

## Influences of Aerobic and Resistance Exercise on Health-related Problems in Cancer Patients: A review of the literature

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### Abstract

**Purpose** : Until recently, the number of cancer patients continues to increase, and these patients have many limitations in their activities of daily living. In the republic of Korea, cancer patients are showing an increasing trend every year. Cancer disease not only significantly reduces the quality of life in individuals, but also causes various side effects if not managed. The purpose of this study was to investigate the effects of aerobic exercise and resistance exercise on health-related problems in cancer patients.

**Methods** : This study searched for studies that applied aerobic exercise and resistance exercise to cancer patients reported in search engines (google scala, dbpia, and pubmed) from 2017 to 2022. Six randomized controlled trials and two systematic reviews and meta-analyses were used for analysis in our study. “physical activity”, “exercise”, “aerobic exercise”, “resistance exercise”, and “cancer patient” were the main search terms. The data included aerobic exercise, resistance exercise, cancer patients’ muscle strength, physical strength, quality of life, and physical activity.

**Results** : According to the eight studies that met the criteria included in this review study, it was found that aerobic exercise and resistance exercise had an effect on the increase in physical fitness, muscular strength, quality of life, and range of motion in cancer survivors.

**Conclusion** : It was confirmed that aerobic exercise and resistance exercise are safe and effective interventions that can be applied to cancer patients without side effects. A limitation of this study is that it did not examine cancer diseases in various population groups such as the elderly and children. Therefore, in future studies, studies that consider specific details such as age, gender, type of cancer, and physical differences are needed.

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**Key Words** : aerobic exercise, cancer, physical activity, quality of life, resistance exercise

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## I. Introduction

Cancer is the leading cause of death in Korea, and the risk of developing cancer from birth to life expectancy in Koreans is 37 %. The number of people diagnosed with cancer increased by 33 % from 182,730 in 2008 to 243,837 in 2018 (Kim & Kim, 2021). Recently, the Ministry of Health and Welfare designated the Central Cancer Registry and announced Korea's national cancer registration statistics collected through the national cancer registration statistics project (Korea central cancer registry, 2019; Korean Statistical Information Service, 2020). The number of new cancer patients in 2020 was 247,952 (130,618 males and 117,334 females), a decrease of 9,218 (4 %) compared to 2019 (257,170). If Koreans survived to life expectancy (83.5 years), the probability of getting cancer was 37 %. It was estimated that 2 out of 5 males (80.5 years old) (39 %) will develop cancer. Additionally, 1 in 3 females (86.5 years old) (34 %) will also develop cancer. The age-standardized incidence rate per 100,000 people was 295.8, an increase of 3.4 (1 %) from the previous year. By gender, the male cancer incidence decreased by 6 people compared to the previous year, but the female cancer incidence increased by 6.6 people. The 5-year relative survival rate of patients diagnosed with cancer in the last 5 years ('16-'20) is 72 %, and it has been reported that 7 out of 10 cancer patients survive for more than 5 years. Compared to the survival rate of cancer patients about 10 years ago ('06-'10), it increased by 5 % (Korean Statistical Information Service, 2020).

Although the number of cancer patients is rapidly increasing due to various causes, the number of cancer survivors is also increasing with the development of medical technology (Jee, 2022). Cancer incidence continues to increase due to aging, westernized eating habits, and low physical activity (Min et al., 2020). Cancer research fund international and US national cancer institute report that cancer incidence is closely related to smoking, diet,

infection, alcohol consumption, and insufficient physical activity (Kim & Kim, 2021). Maintaining a healthy lifestyle is essential to prevent cancer (Kim & Kim, 2021). According to Min et al. (2020), physical activity is one of the representative lifestyle factors that directly or indirectly affect the prognosis of cancer patients and cancer survivors and is reported to be closely related to the quality of life (Min et al., 2020). In recent medical and pharmacological research papers that play a role in physical activity, physical activity is effective against various diseases such as mental diseases, nervous system diseases, metabolic diseases, cardiovascular diseases, lung diseases, musculoskeletal diseases, immune diseases, and cancer, which emphasize the importance of exercise. It is growing more and more as research reports on treatment that prevents it (Seo & Kwak, 2020). Cancer survivors experience depression, anxiety, low self-esteem, and poor quality of life, and experience problems such as increased fatigue, weight gain, and decreased immune function. Regular exercise improves the psychological and physical health of cancer survivors and helps cancer survivors recover their health and alleviate various cancer-related sequelae, increasing the importance of cancer survivors' recovery and rehabilitation (Min et al., 2020; Prieto-Gómez et al., 2022).

The cancer population includes cancer patients and survivors. Among them, sarcopenia, a decrease in muscle mass, is easily found. Cancerous sarcopenia significantly reduces the quality of life by weakening physical strength and interfering with body functions that enable daily living (Jee, 2022). Despite the high demand for effective treatment of sarcopenia, pharmacological agents produce relatively unsatisfactory results, while resistance training is considered a safe way to increase muscle mass or prevent sarcopenia (Cao et al., 2022; Jee, 2022).

Cancer patients are generally advised to engage in regular aerobic and resistance training and, most importantly, avoid inactivity. In addition to the overall health benefits, exercise is important for preventing physical

## II. Methods

loss and loss of muscle mass during cancer treatment (Mikkelsen et al., 2022). Numerous randomized controlled trials have provided evidence to suggest exercise training (e.g., cardiovascular training, resistance training, balance, flexibility exercise, and pilates) as a safe and effective strategy for maintaining muscle mass, physical performance, and psychological well-being (Buffart et al., 2017; Campbell et al., 2019; Kang et al., 2022; Mikkelsen et al., 2022; Stout et al., 2017). Combined resistance and aerobic exercise effectively attenuated metabolic syndrome, sarcopenic obesity, and related biomarkers in an ethnically diverse sample of sedentary, overweight, or obese survivors of breast cancer (Dieli-Conwright et al., 2018a). The purpose of this study was to conduct a systematic review study on the results of aerobic exercise and resistance exercise interventions based on research on interventions in cancer patients.

In this study, randomized controlled trials and systematic reviews of exercise interventions for cancer patients submitted from January 2017 to June 2022 were searched using google scholar, dbpia, and pubmed. “physical activity”, “exercise”, “aerobic exercise”, “resistance exercise”, and “cancer patient” were the main search terms. The data included aerobic exercise, resistance exercise, cancer patients’ muscle strength, physical strength, quality of life, and physical activity. 1,300 studies on the effects of physical activity, aerobic exercise, and resistance exercise interventions on cancer patients, and the quality of life of cancer patients were searched. Among them, about 1,279 studies whose original text could not be confirmed or did not present appropriate results regarding exercise intervention were excluded, and 21 studies suitable for this study were classified. Of the 21 studies, suitable 6 randomized controlled trials and 2 systematic reviews and meta-analyses that analyzed the effects of aerobic exercise and resistance exercise on health-related problems in cancer patients were included in this study.

Table 1. A study on the effect of aerobic exercise and resistance exercise on cancer patients

Authors	Method		Result
	Aerobic exercise	Resistance exercise	
Dieli-Conwright et al. (2018b)	treadmill/walking/running/rowing machine/stationary bicycle To maintain Heart Rate 60-80 %, build cardiorespiratory endurance and maintain prescribed strength, the target Heart Rate is increased every 4 weeks Increases from 30 minutes (week 1) for 50 minutes (week 16) according to the increase in cardiorespiratory fitness, and end with a 5 minute cooldown at VO2 max.	LegPress /ChestPress/Lunges/Seated/Row/LegExt ensions /TricepsExtensions /Leg Flexion/Biceps Curl Set to 1-RM 80 % for the lower body and 1-RM 60 % for the upper body, and after completing 3 sets of 10 reps, a 10 % increase. Every 4 weeks, the number of repetitions increases by 10 (week 4), 12 (week 8), 15 repetitions (week 12).	After intervention, the quality of life and depression of the exercise group were superior to those of the general group. At a 3-month follow-up, muscle strength and physical strength remained significantly improved as a result of all patient-reported results.
Dieli-Conwright et al. (2018a)	treadmill/walking/running/rowing machine/stationary bicycle To maintain Heart Rate 60-80 %, build cardiorespiratory endurance and	LegPress /ChestPress/Lunges/Seated/Row/LegExt ensions /TricepsExtensions /Leg Flexion/Biceps Curl	Combined resistance and aerobic exercise effectively attenuated metabolic syndrome, sarcopenic obesity and related biomarkers in an ethnically

Authors	Method		Result
	Aerobic exercise	Resistance exercise	
	maintain prescribed strength, the target Heart Rate is increased every 4 weeks Increases from 30 minutes (week 1) for 50 minutes (week 16) according to the increase in cardiorespiratory fitness, and end with a 5 minute cooldown at VO2 max.	Set to 1-RM 80 % for the lower body and 1-RM 60 % for the upper body and increase by 10 % when you complete 3 sets of 10 reps 2 times in a row Every 4 weeks, the number of repetitions increases by 10 (week 4), 12 (week 8), 15 repetitions (week 12).	diverse sample of sedentary, overweight, or obese survivors of breast cancer.
Sweeney et al. (2019)	12 min of walking, 5 times per week. Target Heart Rate = Resting Heart Rate + 30 BPM 30 min of walking, minimum of 3 days per week. 60 – 70 % of max Heart Rate. Moderate intensity walking, 20 min, 4 times a week Individualized prescription. Majority beginning at 10-15 min of walking, 5-6 times per week. Progressing to 30 min per session, 5-6 times per week. 10-min warm up, 30 min of walking, 5-10-min cool down. 65 % of heart rate reserve. 3 times per week. 30 min of moderate intensity seated exercise, 3 times a week. Bed ergometer, daily, 1 min on, 1 min off. 15 times. Minimum of 50 % of heart rate reserve. Progressive cycle ergometer. Initially, 15-20 min, 3 times per week, beginning at 60 % of peak power output	9 exercises, 2 sets of each exercise, 8-12 reps per set, 60-70 % of 1RM, 3 times per week. Resistance arm: 10 exercises, 2 sets, 8-12 repetitions per set, 60-70 % of 1RM, 3 times per week. Intensity progressively increased. Aerobic arm: Cycle ergometer, treadmill, or elliptical trainer, 50-60 % of VO2 max, initially beginning at 15 min per session, 3 times per week. Volume and intensity progressively increased. Resistance arm: 8 resistance machine exercises, 3 sets, “intensity of 12 repetitions maximum” Relaxation arm: Progressive muscle relaxation (Jacobsen method), no aerobic or resistance exercise. Resistance and endurance groups: 60 min, two times a week. Endurance group: cycle ergometer, 11-14 on the Borg scale. Resistance Group: 10 exercises, 1 set per exercise with 20 repetitions per set, 50 % of 1RM.	All active range of motion measures were significantly increased in the exercise group compared to the baseline measure and the general control group.
Jo & Lee (2020)	-	(elastic band exercise) Shoulder flexion, extension, abduction, E/R, I/R Shoulder joint flexion, extension, abduction, external rotation, and internal rotation are repeated for 10 seconds each. With both arms spread apart, Neck joint flexion, extension, rotation, and 10 seconds each for a total of 30 minutes.	In both the control group treated with the closed grip and the test group treated with the open grip, the circumference and pain around the upper arm edema were reduced, and the range of motion of the shoulder joint increased. The experimental group of the open grip decreased swelling and pain and increased the range of motion of the shoulder joint compared to the control group of the closed grip when the elastic band exercise program was performed for more than 6 weeks.

Authors	Method		Result
	Aerobic exercise	Resistance exercise	
Takemur et al. (2020)	<p>Walk 40 minutes 3 times a week for 12 weeks</p> <p>12 weeks of supervised walking.</p> <p>Gradually increase to 150 minutes per week.</p> <p>Walk for 1 hour twice a week for 3 months, rest 10 minutes.</p> <p>Walk 20-30 minutes 5 times a week for 5-35 weeks</p>	-	Aerobic and mind and body are beneficial and safe for improving sleep in cancer patients with all sleep disorders.
Lee et al. (2019)	<p>treadmill/walking/running/rowing machine/stationary bicycle</p> <p>Perform 1:1 supervised exercise 3 times a week for 16 weeks, and perform 65-80 % of max heart rate, including approximately 80 minutes of resistance exercise on days 1 and 3</p>	<p>LegPress /Chest Press/Lunges/Seated/Row/LegExtensions /TricepsExtensions /LegFlexion/Bicepsfull down</p> <p>Perform 1:1 supervised exercise 3 times a week for 16 weeks, and perform 60-80 % of max heart rate, including approximately 80 minutes of aerobic exercise on days 1 and 3</p>	It was significantly decreased in the Framingham Risk Score (FRS) exercise group.
Hussey & Ananya (2022)	<p>Walk 5 times a week for 12 minutes for 3weeks. Objective Heart Rate = Rest Heart Rate + 30 BPM</p> <p>Walk at least three days a week 30 minutes, 60-70 % of maximum Heart Rate.</p> <p>20 minutes of walking 4 times a week at moderate intensity a 30-minute walk 5-6 times a week</p> <p>3 times a week, 10 minutes of warm-up, 30 minutes of walking, 5-10 minutes of cooldown.</p> <p>65 % of heart rate reserve 3 times a week, 30 minutes of moderate-intensity sedentary exercise.</p> <p>Bed ergometer, 1 minute on, 1 minute off daily, 15 times. At least 50 % of your heart rate reserve.</p> <p>Progressive cycle ergometer 3 times a week 15-20 minutes, starting at 60 % of full power output initially.</p>	<p>strength exercise</p> <p>3 times a week, 2 sets of each exercise, 8-12 reps per set, 60-70 % of 1-RM.</p> <p>2 sets of 10 arm resistance exercises 3 times a week, 8-12 reps per set, 60-70 % of 1-RM, intensity gradually increases</p> <p>3 sets of mechanical resistance arm exercises, up to 12 reps</p> <p>Resistance exercise 10 reps, 1 set per exercise, 20 reps per set, 50 % of 1-RM.</p>	It reduced the severity of cancer fatigue and improved the fatigue level of cancer patients.

Authors	Method		Result
	Aerobic exercise	Resistance exercise	
Dieli-Conwright et al. (2018c)	treadmill/walking/running/rowing machine/stationary bicycle To maintain Heart Rate 60-80 %, build cardiorespiratory endurance and maintain prescribed strength, the target Heart Rate is increased every 4 weeks Increases from 30 minutes (week 1) for 50 minutes (week 16) according to the increase in cardiorespiratory fitness, and end with a 5 minute cooldown at VO2 max.	Leg Press /Chest Press/Lunges/Seated/Row/Leg Extensions /Triceps Extensions Set to 1-RM 80 % for the lower body and 1-RM 60 % for the upper body and increase by 10 % when you complete 3 sets of 10 reps 2 times in a row Every 4 weeks, the number of repetitions increases by 10 (week 4), 12 (week 8), 15 repetitions (week 12).	In the exercise group, there was a significant improvement in body composition, cardiac metabolic biomarkers, and systemic inflammation.

### III. Results

All studies included in this study were interventional studies on physical activity, aerobic exercise, and resistance exercise, and 8 of 21 studies were analyzed. The publication years were 3 studies in 2018, 2 in 2019, 2 in 2020, and 1 in 2022.

It was found that aerobic exercise and resistance exercise improved shoulder function and had an effect on physical strength and quality of life in breast cancer patients. A previous study investigated the effects of exercise interventions in a 16-week randomized controlled trial on shoulder function in women with breast cancer (Sweeney et al. 2019). The participants' range of motion was measured for flexion, extension (0 °), extension (90 °), supine internal rotation, and external rotation (90 °). The range of motion between the exercise group and the general treatment group was significantly increased in the exercise group. During follow-up, it was reported that the exercise group maintained a significantly improved state, and the general treatment group did not improve (Sweeney et al., 2019).

The previous study reported the effects of 16 weeks of aerobic exercise and resistance exercise intervention on physical fitness and bone health of physically inactive, overweight/obese breast cancer survivors (Deli-Conwright et al., 2018b). Breast cancer survivors within 6 months were

evaluated for physical fitness, bone density, and serum concentration and quality of bone biomarkers at baseline and 3 months post-intervention follow-up (exercise group only), and exercise intervention was administered at moderate intensity 3 times a week for 16 weeks. It consisted of aerobic exercise and resistance exercise. After intervention, the exercise group was superior to the general management group in quality of life, fatigue, and depression, and muscle strength showed a significant increase in the exercise group. In follow-up, it was reported that the exercise group maintained a significantly improved state of physical strength. However, in bone health, only calcium and 25-hydroxyvitamin D levels were reported to be increased in the exercise group (Dieli-Conwright et al., 2018b).

Aerobic and resistance exercise affect overweight, sarcopenic obesity, and metabolic syndrome in breast cancer survivors (Dieli-Conwright et al., 2018a). After 16 weeks of aerobic exercise and resistance exercise, the exercise group was followed up. The metabolic syndrome between the general group and the exercise group showed significant improvement in all metabolic syndrome variables in the exercise group, and the exercise group maintained a significantly improved state compared with the baseline even after 3 months of follow-up. With sarcopenic obesity and changes in body composition, it was reported that the

exercise group showed a significant decrease in body weight and all obesity indicators, and that the exercise group maintained a significantly improved state (Dieli-Conwright et al., 2018a). In another randomized pilot clinical study by previous study, it was reported to reduce inflammation in adipose tissue of breast cancer survivors (Dieli-Conwright et al., 2018c).

The effect of elastic band resistance exercise on pain and range of motion of the shoulder joint according to the type of grip type in patients with upper extremity lymphedema due to mastectomy was compared (Jo & Lee, 2020). Grip types were open hand-grip and closed hand-grip, and upper arm edema circumference, shoulder pain, and shoulder joint range of motion (shoulder joint extension, flexion, abduction, internal rotation, and lateral rotation) were evaluated. First, there was no difference in the circumference of upper arm edema at weeks 1 and 2, but there was a significant difference at weeks 4 and 6. There was no significant difference in shoulder pain at week 1, but it was further reduced in the experimental group at week 6, and a significant difference between the groups was reported. The shoulder joint range of motion (shoulder joint extension, flexion, abduction, internal rotation, and lateral rotation) were also reported to show an increase in angle in the experimental group (Jo & Lee, 2020).

In previous studies, the effects of aerobic and resistance exercise on cardiovascular disease in women with early breast cancer were investigated (Lee et al., 2019). The general group and the exercise group were evaluated by Framingham risk score (FRS), and the exercise group received aerobic and resistance exercise intervention 3 times a week for 16 weeks under supervision. It was reported that the total FRS score significantly decreased in the exercise group after the intervention than in the general group, and was maintained even during the 3 month follow-up period, which corresponds to a statistically reduced risk of cardiovascular disease at 10 years of FRS prediction (Lee et al., 2019).

The previous study systematically reviewed and

meta-analyzed randomized controlled trials on the effects of aerobic exercise and mind and body exercise in cancer patients with poor sleep quality (Takemura et al., 2020). As a result, it was reported that aerobic exercise and mind and body exercise were beneficial and safe for improving sleep in cancer patients with all sleep disorders. Significant effects were maintained even after 3 to 6 months of aerobic exercise, but not in the case of mind and body exercise (Takemura et al., 2020).

In another systematic review, it was reported that aerobic exercise and multimodal intervention for fatigue reduction in cancer patients reduced or improved fatigue in cancer patients, and resistance exercise intervention for cancer patients could improve muscle strength in cancer patients (Hussey & Gupta, 2022). However, it was reported that resistance exercise requires a higher level of coordination than aerobic exercise because it requires specialized equipment (Hussey & Gupta, 2022).

## IV. Discussion

Cancer patients face many difficulties in their daily life due to physical side effects that appear during treatment or even after treatment is finished. According to the eight studies that met the criteria included in this review study, it was found that aerobic exercise and resistance exercise had an effect on the increase in physical fitness, muscular strength, quality of life, and range of motion in cancer survivors. The intervention of aerobic exercise and resistance exercise has no side effects for cancer patients and shows that it is a safe exercise.

Rational exercise interventions can increase energy expenditure, strengthen muscles, lower blood pressure and blood lipids, increase bone density, and regulate psychological processes (Luan et al., 2019). Aerobic exercise generates energy in response to exercise and plays a homeostatic role in regulating blood flow and substrate

utilization (Luan et al., 2019). In previous studies, aerobic exercise and resistance exercise improved the inflammation of adipose tissue in breast cancer survivors and influenced overweight and sarcopenic obesity and metabolic syndrome variables in breast cancer survivors (Dieli-Conwright et al., 2018a; Dieli-Conwright et al., 2018c). Another study reported that aerobic exercise led to favorable changes in prognostic biomarkers in patients treated for colon cancer (Brown et al., 2018). Also, cancer-related fatigue (CRF) is one of the side effects associated with a decline in the health-related quality of life of cancer survivors and negatively affects socioeconomic status, increased healthcare utilization, and decreased survival rates (Prieto-Gómez et al., 2022). Aerobic exercise may reduce fatigue in cancer survivors (Kessels et al., 2018). The previous study reported that inspiratory muscle training and aerobic exercise increased respiratory muscle recovery and lung volume in lung cancer patients undergoing video-assisted thoracoscopic surgery and that none of the patients developed postoperative pulmonary complications (Liu et al., 2021). Also, it was recommended early intervention of inspiratory training and aerobic exercise (Liu et al., 2021).

Resistance exercise is part of a recommended activity to help adults maintain overall health and has been shown to reduce mortality, cardiovascular disease, cholesterol levels, depression, and fatigue, and improve bone mineral density and insulin sensitivity (Luan et al., 2019). In addition, resistance exercise had a positive effect on pain and swelling in mastectomy patients (Jo & Lee, 2020). Existing literature reported that resistance exercise was beneficial for the effective management of women at risk of lymphedema in breast cancer patients and increased the performance of muscle strength, maximal power, and lean mass (Santagnello et al., 2020; Wanchai & Armer, 2019). Another study showed that resistance exercise had a significant effect on physical function, quality of life, cognitive function, and sleep problems in patients with pancreatic cancer, in patients with nasopharyngeal cancer, resistance exercise intervention has been shown to alleviate

oral mucositis, difficulty opening the mouth, dry mouth, physical and mental fatigue (Hu & Zhao, 2021; Steindorf et al., 2019). And it can be seen that resistance exercise reduced the occurrence of acid reflux in gastric cancer patients and relieved fatigue and anorexia (Hong et al., 2020). As such, cancer and its treatment are usually accompanied by symptoms that affect physical function and health-related quality of life, such as fatigue, pain, depression, or insomnia (Prieto-Gómez et al., 2022). Several studies have shown an association between increased plasma levels of proinflammatory cytokines and increased levels of fatigue, pain, sleep disturbances, and depressive symptoms in cancer survivors (Doong et al., 2015; Prieto-Gómez et al., 2022).

In this reviewed study, it was found that physical function and quality of life were improved with respect to the effects of aerobic exercise and resistance exercise in cancer patients. The American college of sports medicine/American cancer society (ACSM/ACS) recommends exercising guidelines for cancer patients (150 minutes of aerobic exercise per week and 2-3 days of resistance exercise) (Seo & Kwak, 2020). This shows that aerobic exercise and resistance exercise are very important for cancer patients, namely, physical activity. In order to maintain the positive effects of all exercise interventions, each patient should focus on exercise interventions. The optimal aerobic exercise and resistance exercise interventions should be established and standardized in future studies in order to focus on the quality of sleep, muscular strength, physical fitness, muscle loss, joint mobility, and reduction in edema circumference in cancer survivors.

## V. Conclusion

It can be concluded that aerobic exercise and resistance exercise have a positive effect on cancer patients. However,



many of the cancers that we can have and many of the cancers from children to the elderly have not been reviewed, so it does not have a positive effect on all cancer patients. Future research is needed that considers various variables such as age, gender, race, cancer type, and individual physical differences.

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