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Using Physical Exercise Interventions to Reduce Depression and Anxiety in People With Lung Cancer

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USING PHYSICAL EXERCISE INTERVENTIONS TO REDUCE DEPRESSION AND AXIETY IN PEOPLE WITH LUNG CANCER

by

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ABSTRACT

People with lung cancer are at a high risk of developing anxiety and depression during cancer treatments. Previous research has shown physical activity to be effective in improving psychological symptoms in people with cancer, however, the majority of studies have focused on female breast cancer survivors. The purpose of this literature review was to determine if physical activity interventions can effectively and feasibly reduce anxiety and depression in people with lung cancer who are undergoing treatment. A database search was conducted in CINAHL Plus, MEDLINE, APA PsycInfo, and SPORTDiscus. The search resulted in 265 articles and 9 were selected for inclusion in this review. Four studies showed significant improvements in anxiety and depression, six studies showed significant improvements in only anxiety, and the remaining studies showed no effect. The studies that improved both anxiety and depression used multimodal physical activity programs that included the use of supplemental psychological and health promoting interventions. Limitations included high drop-out rates, small sample sizes, and using different physical activity programs in a portion of the studies. Multimodal physical activity programs are safe and feasible and should be recommended to reduce anxiety and depressions in people with lung cancer undergoing treatment.

DEDICATIONS

To my family, mentors, professors, and peers for believing in me and making this possible.

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BACKGROUND

The Centers for Disease Control and Prevention (CDC) (2019) states that lung cancer is the leading cause of cancer related deaths in the United States for both men and women and is accountable for nearly 20% of total cancer deaths worldwide (Carnio et al., 2016). By the time of diagnosis of lung cancer, more than 70% of patients are inoperable (Quist et al., 2020). The five-year survival rate for people with lung cancer is around 16-20%, with only an average life expectancy of 10-15 months for people diagnosed with advanced inoperable lung cancer (Quist et al., 2020). Another study states that only 10.9% of people diagnosed with lung cancer live more than five years (Carnio et al., 2016). However, Chen et al. (2015) state that the number of lung cancer survivors are increasing worldwide.

Common treatment options seen with lung cancer include several types of surgery, radiation therapy, chemotherapy, stereotactic body radiotherapy, targeted drug therapy, and immunotherapy (Mayo Clinic, 2020). All of these treatment options can cause numerous side effects, including but not limited to cardiac toxicities, long-term neuropathy, hearing loss, anxiety, and depression (Johns Hopkins Medicine, n.d.). Of these symptoms, psychological problems such as anxiety and depression are frequently experienced among people with lung cancer (Chen et al., 2015). Around 44% of people with lung cancer suffer from depression and anxiety, which is noted to be consistently higher than other cancer types, and the psychological effects of these symptoms have been shown to negatively affect anticancer treatment and mortality (Quist et al., 2020). Chen et al. (2015) report anxiety being present in one-third of people with lung cancer, and another study reports depression being observed in nearly one-third of patients as well (Henshall et al., 2019). Brown et al. (2014) report that lung cancer patients

experience the highest levels of psychological distress among 14 different cancer diagnoses. They state that lung cancer patients are at high risk for developing or worsening psychosocial problems during and after treatment, and that one study reported anxiety and depression nearly doubled after three months from the time of diagnosis for people with lung cancer (Brown et al., 2014). These studies show that anxiety and depression are very prevalent in lung cancer and that many patients suffer from these symptoms.

Quist et al. (2020) state that patients suffer psychologically throughout the course of the disease from the symptoms, co-morbidities, and side effects of treatment of the disease with patients mainly fearing losing function and their independence. Henshall et al. (2019) also state that depression and anxiety in people with lung cancer can arise and worsen from multiple modalities, including surgery, radiotherapy, and/or chemotherapy. Aside from common treatment options playing a role in increasing depression and anxiety levels (Brown et al., 2014), lung cancer stigma (LCS) also contributes to the high distress levels in lung cancer patients. LCS is a perceived health stigma that comes from the negative perceptions about the relationship between smoking and lung cancer, and previous research has shown LCS to be associated with higher depression and anxiety levels, regardless of the patient's smoking status (Brown et al., 2014).

Treatment and recognition of anxiety and depression in people with lung cancer is important because anxiety and/or depression can have profound effects on survivor's emotional and physical well-being, which in turn can interfere with their activities of daily living (Henshall et al., 2019). Chen et al. (2015) recognize that anxiety, depression, and cancer-related symptoms may impair a person's quality of life (QoL) and functional ability in lung cancer survivors. Brown et al. (2014) state that depression and anxiety specifically are associated with a decreased

QoL in people with lung cancer. A study published by Vodermaier et al. (2017) found that people who experience anxiety and depression after being diagnosed with advanced lung cancer are more likely to die sooner than people who report not having anxiety or depression. Previous research supports this, as it suggests an association between a patient's higher reported QoL at the time of diagnosis and an increased life span (Brown et al., 2014).

Treating anxiety, depression, or both symptoms can be done using multiple different interventions, a lot of which are also used for treating the general public. One intervention used worldwide, not just for oncology patients but for anyone experiencing either of these symptoms, is the use of pharmaceuticals. In 2017, the National Center for Health Statistics reported that 12.7% of the U.S. population over the age of 12 took antidepressant medication in the past month (Winerman, 2017). According to the 2013 Medical Expenditure Panel Survey (MEPS), around 1 in 6 Americans currently took a psychiatric drug, also confirming that 12 percent of adults were taking an antidepressant medication (Anxiety and Depression Association of America (ADAA), 2019). One study indicated that cancer survivors in the United States use medication for anxiety and depression more frequently than the general public (Hawkins et al., 2016). Responses from the National Health Interview Survey between the years 2010 to 2013 indicated that nearly 19% of cancer survivors take medication for anxiety and/or depression, with previous research finding that 31% of survivors sought help for psychological concerns (Hawkins et al., 2016).

Pharmaceuticals have been shown to be effective when treating anxiety and depression in people with lung cancer (Begley, 2016). A study conducted by Zingone et al. (2017) reported that antidepressants such as norepinephrine-dopamine reuptake inhibitors (NDRIs) and tricyclic antidepressants (TCAs) were associated with improved survival rates for people with lung cancer

who took them for conditions including depression and/or anxiety. Zingone et al. (2017) state that these are feasible adjunct therapeutics for people with lung cancer due to the low cost of these drugs and tolerable side effects. However, while this can be a convenient intervention for some people, others may experience unwanted and harmful side effects (Begley, 2016). Zingone et al. (2017) also reported that a phase IIA clinical trial targeting stage IV small cell lung cancer patients with a TCA had ended due to most of the patients having intolerable side effects to the medication. This data suggests that treating anxiety and depression with pharmaceuticals may not be the best option for every person who has lung cancer.

Luckily, there are non-pharmaceutical interventions that exist to help treat anxiety and depression that can be used in people with lung cancer. Common non-pharmaceutical treatment options used that have shown to be effective in improving mood in cancer survivors include cognitive behavioral therapy, hypnosis, self-management strategies, and physical activity (Yi & Syrjala, 2017). While evidence from randomized controlled trials indicates all of these interventions being effective in improving psychological symptoms, the majority of studies have focused on female breast cancer survivors (Yi & Syrjala, 2017). Further research is needed to determine the effectiveness and feasibility of using these interventions in people with different types of cancers, such as lung cancer, that include all genders.

One non-pharmaceutical intervention that has been studied is the use of physical activity in people with lung cancer to reduce psychological symptoms such as anxiety and depression. Physical activity such as exercise has been universally accepted as being beneficial to one's health (Medline Plus, 2020). A few benefits that result from exercise in general population include helping control body weight, reducing risk for heart disease, strengthening bones and

muscles, improving sleep, increasing chances of living longer, reducing risks of some cancer including lung cancer, and improving mental health and mood (Medline Plus, 2020).

Studies have shown that physical activity interventions reduce depression and anxiety effectively in cancers such as breast cancer (Yi & Syrjala, 2017). There are randomized controlled trials that have also suggested physical activity interventions to be effective on reducing these symptoms, specifically in people with lung cancer. These studies have been conducted in many different patient populations, however, many of these studies have a small sample size, may contain bias, and all use different physical activity interventions (Quist et al., 2020). This leads to an uncertainty of which physical activity interventions are actually effective, which ones are the most effective, and which interventions are feasible for nurses to recommend to patients. Wang et al. (2019) encourage recommending home-based exercise programs as treatment but suggest further research to determine the most effective physical activity interventions for improving psychological symptoms.

PURPOSE

The primary purpose of this literature review was to determine if physical activity interventions can effectively reduce depression and anxiety in people with lung cancer undergoing treatment. The secondary aim of this literature review was to determine the feasibility of prescribing physical activity interventions to reduce anxiety and depression. It must be determined if patients are capable and willing to adhere to the recommended interventions, and if it is practical for nurses to recommend these interventions to people with lung cancer.

METHODS

A review of the literature was conducted to determine if physical activity interventions are effective in reducing anxiety and depression in people with lung cancer undergoing treatment. The databases used to find articles included CINAHL, APA PsycInfo, MEDLINE, and SPORTDiscus databases. The search for articles took place between June 2020 and October 2020. Key terms used in the search included “TI cancer* or AB cancer* or SU cancer or (MH "Cancer Patients") OR (MH "Neoplasms")”, AND “exercis* or ‘physical activity’”, AND “depression or depressive or anxiety”, AND “lung.” Studies met inclusion criteria for the review if they included lung cancer survivors currently undergoing radiation therapy, chemotherapy, targeted drug therapy, immunotherapy, and/or surgery. Studies were excluded if they were not published in English, were published before 2010, if the patients in the study were receiving palliative care, and if any of the patients were under 18 years old.

RESULTS

An initial search resulted in 265 articles: MEDLINE (120), CINAHL Plus with Full Text (97), APA PsycInfo (34), and SPORTDiscus (14). After the removal of duplicates, carefully reviewing the title, abstract, and/or full text of the remaining articles, 256 were excluded because they did not meet the inclusion criteria. Nine articles were selected for inclusion in this review. Figure 1 shows the selection process for the literature review.

The characteristics of each study are listed in Table 1. Five studies were conducted on patients only receiving chemotherapy (Arai et al., 2010; Olivier et al., 2018; Park et al., 2019; Quist et al., 2015; Quist et al., 2020), one study included patients receiving chemotherapy and/or radiotherapy (Kuehr et al., 2014), two studies included patients who received recent surgery directly related to lung cancer and also receiving chemotherapy (Cavalheri et al., 2017, Sommer et al., 2018), and one study included patients who had received surgery directly related to lung cancer without any current adjuvant therapies (Lu et al., 2020).

The effects of a physical activity (PA) program on people with anxiety and depression undergoing treatment were assessed in eight of the studies (Arai et al., 2010; Cavalheri et al., 2017; Lu et al., 2020; Park et al., 2019; Olivier et al., 2018; Quist et al., 2015; Quist et al., 2020; Sommer et al., 2018), while the study by Kuehr and colleagues (2014) only assessed depression. The HADS tool was used to measure anxiety and depression in six studies (Arai et al., 2010; Cavalheri et al., 2017; Olivier et al., 2018; Quist et al., 2015; Quist et al., 2020; Sommer et al., 2018). The PHQ-9 measurement tool was used in two studies to measure depression (Kuehr et al., Park et al., 2019), the GAD-7 tool was used in one study to measure anxiety (Park et al.,

2019), and the SAS and SAD tools were used to measure anxiety and depression in one study (Lu et al., 2020).

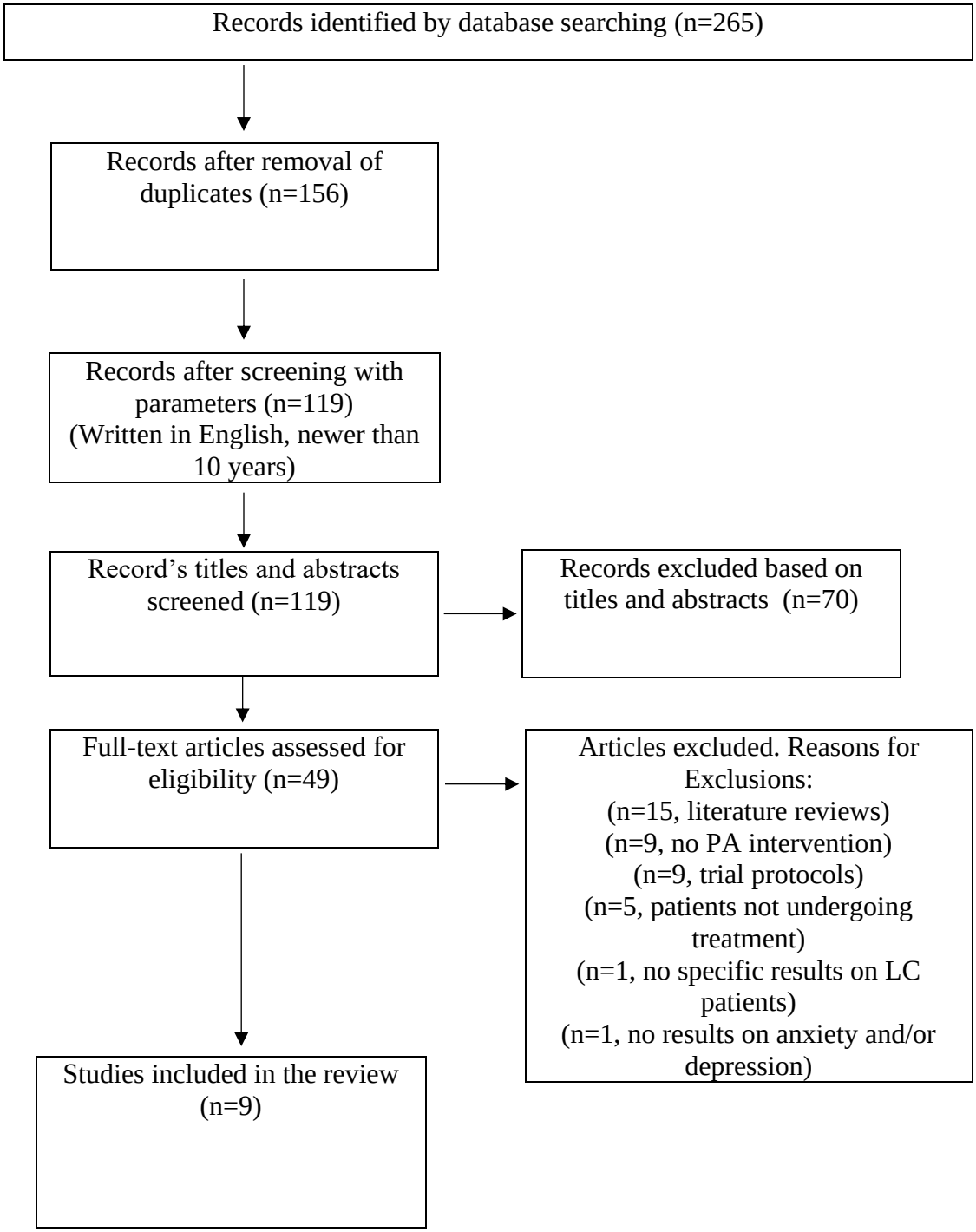
Six of the articles used a pretest-posttest cohort study design (Arai et al., 2010; Kuehr et al., 2014; Lu et al., 2020; Olivier et al., 2018; Park et al., 2019; Quist et al., 2015), two studies used a randomized controlled trial comparative study design (Cavalheri et al., 2017; Quist et al., 2020) and one study used a 4-arm, randomized feasibility design (Sommer et al., 2018). Sample sizes for the studies ranged from 9 to 218 participants. The mean ages of participant's ranged from 55.1 to 68 years old. Diagnosis' of the participant's lung cancers ranged from stage I-IV.

One study implemented an intervention that included information and encouragement about PA without a specific exercise program in place (Arai et al., 2010), two of the studies implemented an intervention consisting of exercise-only programs (Cavalheri et al., 2017; Kuehr et al., 2014), and six of the studies implemented multiple interventions that included an exercise program with additional non-exercise interventions (Lu et al., 2020; Olivier et al., 2018; Park et al., 2019; Quist et al., 2015; Quist et al., 2020; Sommer et al., 2018).

The length of the programs varied among the studies, as four studies were 12 weeks in length (Lu et al., 2020; Park et al., 2019; Quist et al., 2020; Sommer et al., 2018), three studies were eight weeks in length (Cavalheri et al., 2017; Kuehr et al., 2014; Olivier et al., 2018), one study was six weeks (Quist et al., 2015), and the last study was four weeks (Arai et al., 2010). Four of the studies conducted supervised PA programs (Cavalheri et al., 2017; Quist et al., 2015; Quist et al., 2020; Sommer et al., 2018), two of the studies used a combination of supervised and unsupervised PA programs (Kuehr et al., 2014; Lu et al., 2020), and three of the studies implemented an unsupervised PA program (Arai et al., 2010; Olivier et al., 2018; Park et al., 2019).

Figure 1

Prisma Flow Diagram



FINDINGS

The results of each study and details of each intervention are described below. Findings listed include the effects of PA on anxiety and depression, and any other significant findings that the researchers were measuring for each study. Interventions used in the studies alongside PA interventions are included as well.

Encouragement and Supportive PA Interventions

The study by Arai and colleagues (2010) examined the feasibility of an intervention aimed to increase PA levels and to measure psychological adjustment in advanced LC patients. The researchers implemented an intervention that provided support and encouragement through a 4-week period that aimed to enhance participant's PA levels. Participants (n=9) wore a step counter throughout the day which tracked their activity levels. Each patient was instructed to live normally for one week, then the intervention was provided to each participant to enhance their PA the following week (start of week 1 – T1, end of week 1 – T2). The intervention included feedback, positive reinforcement, enhancement of autonomy, and information for setting goals relating to PA. This occurred again after week 2 (T3), and again after week 4 (T4). Outcomes including anxiety and depression were compared with step counts throughout the study to observe for any correlation between the two. No significant changes were noted throughout the study in mean step counts, anxiety scores, or depression scores. Higher step counts did have a significant relationship with lower depression scores in the beginning of the intervention at week 1 (T2) and week 2 (T3) but had no correlation after this. The researchers state that this indicates a relationship between PA and psychological adjustment and a successful PA intervention design

are possible. Three participants dropped out of the study by the end of the second week (33.3% dropout rate). The researchers suggest that a PA intervention program is not feasible for LC patients undergoing chemotherapy based on their results.

Endurance and Strength PA Interventions

Two studies implemented exercise only interventions and both used an 8-week endurance and strength exercise program (Cavalheri et al., 2017; Kuehr et al., 2014). The first was A randomized clinical trial (RCT) by Cavalheri and colleagues (2017) examining the correlation between supervised exercise training and exercise capacity, PA levels, peripheral muscle force, lung function, and psychological reportings from patients. The 8-week exercise program engaged participants in supervised, individualized training three times per week for 60 minutes. Each session consisted of aerobic (walking or cycling) and resistance (upper and lower limbs) training. Participants in the exercise group (EG) (n=9) walked in a corridor or on a treadmill for 20 minutes at an intensity of 70%-80% of their maximum effort. The resistance training consisted of step-ups (2 sets of 10 repetitions) and exercises with weights for the upper arms (3 sets of 10 repetitions). The control group (CG) (n=8) was instructed to continue to perform their usual activities. They received phone calls once a week, consisting of general conversation and standardized questions about their well-being. It is unclear if the intervention group received these phone calls as well. Anxiety scores and depression scores were compared between the EG and CG. Anxiety scores and depression scores showed no significant changes post-intervention, although there was a significant increase in exercise capacity for the exercise group: oxygen consumption ($p=0.02$) and 6-minute walk distance ($p=0.02$). Four of the nine participants (44%) completed at least 15 (60%) of the training sessions (mean 17 ± 3). The researchers suggest that LC patients may benefit from PA programs.

The other study was a cohort study by Kuehr and colleagues (2014) aimed at determining the feasibility of an exercise program and assessing if there was a correlation between exercise and strength capacity, QoL, fatigue, and depression. The intervention was an 8-week consecutive hospital and home-based exercise program, combining endurance and resistance training. All patients (n=40) received exercise materials and a training manual and recorded their exercises in a standardized diary. During the inpatient setting, participants exercised five times a week, with three of the days being supervised, and two of the days being independent training sessions. At home, participants exercsied three times a week. Endurance training included brisk walks or a cycle ergometer during inpatient stays, and resistance training exercises were performed following a training manual. In addition, participants received a follow up phone call each week so they could report any problems or difficulties with the interventions. Outcomes were measured at baseline (T0), post-intervention (T1), and at 8 weeks post-intervention (T2). The researchers concluded this as a feasible PA program, as twenty-two (55%) of the 40 participants met feasibility requirements of performing at least two training sessions per week in six of the eight intervention weeks. The dropout rate of participants was 23%. Depression scores had no significant change over time, however, depression scores actually increased slightly from T0 to T1 (T0: 5.4 ± 3.8; T1: 6.0 ± 4.6), but this was not statistically significant and declined by T2 (T2: 4.7 ± 3.6). There was a significant improvement in functional capacity, including increased strength in knee extension and flexion ($p<0.01$), hip abduction ($p<0.01$), and endurance (28 m; $p<0.01$).

Multimodal Pulmonary Rehabilitation Interventions

Two of the studies implemented pulmonary rehabilitation (PR) programs while also offering education and counseling. (Olivier et al., 2018; Park et al., 2019). The cohort study by Olivier and colleagues (2018) aimed to assess the feasibility of a home-based pulmonary rehabilitation (PR) program and to evaluate safety and effectiveness of the intervention in LC and mesothelioma patients receiving chemotherapy. In this 8-week, home-based PR program, participants exercised five days a week for 30-45 minutes a day. The training programs were individually tailored to participants, involving endurance training on the cycle ergometer, strength developing exercises using weights and resistance bands, and incorporating activities of daily living. At the end of each week, a member of the rehabilitation team provided follow-up care to each patient for 90 minutes. These sessions included feedback and information on exercise training, information on resuming daily living activities, therapeutic education, psychological counseling, motivational communication, and advice on nutrition to aid in healthy behavior and self-management. Of the 243 potential participants eligible for participation, 65.8% refused to enroll. Once patients enrolled, 11 more dropped out, leaving 71 patients who started the intervention. Twenty-four additional participants dropped out before the end of the PR program, leaving only 47 patients who finished the program. The researchers considered this program feasible and safe. There was a significant decrease in anxiety scores by the end of the program (Before PR: 7 [5-10], After PR: 6 [3-8], $p=0.03$), however, there was no significant decrease in depression scores. Daily PA scores ($p=0.007$), the 6-minute stepper count ($p=0.02$), and the time needed to complete 10 chair stands (10CS) ($p=0.04$) significantly improved in LC patients as well.

The cohort study by Park and colleagues (2019) evaluated the feasibility and efficacy of a 12-week, home-based, smartphone-based PR and educational program on exercise capacity, QoL, and symptom management in patients. A mobile health care application (Smart Aftercare) for cellphones was used to provide exercise information to participants. Aerobic exercises were prescribed for at least three days a week, 30-60 minutes a day. Strengthening exercises were prescribed once a day for 30 minutes, consisting of exercises for all major muscle groups in the limbs and trunk. The patients were instructed to run the app and wear an activity measuring device during workouts. A clinical nurse specialist provided counseling services to patients through the app. The app also provided information on pain control, nutritional support, and symptom management. The researchers deemed this intervention feasible and effective, as 90 of 100 (90%) participants completed the 12-week PR program. Anxiety among participants significantly improved by 12 weeks (baseline: 3.9 [SD 4.1], 6 weeks: 3.4 [SD 3.7, $p=0.11$], 12 weeks: 2.4 [SD 3.8, $p<.001$]). Depression worsened by 6 weeks (baseline: 4.7 [SD 4.9], 6 weeks: 5.0 [SD 5.2, $p=0.44$]), but significantly improved by the end of 12 weeks (3.5 [SD 4.5, $p=0.02$). The 6-minute walk distance significantly improved through week 12 ($p<0.01$) and dyspnea scores significantly improved in patients with a stable tumor response ($p=0.07$). Role scores ($p=0.02$), emotional scores ($p<0.001$), and social functioning scores ($p=0.002$) significantly improved after the PR intervention. Symptoms including fatigue ($p<0.001$) and anorexia ($p=0.048$) significantly improved as well.

Multimodal PA Interventions

Two studies implemented exercise programs that included strength training, endurance training, stretching, and relaxation (Quist et al., 2015; Quist et al., 2020), one study implemented strength training, endurance training, education, and counseling (Sommer et al., 2018), and one study implemented strength training, endurance training, Tia Chi, and education (Lu et al., 2020). The cohort study by Quist and colleagues (2015) aimed to measure the benefits of a multimodal group exercise intervention on aerobic capacity, HRQoL, muscle strength, anxiety, and depression. The 6-week program was supervised, and each training session included warmup exercises, strength training, cardiovascular training, and stretching exercises. Participants completed the training twice a week for 90-minutes each session. After each training session, 15-20 minutes of progressive relaxation was performed. Of the patients (n=114) who completed baseline testing, 43 dropped out (37.7%) and did not perform the 6-week test point. The researchers considered this program to be feasible. Results showed that there was a statistically significant reduction in anxiety scores at post-intervention (median score, -0.9 [95% CI, -1.55 to -0.25]), but no significant reduction in depression scores was noted. Significant improvements were reported for VO2 peak (P<.001), 6-minute walk distance (p<.001), muscle strength measurements (p<.05), and emotional well-being (p<0.0001).

Using an RCT design, Quist and colleagues (2020) conducted a 12-week physical exercise intervention to evaluate the effects of this program on VO2 peak, 1 repetition maximum (1RM) strength, functional capacity, HRQoL, anxiety, and depression in participants. This intervention consisted of supervised, structured cardio and strength training twice a week for 90 minutes in a group of 10-12 participants. After each session, 15-20 minutes of progressive relaxation training took place. The control group received usual treatment as prescribed and were

recommended to stay active during their chemotherapy treatments. Among the 687 eligible patients, 218 were included in the program, with 110 participants being allocated to the intervention group and 108 to the control group. Sixty-six participants (60%) from the intervention group were assessed at 12 weeks, and 67 participants (62%) from the control group were assessed at 12 weeks. Mean adherence to the 24 sessions attended was 44%. There was a significant reduction in anxiety (mean difference, -1.1 [95% CI, -2.1 to -0.1]) and depression (mean difference, -1.3 [95% CI, -2.4 to -0.2]) between the control group and intervention group at 12-weeks. There were also statistically significant improvements in social well-being ($p=0.04$) and muscle strength, which included leg press ($p=0.01$), leg extension ($p<0.01$), lateral pull down ($p=0.04$), and chest press ($p<0.01$). The feasibility of this program was shown previously in the study by Quist and colleagues (2015).

The 4-arm, randomized feasibility study by Sommer and colleagues (2018) evaluated the safety and feasibility of a rehabilitation exercise program in an outpatient setting and reported health-related quality of life (HRQoL) changes before and 1 year after surgery. The study allocated participants into four groups: 1) preoperative (pre-op) and postoperative (post-op) exercise started two weeks after surgery, 2) pre-op and post-op exercise started six weeks after surgery, 3) post-op exercise started two weeks after surgery, and 4) current standard care, post-op exercise started six weeks after surgery. The pre-op intervention consisted of 30 minutes of endurance training daily until surgery, which ranged from 2-15 days. All participants were involved in the same post-op PA exercise intervention. The study implemented the 12-week supervised post-op intervention, where about half of the patients began the exercise intervention 2-weeks post-surgery, while the other half began the intervention 6-weeks post-surgery. The intervention was comprised of 24 group-based exercise sessions, three individual counseling

sessions, and three group-based sessions involving information on health-promoting behavior. Smoking cessation information, nutritional counseling, and patient education was also offered. Individually tailored strength exercises and group aerobic training took place twice a week on non-consecutive days for 60 minutes per session. Follow up telephone calls were provided to each patient, although it was not stated when and how often they took place. Assessments of the patients took place at five different time periods: baseline assessments at the time of diagnosis, an assessment the day before surgery, an assessment 2-14 days after the intervention period ended, an assessment near 26 weeks after surgery, and a final assessment near 52 weeks after surgery. A previous study conducted by Sommer and colleagues (2016) indicated that the postoperative rehabilitation program is safe and feasible. Forty patients started the post-op exercise intervention, with 11 dropping out before the end of the 12-weeks. Twelve of the 18 patients allocated to pre-op exercises received instructions, and 3 adhered to the daily exercise. The following results are concluded as a whole from the 29 patients who completed the post-op intervention, as results were not provided for each arm of the study. Emotional well-being ($p<0.0001$), global quality of life ($p=0.0032$), and mental health ($p=0.0004$) all had significant improvements throughout the study. There was a significant reduction in anxiety ($p=0.0003$) and depression ($p=0.0062$) levels during the study period, with the greatest reductions observed at 6 months post-op. When evaluated at the one-year point, anxiety and depression scores had increased from the 6-month time period.

The final study was conducted by Lu and colleagues (2020), where the researchers implemented a three-part exercise program and offered additional education to the participants. The researchers assessed the feasibility and safety of implementing an exercise program in patients who have recently undergone LC surgery. Secondary outcomes measured included

physical functioning of patients and patient-reported questionnaires. The researchers utilized a 12-week PA program that combined supervised and home-based exercise interventions. Patients exercised five times a week, being supervised twice a week in the physical therapy department comprising of 90-minute sessions. The first part of the supervised portion was resistance training consisting of 6 different progressive exercises involving major limb movements. Exercises were conducted in three sets with 8 to 15 repetitions each set. The second part of the supervised portion consisted of simplified 8-style Tai Chi and natural breathing. The last part consisted of brisk walking for aerobic training at a pace of 80% of their maximum effort. The other three days consisted of an unsupervised home-based exercise program, where the patients walked for 20-30 minutes per session. Education was given to patients, including importance and intensity of exercise, dietary advice, how to manage their symptoms, and how to overcome exercise barriers. Participants checked in weekly with the therapists to discuss adherence and subsequent instructions for the following week. Eight of the 17 (47%) participants met feasibility requirements by attending at least 70% of the scheduled supervised exercise sessions. Five participants (29.4%) did not attend any supervised exercises after their baseline assessment. However, 16 of the 17 (94%) completed the post-intervention questionnaire assessment. This study was not considered feasible by the authors, as there was a low consent rate (17 of 78 eligible participants - 22%) and low adherence rate. Significant improvements were observed in the 16 participants who completed the post-intervention questionnaire in both anxiety (baseline 37.4 ± 6.8, follow-up 31.3 ± 5.8, p=0.002) and depression scores (baseline 36.0 [32.0-54.0], follow-up 31.0 [28.0-35.5], p=0.020) from baseline to follow-up. Improvements in respiratory function were observed, with an increased forced expiratory volume (FEV_1) noted (p=0.02). Significant improvements were also observed in emotional functioning (p=0.012), global

HRQoL (p=0.018), and sleep quality (PSQI) (p=0.003). A significant decrease in dyspnea (=0.157) and coughing (p=0.008) was observed as well in participants.

Table 1

Study Comparison Table

Author	Title/Source	Study Design	Purpose	Sample	Method	Interventions	Results
Quist et al. (2020)	Effects of an exercise intervention for patients with advanced inoperable lung cancer undergoing chemotherapy: A randomized clinical trial.	Comparative study; RCT	**Primary outcome:** change in maximal oxygen uptake (VO2 peak). **Secondary outcomes:** muscle strength, functional capacity, forced expiratory volume in 1 s, HRQoL, anxiety, and depression.	218 patients with advanced inoperable lung cancer, >18 years old, has a WHO performance status of 0,1,or 2 with stage IIIb-IV non-small-cell lung carcinoma (NSCLC) or extensive disease small-cell carcinoma and were undergoing chemotherapy. 110 people INT group 108 people CON group Mean age 64.5. Location: Denmark.	VO2 peak (Cardiopulmonary exercise testing on a cycle ergometer); 1 Rep Max (Technogym); functional capacity (6MWT) FEV1 (standard spirometry test); HRQoL (FACT-L); anxiety and depression (HADS).	12-week physical exercise intervention (INT) comprising supervised, group structured exercise training (cardio, strength, stretching, and relaxation training) twice weekly versus a control group with usual care (CON).	218 patients randomized, 110 starting the PA program. 66/110 patients completed the 12-week assessment from the intervention group. Mean adherence of the 24 sessions was 44%. No significant difference between VO2 peaks. Significant improvement in muscle strength. Significant reduction in anxiety and depression. Significant difference in groups for social well-being. Program is considered feasible.
Kuehr et al. (2014)	Exercise in patients with non-small cell lung cancer.	Cohort Study; pretest-posttest	**Primary outcome:** feasibility (adequate adherence) **Secondary outcomes:** endurance and	40 enrolled (24 males, 16 females), Pts must have NSCLC (stages IIa-IV), be undergoing radio and/or chemotherapy,	Functional capacity (6MWT); maximal voluntary isometric contraction (HHDM); Quality of Life [QoL]	8-week consecutive hospital and home-based combined endurance and resistance training program. Participants exercised 5 times a	40 patients started the PA program, 31/40 (77.5%) completed post-exercise assessment (T1) and 22/40 (55%) completed follow-up assessment (T2). 55% of participants met feasibility. Significant.

			strength capacity, QoL, fatigue and depression.	BMI >18, and ability to read German. Mean age 60 (22-75). Location: Germany.	(FACT-L); fatigue (MFI); depression (PHQ-9); exercise program status (individual standardized diary)	week, being supervised for 3 days a week. Outpatient participants exercised 3 times a week. Participants received weekly follow up phone calls.	improvement in the 6-minute walk distance and in knee, elbow, and hip muscle strength after the intervention T1. No significance for QoL, fatigue, and depression scores - remained stable or declined slightly. Significant improvements in knee-muscle strength were also observed at T2. Program is considered feasible.
Sommer et al. (2018)	Changes in health-related quality of life during rehabilitation in patients with operable lung cancer: A feasibility study (PROLUCA)	4-arm, comparative, randomized feasibility study	To investigate the safety and feasibility of preop and early postop rehab in a nonhospital setting, focusing on exercise, in pts undergoing surgery for LC. The aim of the article is to present HRQoL changes over time before and 1 year after surgery in the same population.	40 patients included (16 males, 24 females). 9(22%) underwent a thoracotomy, 31(78%) had video-assisted thoracic surgical resection (VATS), 13 (33%) received postoperative (adjuvant) chemotherapy. Inclusion – NSCLC, scheduled for surgery with curative intent, >18, WHO status 0 to 2, resident of City of Copenhagen or nearby, ability to read/understand	HRQoL (EORTC-QLQ-C30 & the FACT-L scale); general well-being (SF-36 form); anxiety and depression (HADS); distress (NCCN Distress Thermometer); social support (MSPSS).	Pre-op endurance training daily until surgery (2-15 days). Post-op, individually tailored, supervised strength and cardiorespiratory exercise twice a week (60 min/session) on nonconsecutive days for 12 weeks (total 24 sessions). 3 individual counseling sessions and 3 group-based lessons in health - promoting behavior were included. HRQoL was assessed 5 times: at diagnosis, day before surgery, 2-14 days after last	18 patients allocated to the pre-op intervention, 3 adhered to daily exercise. 40 patients started the post-op PA program, 11/40 patients dropped out, including 3 due to side effects of chemo. Post-op adherence was >70% in 15/29 patients. Global quality of life, mental health, and emotional well-being had a statistically significant improvement throughout the study. Statistically significant reductions in anxiety, depression, and distress, with greatest reduction found at 26 weeks after surgery. Program is considered feasible (Sommer et al., 2016).

				Danish, and approval by primary surgeon. Mean age 68. Location: Denmark.		exercise intervention, 26 weeks after surgery, and 52 weeks after surgery.	
Park et al. (2019)	Mobile phone app-based pulmonary rehabilitation for chemotherapy-treated patients with advanced lung cancer: Pilot study	Cohort study; pretest-posttest	To investigate the feasibility and efficacy of a smartphone app-based pulmonary rehabilitation and educational program on exercise capacity, symptom management, and QoL in patients with NSCLC undergoing chemotherapy.	100 patients enrolled (46 males, 54 females). Patients undergoing chemotherapy, aged 20-75 years (mean age 55.1), had NSCLC stage II-IV, ECOG-PS score of 0-2, and had an android smartphone. Location: South Korea.	Endurance (6MWT); Strength (arm abduction test); QoL (EORTC QLQ-C30); pain (NRS); anxiety (GAD-7); depression (PHQ-9).	12-week pulmonary rehab program. Exercise prescribed once a day for 30-60 min. at least 3 days a week, a walking distance target of 60-80% of the 6MWT, and strength once a day for 30 min. Counseling, pain control nutritional support, and symptom management services were provided through the app.	100 patients started the 12-week rehab program, with 90/100 participants completing it. 6MWD had significant improvement. No significant improvement in patients overall. Emotional and social functioning had significant improvements. Fatigue, anorexia, and diarrhea showed significant improvements. Depression and anxiety had significant improvements. No significant change in QoL or severity of pain.
Quist et al. (2015)	The impact of a multidimensional exercise intervention on physical and functional capacity,	Cohort study; pretest-posttest	To investigate the benefits of a 6-week supervised group exercise intervention and to determine the effect on aerobic	114 included (57 males, 57 females). Subjects are over 18, WHO status of 0-2, stage IIIb-IV NSCLC and SCLC-ED, and	Aerobic capacity, muscle strength, & functional capacity (6MWD); FEV1 (spirometer); HRQoL and cancer-related	6-week program, supervised group training (physical training and relaxation) carried out in group 10-12 patients twice weekly. Each	369 eligible participants, 114 started PA program. 71/114 patients (62%) completed training and offered results. Significant increase in aerobic capacity, VO2peak, and functional capacity.

	anxiety, and depression in patients with advanced-stage lung cancer undergoing chemotherapy.		capacity, strength, HRQoL, anxiety, and depression.	were undergoing chemotherapy. Mean age 66 (31-88). Location: Denmark.	symptoms (FACT-General and FACT-L); anxiety and depression (HADS).	session was 1.5 hours. Sessions included warmup, strength and fitness training, stretching, and relaxation.	Significant improvement in strength. Significant reduction in anxiety score. No significant reduction in depression. Significant decrease in social well-being. No significant improvement in HRQoL, fatigue, or FACT-L subscales. Program is considered feasible.
Cavalheri et al. (2017)	Exercise training for people following curative intent treatment for non-small cell lung cancer: A randomized controlled trial	Comparative study; RCT	**Primary outcome:** exercise capacity **Secondary outcomes:** PA and sedentary behavior, peripheral muscle force, HRQoL, fatigue, feelings of anxiety and depression, and lung function.	17 participants were included (5 males, 12 females); 9 in exercise groups and 8 in control groups. Inclusion was people 6-10 weeks after lobectomy for NSCLC (stages I-IIIA), or for patients who required post-op chemotherapy 4-8 weeks after their last cycle. Mean age 67. Location: Australia.	Exercise capacity (6MWD); HRQoL (SF-36, FACT-L, and EORTC QLQ-C30); anxiety and depression (HADS); fatigue (FACIT-Fatigue); handgrip force (dynamometer); PA levels (two PA monitors).	8-week program aimed at improving aerobic capacity and muscle strength. Included individualized training 3X per week, lasting 60 min each. Each class comprised aerobic and resistance training. Control group received no exercise training.	17 patients enrolled in study, 9 started the PA program. 4/9 participants (44%) adhered to exercise training. Significant increased exercise capacity. No changes observed in PA and sedentary behavior, peripheral muscle force, HRQoL, fatigue, feelings of anxiety and depression, and lung function. Researchers suggest PA programs may be beneficial for LC patients.
Arai et al. (2010)	Physical activity and psychological adjustment in Japanese advanced lung cancer patients in	Cohort Study; pretest-posttest	1) To examine the feasibility of the PA intervention program 2) examine the change in patient's PA and	9 patients initially enrolled. 6 participants (5 males, 1 female) completed the study Participants were undergoing chemotherapy,	Physical activity and step count (Uniaxial accelerometry monitor [Lifecoder EX]); psychological adjustment -	Each patient was instructed to wear the step counter during the day. For week 1, each participant was instructed to live normally. After	9 patients started the intervention, 6/9 participants completed the intervention period (66.6% completion rate). Results suggest a PA intervention program is not feasible. Psychological adjustment

	chemotherapy: The feasibility of intervention.		psychological adjustment 3) examine the relationship between PA and psychological adjustment in Japanese advanced lung cancer patients in chemotherapy.	without mental disease, and received a rating of 0-2 on the Eastern Cooperative Oncology Group Performance Status. Mean age 61 (48-64). Location: Japan.	anxiety and depression (HADS); Lung cancer symptoms (MDASI-J); participants activity level at week 0 (transtheoretical model of change).	this, an intervention was given to each participant to enhance their PA. This occurred again after week 2, and then again after week 4. Data from the step-counters were collected throughout the entirety of the study.	did not change at any time during the study. No significant changes with anxiety or depression.
Olivier et al. (2018)	Real-life feasibility of home-based pulmonary rehabilitation in chemotherapy-treated patients with thoracic cancers: A pilot study	Cohort Study; Pretest-posttest	**Primary outcome:** feasibility and safety **Secondary outcomes:** exercise capacity, lower limb muscle strength, dyspnea, QoL, anxiety, and depression.	71 patients started the home-based PR (54 males, 17 females). Most were men in their 60s with a smoking history and advanced LC. All pts treated with chemotherapy. Mean age was 60.1. Location: France.	Exercise capacity (6MWT); lower limb muscle strength (TUG, 10CS); chronic dyspnea on exertion (mMRC scale); QoL (VSRQ); anxiety and depression (HADS).	Independent, home based 8-week program, 5 days per week. Each day lasted 30-45 min and included endurance training on cycle ergometer and muscle strengthening exercises. Resumption of daily physical activities, therapeutic education, psychological counseling, motivational communication, and nutritional advice was implemented.	243 eligible participants, 71 started the PA program. 24 patients did not complete program. 47/71 (66%) finished the program. Significant decrease in anxiety. No significant decrease in depression. 6MWT stability and 6MST improvement. Daily PA was significantly improved. No significant decrease in dyspnea scores and in lower limb muscle tiredness. QoL improvement was not significant.

Lu et al. (2020)	A 12-week multi-modal exercise program: Feasibility of combined exercise and simplified 8-style Tai Chi following lung cancer surgery.	Cohort study; pretest-posttest	**Primary outcome:** feasibility and safety. **Secondary outcomes:** measurements of physical function and patient-reported questionnaires.	78 patients with stage I-IIIA NSCLC at 6-12 weeks following completion of treatment were approached, 17 consented (5 males, 12 females). Mean age was 59 (44-63). Conducted at a tertiary hospital in Nantong, China.	Physical function (6MWT and Short Physical Performance Battery [SPPB]); PA levels (electronic pedometer); mood (Self-rated Anxiety Scale [SAS] and the Self-rating Depression Scale [SDS]); HRQoL (EORTC-QLQ-C30 and LC13); symptoms (MDASI-T); sleep (PSQI).	12-week program, supervised exercise 2X per week in PT department, 90-minute sessions, and exercise at home for 3X per week. 3 parts exercise intervention: resistance training, simplified 8-style Tai Chi, & aerobic exercise (brisk walking). Home program included walking at home 20-30 minutes a week on non-supervised exercise days. Education about exercise and dietary advice was given. Exercises were individually tailored each week.	78 eligible participants, with 17 consenting to study. 16/17 participants completed the post-intervention follow-up questionnaire (94%). 47% (8/17) attended at least 70% of scheduled supervised sessions – feasibility is not supported. 3 minor adverse events occurred; no serious adverse events reported. Significant improvement in FEV1. Significant improvement in HRQoL. Significant reduction in anxiety and depression. No significant improvement in functional capacity or PA levels.

Notations

RCT – randomized control trial
HRQoL – health related quality of life
1 Rep Max – 1 repetition maximum
FEV1 – forced expiratory volume in 1 second
CON – control group
PA – physical activity
NSCLC – non-small-cell lung carcinoma
BMI – body mass index
MFI - multidimensional fatigue inventory
LC – lung cancer
EORTC - European Organization for Research and Treatment in Cancer
SF-36 – Short Form Health Survey
MSPSS - Multidimensional Scale of Perceived Social Support
Post-op – post operation
NRS – numeric rating scale
6MWD – 6-minute walk distance
FACIT-Fatigue – Functional Assessment of Chronic Illness Therapy – Fatigue subscale
TUG – timed Up and Go Test
mMRC - Modified Medical Research Council dyspnea scale
SPPB - Short Physical Performance Battery
SDS – Self-rating Depression Scale
PSQI - Pittsburgh Sleep Quality Index
VO2 – maximal oxygen uptake
WHO – World Health Organization
6MWT – 6-meter walk test
INT – intervention group
FACT-L – functional assessment of cancer therapy – lung
HADS – Hospital Administered Anxiety and Depression Scale
QoL – quality of life
HHDM - handheld dynamometry
PHQ-9 - patient health questionnaire
VATS - video-assisted thoracic surgical resection
QLQ – Quality of Life Questionnaire
NCCN - National Comprehensive Cancer Network
Pre-op – pre operation
ECOG-PS - Eastern Cooperative Oncology Group-Performance Status
GAD-7 – generalized anxiety disorder-7
SCLC-ED – extensive stage disease small cell lung cancer
MDASI-J – Japanese version of the M.D. Anderson Symptom Scale

10CS – 10 chair stands
VSRQ - Visual simplified respiratory questionnaire
SAS – Self-rating Anxiety Scale
LC13 – lung cancer module
MDASI-T – Taiwanese version of the M.D. Anderson Symptom Scale

DISCUSSION

This review examines the literature published within the last 10 years regarding the effects of PA on depression and anxiety in people with lung cancer undergoing treatment. The findings from this literature review indicate that implementing PA programs is feasible in this population to decrease anxiety and depression. Feasibility was defined in these studies as participants adhering to the PA programs, which included consenting to the study and/or completing a certain amount of intervention sessions. A majority of the studies (six) reported their interventions as being feasible (Cavalheri et al., 2017; Kuehr et al., 2014; Olivier et al., 2018; Park et al., 2019; Quist et al., 2015; Quist et al., 2020; Sommer et al., 2018), 2 of the studies reported PA intervention programs as not being feasible (Arai et al., 2010; Lu et al., 2020), and Cavalheri and colleagues (2017) suggested LC patients undergoing curative treatment may benefit from PA programs. The study by Lu and colleagues (2020) reported that their study was not considered feasible due to the low consent and adherence rate, even though their PA program significantly reduced anxiety and depression. The study did have participants exercise five times a week, ranging from 20-90 minutes, and did implement a three-part exercise intervention. The perceived large amounts of exercise may have contributed to participants not wanting to join and/or adhere to these study conditions. Implementing a less-extensive exercise intervention therefor may be more feasible, as other studies with successful results implemented less-frequent and shorter-duration workouts.

The studies that had the lowest dropout rates included the studies conducted by Park and colleagues (2019), Kuehr and colleagues (2014), and Sommer and colleagues (2018). While these three studies all had over a 70% completion rate, two of the studies did not offer

adherence/feasibility rates (Park et al., 2019; Sommer et al., 2018). The study by Kuehr and colleagues (2014) did offer a feasibility rate, stating that only 55% of participants met the feasibility requirements of attending a certain amount of intervention sessions. Only four studies overall offered the number of participants meeting adherence rates, which ranged between 44% to 55% of participants (Cavalheri et al., 2017; Kuehr et al., 2014; Lu et al., 2020; Quist et al., 2020). It is hard to determine which PA intervention programs actually had the highest attendance rate of participants throughout the entirety of the studies since not all studies provided the adherence rates and/or number of participants who met feasibility requirements. Each study also had their own guidelines for meeting adherence and feasibility. The interventions used in each study were all found to be safe, as no serious adverse events were reported by any of the researchers. However, Lu and colleagues (2020) did report three minor adverse events occurring throughout their intervention period.

While three studies show no evidence of PA interventions improving anxiety and/or depression (Arai et al., 2010; Cavalheri et al., 2017; Kuehr et al., 2014), six studies provide evidence of a PA program improving anxiety (Olivier et al., 2018; Quist et al., 2015), and four of those studies provide evidence of a PA program improving both anxiety and depression (Lu et al., 2020; Park et al., 2019; Quist et al., 2020; Sommer et al., 2018).

The findings suggest that a PA program is beneficial at reducing anxiety and depression in this population when meeting certain criteria—at least 12 weeks in length and implementing a multimodal PA intervention. The results show that any unimodal intervention was not effective in reducing anxiety and/or depression (Arai et al., 2010; Cavalheri et al., 2017; Kuehr et al., 2014). Each of these studies only implemented one type of intervention, including only support and encouragement to improve PA levels (Arai et al., 2010), or only a strength and endurance

exercise program (Cavalheri et al., 2017; Kuehr et al., 2014). These three studies did however have small sample sizes and used intervention periods of eight weeks or less. The other six multimodal intervention studies implemented a PA intervention, as well as a psychological and/or health promoting intervention, which included therapy, education, counseling, motivational communication, nutritional advice, relaxation, health promotion, and/or symptom management (Lu et al., 2020; Olivier et al., 2018; Park et al., 2019; Quist et al., 2015; Quist et al., 2020; Sommer et al., 2018). All six of these studies' intervention were associated with significantly reduced anxiety in people with lung cancer, however, only four of the studies reduced both anxiety and depression (Lu et al., 2020; Park et al., 2020; Quist et al., 2020; Sommer et al., 2018).

The key difference found in these studies that affected both anxiety and depression was the length of the intervention period. The four studies that significantly reduced anxiety and depression scores implemented a 12-week intervention (Lu et al., 2020; park et al., 2020; Quist et al., 2020; Sommer et al., 2018), while the two other studies that only reduced anxiety implemented a 6-week intervention (Quist et al., 2015) and an 8-week intervention (Olivier et al., 2018). To further support this, the two studies conducted by Quist and colleagues (2015) and Quist and colleagues (2020) implemented a near-identical intervention, with the length of intervention being the major difference. The study by Quist and colleagues (2015) only implemented the intervention for six weeks and found a significant reduction in anxiety, but not depression. In contrast, the study by Quist and colleagues (2020) implemented nearly the same intervention for 12 weeks and found a significant reduction in both anxiety and depression. This suggests that long-term exercise may be more beneficial than temporary PA programs.

An interesting finding presented by two studies is an increase in depression near 6-8 weeks after an intervention began (Kuehr et al., 2014; Park et al., 2019). The study by Kuehr and colleagues (2014) showed a slight, non-statistically significant increase in depression by the end of the 8-week intervention, but then had a decrease in depression when evaluated eight weeks after the end of the intervention. The study by Park and colleagues (2019) also showed depression worsening by six weeks after the start of the intervnetion, but then significantly improving by the end of the intervention at 12 weeks. These findings further support that the criteria of an effective intervention should be at least 12 weeks in length when targeting depression.

While not all of the studies were effective in reducing both anxiety and depression, the interventions implemented were found to have other significant positive effects on the participants, including improved PA levels, strength, emotional and social well-being, cancer-related symptoms, and/or quality of life (Cavalheri et al., 2017; Kuehr et al., 2014; Lu et al., 2020; Olivier et al., 2018; Park et al., 2019; Quist et al., 2015; Quist et al., 2020; Sommer et al., 2018). The results show that exercise can be beneficial in other aspects of health and that some exercise may be better than none, as one study used shorter 30-45-minute exercise intervals and had significantly reduced anxiety in participants (Olivier et al., 2018). However, this study did implement other interventions in their study as well, and none of the exercise-only interventions were effective in reducing anxiety and/or depression (Cavalheri et al., 2017; Kuehr et al., 2014).

Limitations of the studies that may affect the results include a high drop-out rate of greater than 30% in a majority of the studies and low sample sizes (<50 participants) in over half of the studies. High dropout rates and small sample sizes may result in a reduced probability that the significant results can be generalized. Both of these limitations may lead to biases, such as

toward people who liked to exercise prior to LC. Each of the studies, with the exception of the studies by Quist and colleagues (2015) and Quist and colleagues (2020), uses a different PA intervention as well. This may also cause a limitation of knowing which programs actually work best. However, it does show that multiple different types of interventions are effective, meaning if one type of program doesn't work for a particular patient, another type of intervention might be beneficial.

There does not appear to be a difference in outcomes between PA interventions that were supervised vs. unsupervised, group-exercises vs. individualized exercises, or home-based settings vs. inpatient/outpatient settings. There also does not appear to be a difference in outcomes when comparing the amount of exercise participants engaged in while completing the intervention periods. Successful interventions ranged from exercising 120 minutes a week to up to 390 minutes a week.

IMPLICATIONS

The implications of this review present recommendations for nurses to implement in clinical practice and recommendations for further research regarding PA in people with lung cancer undergoing treatment.

Recommendations for Clinical Practice

Nurses should first screen patients at baseline for past and present anxiety and depression, their current activity levels, and their willingness for engaging in PA. Nurses can help patients find a good starting point on a multimodal PA program based on their assessment. Starting all patients on a PA program is recommended even if they are not experiencing anxiety and depression symptoms, or if they are already taking medications for these symptoms. Doing so may help prevent developing and/or worsening anxiety and depression levels while also providing many other health benefits.

Nurses should then have a discussion with patients and educate them on PA and how it can be an effective long-term strategy to reduce anxiety and depression. When discussing PA programs with patients, patients should be involved as much as possible in creating a program and schedule. Nurses can use these findings to promote PA in their patients with lung cancer or encourage them to find a formal activity program that meets the several recommendations from this review. In either situation, in order to help patients reduce their anxiety and depression, PA programs should combine endurance and resistance training, along with at least one other psychological/health promoting strategy. Programs should be at least 12 weeks in length or longer, and patients should be encouraged to be active as much as possible. If patients don’t want or can’t adhere to a program that has them exercising five days a week, then starting them on a

program that implements PA exercises 2-3 times a week would be more practical and might be easier for them to adhere to. Some patients may not be able to tolerate long exercise periods, so starting them on shorter exercise periods, such as 20-minute workout intervals, and then increasing the length of workouts each week may be beneficial for the patient to meet the recommended guidelines. The recommendations of the U.S. Department of Health and Human Services (HHS) (2018) and World Health Organization (WHO) (2020) both recommend 150-300 minutes of moderate-intensity PA per week for adults, including cancer survivors. They state this population should gradually increase activity as tolerated and should aim to engage in more than the recommended activity levels (when not contraindicated) to avoid the harmful effects of a sedentary lifestyle (WHO, 2020).

Additional psychological/health promoting strategies that nurses should recommend include therapy, counseling, education, nutritional advice, motivational communication, relaxation, and/or symptom management. Since there isn't enough evidence that supports which intervention is best when used alongside PA, nurses can offer any of these additional interventions to patients depending on what they are interested in and have access too. Nurses can refer clients to personal trainers or physical therapists, find a program online and provide it to the patient, or use a smartphone-based application to guide the patient in PA. While not everyone has convenient access to the supplemental therapies such as therapists, counselors, or dieticians, nurses can also use and recommend smartphone-based applications and internet services that involve teachings and demonstrations of psychological/health promoting interventions.

Nurses should discuss with patients whether home-based settings or outpatient settings better fit their needs, as well as group-training sessions vs independent training sessions. The

variety of settings that can be used increases patients' autonomy and allows them to be included in determining what type of program best fits their needs, such as their personalities, desires, and financial situation. This may increase their adherence to their PA programs and outcomes as they get to choose what they like.

Evaluating patients' levels of anxiety and depression throughout treatment is important as well to determine if the current PA exercises and supplemental psychological/health promoting interventions are effectively reducing symptoms. If it is found that the patient isn't having reduced symptoms, nurses should suggest a change or implement additional supplemental psychological/health promoting interventions or have them do additional physical activities. Nurses should also assess the need for medication if the patients aren't seeing any significant improvements in their anxiety and depression and/or if they are not on any medications already. Nurses should also evaluate if the patients are adhering to their programs.

Recommendations for Research

Further research must be conducted to evaluate if additional interventions such as psychological or health promoting interventions are necessary in conjunction with exercise interventions. Further research using exercise-only PA programs needs to be conducted using longer intervention periods of at least 12 weeks, with much larger sample sizes to evaluate if exercise alone is feasible and if engaging in some exercise is better than none. This research should also include measuring anxiety and depression in participants well after the intervention has completed, such as 12-weeks post intervention. In future studies, cardio-only exercises, such as walking, biking, hiking, or swimming, or resistance-training-only exercises, such as weightlifting, should be implemented to determine if one type of exercise is beneficial, which

one is more beneficial (if any), or if participants must engage in both types of exercise to reduce anxiety and depression.

Additional research is also needed to determine the best type of supplemental psychological/health promoting interventions to be used alongside exercise or independently when targeting anxiety and depression in this population. Future studies should implement the same PA exercise program in a large sample size study and consider conducting multi-arm clinical trials to determine which supplemental interventions best complement the PA program.

Further research must also be conducted to determine how to increase exercise adherence. Future studies may consider comparing PA programs among participants exercising two times a week to participants exercising four times a week, attempting to use very similar exercise routines. This will help determine if PA programs with less frequent exercise have a greater adherence rate or vice versa. Multi-arm clinical trials should also be considered for conducting future studies with very similar PA programs to compare home-based settings to outpatient settings and individualized training to group training sessions. This can help determine which types of programs have the greatest adherence rates among participants.

CONCLUSION

This review is intended to provide nurses with insight regarding whether implementing a PA program in people with lung cancer undergoing treatment is effective and feasible in reducing anxiety and depression, and if so, what kind of PA program is best. A PA program that is at least 12 weeks in length, includes strength and cardio exercises, and implements other psychological and/or health promoting interventions was found to be most effective. Further research is needed to determine if exercise-only PA programs are feasible, which additional interventions best compliment PA programs, and how to increase adherence rates among participants. Nurses should promptly recommend long-term multimodal PA interventions that consists of endurance training, resistance training, and at least one supplemental psychological/health promoting intervention to all people with lung cancer to help reduce or prevent these symptoms from occurring during and after lung cancer treatment.

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