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Physical Activity in Patients With Advanced-Stage Cancer: A Systematic Review of the Literature

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Abstract



The importance of physical activity for chronic disease prevention and management has become generally well accepted. The number of research interventions and publications examining the benefits of physical activity for patients with cancer has been rising steadily. However, much of that research has focused on the impact of physical activity either prior to or early in the cancer diagnosis, treatment, and survivorship process. Research focusing on the effects of physical

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activity, specifically for patients with advanced-stage cancer and poorer prognostic outcomes, has been addressed only recently. The purpose of this article is to examine the state of the science for physical activity in the advanced-stage disease subset of the cancer population. Exercise in a variety of intensities and forms, including yoga, walking, biking, and swimming, has many health benefits for people, including those diagnosed with cancer. Research has shown that, for people with cancer (including advanced-stage cancer), exercise can decrease anxiety, stress, and depression while improving levels of pain, fatigue, shortness of breath, constipation, and insomnia. People diagnosed with cancer should discuss with their oncologist safe, easy ways they can incorporate exercise into their daily lives.

Substantial research exists on physical activity (PA) regarding generally healthy individuals, as well as those with chronic diseases. Some of the most common benefits of activity are understood to be improved mood, prevention or management of chronic diseases (e.g., hypertension, diabetes, hyperlipidemia), increased energy, and more restful sleep (Blair & Morris, 2009). PA is now considered a common disease prevention and management modality within current clinical practice guidelines (Haskell et al., 2007). Specifically, within oncology research, findings have shown an association among sedentary lifestyles and increased risk of developing a malignancy (Pan, Ugnat, Mao, & Canadian Cancer Registries Epidemiology Research Group, 2005; Patel, Rodriguez, Pavluck, Thun, & Calle, 2006). In addition, PA is increasingly being researched as a nonpharmacologic method to optimize patient outcomes by increasing the length of survival after cancer diagnosis and treatments (Courneya & Friedenreich, 2001) while also managing physical and psychological symptoms commonly reported in this patient population (Jones & Peppercorn, 2010; Speck, Courneya, Masse, Duval, & Schmitz, 2010). Several key studies have found PA to be inversely related to risk of disease recurrence and overall mortality in patients with breast or colorectal cancers (Holmes, Chen, Feskanich, Kroenke, & Colditz, 2005; Jones & Peppercorn, 2010; Meyerhardt et al., 2009).

Symptom-related research in patients diagnosed with a malignancy has shown that PA is associated with decreases in physiologic symptoms such as pain, peripheral neuropathy, and fatigue, as well as psychological symptoms of anxiety and depression (Mustian et al., 2009; Nicholas et al., 2007; Oldervoll et al., 2006; Stevinson et al., 2007, 2009). As a result of these positive physical and psychological effects, PA has shown the potential to improve health-related quality of life (HRQOL) and the functional status of patients before, during, and after cancer treatment (Holmes et al., 2005; Jones & Peppercorn, 2010; Meyerhardt et al., 2009; Mustian et al., 2009; Nicholas et al., 2007; Oldervoll et al., 2006; Speck et al., 2010).

The positive findings related to the use of PA in patients with cancer have spurred an increased interest in the benefits of exercise throughout the various cancer-related trajectories. In an effort to facilitate and stimulate research on PA in the oncology care setting, Courneya and Friedenreich (2007) developed the Physical Activity and Cancer Control (PACC) framework. The PACC framework identifies six cancer-related time periods that fall either into pre- or postdiagnosis. Prediagnosis includes prescreening (prevention) and screening (detection), whereas postdiagnosis includes pretreatment

(treatment preparation and coping), treatment (treatment effectiveness and coping), survivorship (recovery and rehabilitation), and end-of-life issues (palliation and survival) (Courneya & Friedenreich, 2007).

In patients with advanced-stage cancer, fatigue is the most prevalent symptom experienced and reported (Bruera & Yennurajalingam, 2010; Portenoy & Itri, 1999; Yennurajalingam, Palmer, Zhang, Poulter, & Bruera, 2008). Yennurajalingam et al. (2008) reported that fatigue most likely has the greatest influence on a patient's HRQOL when compared with all other cancer-related symptoms because it commonly interferes with normal life activities. Patients who experience fatigue often also experience decreased memory, generalized weakness, decreased social involvement, and emotional lability (Portenoy & Itri, 1999) and have a lower functional status (Yennurajalingam et al., 2008). Given this knowledge, additional investigation regarding the benefits of PA in patients with advanced-stage cancer is warranted.

The majority of research and reviews conducted have included patients who are in one of the first five cancer-related time periods identified by the PACC framework (prescreening, screening, pretreatment, treatment, and survivorship). Although one systematic review of PA did focus on the end-of-life cancer-related time period, it only included a palliative care population (Lowe, Watanabe, & Courneya, 2009). The current article reports on the findings of a systematic, comprehensive literature review conducted from November 2006 to May 2007 to examine the effectiveness of PA as an intervention for patients with cancer who fall within the PACC-defined end-of-life time period (i.e., palliation and survival).

Methods

A literature search was conducted using Ovid, MEDLINE[®], CINAHL[®], and PubMed. Key words and phrases used in the literature search included *advanced cancer*, *metastatic cancer*, *exercise*, *physical activity*, *supportive care*, and *rehabilitation*. To be included in this review, articles had to be written in English, published after 1991, and focus on adult participants with advanced-stage cancer, and examine the effects of a form of PA. The articles reviewed included a variety of study designs, including retrospective chart reviews, feasibility studies, case studies, and randomized trials. For purposes of this article, staging and metastatic involvement were used to define advanced-stage cancer. In addition, the PACC framework was used to guide the selection of studies that included either patients in a palliative care setting or those who were categorized by the Institute of Medicine's definition of survivorship: "the period following first diagnosis and treatment and prior to the development of a recurrence of cancer or death" (Courneya & Friedenreich, 2007, p. 243). PA included any form of additional physical movement that resulted in increased energy expenditure (e.g., physical aerobic activity, group exercise, rehabilitation exercises).

The overall goal of this article is to provide a systematic, unbiased review of the best evidence currently available for healthcare practitioners and patients. The authors initially attempted to use the Jadad scale (Jadad et al., 1999) to assess the methodologic quality of the current evidence. However, given the limited amount of literature on PA in patients with advanced-stage cancer, the authors decided that a scoring rubric did not give sufficient merit

to the selected mixed-method studies identified, because many did not include rigorous measurement criteria such as randomization and participant blinding and would have been rejected for inclusion using the Jadad scale. Therefore, a total of 16 research articles of either qualitative or quantitative methods that met the inclusion criteria were selected (see Table 1).

Results

Exercise in Patients With Advanced-Stage Cancer

The benefits of PA are consistently documented as a method to improve vitality, fitness levels, and HRQOL while decreasing many negative symptoms associated with cancer treatment and the disease process. However, whether exercise is a safe and feasible intervention for patients with advanced-stage cancer is not known. Although all 16 articles supported the safety and feasibility of PA for patients with advanced-stage cancer, only 6 of the 16 articles specifically addressed the safety and feasibility associated with introducing a PA program to patients diagnosed with advanced-stage cancer.

In one of the six publications, the study focused specifically on the safety and feasibility of cardiopulmonary exercise testing (CPET) in patients with advanced-stage cancer (Jones et al., 2007). CPET is a procedure that can produce results that assist in determining the appropriate prescription for safe and efficacious PA. The findings from this feasibility study showed an adverse event rate of 6%; Jones et al. (2007) concluded that this demonstrates a self-limiting, individualized PA test that is a safe and feasible tool for patients with advanced-stage cancer.

Two case studies examined the feasibility of aerobic exercise in patients with advanced-stage cancer. In one study, a 55-year-old man diagnosed with advanced hepatocellular cancer completed six weeks of monitored aerobic exercise (Crevenna, Schmidinger, Keilani, Nuhr, Nur, et al., 2003). In the second study, a 48-year-old woman with metastatic breast cancer was able to participate in monitored aerobic exercise three times a week for one year (Crevenna, Schmidinger, Keilani, Nuhr, Fialka-Moser, et al., 2003). Neither of those patients experienced any adverse events or difficulties in completing the exercise program.

A focus group that included women with metastatic breast cancer reported widespread consensus among the participants that yoga is an appropriate and useful method of PA (Carson et al., 2007). Similar findings regarding group PA were reported in a study involving patients in a palliative care setting (Paltiel, Solvoll, Loge, Kaasa, & Oldervoll, 2009). However, this study also concluded that, in this population, having a PA leader who is familiar with patients with cancer and those in a palliative care setting is important so that he or she understands and is able and willing to modify the program as participants' situations change (Paltiel et al., 2009). Oldervoll et al. (2005) acknowledged that although it may be challenging to implement and complete a PA program for this population, it still is feasible. All six articles concluded that PA is a safe and possible intervention for patients with advanced-stage cancer.

Physical Activity Interest and Preference

The potential benefits that patients with advanced-stage cancer may receive with the inclusion of PA as supportive therapy is inconsequential if the patients are not willing or interested in participating in activity of any kind. Therefore, understanding what this population is interested and able to participate in is important. However, only 3 of the 16 studies examined the interests and preferences for PA in patients with advanced-stage cancer. Findings from two studies show that as many as 63%–92% of patients diagnosed with advanced-stage cancer are interested and physically able to participate in PA (Lowe, Watanabe, Baracos, & Courneya, 2010; Oldervoll et al., 2005). Walking was the preferred form of PA for 72% of participants, and 12% were interested in resistance training. About 66% of participants reportedly preferred to engage in less than 20 minutes of PA per session, and 56% preferred to participate in as many as three sessions of PA per week (Lowe et al., 2010).

Preferences for group PA were not uniform across studies. Lowe et al. (2010) reported that 54% of participants expressed strong preference to participate in non-group PA. However, Oldervoll et al. (2005) found that 77% of participants preferred group PA, with only 15% expressing a preference to complete non-group PA. In addition, a qualitative study found that a group setting for PA provided a method of coping for participants (Paltiel et al., 2009). Participants also expressed how the group setting positively transitioned the focus and attention from sickness to health; for these participants, group PA was also seen as a motivational factor given the commitment it created (Paltiel et al., 2009).

The environment should be considered when designing an intervention that includes PA. A gym was an unsuitable setting, even for participants who, prior to their diagnosis, engaged regularly in PA at a gym (Paltiel et al., 2009). They explained that, in an environment where high performance was expected, their physical appearance and concept of health were not compatible with that setting anymore (Paltiel et al., 2009). Therefore, an environment endorsing PA, but also accepting sickness and varying performance levels from one day to the next, was seen as positive and instilled a sense of control (Paltiel et al., 2009). Oldervoll et al. (2005) found that one participant (3%) preferred to complete PA at home, three (9%) preferred the physiotherapy institute, 12 (36%) preferred to divide the PA location between home and hospital, and 16 (47%) preferred solely the hospital setting. However, in the study completed by Lowe et al. (2010), 42 participants (84%) preferred engaging in PA in the home setting.

Although varying views were expressed among participants as to where PA should occur, the main consensus was that PA is something that this population is willing and able to complete. One study also reported that all participants ($n = 34$) expressed a need for a PA group, which was greater in those with advanced-stage disease, and poorer perceived state of health found it important to participate in group PA (Paltiel et al., 2009). Therefore, when designing and implementing PA interventions, taking into consideration the preferences and needs of the specific population is warranted and necessary.

Physical Activity and Functional Status

Patients with advanced-stage cancer have a high incidence of decreased physical functioning related to the cancer treatment and the progression of their disease. Findings have shown that as many as 30% of cancer survivors report functional impairment years after their treatment had been completed (Dimeo, 2001). Dietz (1981) reported that, in about one-third of patients with cancer, the reduction in physical functioning was attributable to physical inactivity. Therefore, one goal should be optimizing the functional abilities that remain in patients with advanced-stage cancer (Ferrans, Zerwic, Wilbur, & Larson, 2005; Stewart et al., 1989), and one approach to that is through PA (Mustian et al., 2009; Oldervoll et al., 2005, 2006).

In the current literature review, eight studies examined the effects of PA on functional activity in patients with advanced-stage cancer. In one study, findings revealed that, for patients with a terminal illness who participated in rehabilitation, the functional activities of daily living improved by a rate of 27% (Yoshioka, 1994). Similarly, the use of physical therapy in patients with advanced-stage cancer in a palliative care unit showed that 56% had functional improvements within the second week of the program, and for 33%, this functional improvement was maintained through the entire intervention (Montagnini, Lodhi, & Born, 2003). In two separate case studies, the participants had improvements in physical functioning. Specifically, a woman with metastatic breast cancer estimated her physical performance to have increased by 40%, and a man with hepatocellular carcinoma reported an increase of 30% (Crevenna, Schmidinger, Keilani, Nuhr, Fialka-Moser, et al., 2003; Crevenna, Schmidinger, Keilani, Nuhr, Nur, et al., 2003). In addition, a group exercise program for patients in a palliative care setting observed significant improvements in role ($p = 0.006$) and social ($p = 0.008$) functioning (Oldervoll et al., 2006).

However, two studies found improvements that were not statistically significant among study participants. With an intervention of physiotherapy for patients in a palliative care setting, Laakso, McAuliffe, and Cantlay (2003) found that, although a clinically significant difference existed, it was only a trend toward significance ($p = 0.09$) between the standard care and intervention groups; that is, at mid-survival the intervention group was functionally more independent than the standard care group. Using self-reported activity levels in a group of patients in a palliative care setting, one study found that those who engaged in more than 30 minutes per day of PA showed trends toward better functioning (Lowe, Watanabe, Baracos, & Courneya, 2009). However, a study examining seated exercise in women with advanced-stage breast cancer did not find significant differences in functional well-being (Headley, Ownby, & John, 2004).

Physical Activity and Symptoms

Patients with cancer often experience multiple concurrent symptoms (i.e., symptom clusters) that are disruptive or debilitating and occur as a result of the treatment and the disease process. In adult patients with cancer, studies have noted that symptoms typically are multiple and vary widely depending on treatment and stage of the disease (Carr et al., 2002). The most common symptom cluster observed in patients with advanced-stage cancer includes pain, fatigue, nausea, and dyspnea, with fatigue being the most common, most

disruptive, and longest lasting symptom according to 60%–90% of patient reports (Barnes & Bruera, 2002). Those findings are clinically significant given that fatigue affects physical, cognitive, and functional aspects of a patient's life and subsequently his or her HRQOL (Barnes & Bruera, 2002).

Ten of the 16 studies reported the effects of PA on symptom management, with the majority of these studies examining the participants' fatigue and pain ratings. Headley et al. (2004) conducted a randomized, controlled trial to examine the effects of seated exercise in women with advanced-stage breast cancer. In the study, the women randomized into the seated exercise intervention group showed statistically lower fatigue scores compared to the usual care group ($p = 0.02$). Similarly, a pilot study examining the effects of yoga in women with metastatic breast cancer found that, on the day after the women practiced yoga, they were significantly more likely to report lower levels of pain ($p = 0.03$) and fatigue ($p = 0.05$) (Carson et al., 2007). Also of interest are findings from the study by Porock, Kristjanson, Tinnelly, Duke, and Blight (2000), who investigated the Duke Energizing Exercise Plan (DEEP). During the study, participants were able to increase activity levels without increasing their fatigue levels.

In the case studies by Crevenna, Schmidinger, Keilani, Nuhr, Fialka-Moser, et al. (2003) and Crevenna, Schmidinger, Keilani, Nuhr, Nur, et al. (2003), the SF-36[®] questionnaire was used and showed improvements in mental health, pain, and vitality for the participants. In addition, the 48-year-old woman self-reported receiving immense benefits from the exercise, stating that her daily fatigue level had been reduced by about 20% and her sleep pattern had improved by 100% (Crevenna, Schmidinger, Keilani, Nuhr, Fialka-Moser, et al., 2003).

In the studies that specifically focused on patients in a palliative care setting, similar symptom improvement also was noted. In one study, patients in a palliative care setting were asked to participate in 50 minutes of group exercise twice a week for six weeks, during which the patients' physical fatigue decreased significantly ($p < 0.05$) (Oldervoll et al., 2006). In addition, Paltiel et al. (2009) examined the experiences of patients in a palliative cancer setting with a group exercise program and found that participants reported relief of mental stress and anxiety. Laakso et al. (2003) studied the impact of physiotherapy on patients in a palliative care setting and found that the patients who received optimized levels of physiotherapy experienced significant improvements in pain ($p = 0.05$), as well as strong trends toward lessened fatigue ($p = 0.08$) and improved appetite ($p = 0.09$). In addition, although p values for between-group differences in symptoms measured were not reported, the intervention group showed clinically significant improvements when compared to the standard care group (Laakso et al., 2003). The majority of terminally ill patients with cancer in a hospice facility who participated in a PA-based rehabilitation-like program showed improvements in symptoms such as pain, dyspnea, edema, and constipation (Yoshioka, 1994).

Most of the studies (70 %) investigating PA's effect on physical symptoms reported findings related to fatigue and pain, which are two of the most common symptoms affecting activity levels. However, some of the studies (40%) included in the review also found improvements in other symptoms. The study conducted by Carson et al. (2007) found that women who

practiced yoga also were more likely to experience higher levels of invigoration ($p < 0.01$), acceptance ($p = 0.02$), and relaxation ($p = 0.03$). The DEEP intervention study also showed strong trends toward decreased levels of anxiety, although the p value was not reported (Porock et al., 2000). Lowe, Watanabe, and Courneya (2009) generally found an association between self-reported PA and level of symptoms experienced, such as anxiety, depression, and nausea, with individuals who report higher levels of activity also reporting better control of those symptoms.

Physical Activity and Health-Related Quality of Life

Quality of life (QOL) has been used within the healthcare profession to measure health-related outcomes since the 1960s (Neugarten, Havighurst, & Tobin, 1961). However, it was not until the 1990s that nursing began to conceptualize QOL and develop a universal definition (Meneses & Benz, 2010). Simplistically defined, QOL is the perceived satisfaction an individual experiences in his or her current life circumstance (Young & Longmann, 1983). HRQOL often is used to focus specifically on outcomes related to disease and treatment—influences related to an individual's health (Ferrans et al., 2005). Four specific domains are accepted as contributing to an individual's overall HRQOL: symptom status, functional status, general health perceptions, and overall QOL (Ferrans, 2010). In general, HRQOL is accepted as subjective, unique for each individual, and dependent on personal and environmental factors.

Nine of the 16 studies reviewed addressed HRQOL in relation to PA in patients with advanced-stage cancer. Of those nine studies, seven showed an increase in the reported HRQOL of the participants. The two case studies described by Crevenna, Schmidinger, Keilani, Nuhr, Fialka-Moser, et al. (2003) and Crevenna, Schmingner, Keilani, Nuhr, Nur, et al. (2003) reported that, after six weeks of aerobic exercise, the woman with metastatic breast cancer reported her HRQOL to have improved by 50%, and the man with hepatocellular cancer reported his HRQOL to have improved by 30%. Kelm et al. (2003) examined the effects of physical training during intrahepatic chemotherapy in participants with metastatic rectal cancer. The Gastrointestinal Quality of Life Index, used to measure the participants' HRQOL after 20 weeks of the intervention, showed a reported increase of 22%. In addition, the 28-day DEEP exercise intervention study in patients with advanced-stage cancer showed a trend toward improved HRQOL, although neither p values nor percent increase were reported (Porock et al., 2000).

For patients in palliative care settings, specifically, the impact of physiotherapy showed an improvement trend, with weak but significant correlations between the intervention and usual care groups ($r = 0.63$, $p < 0.01$) (Laakso et al., 2003). PA in patients under long-term palliative care showed an increase in HRQOL in the consecutive weeks of the study and a correlation with the PA level (Pop & Adamek, 2010). In addition, the patients with advanced-stage cancer receiving palliative care who walked at least 30 minutes per day were found to have higher total HRQOL scores compared to those who exercised less ($p = 0.046$) (Lowe, Watanabe, & Courneya, 2009).

In the remaining two studies that addressed HRQOL in relation to PA in patients with advanced-stage cancer, findings did not show improvements in HRQOL reported by

participants. Specifically, the study comparing usual care to seated exercise in women with advanced-stage breast cancer showed that, although both groups reported declines in HRQOL, the intervention group had a slower decrease in reported HRQOL through four cycles of chemotherapy, with trends toward significance ($p = 0.07$) (Headley et al., 2004). The study by Oldervoll et al. (2006) found that global HRQOL remained stable over the six-week physical exercise intervention with patients in palliative care settings.

Implications for Practice

Understanding the desires, capabilities, and benefits related to PA in patients with advanced-stage cancer is not only beneficial, but necessary to make the best recommendations for patients and their families. Nurses in key practice settings can discuss PA options and make an impact providing education and support to patients, their families, and care partners. Oncology nurses should routinely inquire about patients' activity patterns, as well as offer advice, counseling, and encouragement relating to either maintaining or increasing PA. Improving, delaying decline or maintaining functional status, symptom management, and HRQOL for patients with advanced-stage cancer through the use of PA has the potential to reduce care partner burden, as well as medical costs associated with longer stays in hospitals or skilled nursing facilities. In addition, knowing that many patients with cancer seem to enjoy the motivation and support that group PA provides, developing a PA group program led by a trained exercise physiologist could be supported by many patients. Therefore, the routine education, support, inquiry into personal PA practice, and the development of personalized PA programs for patients with advanced cancer, may be an important method to manage some of the common side effects of advanced-stage cancer and its treatment, which contribute to a decreased HRQOL.

Conclusion

Findings support the use of PA, not only as a safe and feasible intervention in patients with advanced-stage cancer, but also as a potential method to manage functional decline, symptom management, and HRQOL for this unique group of patients. Consideration should be given to the PA setting and the option for group PA, with the specific interests and unique needs of each patient allowed for. Another consideration should be the availability of healthcare professionals during PA for the patients, as Crevenna, Schmidinger, Keilani, Nuhr, Fialka-Moser, et al. (2003) and Crevenna, Schmidinger, Keilani, Nuhr, Nur, et al. (2003) found. In those studies, the patients attributed much of the benefit they received from the PA to the competence of the medical staff during the exercise sessions. Knowledge and information regarding PA in this special patient population is still in its infancy. Therefore, additional investigation into successful models of PA that contain clear guidelines is necessary and could be beneficial.

The potential benefits of PA as a complementary treatment modality for patients with cancer are well documented. PA may be one intervention that not only promotes and encourages living and enjoying life to the very end, but also assists in alleviating many common side effects experienced by patients with progressing disease. Therefore, the inclusion of PA in this population is warranted to improve the HRQOL of patients and care partners, as well as

potentially reduce healthcare-related costs associated with the care of patients with advanced-stage cancer.

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Implications for Practice

- Physical activity as supportive care in patients with advanced-stage cancer is a feasible treatment approach and has the potential to decrease symptoms and improve health-related quality of life.
- Nurses can play an integral role through education and support of patients with advanced-stage cancer related to the benefits of physical activity programs.
- The development of group physical activity programs for patients with advanced-stage cancer that are led by knowledgeable healthcare professionals would likely be supported by patients.

TABLE 1

Research on PA in Patients With Advanced-Stage Cancer From 1994–2010

Study	Purpose	Design and Sample	Findings	Limitations
Carson et al., 2007	Determine the feasibility of a yoga-based intervention in women with metastatic breast cancer, and examine its effects on pain, fatigue, distress, invigoration, acceptance, and relaxation.	Pilot/feasibility study; N = 13 women with metastatic breast cancer; X age = 59 years (SD = 44–75 years)	Yoga improved daily invigoration and acceptance, with trends for improved pain and relaxation. Yoga practice is predictive of improved levels of next-day pain, fatigue, invigoration, acceptance, and relaxation. Program was appropriate and very useful.	Small sample size ^a limits generalizability of findings; lack of control group
Crevenna, Schmidinger, Keilani, Nuhr, Fialka-Moser, et al., 2003	Determine the feasibility and effects of an aerobic exercise program for patients with bone metastases.	Prospective case study; 48-year-old woman with breast cancer and advanced metastasis to the lung, liver, and bone	Exercise was safe, practical, and feasible. Compliance was excellent. Improvements were seen in endurance, physical and social functioning, mental health, pain, vitality, and general health perception. Immense benefit was reported from the PA.	Case study, making generalizing to other populations difficult
Crevenna, Schmidinger, Keilani, Nuhr, Nur, et al., 2003	Determine the feasibility and effects of an aerobic exercise program for a patient with advanced hepatocellular cancer.	Prospective case study; 55-year-old male with advanced hepatocellular carcinoma	The exercise was safe, practical, and feasible, leading to improvements in physical performance; physical, role, emotional, and social functioning; mental health; pain; and vitality.	Case study, making generalizing to other populations difficult
Headley et al., 2004	Examine the effects of a seated exercise program on fatigue and QOL in patients with metastatic breast cancer.	Randomized, controlled longitudinal trial (N = 32)	Intervention group had a slower decline in total and physical well-being and QOL and less increase in fatigue scores starting with the third cycle of chemotherapy.	Potential confounders such as spousal support; 16% attrition; small sample size ^a
Jones & Peppercorn, 2010	Determine the safety and feasibility of cardiopulmonary exercise testing with advanced-stage cancer.	Cross-sectional pilot study enrolling consecutive patients with inoperable NSCLC or metastatic breast cancer (N = 85)	A symptom-limited, individualized cardiopulmonary exercise testing appears to be a relatively safe and feasible assessment tool to evaluate physical functioning in patients with advanced cancer.	Potential selection bias; exclusion of patients with low performance status; cross-sectional design; small sample size ^a
Kelm et al., 2003	Evaluate the role of strength and endurance training during intrahepatic chemotherapy.	Case study of a 58-year-old male with rectal adenocarcinoma	The intervention led to improvements in endurance and lung function as well as an increase in QOL by 22%.	Case study; does not discuss limitations
Laakso et al., 2003	Measure the effects of physiotherapy on QOL and functional levels in patients in a palliative care setting.	Randomized trial (optimal trial physiotherapy service versus usual care) (N = 40)	The intervention group was more likely to be discharged home (p = 0.05) and die at home (p = 0.01). QOL trends improved in the intervention group and declined in the control group.	Small sample size ^a ; does not discuss demographics, specific exercise details; mean length of study
Lowe et al., 2010	Examine the PA interests and preferences of patients in a palliative care setting.	Cross-sectional survey (N = 50); patients with advanced-stage cancer aged 18 years and older with a life expectancy of less than 12 months	The majority of the participants were interested and able to participate in a PA program (92%). Home-based PA programs were preferred by 84%. Less than 20 minutes of PA once a day was preferred by 42%. Walking was the preferred method of PA (72%).	Small sample size ^a ; possible selection bias (self-selection)

Study	Purpose	Design and Sample	Findings	Limitations
Lowe, Watanabe, Baracos, et al., 2009	Examine the association between PA and QOL in patients with cancer receiving palliative care.	Cross-sectional survey (N = 50); advanced-stage cancer in patients aged 18 years and older with a life expectancy of less than 12 months	The study noted trends toward higher physical functioning in participants who engaged in 30-plus minutes of PA per day, and trends toward better reported symptoms in those with self-reported higher PA. An association was seen between PA and QOL.	Self-reported data; small sample size ^a
Montagnini et al., 2003	Assess the use of PT in a hospital-based palliative care unit, characterize functional disabilities in patients who received PT; identify factors related to functional improvement following PT.	Retrospective chart review (N = 100) (96% of patients had end-stage cancer)	Less than 40% received PT and 10% improved in activities of daily living after two weeks. By week two, improvements were seen in 56% of patients receiving PT, and 33% improved throughout the length of PT program. Higher albumin levels correlated significantly with improved function. Patients who were more independent were more likely to receive PT referral.	Retrospective design; difficult to determine if PT alone facilitated the improvements observed
Oldervoll et al., 2005	Identify patients in a palliative care setting who are willing and able to complete a group PA training program.	Phase II intervention study (N = 34); diagnosed with incurable cancer; life expectancy of less than one year	Sixty-three percent of patients with incurable cancer were willing to participate in PA program, with 54% completing the PA program despite severe illness.	Lack of control group; mostly Caucasian; small sample size ^a ; high attrition (46%)
Oldervoll et al., 2006	Assess the effects of PA on physical performance and QOL in a population with incurable cancer and a short life expectancy.	Phase II pilot study (N = 34) (15 male and 19 female); life expectancy of 3–12 months with a Karofsky Performance Scale score of 60 or higher	Significant improvements were found in endurance, emotional functioning, fatigue, role, and social functioning. PA appears to be a feasible way to improve well-being among patients with advanced-stage cancer.	Lack of control group; mostly Caucasian participants; small sample size ^a ; high attrition (46%)
Paltiel et al., 2009	Understand the meaning of PA intervention for the individual participant.	Qualitative semi-structured interview; 5 patients randomly selected from 34 who completed PA intervention	An individually adjusted group exercise program with competent leaders can provide a setting to enhance psychological well-being in patients with cancer who have a life expectancy of less than one year.	Small sample size ^a
Pop & Adamek, 2010	Assess the dynamics of PA in patients in long-term palliative care.	Observational (N = 60) (35 female and 25 male); X age = 71 years (SD = 35–71)	PA increased by 10%–20% in 20% of the participants, no change in 36%, and 44% had a decrease in activity. QOL improved in consecutive weeks of the study and correlated with PA level.	Small sample size ^a ; does not address limitations of study
Porock et al., 2000	Test the effects of a 28-day exercise intervention on levels of fatigue in patients with advanced-stage cancer.	Pilot experimental pre-and post-test design (N = 9) (6 female and 3 male); Eastern Cooperative Oncology Group Score greater than 1; life expectancy greater than one month	PA levels were increased without an increase in fatigue. Trends showed increasing QOL and lower anxiety, and findings provided evidence that PA is suitable for patients in a palliative care setting.	Small sample size ^a ; type of exercise is not discussed for each participant, only length of stay
Yoshioka, 1994	Determine if physical therapy in the terminal stage of cancer can be significantly effective for dying patients.	Observation of rehabilitation intervention (N = 301 terminal patients); questionnaires mailed to family members within three months after patient death (N = 169 returned)	Almost all of the patients experienced relief from pain, dyspnea, edema, constipation, and difficulty completing activities of daily living, with an average improvement of 27%. The questionnaires showed that 88% of the patients desired ambulation, 78% were satisfied	56% response rate from follow-up questionnaire; observational nonrandomized study; does not address limitations

Study	Purpose	Design and Sample	Findings	Limitations
			with rehabilitation, and 98% were satisfied with terminal care.	

^aSmall sample sizes in studies enrolling patients with advanced cancer generally are seen because of challenges in recruitment and retention of this population.

NSCLC—non-small cell lung cancer; PA—physical activity; PT—physical therapy; QOL—quality of life

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