature search of weight management (weight loss or avoidance of weight gain) identified 171 systematic reviews; one met eligibility criteria and was included in the review.[65]

Characteristics and results of included systematic reviews are provided in the Data Supplement (online only). In addition, the searches identified 13 exercise RCTs,[66-78] eight nutrition RCTs (11 publications),[72,79-88] and two weight management RCTs[89,90] that were published after the included systematic reviews. In the opinion of the Panel, these RCTs did not alter the conclusions drawn from the systematic reviews.

Study Quality Assessment

The quality of included systematic reviews was assessed using the 11-item AMSTAR tool,[91] with results provided in the Data Supplement. Quality scores of reviews ranged from 4 to 11. The quality of the individual studies included in each review was variable, and there was heterogeneity in the interventions evaluated. Overall, the quality of evidence was higher for exercise interventions than for dietary interventions in this population. Very little evidence was available to evaluate the effects of intentional weight loss or avoidance of weight gain during cancer treatment.

RECOMMENDATIONS

Clinical Question 1

Does exercise during cancer treatment safely improve outcomes related to QoL, treatment toxicity, or cancer control?

Recommendation 1.1. Oncology providers should recommend aerobic and resistance exercise during active treatment with curative intent to mitigate side effects of cancer treatment (Type: evidence based, benefits outweigh harms; Evidence quality: moderate to low; Strength of recommendation: strong).

Note: Exercise interventions during active treatment reduce fatigue; preserve cardiorespiratory fitness, physical functioning, and strength; and in some populations, improve QoL and reduce anxiety and depression. In addition, exercise interventions during treatment have low risk of adverse events. Evidence was not sufficient to recommend for or against exercise during treatment to improve cancer control outcomes (recurrence or survival) or treatment completion rates.

Literature review and analysis.

Fatigue. Meta-analyses in several different types of cancer report that exercise during cancer treatment provides a moderate reduction in fatigue. In a meta-analysis of 74 studies with a total of 5,174 patients, Oberoi et al[43] reported a standardized mean difference (SMD) of –0.52; 95% CI, –0.70 to –0.34. Hilfiker et al[29] reported a similar or slightly greater magnitude of benefit in analyses across different types of exercise (aerobic: SMD –0.53; 95% CI, –0.80 to –0.26; resistance: SMD –0.53; 95% CI, –1.02 to –0.03; combined resistance and aerobic: SMD –0.67; 95% CI, –1.10 to –0.34), although findings for resistance exercise were no longer significant after excluding studies with fewer than 25 patients per arm (SMD –0.52; 95% CI, –1.21 to 0.17). Meta-analyses that focused on specific types of cancer reported benefits in breast cancer treated with adjuvant chemotherapy and/or radiotherapy,[26] colorectal cancer treated with chemotherapy,[39] lung cancer treated with chemotherapy,[48] prostate cancer treated with radiation therapy,[31] and hematologic malignancies.[10,17]

Cardiorespiratory fitness. Meta-analyses evaluating the impact of exercise interventions on maximal or peak oxygen consumption (VO_2max or VO_2peak, respectively) consistently reported moderate to large benefits. A 2019 meta-analysis evaluating the effect of aerobic exercise with or without resistance exercise in patients receiving neoadjuvant or adjuvant therapy for a mix of cancer types found that exercise led to a moderate improvement in VO_2max (SMD 0.46; 95% CI, 0.23 to 0.69; 12 studies, N = 1,318 patients).[19] Similarly, a 2018 meta-analysis of aerobic and/or resistance exercise during treatment in patients with a mix of cancer types reported that individuals randomly assigned to exercise increased VO_2 peak relative to control patients (weighted mean difference [MD] 1.37 mL $O_2 \times kg^{-1} \times min^{-1}$; 95% CI, 0.58 to 2.16; 14 studies, N = 980 patients).[46] Meta-analyses that focused on specific cancer types reported cardiorespiratory benefits of aerobic and/or resistance exercise in breast cancer treated with chemotherapy[40]; lung cancer following surgery[22]; and prostate cancer treated with androgen-deprivation therapy (ADT).[38] Exercise also improved 6-Minute Walk Test (6MWT) scores among patients with non–small-cell lung cancer who took part in an exercise intervention preoperatively[45] or postoperatively,[22] but did not have a statistically significant effect among patients receiving chemotherapy for lung cancer.[34] Patients with hematologic malignancies who took part in exercise interventions during bone marrow transplantation also experienced increases in 6MWT distances.[17]

Muscle strength. Meta-analyses evaluating the impact of aerobic and/or resistance exercise on muscle strength in men with prostate cancer undergoing treatment with ADT

demonstrate significant and consistent improvements in upper-body and lower-body strength.[24,38,55] Evidence regarding the impact of aerobic and/or resistance exercise on strength in other cancer types was less consistent, but improvements in upper-body or lower-body strength were reported among patients with breast cancer,[49] hematologic malignancies treated with bone marrow transplantation,[17] and lung cancer during chemotherapy[48] or in the preoperative[48] or postoperative[22] periods.

Physical function. Meta-analyses evaluating the impact of aerobic and/or resistance exercise interventions during cancer treatment demonstrate small but statistically significant improvements in self-reported and objectively measured physical function. Aerobic and/or resistance exercise led to small but statistically significant improvements in self-reported physical function among patients with a mix of cancer types (SMD 0.22; 95% CI, 0.13 to 0.32; 25 exercise arms)[50]; breast cancer (SMD 0.14; 95% CI, 0.01 to 0.27; 10 studies, N = 1,016 patients)[32]; and colorectal cancer (SMD 0.26; 95% CI, 0.04 to 0.48; five studies, N = 330 patients).[39] The results from a meta-analysis of patients with hematologic malignancies were of a similar magnitude but not statistically significant (SMD 0.15; 95% CI, –0.01 to 0.32; eight trials, N = 1,329 patients).[10] Exercise interventions led to mixed results across a range of physical function tests, including 6MWT and Sit to Stand tests, in men with prostate cancer treated with ADT.[18,38]

Quality of life. The impact of exercise interventions on QoL varied across the included meta-analyses. Among patients with a mix of cancer types, exercise led to a small QoL benefit (SMD 0.16; 95% CI, 0.08 to 0.23; 32 exercise arms).[50] A small benefit was also reported among patients with colorectal cancer who took part in exercise training during neoadjuvant, adjuvant, or palliative chemotherapy (SMD 0.22; 95% CI, 0.02 to 0.43; six studies, N = 369 patients).[39] A moderate benefit was reported in one meta-analysis of patients with breast cancer during treatment (SMD 0.43; 95% CI, 0.33 to 0.54; 16 studies, N = 1,563 patients).[49] A second meta-analysis, focused on patients with breast cancer who were receiving adjuvant radiation therapy, reported a numerically similar result that was not statistically significant (SMD 0.46; 95% CI, –0.01 to 0.93; seven studies, N = 691 patients).[36] Among patients with hematologic malignancies, a 2019 Cochrane review found a nonsignificant impact of exercise on QoL (SMD 0.11; 95% CI, –0.03 to 0.24; eight studies, N = 1,259 patients),[10] whereas a 2021 review of patients treated with bone marrow transplantation reported a significant improvement (MD 3.38 points; 95% CI, 0.37 to 6.39; 11 studies, N = 624 patients).[17] Two meta-analyses of patients with prostate cancer treated with radiation therapy[31] or ADT[54] reported no significant impact of exercise on QoL.

Depression and anxiety. In patients with breast cancer, meta-analyses suggest that exercise during cancer treatment may reduce both depression (SMD 0.67; 95% CI, 0.51 to 0.83; 10 studies, N = 730 patients) and anxiety (SMD 0.75; 95% CI, 0.60 to 0.91; 10 studies, N = 793 patients).[49] Fewer studies have addressed other cancer types, and the results were not significant in meta-analyses of patients with colorectal cancer,[39] hematologic malignancies,[10,17] or lung cancer.[48]

Body composition. Among patients receiving ADT for prostate cancer, meta-analyses suggest that resistance exercise with or without aerobic exercise modestly reduces percent body fat (MD –1.0%; 95% CI, –1.3 to –0.6; 10 studies, N = 603 patients)[38] and fat mass (MD –0.6 kg; 95% CI, –0.8 to –0.3; 15 studies, N = 917 patients),[38] without a significant effect on body mass index.[18,38] Exercise interventions also led to a statistically significant increase in lean mass in some meta-analyses,[18,38] but not in others.[24] Aerobic and/or resistance exercise did not have a significant impact on body composition or weight in patients undergoing treatment for breast cancer (two trials, N = 324 patients),[49] or in patients with hematologic malignancies (body weight: three studies, N = 964; lean body mass: three studies, N = 290 patients).[10]

Sleep. A meta-analysis of two studies in breast cancer (N = 227 patients) reported a moderate reduction in sleep disturbance with exercise interventions during cancer treatment (SMD –0.47; 95% CI, –0.88 to –0.05).[33] A trial of 301 patients with breast cancer, reported in the systematic review but not included in the meta-analysis, suggested that a higher dose of aerobic exercise during chemotherapy may provide greater sleep benefits than a lower dose.[92]

Cognitive function. A 2020 systematic review evaluated the impact of exercise interventions on cognition in patients with early-stage cancer, with most of the included studies evaluating cognition as a secondary outcome.[21] Nine RCTs evaluated aerobic and/or resistance exercise during treatment and assessed cognition using the European Organization for Research and Treatment of Cancer QoL Questionnaire-Core 30. A statistically significant benefit of exercise was reported in three trials. The remaining studies reported no statistically significant difference between arms. No meta-analysis was performed.

Chemotherapy completion. Relatively little information is available on the impact of exercise interventions during cancer treatment on chemotherapy completion or dose intensity. The available evidence consists primarily of null results,[20,23,39] although two breast cancer trials have reported benefits.[93,94]

Cancer control. Systematic reviews of patients with a mix of tumor types,[23] hematologic malignancies,[10] or advanced cancer[51] have identified only a small number of RCTs that assessed cancer outcomes such as recurrence or survival in relation to exercise during cancer treatment. The results were null, but most of the included studies were not designed to assess survival outcomes.

Type and dose of exercise. The majority of meta-analyses included in this review combined data from a variety of

types, modes of administration, and schedules of exercise, making it difficult to differentiate effects of aerobic versus resistance exercise or determine the best duration, schedule, or intensity of exercise program during cancer treatment. As reported previously, meta-analyses demonstrated significant improvements in fatigue as a result of aerobic and combined resistance and aerobic exercise interventions.[29] Additionally, both supervised (SMD 0.32; 95% CI, 0.12 to 0.52) and unsupervised (SMD 0.33; 95% CI, 0.13 to 0.54) exercise interventions led to reductions in fatigue.[26] In terms of cardiorespiratory fitness, Bjørke et al[19] reported that improvements in VO_2max in patients with a mix of cancer types were greater with longer duration of exercise sessions, longer weekly exercise durations, and greater weekly exercise volumes. Additionally, a shorter overall intervention duration was associated with greater improvements in VO_2max. Finally, one meta-analysis looking at the effect of exercise on strength in men with prostate cancer on ADT suggested a significant relationship between resistance exercise and changes in upper-body strength,[38] but other meta-analyses on this topic did not stratify by exercise type. Thus, the current evidence does not allow for the creation of specific dosing guidance for the duration or intensity of exercise during treatment required to favorably affect outcomes.

Adverse events. Reporting of adverse events is variable across studies, reducing the certainty of the evidence. Nevertheless, the frequency of adverse events with exercise during treatment appears to be low. In a meta-analysis of the impact of exercise interventions on cardiorespiratory fitness, 13 of 14 studies conducted in patients receiving cancer treatment provided information about adverse events.[46] Eleven exercise-related adverse events were reported among 670 patients randomly assigned to an exercise arm: acute myocardial infarction (n = 1), syncope (n = 1), hypotension (n = 1), chest pain (n = 1), dizziness (n = 1), leg pain (n = 1), musculoskeletal adverse event (n = 4), and tiredness (n = 1). Low rates of adverse events and nonreporting of adverse events by some studies were also noted in other systematic reviews.[17,18,22,38] Meta-analyses of serious or grade 3-5 adverse events in relation to exercise were not statistically significant, but certainty of evidence tended to be very low.[10,48,49]

Recommendation 1.2. Oncology providers may recommend preoperative exercise for patients undergoing surgery for lung cancer to reduce length of hospital stay and postoperative complications (Type: evidence based, benefits outweigh harms; Evidence quality: low; Strength of recommendation: weak).

Literature review and analysis. Meta-analyses have evaluated the effects of preoperative exercise on postoperative complications and other outcomes among patients undergoing surgery for lung cancer[35,45] or for GI or genitourinary cancers.[25,52] In two 2019 meta-analyses of patients with lung cancer, one focused specifically on non–small-cell lung cancer and the other on lung cancers more broadly, preoperative exercise reduced postoperative length of hospital stay (SMD –0.58; 95% CI, –0.97 to –0.20; six studies, 513 patients[45]; MD –4.23 days; 95% CI, –6.14 to –2.32; five studies, N = 231 patients[35]). Preoperative exercise also reduced postoperative pulmonary complications (odds ratio [OR] 0.44; 95% CI, 0.27 to 0.71; six studies, N = 382 patients[35]; relative risk 0.50; 95% CI, 0.39 to 0.66; eight studies[45]) and reduced postoperative pneumonia (OR 0.47; 95% CI, 0.24 to 0.95; six studies, N = 379 patients[35]) among patients with lung cancer. Both meta-analyses had limitations: one included a nonrandomized study,[35] and the other included the same study twice when analyzing postoperative pulmonary complications.[45] Among patients undergoing abdominal surgery for GI or genitourinary cancers, preoperative exercise did not significantly affect risk of postoperative overall or pulmonary complications, although one meta-analysis of six studies suggested a modest reduction in postoperative length of stay (MD –1.08 days; 95% CI, –2.29 to –0.14).[25,52]

Question 1: Clinical interpretation. Aerobic and resistance exercise during cancer treatment has numerous well-documented benefits for patients undergoing cancer treatment with curative intent.[12,46] Although the literature evaluating the benefits of exercise in the setting of active cancer treatment has evaluated different forms of exercise with different schedules, intensities, and means of administration, the results consistently demonstrate that increasing exercise during treatment improves cardiorespiratory fitness and reduces symptoms such as fatigue. Studies have also demonstrated few adverse events in patients taking part in exercise interventions during cancer treatment,[46] although it should be noted that a proportion of these trials used supervised exercise programs overseen by exercise professionals. These findings suggest that the incorporation of exercise during active treatment has clear benefits for patients with cancer, and oncology providers should include assessment of exercise behaviors and recommendations to exercise as a part of oncology visits.

Although the data are more limited, exercise interventions also appear to have benefits when implemented before surgery for lung cancer, a procedure associated with significant morbidity and mortality.[35,45] Preoperative exercise may also provide benefits in other malignancies, but evidence is currently weaker than for lung cancer.[25,52] Prehabilitation is still an emerging field, and additional RCTs are warranted. Given the benefits of exercise in patients with cancer, several guidelines recommend exercise for patients and survivors.[9,11,12]

Despite these recommendations, many patients are inactive during cancer treatment. A recent ASCO survey of 2,419 patients with cancer, 48% of whom were currently receiving treatment at the time of survey completion, found

that 25% of survey respondents were not engaging in any regular exercise and another 25% engaged in suboptimal levels of exercise.[95] Notably, individuals whose oncology providers discussed the importance of exercise or a healthy diet as a part of cancer care reported a greater likelihood of making changes in lifestyle behaviors after cancer diagnosis, and another recent study in individuals with colon cancer in the United Kingdom found that patients who reported that their oncology providers addressed exercise during oncology visits were more likely to engage in physical activity (51% in the advice group *v* 42% in the no advice group; OR 1.74; 95% CI, 1.60 to 1.90; $P < .001$), and more likely to meet physical activity guidelines (25% *v* 20%; OR 1.70; 95% CI, 1.54 to 1.88; $P < .001$).[96] This work highlights the importance of oncology provider engagement in encouraging regular physical activity in their patients receiving cancer treatment.

Notably, the appropriate referral for exercise in patients undergoing treatment for cancer may depend on several factors, such as comorbidities, treatment toxicities, and the patient's physical activity level. Many patients can safely perform unsupervised exercise, whereas others may need supervised cancer-specific exercise, clinically supervised exercise, or to participate in a cancer rehabilitation program before undertaking exercise on their own. National efforts are focusing on building algorithms and decision-support tools to point to the most safe, feasible, and effective intervention for a given patient.[97,98]

Clinical Question 2

Does consuming a particular dietary pattern or food(s) during cancer treatment safely improve outcomes related to QoL, treatment toxicity, or cancer control?

Recommendation 2.1. There is currently insufficient evidence to recommend for or against dietary interventions such as ketogenic or low-carbohydrate diets, low-fat diets, functional foods, or fasting to improve outcomes related to QoL, treatment toxicity, or cancer control.

Literature review and analysis. Systematic reviews have evaluated a broad range of dietary interventions in patients during cancer treatment, including changes in timing of food intake (eg, intermittent fasting), dietary patterns, macronutrient composition (eg, low-fat or low-carbohydrate diets), and intake or omission of particular foods.[56,58-60,62,64] The majority of randomized trials conducted in patients undergoing active treatment have focused on patient-reported outcomes or on biomarkers (see the section on biomarkers in discussion), with little or no information regarding the impact of dietary change during treatment on cancer outcomes. Additionally, most of these trials have been small, enrolling fewer than 100 patients, often with different cancer types and stages. The results have generally failed to show consistent effects of dietary change during treatment on patient-reported or other outcomes in patients with cancer.[56,58-60]

A 2019 meta-analysis broadly evaluated the impact of dietary interventions on patient-reported outcomes. The analysis included 15 trials and 1,290 patients, although trial populations included patients both during and after cancer treatment and dietary interventions were varied, including plant-based diets, weight loss diets, and healthy diets.[56] There was no effect of most dietary interventions in aggregate on fatigue (SMD 0.18; 95% CI, –0.02 to 0.39) or QoL (SMD 0.07; 95% CI, –0.10 to 0.24), but potentially an effect of a plant-based dietary pattern on fatigue (SMD 0.62; 95% CI, 0.10 to 1.15). In another analysis evaluating a broad range of dietary interventions on patient-reported outcomes, a Cochrane review evaluated the impact of dietary interventions during pelvic radiotherapy on GI symptoms. Low-certainty evidence, on the basis of small numbers of patients, suggested that protein supplements, dietary counseling, and probiotics may reduce the risk of acute, grade 2 or worse diarrhea.[60] Also, with low certainty of evidence, one study in 108 patients showed that a high-fiber diet led to improvements in GI symptoms and QoL at one year postradiotherapy.[99] Significant work remains to be done, as detailed in the research gaps section below.

Recommendation 2.2. Neutropenic diets (specifically diets that exclude raw fruits and vegetables) are not recommended to prevent infection in patients with cancer during active treatment (Type: evidence based, harms likely to outweigh benefits; Evidence quality: low; Strength of recommendation: weak).

Literature review and analysis. There is no standard definition of a neutropenic diet. Diets included in this review focused on food safety practices that were more restrictive than those endorsed by the US Food and Drug Administration[100] or the Centers for Disease Control and Prevention[101] for the general population and/or recommended the avoidance of foods such as raw fruits and vegetables with the intent of decreasing exposure to microbes and bacteria. Three systematic reviews of neutropenic diets were included in the current review[57,61,63] In a meta-analysis that included studies of children and adults, infection was noted in 53.7% of the patients randomly assigned to a neutropenic diet and 50.0% of the patients assigned to an unrestricted diet (relative risk 1.13; 95% CI, 0.98 to 1.30; five studies, 388 patients).[57] Of the three RCTs conducted in adults, only one enrolled more than 50 patients: Gardner et al enrolled 153 patients (age range, 17-88 years) who were receiving induction chemotherapy for acute myeloid leukemia.[102] Patients were randomly assigned to a diet containing no raw fruits or vegetables (cooked diet) or to a diet containing fresh fruit and fresh vegetables (raw diet). A major infection occurred in 29% of patients in the cooked arms and 35% of patients in the raw arm ($P = .60$). There was no significant difference in survival between the two arms ($P = .36$).

Question 2: Clinical interpretation. Although interest in dietary modification for the purpose of improving cancer outcomes or reducing treatment toxicity remains high,[103-105] there are very few data at this time to support specific dietary modifications or foods as a part of cancer treatment. Neutropenic diets, generally defined as diets that seek to reduce bacterial exposure by limiting raw fruits and vegetables, have long been recommended to prevent infection in patients with hematologic malignancies, and especially in individuals who have undergone bone marrow transplant. Although the available literature is somewhat limited, with many studies having small samples sizes or lack of randomized design, data do not support the use of neutropenic diets to lower infection risk in this patient population. Given that these diets are also less palatable to patients and may limit important nutrients and bioactive compounds,[57] the ASCO Expert Panel generally felt that the harms outweigh potential benefits, especially given that data currently suggest no difference in infection risk in individuals randomly assigned to neutropenic diets (however defined in the individual studies) and unrestricted diets.

It was not possible to make other recommendations regarding diet during cancer treatment on the basis of the available literature. There are exceedingly few RCTs testing the effect of specific diets, eating patterns, or foods during cancer treatment on cancer or patient-reported outcomes.[60,62,64] The heterogeneity of the RCTs that have been conducted and the limited number of rigorously designed studies with robust sample sizes make it difficult to develop recommendations on the basis of this literature. The limited data currently available do not support a benefit of dietary modification during treatment on fatigue, QoL, or other patient-reported outcomes. On the basis of the early-stage nature of trials evaluating diets and dietary patterns associated with lower cancer risk in observational and/or preclinical studies—including ketogenic or low-carbohydrate diets, intermittent fasting, or the consumption of functional foods such as green tea or soy—it is not possible to determine whether these diets offer any benefit to patients with cancer. It is also notable that studies have suggested that patients randomly assigned to ketogenic diets express lower levels of dietary satisfaction compared with patients randomly assigned to control or other dietary interventions.[64] Finally, despite the significant observational data showing an association between a healthy or prudent diet and lower cancer risk and/or better outcomes in several malignancies,[3] there are very limited data testing the impact of plant-based diet interventions during active treatment on toxicity or cancer outcomes, highlighting a critical need for further research in this area.

Clinical Question 3

Do interventions to promote intentional weight loss or avoidance of weight gain during cancer treatment safely improve outcomes related to QoL, treatment toxicity, or cancer control?

Recommendation 3. There is currently insufficient evidence to recommend for or against intentional weight loss or prevention of weight gain interventions during active treatment to improve outcomes related to QoL, treatment toxicity, or cancer control.

Literature review and analysis. There have been few RCTs of weight management interventions during cancer treatment.[18,38,65] Most of the studies conducted to date have had small samples sizes and have had weight loss as the primary end point, providing information regarding feasibility, but making it difficult to determine the effect of weight loss on patient-reported or other outcomes in patients receiving cancer treatment. A 2017 systematic review evaluated the efficacy of behaviorally based dietary interventions, with or without physical activity, for avoidance of weight gain among women receiving chemotherapy for breast cancer.[65] Of the four included RCTs, two of five weight loss arms resulted in lower body weight at study completion compared with usual care control arms. A number of weight loss intervention trials have also been conducted in men with prostate cancer, but study heterogeneity makes it difficult to draw conclusions from this literature.[18,38] Exercise-only interventions have not demonstrated significant weight loss in this population. These somewhat limited findings suggest that weight management interventions may be possible during cancer treatment, but evidence regarding the risks and benefits of on-treatment weight management remain uncertain.

Question 3: Clinical interpretation. The limited evidence available does suggest intentional weight loss is feasible during cancer treatment, at least in individuals undergoing treatment for breast and possibly prostate cancers, but there is little evidence at this time that purposeful weight loss provides significant benefit to patients during active treatment. Given the abundant data from observational studies suggesting a relationship between excess adiposity and increased risk of developing and dying from cancer,[1-6] there is a critical need for more research in this area.

DISCUSSION

The overarching goal of this guideline is to provide evidence-based recommendations to guide lifestyle changes in patients *undergoing treatment for cancer*. This guideline is the first to focus specifically on this portion of the cancer care trajectory. This guideline was also developed for oncology professionals, with the intent of providing evidence-based recommendations for optimizing treatment tolerance, QoL, and cancer control in patients undergoing treatment.

Our review of the evidence, including 42 systematic reviews and several additional RCTs, showed that exercise interventions led to significant and clinically important benefits for patients with cancer being treated with systemic therapy, radiation, and/or surgery. Exercise led to improvements in cardiorespiratory fitness and physical function, both of

which are negatively affected by cancer treatment and are related to both development of comorbidities and decline in functional status. Exercise also mitigated other toxicities of cancer treatment, including fatigue and mood disorders. Finally, exercise helped to preserve strength, especially in men with prostate cancer currently undergoing treatment with ADT. These findings suggest that the incorporation of exercise can improve treatment tolerability and enhance fitness and functional status in patients undergoing treatment. On the basis of this evidence, exercise should be incorporated as a standard part of oncology treatment.

Like several other guidelines, including the American College of Sports Medicine (ACSM) Roundtable Report,[12] the National Comprehensive Cancer Network Survivorship Guidelines,[106] and the American Cancer Society Nutrition and Physical Activity Guidelines for Cancer Survivors,[11] this guideline recommends that patients with cancer engage in aerobic and resistance exercise. Our review of the literature of the impact of exercise interventions during cancer treatment also resulted in a similar list of benefits as the ACSM Roundtable Report, although the ACSM report included both patients currently receiving treatment and post-treatment survivors.[12]

As noted before, this guideline focused only on the on-treatment period, and thus, included only a subset of the evidence used to shape other guidelines. In addition, the guideline Panel exclusively considered data from RCTs in humans as the basis for its recommendations. This approach differs somewhat from some other guidelines on this topic but was adopted to provide direct evidence for the oncology clinician and patient of the expected impact of making a change in diet, exercise, or weight during cancer treatment. Although observational data of lifestyle factors and cancer risk and outcomes have played an important role in identifying critical relationships between diet, exercise, weight, and cancer, healthy lifestyle behaviors are generally related to each other and to other so-called healthy person attributes, such as avoiding tobacco products, compliance with screening guidelines, higher socioeconomic status, better preventative care, etc. Data from RCTs are thus critical to avoid these healthy person biases and establish the expected benefits of lifestyle changes after cancer diagnosis on cancer recurrence, functional status, patient-reported outcomes, and other end points important to patients and clinicians.

As the Expert Panel reviewed the evidence from randomized trials of lifestyle interventions during cancer treatment, it became apparent that there were significant gaps in this literature, in particular regarding the impact of exercise, dietary change, or weight loss on outcomes such as cancer recurrence and mortality. In the case of dietary or weight management interventions, there was little information from RCTs even regarding the impact of these interventions on functional or patient-reported outcomes. Additionally, given the design of the majority of the RCTs used to inform these guidelines, evidence regarding the long-term impact of exercise, diet, and weight management interventions during active treatment was limited. Although ongoing work will fill in some of these gaps over the next decade, the limited research in this area made it challenging to develop comprehensive guidance for patients undergoing cancer treatment.

It should be noted, however, that the lack of guidance in these areas should not be interpreted as a statement that dietary change and weight management have no value in patients during or after cancer treatment. The Panel expressly did not want to convey the impression that these recommendations either be considered a tacit endorsement of diets high in processed and red meat, processed foods, or refined carbohydrates or suggest that weight management is not important for overall health, given the high prevalence of obesity among cancer survivors and the known adverse health consequences of excess adiposity. The literature suggests that a cancer diagnosis is a teachable moment, in which patients look to make changes in behavior to improve long-term outcomes. A recent ASCO survey of 2,419 oncology patients in the United States found that almost 75% of patients reported making changes in their diet or exercise patterns after cancer diagnosis in an effort to improve outcomes.[95] The importance of regular exercise, maintaining weight in a healthy range, and consuming a high-quality diet have well-established value in decreasing risk of cardiovascular disease, metabolic disorders, and other chronic illnesses. Improving lifestyle behaviors earlier in the cancer care continuum could have longer-term benefits for patients, which are not reflected in the current literature. Our goal was to highlight the areas in which there is consistent and convincing evidence that lifestyle change provides benefits for patients undergoing cancer treatment and underscore the need for more research in areas where evidence is currently insufficient to provide concrete recommendations, in hopes that future guidelines will provide a more comprehensive blueprint to improve short-term and longer-term outcomes in patients undergoing cancer therapy.

SPECIAL CONSIDERATIONS

Exercise in Individuals Living With Advanced Cancers

The literature evaluating the feasibility, safety, and potential benefits of exercise in patients with advanced cancer is relatively limited. A few systematic reviews have summarized this literature and have largely reported mixed results—either null or showing a modest benefit of exercise—in relation to outcomes such as QoL and physical function.[28,42,44,53,107] A 2021 systematic review evaluated the safety and potential benefits of exercise interventions in patients with bone metastases.[53,108] Seventeen RCTs, including a mix of patients with and without bone metastases, were included. Some of the individual studies reported benefits in outcomes such as physical function. Serious

adverse events were rare, even in patients with bone metastases. Another meta-analysis involving small numbers of patients with advanced lung cancer (sample sizes ranging from 59 to 121 patients) reported an improvement in the 6MWT and disease-specific global health-related QoL with exercise.[44] The results for dyspnea, the physical function component of health-related QoL, and fatigue were not statistically significant. Finally, one systematic review focused specifically on exercise in relation to survival in individuals with advanced cancer.[51] None of the six included RCTs reported a statistically significant impact of exercise on survival, and a meta-analysis of four of the trials also produced a nonsignificant result. However, duration of the exercise intervention was brief (6-12 weeks), the population was heterogeneous, and survival was an exploratory outcome. This literature in aggregate provides preliminary support for the safety of exercise in the setting of advanced cancer,[27] but more work is needed to define its benefits in this population.

Exercise, Diet, Weight Management, and Health Disparities

Although ASCO clinical practice guidelines represent expert recommendations on the best practices in disease management to provide the highest level of cancer care, many patients have limited access to medical care or receive fragmented care. Factors such as race and ethnicity, age, socioeconomic status, sexual orientation and gender identity, geographic location, and insurance access are known to affect cancer care outcomes, as well as diet and exercise behavior.[109] Racially and/or ethnically diverse patients with cancer suffer disproportionately from comorbidities, experience more substantial obstacles to receiving timely care, are more likely to be uninsured, and are at greater risk of receiving fragmented care or poor-quality care than other Americans.[110-112] In addition, the very factors that are related to cancer disparities also affect patients' ability to achieve adequate levels of exercise, eat a plant-based diet (with lower amounts of refined grains, sugars, and red and processed meats), and achieve and maintain a healthful weight. Social determinants of health that are governed by a residential zip code often dictate the availability of safe places to exercise, large grocery stores that offer a variety of fresh, healthful, and affordable foods, and the food security that frees patients to pursue calorie restriction without the worry of knowing whether there will be a next meal or not.[113] Sociodemographic factors such as age, race, and education further compound these disparities and accentuate the need for social workers and adequate social support.

Biomarker End Points

Various surrogate end points have been explored in exercise and dietary interventions, and largely include those involved in glucose homeostasis and energy balance (eg, glucose, insulin, insulin-like growth factors, leptin, and adiponectin), sex hormones (eg, estradiol, testosterone, and sex hormone–binding globulin), immune function (eg, CD-4 cells), and inflammatory markers (eg, c-reactive protein, tumor necrosis factor-α, and interleukin 6). In general, exercise appears to favorably influence insulin-like growth factor-I and II, CD-4 cells, and c-reactive protein,[8] whereas calorically restricted diets reduce leptin (and triglycerides—more related to subsequent cardiovascular disease)[114]—mixed effects are noted with other circulating biomarkers.[8,114] However, almost all of these studies have been performed in longer-term cancer survivors who have long completed therapy, and the effects among patients actively undergoing treatment is unknown. Given that various forms of treatment are likely to exacerbate inflammation and suppress immunity, the generalizability of current data to patients currently undergoing treatment is questionable. Moreover, the search for an ideal biomarker that is influenced by these lifestyle factors but at the same time is closely linked with cancer outcomes is a continual work in progress. Studies such as the Men's Eating and Living Study (CALGB 70807 [Alliance]) in which prostate-specific antigen doubling time or tumor upgrading on the basis of tumor volume or grade serve as useful models that can inform future studies within the patient population.[115]

RESEARCH GAPS AND FUTURE DIRECTIONS

Our review of the published literature demonstrates a profound gap in quality research focusing upon defining optimal diet, weight management, and to a somewhat lesser degree, exercise strategies to maximize therapeutic responses and the reduction in both acute and long-term toxicity. Unfortunately, the shallow evidence base limited the recommendations this Panel could make, especially for diet and weight management. There is a critical need for greater investment in clinical research in this area. Outcomes of interest are diverse. Improving efficacy of therapy and reducing toxicity are of foremost interest and potential impact. Data regarding maintenance of optimal treatment intensity, such as limiting dose reductions and delays in therapy, are relevant to improved outcomes. In addition, patient-reported outcomes related to treatment tolerance, comorbidity risk, prognostic biomarkers, and QoL, including physical performance, fatigue, and psychosocial issues, are relevant study outcomes. Studies should address the potential of lifestyle interventions to reduce the cost of care by lowering the frequency of emergency department visits, hospitalizations, or readmissions, as well as reduction in costs associated with therapy-related chronic toxicities.

Although RCTs testing the impact of exercise, diet, and weight management interventions during treatment on outcomes of interest will provide the strongest evidence to support the incorporation into cancer care, integration and embedding nutritional status and dietary assessment and monitoring into clinical trials of novel cancer therapeutics, particularly large phase III trials, would provide important

hypothesis-generating information to direct the development of RCTs.

Many opportunities exist at modest overall cost, to integrate validated and novel assessment tools of diet, nutritional status, and exercise into clinical trials, such as body composition assessment including fat distribution and lean muscle mass, use of enhanced statistical tools to analyze dietary patterns, use of wearables to capture physical activity, and validated fitness tests such as the 6MWT. Technological advances providing new tools for biosensing of metabolic state and monitoring of physical activity, as well as the remarkable progress in metabolomics and lipidomics of biospecimens, will enhance the quality of future studies.

Ultimately, a significant investment in phase I, II, and randomized phase III interventions trials of diet, exercise, weight management interventions, or their combinations, during cancer treatment protocols with sufficient power and innovative designs will be needed for defining standards of care. Such efforts in diet and exercise will require new initiatives from government and philanthropic sources, as unlike the pharmaceutical industry that provides enormous investment in cancer clinical trials, the options for substantial industry support for diet and fitness trials is very modest. Large RCTs in diet and exercise with sufficient statistical power to provide results on critical outcomes such as survival that will define care standards warrant the same investment as novel therapeutics.

Additionally, host genetics and tumor genomics is increasingly directing cancer therapeutics and will contribute to precision nutrition and exercise efforts in the oncology setting. In parallel, the field of nutrigenomics is emerging as the study of how genetic variation affects host responses to dietary patterns, nutrients, and bioactives in the foods, and potentially contributes to individual responses to specific cancer therapeutics. The National Institutes of Health has prioritized the theme of Nutrition for Precision Health with the goal of translation to clinical care allowing for more personalized and individual guidance. Such a strategy is very relevant to management of individuals undergoing cancer therapy.

Future research must incorporate more diverse patient samples. Studies are needed in patients with cancers other than breast, prostate, lung, and colorectal, which were the most commonly studied cancers, and in patients on immunotherapies or those with metastatic disease. Studies need to test interventions in sociodemographically diverse samples, especially those who are medically vulnerable, and should have careful attention to eligibility criteria or allow for stratification of results.

In summary, a commitment to studies that provide high-quality evidence is imperative. The quality of many studies we reviewed was low, which contributed to the weak recommendations. Future research must be conducted rigorously using sufficient sample sizes and methods that decrease the risk of bias, reduce confounding, and improve the quality of the research and certainty of the evidence to strengthen future guidelines.

GUIDELINE IMPLEMENTATION

This guideline represents an important step in providing guidance for adult patients regarding exercise, diet, and weight management during cancer treatment. Although the lack of evidence base, especially for diet and weight management, limited the number of recommendations ultimately made, the Panel recommended the incorporation of exercise into cancer treatment for patients receiving systemic therapy and radiotherapy, as well as potentially in the preoperative setting for patients with lung cancer.

Facilitating implementation of these recommendations for exercise during cancer treatment will require addressing barriers to this care that exist at the patient, clinician, health system, and policy levels. For example, although patients report high interest in exercise,[116] in order for this to be successfully incorporated into patient care, patient-level barriers, including toxicities of cancer treatment; comorbidities; concerns about falls, injuries, or appearance while exercising; financial issues (lack of affordable programs); lack of access to programs; lack of time or social support; and limited guidance by clinicians, must be addressed.[116,117]

Overcoming these barriers will require a systematic, multifaceted approach involving the clinician, health care system, and overarching health care policies. Example clinician-level strategies include training on how to address these issues with patients[118] and incorporating exercise or cancer rehabilitation clinicians and behavior change experts in the multidisciplinary oncology treatment team.[119] Health care system strategies must focus on improving patient-provider communication about these interventions and building referrals for programs in multiple settings close to patients' homes or via telemedicine, at varied hours or self-directed, and including low- or no-cost options[120] through partnerships with community programs and organizations.[121] Needed policy changes include insurance reimbursement for support of exercise during cancer treatment and the care coordination necessary to integrate this with the rest of the patient's care. Accreditation standards or quality metrics that include exercise as a standard component of cancer care would drive practice change, allowing greater adoption of the recommendations of this and other guidelines focused on these topics in patients with cancer.

PATIENT AND CLINICIAN COMMUNICATION

Communication between patients and clinicians will be a critical aspect in ensuring implementation of these guideline recommendations. Some patients may be unaware of the impact of exercise during treatment on patient outcomes, whereas others may pursue exercise and diet

changes that are not supported by evidence. The goal of the clinician should be to introduce the importance of exercise during cancer treatment and to make appropriate referrals fostering *healthy lifestyle behaviors* in patients undergoing therapy, as behavior change not only requires the sharing of knowledge between clinicians and patients, but also the incorporation of motivational strategies, identification of barriers, and creative approaches to identification of and payment for resources to support behavior change. In a recent ASCO membership survey, 84% of oncologists[118] report that although they recognize the benefits of diet, exercise, and weight management, they feel that another team member should be delivering the interventions. Thus, the overall goal of implementation of this guideline should be to support clinicians in educating their patients about the importance of exercise as a part of cancer care and to encourage them to use appropriate resources (oncology rehabilitation, cancer certified fitness professionals, etc) to help their patients achieve these goals.

EXTERNAL REVIEW AND OPEN COMMENT

The draft recommendations were released to the public for open comment from January 12, 2022, through January 26, 2022. Response categories of "Agree as written," "Agree with suggested modifications" and "Disagree. See comments" were captured for every proposed recommendation with 61 responses received. Across recommendations, the proportion of respondents who agreed or agreed with slight modifications ranged from 88% to 98%. In addition, the full draft guideline was submitted to three external reviewers with content expertise. Expert Panel members reviewed comments from all sources and determined whether to maintain original draft recommendations, revise with minor language changes, or consider major recommendation revisions. All changes were incorporated before Evidence Based Medicine Committee review and approval.

ASCO believes that cancer clinical trials are vital to inform medical decisions and improve cancer care, and that all patients should have the opportunity to participate.

ADDITIONAL RESOURCES

More information, including a supplement with additional evidence tables, slide sets, and clinical tools and resources, is available at www.asco.org/supportive-care-guidelines. Patient information is available at www.cancer.net.

RELATED ASCO GUIDELINES

- Integration of Palliative Care into Standard Oncology Care[122] (http://ascopubs.org/doi/10.1200/JCO.2016.70.1474)
- Patient-Clinician Communication[123] (http://ascopubs.org/doi/10.1200/JCO.2017.75.2311)

AFFILIATIONS

[1]Dana-Farber Cancer Institute, Boston, MA
[2]American Society of Clinical Oncology, Alexandria, VA
[3]University Medical Center Utrecht, Utrecht University, Utrecht, the Netherlands
[4]The Ohio State University, Columbus, OH
[5]University of Alabama at Birmingham, Birmingham, AL
[6]University of Texas MD Anderson Cancer Center, Houston, TX
[7]Yale School of Public Health, New Haven, CT
[8]Patient Representative, Arlington, VA
[9]Cancer Wellness for Life, Lenexa, KS
[10]Ivy Rehab Network, White Plains, NY
[11]University of Arizona, Tucson, AZ
[12]UNC School of Medicine, Chapel Hill, NC
[13]Northwell Health Cancer Institute and Feinstein Institutes for Medical Research, New York, NY

CORRESPONDING AUTHOR

American Society of Clinical Oncology, 2318 Mill Rd, Suite 800, Alexandria, VA 22314; e-mail: guidelines@asco.org.

EDITOR'S NOTE

This ASCO Clinical Practice Guideline provides recommendations, with comprehensive review and analyses of the relevant literature for each recommendation. Additional information, including a supplement with additional evidence tables, slide sets, clinical tools and resources, and links to patient information at www.cancer.net, is available at www.asco.org/supportive-care-guidelines.

EQUAL CONTRIBUTION

J.A.L. and C.M.A. were expert panel cochairs.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Disclosures provided by the authors are available with this article at DOI https://doi.org/10.1200/JCO.22.00687.

AUTHOR CONTRIBUTIONS

Conception and design: Jennifer A. Ligibel, Kari Bohlke, Anne M. May, Steven K. Clinton, Wendy Demark-Wahnefried, Michele Late, Timothy F. Marshall, Cynthia A. Thomson, William A. Wood, Catherine M. Alfano
Administrative support: Kari Bohlke
Collection and assembly of data: Jennifer A. Ligibel, Kari Bohlke, Catherine M. Alfano
Data analysis and interpretation: Jennifer A. Ligibel, Kari Bohlke, Anne M. May, Steven K. Clinton, Wendy Demark-Wahnefried, Susan C. Gilchrist, Melinda L. Irwin, Sami Mansfield, Timothy F. Marshall, Jeffrey A. Meyerhardt, Cynthia A. Thomson, William A. Wood, Catherine M. Alfano
Manuscript writing: All authors
Final approval of manuscript: All authors
Accountable for all aspects of the work: All authors

ACKNOWLEDGMENT

The Expert Panel wishes to thank Drs Dawn Hershman, Kerri Winters-Stone, Karen Basen-Engquist, Lisa Law, and Alicia Morgans, and the Evidence Based Medicine Committee for their thoughtful reviews and insightful comments on this guideline.

REFERENCES

1. Calle EE, Rodriguez C, Walker-Thurmond K, et al: Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. N Engl J Med 348:1625-1638, 2003
2. Dobbins M, Decorby K, Choi BC: The association between obesity and cancer risk: A meta-analysis of observational studies from 1985 to 2011. ISRN Prev Med 2013:680536, 2013
3. World Cancer Research Fund/American Institute for Cancer Research: Diet, nutrition, physical activity and cancer: A global perspective. dietandcancerreport.org, Continuous Update Project Report 2018
4. Chan DSM, Vieira AR, Aune D, et al: Body mass index and survival in women with breast cancer-systematic literature review and meta-analysis of 82 follow-up studies. Ann Oncol 25:1901-1914, 2014
5. Castillo JJ, Reagan JL, Ingham RR, et al: Obesity but not overweight increases the incidence and mortality of leukemia in adults: A meta-analysis of prospective cohort studies. Leuk Res 36:868-875, 2012
6. Protani MM, Nagle CM, Webb PM: Obesity and ovarian cancer survival: A systematic review and meta-analysis. Cancer Prev Res (Phila) 5:901-910, 2012
7. Friedenreich CM, Stone CR, Cheung WY, et al: Physical activity and mortality in cancer survivors: A systematic review and meta-analysis. JNCI Cancer Spectr 4:pkz080, 2020
8. Stout NL, Baima J, Swisher AK, et al: A systematic review of exercise systematic reviews in the cancer literature (2005-2017). PM R 9:S347-S384, 2017
9. Segal R, Zwaal C, Green E, et al: Exercise for people with cancer: A systematic review. Curr Oncol 24:e290-e315, 2017
10. Knips L, Bergenthal N, Streckmann F, et al: Aerobic physical exercise for adult patients with haematological malignancies. Cochrane Database Syst Rev 1: CD009075, 2019
11. Rock CL, Doyle C, Demark-Wahnefried W, et al: Nutrition and physical activity guidelines for cancer survivors. CA Cancer J Clin 62:243-274, 2012
12. 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
13. US Department of Agriculture and US Department of Health and Human Services: Dietary Guidelines for Americans, 2020-2025 (ed 9), 2020. https://www.dietaryguidelines.gov/
14. Shiffman RN, Michel G, Rosenfeld RM, et al: Building better guidelines with BRIDGE-Wiz: Development and evaluation of a software assistant to promote clarity, transparency, and implementability. J Am Med Inform Assoc 19:94-101, 2012
15. Higgins J, Thomas J, Chandler J, et al (eds): Cochrane Handbook for Systematic Reviews of Interventions (ed 2). Chichester, United Kingdom, Wiley, 2019
16. Balshem H, Helfand M, Schünemann HJ, et al: GRADE guidelines: 3. Rating the quality of evidence. J Clin Epidemiol 64:401-406, 2011
17. Abo S, Denehy L, Ritchie D, et al: People with hematological malignancies treated with bone marrow transplantation have improved function, quality of life and fatigue following exercise intervention: A systematic review and meta-analysis. Phys Ther 101:pzab130, 2021
18. Bigaran A, Zopf E, Gardner J, et al: The effect of exercise training on cardiometabolic health in men with prostate cancer receiving androgen deprivation therapy: A systematic review and meta-analysis. Prostate Cancer Prostatic Dis 24:35-48, 2021
19. Bjørke ACH, Sweegers MG, Buffart LM, et al: Which exercise prescriptions optimize V̇O(2) max during cancer treatment?—A systematic review and meta-analysis. Scand J Med Sci Sports 29:1274-1287, 2019
20. Bland KA, Zadravec K, Landry T, et al: Impact of exercise on chemotherapy completion rate: A systematic review of the evidence and recommendations for future exercise oncology research. Crit Rev Oncol Hematol 136:79-85, 2019
21. Campbell KL, Zadravec K, Bland KA, et al: The effect of exercise on cancer-related cognitive impairment and applications for physical therapy: Systematic review of randomized controlled trials. Phys Ther 100:523-542, 2020
22. Cavalheri V, Burtin C, Formico VR, et al: Exercise training undertaken by people within 12 months of lung resection for non-small cell lung cancer. Cochrane Database Syst Rev 6:CD009955, 2019
23. Cave J, Paschalis A, Huang CY, et al: A systematic review of the safety and efficacy of aerobic exercise during cytotoxic chemotherapy treatment. Support Care Cancer 26:3337-3351, 2018
24. Chen Z, Zhang Y, Lu C, et al: Supervised physical training enhances muscle strength but not muscle mass in prostate cancer patients undergoing androgen deprivation therapy: A systematic review and meta-analysis. Front Physiol 10:843, 2019
25. Daniels SL, Lee MJ, George J, et al: Prehabilitation in elective abdominal cancer surgery in older patients: Systematic review and meta-analysis. BJS Open 4: 1022-1041, 2020
26. Ehlers DK, DuBois K, Salerno EA: The effects of exercise on cancer-related fatigue in breast cancer patients during primary treatment: A meta-analysis and systematic review. Expert Rev Anticancer Ther 20:865-877, 2020
27. 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
28. 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
29. Hilfiker R, Meichtry A, Eicher M, et al: Exercise and other non-pharmaceutical interventions for cancer-related fatigue in patients during or after cancer treatment: A systematic review incorporating an indirect-comparisons meta-analysis. Br J Sports Med 52:651-658, 2018
30. Himbert C, Klossner N, Coletta AM, et al: Exercise and lung cancer surgery: A systematic review of randomized-controlled trials. Crit Rev Oncol Hematol 156: 103086, 2020
31. Horgan S, O'Donovan A: The impact of exercise during radiation therapy for prostate cancer on fatigue and quality of life: A systematic review and meta-analysis. J Med Imaging Radiat Sci 49:207-219, 2018
32. Juvet LK, Thune I, Elvsaas I, et al: The effect of exercise on fatigue and physical functioning in breast cancer patients during and after treatment and at 6 months follow-up: A meta-analysis. Breast 33:166-177, 2017
33. Kreutz C, Schmidt ME, Steindorf K: Effects of physical and mind-body exercise on sleep problems during and after breast cancer treatment: A systematic review and meta-analysis. Breast Cancer Res Treat 176:1-15, 2019
34. Lee J: Physiologic and psychologic adaptation to exercise interventions in lung cancer patients undergoing chemotherapy: A systematic review and meta-analysis of randomized controlled trials. Support Care Cancer 29:2863-2873, 2021
35. Li X, Li S, Yan S, et al: Impact of preoperative exercise therapy on surgical outcomes in lung cancer patients with or without COPD: A systematic review and meta-analysis. Cancer Manag Res 11:1765-1777, 2019
36. Lipsett A, Barrett S, Haruna F, et al: The impact of exercise during adjuvant radiotherapy for breast cancer on fatigue and quality of life: A systematic review and meta-analysis. Breast 32:144-155, 2017

37. Lopez P, Galvão DA, Taaffe DR, et al: Resistance training in breast cancer patients undergoing primary treatment: A systematic review and meta-regression of exercise dosage. Breast Cancer 28:16-24, 2021
38. Lopez P, Taaffe DR, Newton RU, et al: Resistance exercise dosage in men with prostate cancer: Systematic review, meta-analysis, and meta-regression. Med Sci Sports Exerc 53:459-469, 2021
39. Lund CM, Dolin TG, Mikkelsen MK, et al: Effect of exercise on physical function and psychological well-being in older patients with colorectal cancer receiving chemotherapy—A systematic review. Clin Colorectal Cancer 19:e243-e257, 2020
40. Maginador G, Lixandrão ME, Bortolozo HI, et al: Aerobic exercise-induced changes in cardiorespiratory fitness in breast cancer patients receiving chemotherapy: A systematic review and meta-analysis. Cancers (Basel) 12:2240, 2020
41. Mikkelsen MK, Juhl CB, Lund CM, et al: The effect of exercise-based interventions on health-related quality of life and physical function in older patients with cancer receiving medical antineoplastic treatments: A systematic review. Eur Rev Aging Phys Act 17:18, 2020
42. 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
43. Oberoi S, Robinson PD, Cataudella D, et al: Physical activity reduces fatigue in patients with cancer and hematopoietic stem cell transplant recipients: A systematic review and meta-analysis of randomized trials. Crit Rev Oncol Hematol 122:52-59, 2018
44. Peddle-McIntyre CJ, Singh F, Thomas R, et al: Exercise training for advanced lung cancer. Cochrane Database Syst Rev 2:CD012685, 2019
45. Rosero ID, Ramírez-Vélez R, Lucia A, et al: Systematic review and meta-analysis of randomized, controlled trials on preoperative physical exercise interventions in patients with non-small-cell lung cancer. Cancers (Basel) 11:944, 2019
46. 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 36:2297-2305, 2018
47. Singh B, Hayes SC, Spence RR, et al: Exercise and colorectal cancer: A systematic review and meta-analysis of exercise safety, feasibility and effectiveness. Int J Behav Nutr Phys Act 17:122, 2020
48. Singh B, Spence R, Steele ML, et al: Exercise for individuals with lung cancer: A systematic review and meta-analysis of adverse events, feasibility, and effectiveness. Semin Oncol Nurs 36:151076, 2020
49. Singh B, Spence RR, Steele ML, et al: A systematic review and meta-analysis of the safety, feasibility, and effect of exercise in women with stage II+ breast cancer. Arch Phys Med Rehabil 99:2621-2636, 2018
50. Sweegers MG, Altenburg TM, Chinapaw MJ, et al: Which exercise prescriptions improve quality of life and physical function in patients with cancer during and following treatment? A systematic review and meta-analysis of randomised controlled trials. Br J Sports Med 52:505-513, 2018
51. Takemura N, Chan SL, Smith R, et al: The effects of physical activity on overall survival among advanced cancer patients: A systematic review and meta-analysis. BMC Cancer 21:242, 2021
52. Waterland JL, McCourt O, Edbrooke L, et al: Efficacy of prehabilitation including exercise on postoperative outcomes following abdominal cancer surgery: A systematic review and meta-analysis. Front Surg 8:628848, 2021
53. Weller S, Hart NH, Bolam KA, et al: Exercise for individuals with bone metastases: A systematic review. Crit Rev Oncol Hematol 166:103433, 2021
54. Ying M, Zhao R, Jiang D, et al: Lifestyle interventions to alleviate side effects on prostate cancer patients receiving androgen deprivation therapy: A meta-analysis. Jpn J Clin Oncol 48:827-834, 2018
55. Yunfeng G, Weiyang H, Xueyang H, et al: Exercise overcome adverse effects among prostate cancer patients receiving androgen deprivation therapy: An update meta-analysis. Medicine (Baltimore) 96:e7368, 2017
56. Baguley BJ, Skinner TL, Wright ORL: Nutrition therapy for the management of cancer-related fatigue and quality of life: A systematic review and meta-analysis. Br J Nutr 122:527-541, 2019
57. Ball S, Brown TJ, Das A, et al: Effect of neutropenic diet on infection rates in cancer patients with neutropenia: A meta-analysis of randomized controlled trials. Am J Clin Oncol 42:270-274, 2019
58. Conigliaro T, Boyce LM, Lopez CA, et al: Food intake during cancer therapy: A systematic review. Am J Clin Oncol 43:813-819, 2020
59. de van der Schueren MAE, Laviano A, Blanchard H, et al: Systematic review and meta-analysis of the evidence for oral nutritional intervention on nutritional and clinical outcomes during chemo(radio)therapy: Current evidence and guidance for design of future trials. Ann Oncol 29:1141-1153, 2018
60. Lawrie TA, Green JT, Beresford M, et al: Interventions to reduce acute and late adverse gastrointestinal effects of pelvic radiotherapy for primary pelvic cancers. Cochrane Database Syst Rev 1:CD012529, 2018
61. Ramamoorthy V, Rubens M, Appunni S, et al: Lack of efficacy of the neutropenic diet in decreasing infections among cancer patients: A systematic review. Nutr Cancer 72:1125-1134, 2020
62. Shingler E, Perry R, Mitchell A, et al: Dietary restriction during the treatment of cancer: Results of a systematic scoping review. BMC Cancer 19:811, 2019
63. Sonbol MB, Jain T, Firwana B, et al: Neutropenic diets to prevent cancer infections: Updated systematic review and meta-analysis. BMJ Support Palliat Care 9:425-433, 2019
64. Yang YF, Mattamel PB, Joseph T, et al: Efficacy of low-carbohydrate ketogenic diet as an adjuvant cancer therapy: A systematic review and meta-analysis of randomized controlled trials. Nutrients 13:1388, 2021
65. Thomson ZO, Reeves MM: Can weight gain be prevented in women receiving treatment for breast cancer? A systematic review of intervention studies. Obes Rev 18:1364-1373, 2017
66. An KY, Morielli AR, Kang DW, et al: Effects of exercise dose and type during breast cancer chemotherapy on longer-term patient-reported outcomes and health-related fitness: A randomized controlled trial. Int J Cancer 146:150-160, 2020
67. CeŠeiko R, Thomsen SN, Tomsone S, et al: Heavy resistance training in breast cancer patients undergoing adjuvant therapy. Med Sci Sports Exerc 52:1239-1247, 2020
68. Demmelmaier I, Brooke HL, Henriksson A, et al: Does exercise intensity matter for fatigue during (neo-)adjuvant cancer treatment? The Phys-Can randomized clinical trial. Scand J Med Sci Sports 31:1144-1159, 2021
69. Gokal K, Munir F, Ahmed S, et al: Does walking protect against decline in cognitive functioning among breast cancer patients undergoing chemotherapy? Results from a small randomised controlled trial. PLoS One 13:e0206874, 2018
70. Heiman J, Onerup A, Wessman C, et al: Recovery after breast cancer surgery following recommended pre and postoperative physical activity: (PhysSURG-B) randomized clinical trial. Br J Surg 108:32-39, 2021
71. Huang HP, Wen FH, Yang TY, et al: The effect of a 12-week home-based walking program on reducing fatigue in women with breast cancer undergoing chemotherapy: A randomized controlled study. Int J Nurs Stud 99:103376, 2019
72. Jacot W, Arnaud A, Jarlier M, et al: Brief hospital supervision of exercise and diet during adjuvant breast cancer therapy is not enough to relieve fatigue: A multicenter randomized controlled trial. Nutrients 12:3081, 2020

73. Mijwel S, Backman M, Bolam KA, et al: Adding high-intensity interval training to conventional training modalities: Optimizing health-related outcomes during chemotherapy for breast cancer: The OptiTrain randomized controlled trial. Breast Cancer Res Treat 168:79-93, 2018
74. Newton RU, Galvão DA, Spry N, et al: Timing of exercise for muscle strength and physical function in men initiating ADT for prostate cancer. Prostate Cancer Prostatic Dis 23:457-464, 2020
75. Özdemir İA, Comba C, Demirayak G, et al: Impact of pre-operative walking on post-operative bowel function in patients with gynecologic cancer. Int J Gynecol Cancer 29:1311-1316, 2019
76. Samuel SR, Maiya AG, Fernandes DJ, et al: Effectiveness of exercise-based rehabilitation on functional capacity and quality of life in head and neck cancer patients receiving chemo-radiotherapy. Support Care Cancer 27:3913-3920, 2019
77. Wiggenraad F, Bolam KA, Mijwel S, et al: Long-term favorable effects of physical exercise on burdensome symptoms in the OptiTrain breast cancer randomized controlled trial. Integr Cancer Ther 19:1534735420905003, 2020
78. Loh KP, Kleckner IR, Lin PJ, et al: Effects of a home-based exercise program on anxiety and mood disturbances in older adults with cancer receiving chemotherapy. J Am Geriatr Soc 67:1005-1011, 2019
79. Abdollahi R, Najafi S, Razmpoosh E, et al: The effect of dietary intervention along with nutritional education on reducing the gastrointestinal side effects caused by chemotherapy among women with breast cancer. Nutr Cancer 71:922-930, 2019
80. Augustus E, Granderson I, Rocke KD: The impact of a ketogenic dietary intervention on the quality of life of stage II and III cancer patients: A randomized controlled trial in the Caribbean. Nutr Cancer 73:1590-1600, 2021
81. Carayol M, Ninot G, Senesse P, et al: Short- and long-term impact of adapted physical activity and diet counseling during adjuvant breast cancer therapy: The "APAD1" randomized controlled trial. BMC Cancer 19:737, 2019
82. de Groot S, Lugtenberg RT, Cohen D, et al: Fasting mimicking diet as an adjunct to neoadjuvant chemotherapy for breast cancer in the multicentre randomized phase 2 DIRECT trial. Nat Commun 11:3083, 2020
83. Forslund M, Ottenblad A, Ginman C, et al: Effects of a nutrition intervention on acute and late bowel symptoms and health-related quality of life up to 24 months post radiotherapy in patients with prostate cancer: A multicentre randomised controlled trial. Support Care Cancer 28:3331-3342, 2020
84. Khodabakhshi A, Akbari ME, Mirzaei HR, et al: Effects of ketogenic metabolic therapy on patients with breast cancer: A randomized controlled clinical trial. Clin Nutr 40:751-758, 2021
85. Khodabakhshi A, Seyfried TN, Kalamian M, et al: Does a ketogenic diet have beneficial effects on quality of life, physical activity or biomarkers in patients with breast cancer: A randomized controlled clinical trial. Nutr J 19:87, 2020
86. Lugtenberg RT, de Groot S, Kaptein AA, et al: Quality of life and illness perceptions in patients with breast cancer using a fasting mimicking diet as an adjunct to neoadjuvant chemotherapy in the phase 2 DIRECT (BOOG 2013-14) trial. Breast Cancer Res Treat 185:741-758, 2021
87. Najafi S, Haghighat S, Raji Lahiji M, et al: Randomized study of the effect of dietary counseling during adjuvant chemotherapy on chemotherapy induced nausea and vomiting, and quality of life in patients with breast cancer. Nutr Cancer 71:575-584, 2019
88. Voss M, Wagner M, von Mettenheim N, et al: ERGO2: A prospective, randomized trial of calorie-restricted ketogenic diet and fasting in addition to reirradiation for malignant glioma. Int J Radiat Oncol Biol Phys 108:987-995, 2020
89. Mohamad H, Ntessalen M, Craig LCA, et al: A self-help diet and physical activity intervention with dietetic support for weight management in men treated for prostate cancer: Pilot study of the Prostate Cancer Weight Management (PRO-MAN) randomised controlled trial. Br J Nutr 122:592-600, 2019
90. Harvie M, Pegington M, McMullan D, et al: The effectiveness of home versus community-based weight control programmes initiated soon after breast cancer diagnosis: A randomised controlled trial. Br J Cancer 121:443-454, 2019
91. Shea BJ, Grimshaw JM, Wells GA, et al: Development of AMSTAR: A measurement tool to assess the methodological quality of systematic reviews. BMC Med Res Methodol 7:10, 2007
92. Courneya KS, Segal RJ, Mackey JR, et al: Effects of exercise dose and type on sleep quality in breast cancer patients receiving chemotherapy: A multicenter randomized trial. Breast Cancer Res Treat 144:361-369, 2014
93. 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 25:4396-4404, 2007
94. 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 33:1918-1927, 2015
95. Ligibel JA, Pierce LJ, Bender CM, et al: Attention to diet, exercise, and weight in the oncology care: Results of an American Society of Clinical Oncology national patient survey. Cancer 128:2817-2825, 2022
96. Fisher A, Williams K, Beeken R, et al: Recall of physical activity advice was associated with higher levels of physical activity in colorectal cancer patients. BMJ Open 5:e006853, 2015
97. Covington KR, Marshall T, Campbell G, et al: Development of the exercise in cancer evaluation and decision support (EXCEEDS) algorithm. Support Care Cancer 29:6469-6480, 2021
98. Schmitz KH, Campbell AM, Stuiver MM, et al: Exercise is medicine in oncology: Engaging clinicians to help patients move through cancer. CA Cancer J Clin 69: 468-484, 2019
99. Wedlake L, Shaw C, McNair H, et al: Randomized controlled trial of dietary fiber for the prevention of radiation-induced gastrointestinal toxicity during pelvic radiotherapy. Am J Clin Nutr 106:849-857, 2017
100. US Food and Drug Administration: Food safety at home. https://www.fda.gov/consumers/free-publications-women/food-safety-home
101. Centers for Disease Control and Prevention: Four steps to food safety: Clean, separate, cook, chill. https://www.cdc.gov/foodsafety/keep-food-safe.html
102. Gardner A, Mattiuzzi G, Faderl S, et al: Randomized comparison of cooked and noncooked diets in patients undergoing remission induction therapy for acute myeloid leukemia. J Clin Oncol 26:5684-5688, 2008
103. Caprara G, Tieri M, Fabi A, et al: Results of the ECHO (Eating habits CHanges in Oncologic patients) survey: An Italian cross-sectional multicentric study to explore dietary changes and dietary supplement use, in breast cancer survivors. Front Oncol 11:705927, 2021
104. Pedersini R, di Mauro P, Bosio S, et al: Changes in eating habits and food preferences in breast cancer patients undergoing adjuvant chemotherapy. Sci Rep 11:12975, 2021
105. Tan SY, Wong HY, Vardy JL: Do cancer survivors change their diet after cancer diagnosis? Support Care Cancer 29:6921-6927, 2021
106. National Comprehensive Cancer Network: NCCN Clinical Practice Guidelines in Oncology: Survivorship. https://www.nccn.org/
107. De Lazzari N, Niels T, Tewes M, et al: A systematic review of the safety, feasibility and benefits of exercise for patients with advanced cancer. Cancers (Basel) 13:4478, 2021

108. Campbell KL, Cormie P, Weller S, et al: Exercise recommendation for people with bone metastases: Expert consensus for health care providers and exercise professionals. JCO Oncol Pract 10.1200/OP.21.00454 [epub ahead of print on January 6, 2022]
109. Patel MI, Lopez AM, Blackstock W, et al: Cancer disparities and health equity: A policy statement from the American Society of Clinical Oncology. J Clin Oncol 38:3439-3448, 2020
110. American Cancer Society: Cancer Facts & Figures for African Americans 2019-2021, 2019. https://www.cancer.org/research/cancer-facts-statistics/cancer-facts-figures-for-african-americans.html
111. Mead H, Cartwright-Smith L, Jones K, et al: Racial and Ethnic Disparities in U.S. Health Care: A Chartbook. New York, NY, The Commonwealth Fund, 2008
112. Howlader N, Noone AM, Krapcho M, et al: SEER Cancer Statistics Review, 1975-2013. Bethesda, MD, National Cancer Institute, 2016
113. Oates GR, Jackson BE, Partridge EE, et al: Sociodemographic patterns of chronic disease: How the mid-south region compares to the rest of the country. Am J Prev Med 52:S31-S39, 2017
114. Shaikh H, Bradhurst P, Ma LX, et al: Body weight management in overweight and obese breast cancer survivors. Cochrane Database Syst Rev 12:CD012110, 2020
115. Parsons JK, Zahrieh D, Mohler JL, et al: Effect of a behavioral intervention to increase vegetable consumption on cancer progression among men with early-stage prostate cancer: The MEAL randomized clinical trial. JAMA 323:140-148, 2020
116. Elshahat S, Treanor C, Donnelly M: Factors influencing physical activity participation among people living with or beyond cancer: A systematic scoping review. Int J Behav Nutr Phys Act 18:50, 2021
117. Keaver L, McGough AM, Du M, et al: Self-reported changes and perceived barriers to healthy eating and physical activity among global breast cancer survivors: Results from an exploratory online novel survey. J Acad Nutr Diet 121:233-241.e8, 2021
118. Ligibel JA, Jones LW, Brewster AM, et al: Oncologists' attitudes and practice of addressing diet, physical activity, and weight management with patients with cancer: Findings of an ASCO survey of the oncology workforce. J Oncol Pract 15:e520-e528, 2019
119. Thomas CA, Hirschorn AM, Tomkins JE, et al: New landscape: Physician compensation. JCO Oncol Pract 17:186-189, 2021
120. Alfano CM, Leach CR, Smith TG, et al: Equitably improving outcomes for cancer survivors and supporting caregivers: A blueprint for care delivery, research, education, and policy. CA Cancer J Clin 69:35-49, 2019
121. Rohan EA, Miller N, Bonner F III, et al: Comprehensive cancer control: Promoting survivor health and wellness. Cancer Causes Control 29:1277-1285, 2018
122. Ferrell BR, Temel JS, Temin S, et al: Integration of palliative care into standard oncology care: American Society of Clinical Oncology clinical practice guideline update. J Clin Oncol 35:96-112, 2017
123. Gilligan T, Coyle N, Frankel RM, et al: Patient-clinician communication: American Society of Clinical Oncology consensus guideline. J Clin Oncol 35: 3618-3632, 2017

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Exercise, Diet, and Weight Management During Cancer Treatment: ASCO Guideline

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/jco/authors/author-center.

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

Steven K. Clinton
Research Funding: NIH, American Institute for Cancer Research, American Cancer Society, Department of Defense-Prostate Cancer Research Program, US Department of Agriculture, and The National Cattleman's Beef Association

Susan C. Gilchrist
Employment: LabCorp

Michele Late
Employment: Tenet Healthcare (I)

Timothy F. Marshall
Employment: Ivy Rehab Network, Select Medical
Consulting or Advisory Role: Select Medical

Jeffrey A. Meyerhardt
Honoraria: Cota Healthcare, Merck
Research Funding: Boston Biomedical (Inst)

William A. Wood
Stock and Other Ownership Interests: Koneksa Health, Elektra Labs
Consulting or Advisory Role: Koneksa Health, Best Doctors Inc, Elektra Labs
Research Funding: Pfizer (Inst), Genentech (Inst)

No other potential conflicts of interest were reported.

APPENDIX

TABLE A1. Recommendation Rating Definitions

Term	Definitions
Quality of evidence	
High	We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate	We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low	Our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low	We have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.
Strength of recommendation	
Strong	In recommendations for an intervention, the desirable effects of an intervention outweigh its undesirable effects. In recommendations against an intervention, the undesirable effects of an intervention outweigh its desirable effects. All or almost all informed people would make the recommended choice for or against an intervention.
Weak	In recommendations for an intervention, the desirable effects probably outweigh the undesirable effects, but appreciable uncertainty exists. In recommendations against an intervention, the undesirable effects probably outweigh the desirable effects, but appreciable uncertainty exists. Most informed people would choose the recommended course of action, but a substantial number would not.

TABLE A2. Exercise, Diet, and Weight Management During Cancer Treatment Guideline Expert Panel Membership

Name	Affiliation	Role or Area of Expertise
Jennifer A. Ligibel, MD, cochair	Dana-Farber Cancer Institute, Boston, MA	Medical oncology, breast cancer, and exercise and weight management interventions
Catherine M. Alfano, PhD, cochair	Northwell Health Cancer Institute and Feinstein Institutes for Medical Research, New York, NY	Behavioral science, symptom management, and cancer care delivery research
Steven K. Clinton, MD, PhD	The Ohio State University, Columbus, OH	Prostate cancer, molecular carcinogenesis, and chemoprevention
Wendy Demark-Wahnefried, PhD, RD	University of Alabama at Birmingham, Birmingham, AL	Diet and weight management in obesity-related cancers
Susan C. Gilchrist, MD, MS[a]	University of Texas MD Anderson Cancer Center, Houston, TX	Cardiorespiratory fitness and cancer
Melinda L. Irwin, PhD, MPH	Yale School of Public Health, New Haven, CT	Exercise and weight management trials in breast and ovarian cancer
Michele Late	Arlington, VA	Patient representative
Sami Mansfield, BA	Cancer Wellness for Life, Lenexa, KS	PGIN representative
Timothy F. Marshall, PhD, MS	Ivy Rehab Network, White Plains, NY	Clinical exercise, rehabilitation, and cancer
Anne M. May, PhD	University Medical Center Utrecht, Utrecht, the Netherlands	Epidemiology, lifestyle interventions, and cancer
Jeffrey A. Meyerhardt, MD, MPH	Dana Farber Cancer Institute, Boston, MA	GI cancer, lifestyle interventions, and cancer
Cynthia A. Thomson, PhD, RD	University of Arizona, Tucson, AZ	Diet and cancer care
William A. Wood, MD, MPH	UNC School of Medicine, Chapel Hill, NC	Malignant hematology, stem-cell transplant, outcomes research, and exercise interventions
Kari Bohlke, ScD	American Society of Clinical Oncology, Alexandria, VA	ASCO Practice Guideline Staff (Health Research Methods)

[a]Panel member through December 2021.