


Effects of Resistance Exercise on Symptoms, Physical Function, and Quality of Life in Gastrointestinal Cancer Patients Undergoing Chemotherapy

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Abstract

This research aimed to investigate the effects of resistance exercise on symptoms, physical function, and quality of life (QoL) in gastrointestinal cancer patients undergoing chemotherapy. Patients were quasi-randomly divided into the resistance exercise group and the relaxation control group, and machine-based resistance exercise was performed twice a week for 12 weeks under the guidance of experienced therapists. The QoL of patients was analyzed by EORTC-QLQ-C30. Resistance exercise training significantly reduced the incidences of lack of energy (inter-group $P = .011$), nausea (inter-group $P = .007$), acid reflux (inter-group $P = .042$), and back pain (inter-group $P = .0009$). Twelve weeks of resistance exercise training significantly elevated the muscular strength of leg press (inter-group $P = .021$) and leg extension (inter-group $P = .041$), and the muscular endurance of leg press (inter-group $P = .005$). The participants' performance in 6-m fast walk (inter-group $P = .008$), 6-m backwards walk (inter-group $P = .016$), and chair rise (inter-group $P = .031$) were dramatically improved. Fatigue (inter-group $P = .024$) and appetite loss (inter-group $P = .012$) in the resistance exercise group were significantly lower than the relaxation control group. In conclusion, the beneficial effects of resistance exercise on symptoms, physical function and QoL in gastrointestinal cancer patients undergoing chemotherapy were demonstrated. Resistance exercise training reduced the incidences of nausea and acid reflux, improved physical function, and alleviated fatigue and appetite loss in gastrointestinal cancer patients undergoing chemotherapy.

Keywords

gastrointestinal cancer, chemotherapy, resistance exercise, quality of life

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Introduction

Gastrointestinal cancer is comprised of several different types of cancers, such as gastric, hepatic, pancreatic, and colorectal cancers.¹ The pathogenesis of gastrointestinal cancer triggers a variety of severe symptoms, including pain, nausea, diarrhea, fatigue, and sleeping disorders.^{2,3} Chemotherapy is one of the widely used therapeutic approaches for gastrointestinal cancer. Despite the benefits in the treatment of gastrointestinal cancer, chemotherapy causes several side effects which interfere with the patients' functional capacity and quality of life (QoL).⁴ Possible consequences of chemotherapy include nausea, ulcerations, emesis, diarrhea, severe malabsorption, dehydration, and electrolyte disorder.⁵ Advances in terms of improved survival alongside with better QoL in patients

with gastrointestinal cancer are based on the improved treatment of acute toxic effects caused during and after chemotherapy.

Physical exercise is an effective method in improving the physical health of cancer patients.⁶ During chemotherapy, exercise interventions have both physiological and psychological benefits and improve the QoL in cancer patients.⁷ Physical exercises include aerobic and resistance

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training. Most randomized exercise trials focus on the effects of aerobic training.⁸ Recently, evidence has demonstrated that resistance exercise has larger effect sizes than aerobic exercise in modulating cancer-related fatigue.⁹ Resistance exercise is a kind of exercise intervention which causes the contraction of muscles against external resistance and improves the muscular mass, strength, and bone density.¹⁰ Recent evidence indicates that resistance exercise during neoadjuvant chemoradiation treatment is feasible in rectal cancer patients and promotes physical function.¹¹ In breast cancer patients undergoing adjuvant chemotherapy, resistance exercise alleviates physical fatigue and maintains QoL.¹² It has been demonstrated that the symptoms and physical condition of gastrointestinal cancer patients during palliative chemotherapy are enhanced by both resistance and aerobic exercise.¹³ But the function of resistance exercise is only confirmed in gastrointestinal cancer patients during palliative chemotherapy.

In this research, we aimed to investigate the effects of resistance exercise on symptoms, physical function and QoL in gastrointestinal cancer patients undergoing chemotherapy.

Methods

Patient Eligibility

This study was registered in Chinese Clinical Trial Register (#ChiCTR2000033103). Patients with gastrointestinal cancer undergoing chemotherapy were recruited in this research from 2016 to 2019. Gastrointestinal cancers included rectal, cholangiocellular, colon, gastric, and pancreatic cancer. Patients with tumor–node–metastasis (TNM) stage II, III, or IV tumor were recruited. Patients who received concomitant radiotherapy were not excluded, neither those who underwent tumor resection surgery before their inclusion in the study. Eligibility criteria included age ≥ 18 years, life expectancy ≥ 6 months, body mass index (BMI) ≥ 18 kg/m², and having capacity and willingness to execute the study protocol. Exclusion criteria included participating in other aerobic or resistance training before this research, having contraindications for resistance training, or having other concurrent malignant diseases. All the participants in this research were recruited from Quanzhou First Hospital Affiliated to Fujian Medical University. This research was approved by the Ethics Committee of Quanzhou First Hospital Affiliated to Fujian Medical University. All patients involved in this research were informed in detail about the process and purpose of the experiment and signed the corresponding informed consent forms.

Grouping and Randomization

In this study, 237 patients were recruited and 33 of them were excluded. The participants were quasi-randomized

into 2 groups according to the order they came for evaluation: resistance exercise group and relaxation control group. Researchers involved in the recruitment, data collection and analyses were blind to patient group assignment.

Exercise Intervention

Machine-based resistance exercise was performed twice a week for 12 weeks under the guidance of experienced therapists. A complete resistance exercise needed approximately 60 minutes and was composed of 8 different machine-based progressive resistance exercises. These exercises included leg extension, leg curl, leg press, shoulder internal and external rotation, seated row, latissimus pull down, shoulder flexion and extension, and butterfly and butterfly reverse. Each exercise included 3 sets for 8 to 12 repetitions at a weight of 60% to 80% of one repetition maximum. In 3 consecutive exercise sessions, if 3 sets of an exercise (12 repetitions) were successfully completed, the weight was increased at least by 5% in the next session.

Relaxation control was composed of progressive muscle relaxation without any aerobic or muscle strengthening exercise.¹⁴ Relaxation intervention was also performed approximately 60 minutes twice a week for 12 weeks. The exercise and control intervention were all performed at an exercise facility located in the hospital.

Outcome Measures

Demographic and clinical characteristics of the participants in both resistance exercise group and relaxation control group were recorded. Incidences of symptoms, including loss of appetite, lack of energy, nausea, mouth ulcers, acid reflux, cough, back pain, fever, and alopecia, were all calculated at baseline and post-intervention. Adverse event items were evaluated based on the Common Terminology Criteria for Adverse Events, version 4.0 (CTCAE). A grade of 0 indicated no adverse events, whereas grade 1 or higher indicated the presence of adverse events.

The primary outcome was defined as physical functions, as described in detail below. One repetition maximum method was used to assess the dynamic muscular strength for leg press, seated row, leg extension, and chest press. One repetition maximum method was the maximal weight which was lifted. At the weight of 70% of 1 repetition maximum, the maximal repetition number for chest press and leg press were employed to evaluate the muscular endurance of the participants. Physical performance tests included 6-m usual walk, 6-m fast walk, 6-m backwards walk, 400-m walk, and chair rise.

The QoL of the patients were analyzed through the administration of European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-C30 (EORTC QLQ-C30). EORTC QLQ-C30 was a widely used

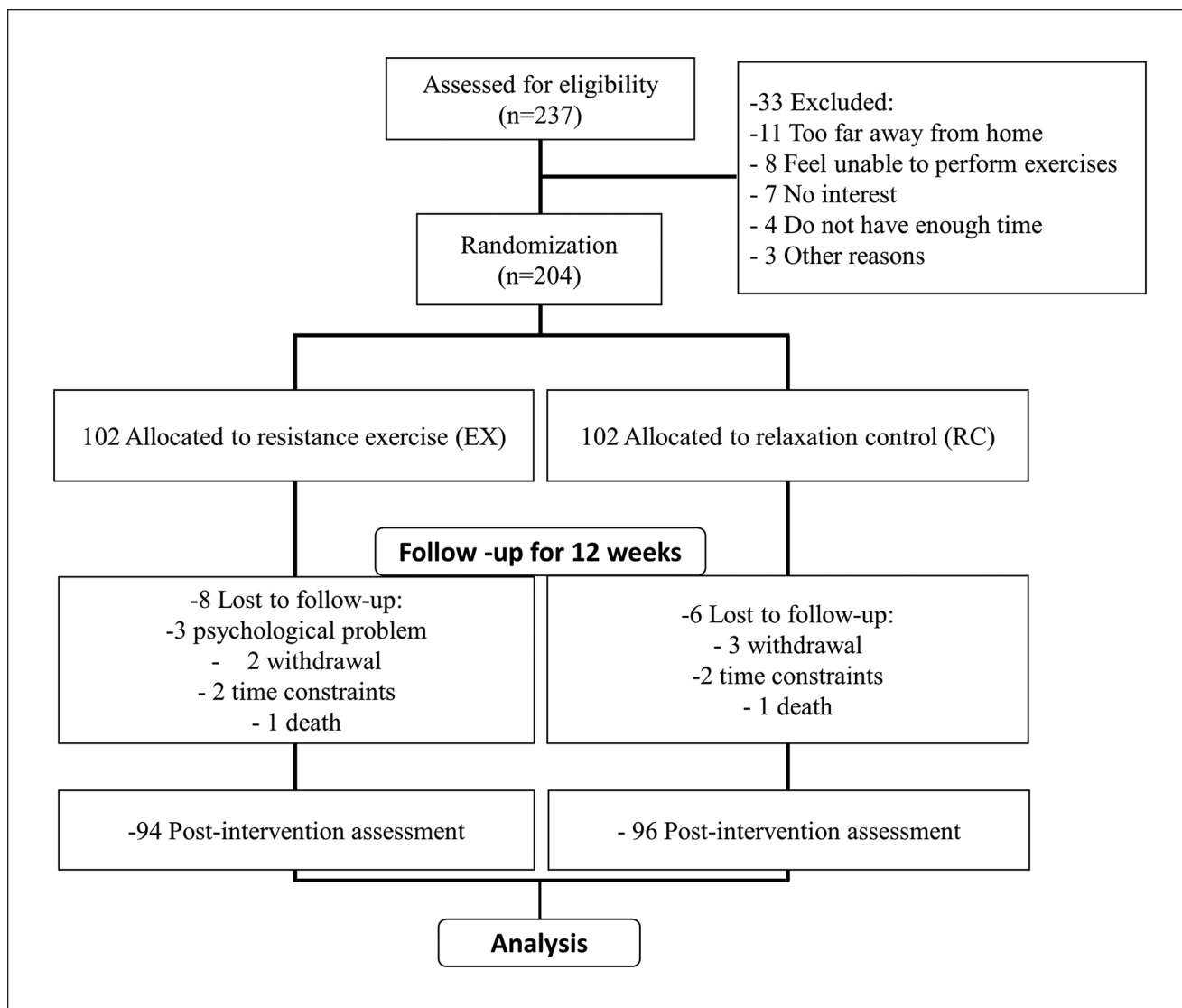


Figure 1. Research framework of this study.

tool for cancer patient QoL evaluation with 30 items. The score of each item was from 0 to 100 and 100 represented the best QoL or worst symptom. The change larger than 10 points in the score of items was considered to be clinically significant.

Statistical Analysis

After collecting the questionnaires, SPSS Statistics Version 22.0 software was employed to perform statistical analysis. Sample size was determined using established statistical power analysis. Differences between means of each compared treatment group were divided by the standard deviation to determine the standardized effect size, then using 5% as significance level in Student t-test followed by Mann

Whitney test and 90% power, the minimum required sample size was calculated, which was sufficient for our current sample size after consideration of dropouts. Chi squared test was used to compare the occurrence of symptoms between 2 groups. The changes in an item's average score after treatment were analyzed through paired t test followed by Wilcoxon matched-pairs signed rank test. Statistical analysis was significant when P value $< .05$.

Results

Patient Characteristics

Participant flow in this research is shown in Figure 1. During the evaluation of eligibility, 237 patients met the inclusion criteria and 204 were finally recruited in the

Table 1. Demographic and Clinical Characteristics of the Patients Analyzed.

Characteristics	Study group		P
	Resistance exercise (n=94)	Relaxation control (n=96)	
Age (years)	55.4 ± 11.6	52.3 ± 12.4	.352
Male gender	54 (57.4 %)	51 (53.1 %)	.563
Body weight (kg)	69.6 ± 14.3	71.3 ± 15.4	.472
BMI	26.3 ± 4.9	25.9 ± 4.4	.318
Smoking before diagnosis	30 (31.9 %)	28 (29.2 %)	.753
Still smoking at baseline	10 (10.6 %)	12 (12.5 %)	.821
Tumor diagnosis			
Rectal cancer	23 (24.5 %)	20 (20.8 %)	.605
Cholangiocellular cancer	17 (18.1 %)	22 (22.9 %)	.474
Colon cancer	29 (30.8 %)	24 (25 %)	.419
Gastric cancer	18 (19.1 %)	18 (18.8 %)	1.000
Pancreatic cancer	7 (7.5 %)	12 (12.5 %)	.334
Tumor Stage TNM			
II	19 (20.2 %)	17 (17.7 %)	.713
III	49 (52.1 %)	56 (58.3 %)	.466
IV	26 (27.7 %)	23 (24.0 %)	.620
Previous tumor resection	74 (78.7 %)	70 (72.9 %)	.399
Time between tumor resection and recruitment (days)	63.6 ± 18.1	55.7 ± 16.3	.248
Concomitant radiotherapy	23 (24.5 %)	15 (15.6 %)	.149
Days since first chemotherapy	56.3 ± 17.6	61.4 ± 19.6	.276
Chemotherapy protocol			
Oxaliplatin + capecitabine	36 (38.3 %)	31 (32.3 %)	.448
Fluorouracil + leucovorin	21 (22.3 %)	26 (27.1 %)	.503
Oxaliplatin + leucovorin + fluorouracil	17 (18.1 %)	23 (23.9 %)	.375
Others	20 (21.3 %)	16 (16.7 %)	.462

BMI, body mass index.

Values were expressed as n (percentage) or mean ± SD.

research study. The participants were quasi-randomly separated into resistance exercise group (n=102) and relaxation control group (n=102). During this research, 8 participants in the resistance exercise group and 6 in the relaxation control group were lost to follow-up. Finally, 94 participants in the resistance exercise group and 96 in the relaxation control group finished the research and their data were recorded and analyzed.

The baseline demographic and clinical characteristics of participants were summarized in Table 1. The demographic characteristics (age, sex, body weight, body mass index, and tobacco use) showed no significant difference between these 2 groups. Five different cancers were involved in this research, including rectal, cholangiocellular, colon, gastric, and pancreatic cancers.

Occurrence of Symptoms

Incidences of symptoms in the participants are shown in Table 2. At baseline, there was no difference in the incidences of symptoms between the resistance exercise group

and the relaxation control group. After the performance of resistance exercise, the incidences of lack of energy, nausea, acid reflux, and back pain were significantly lower than in the relaxation control group. But resistance exercise did not influence the incidences of loss of appetite, mouth ulcers, cough, fever, and alopecia in the gastrointestinal cancer patients undergoing chemotherapy.

Muscular Strength, Muscular Endurance, and Physical Performance

Muscular strength, muscular endurance, and physical performance for patients included in the trial are shown in Table 3. For muscular strength, both leg press and leg extension were significantly improved by resistance exercise, while the chest press and seated row were not influenced by resistance exercise, as no difference was observed between these 2 groups. For muscular endurance, only leg press showed a significant progress with the help of resistance exercise, while chest press was not influenced in this process.

Table 2. Incidences of Symptoms Reported for Patients Included in The Trial.

Symptoms		Study group		P-value
		Resistance exercise (n=94)	Relaxation control (n=96)	
Loss of appetite	Baseline	49 (52.1 %)	52 (54.2 %)	.885
	Post-intervention	44 (46.8 %)	56 (58.3 %)	.146
	P-value	0.559	0.663	
Lack of energy	Baseline	61 (64.9 %)	58 (60.4 %)	.551
	Post-intervention	50 (53.2 %)	69 (71.9 %)	.011
	P-value	0.138	0.127	
Nausea	Baseline	54 (57.4 %)	58 (60.4 %)	.768
	Post-intervention	46 (48.9 %)	66 (68.8 %)	.007
	P-value	0.306	0.291	
Mouth ulcers	Baseline	35 (37.2 %)	40 (41.7 %)	.556
	Post-intervention	33 (35.1 %)	46 (47.9 %)	.079
	P-value	0.879	0.468	
Acid reflux	Baseline	50 (53.2 %)	45 (46.9 %)	.468
	Post-intervention	40 (42.6 %)	56 (58.3 %)	.042
	P-value	0.189	0.148	
Cough	Baseline	37 (39.4 %)	35 (36.5 %)	.765
	Post-intervention	30 (31.9 %)	42 (43.8 %)	.102
	P-value	0.361	0.377	
Back pain	Baseline	32 (34.1 %)	30 (31.3 %)	.757
	Post-intervention	18 (19.2 %)	40 (41.7 %)	.0009
	P-value	0.031	0.177	
Fever	Baseline	23 (24.5 %)	26 (27.1 %)	.741
	Post-intervention	18 (19.1 %)	25 (26.1 %)	.299
	P-value	0.480	0.871	
Alopecia	Baseline	34 (36.2 %)	30 (31.3 %)	.539
	Post-intervention	27 (28.7 %)	36 (37.5 %)	.219
	P-value	0.350	0.448	

Values were expressed as n (percentage, %).
Chi square test. Bold values indicate $P < 0.05$.

After the 12-week resistance exercise training, when compared with the participants in relaxation control group, there were significant improvements in the 6-m usual walk, 6-m fast walk, 6-m backwards walk, and chair rise. There was no significant change in the 400-m walk time.

Quality of Life

Before and after the training intervention, the QoL of the participants in both groups were evaluated through EORTC-QLQ-C30 (Table 4). The global QoL score showed no difference between these 2 groups after resistance exercise training. In the relaxation control group, 12-week resistance exercise training did not significantly elevate the score of physical function and role function. But in the relaxation control group, the scores of physical function and role function declined dramatically during this period. So, we observed significantly higher scores of physical function and role function in the resistance exercise group

than in the relaxation control group after the training intervention. The same phenomenon was also observed in the score of social function. The scores of fatigue and appetite loss were dramatically lower in the resistance exercise group than in the relaxation control group after the training intervention. It was indicated that resistance exercise training had benefits in alleviating the symptoms generated during chemotherapy.

Discussion

This quasi-randomized controlled trial in gastrointestinal cancer patients undergoing chemotherapy illustrated the benefits of resistance exercise in the improvement of physical function and QoL, as well as in alleviating symptoms.

It has been reported that the performance of physical activity has association with reduced risk of several different kinds of cancers, such as colon and breast cancers.¹⁵ In colon cancer patients, participation in physical activity after

Table 3. Effects of Resistance Exercise (EX) on Physical Performance, Muscular Strength, and Endurance Measures for Patients Included in The Trial.

Variables	Study group		P-value	
	Resistance exercise (n = 94)	Relaxation control (n = 96)		
Muscular strength (kg)				
Chest press	Baseline	35.2 ± 17.2	36.1 ± 16.9	.256
	Post-intervention	39.4 ± 16.3	32.6 ± 17.8	.315
	P-value	0.417	0.126	
Seated row	Baseline	65.3 ± 21.5	66.8 ± 22.9	.523
	Post-intervention	67.1 ± 19.6	63.9 ± 23.1	.428
	P-value	0.371	0.442	
Leg press	Baseline	118.4 ± 42.3	121.6 ± 39.5	.294
	Post-intervention	158.3 ± 41.7	112.8 ± 40.1	.021
	P-value	0.034	0.086	
Leg extension	Baseline	54.8 ± 18.6	55.9 ± 19.2	.548
	Post-intervention	69.8 ± 23.3	51.7 ± 24.8	.041
	P-value	0.028	0.215	
Muscular endurance (rep)				
Chest press	Baseline	9.7 ± 3.8	10.5 ± 4.8	.263
	Post-intervention	12.4 ± 4.2	9.5 ± 5.2	.114
	P-value	0.174	0.632	
Leg press	Baseline	11.5 ± 5.1	10.2 ± 6.3	.424
	Post-intervention	22.4 ± 6.8	8.6 ± 7.2	.005
	P-value	0.016	0.173	
Physical performance (s)				
6-m usual walk	Baseline	4.5 ± 0.7	4.2 ± 0.6	.328
	Post-intervention	3.9 ± 0.5	4.6 ± 0.7	.037
	P-value	0.264	0.327	
6-m fast walk	Baseline	2.9 ± 0.3	2.8 ± 0.4	.137
	Post-intervention	2.6 ± 0.4	3.1 ± 0.6	.008
	P-value	0.048	0.216	
6-m backwards walk	Baseline	14.6 ± 3.2	14.4 ± 3.8	.527
	Post-intervention	11.8 ± 2.6	15.2 ± 2.9	.016
	P-value	0.031	0.365	
400-m walk	Baseline	227.1 ± 24.7	231.4 ± 27.1	.448
	Post-intervention	222.4 ± 28.2	238.3 ± 24.9	.116
	P-value	0.292	0.491	
Chair rise	Baseline	10.7 ± 1.3	10.3 ± 1.5	.554
	Post-intervention	9.2 ± 1.6	10.9 ± 1.2	.031
	P-value	0.023	0.117	

Values were expressed as mean ± SD. Bold values indicate $P < 0.05$.

diagnosis is confirmed to have benefits in the reduction of mortality and recurrence risks, independent of pathologic, demographic, and prognostic factors.¹⁶ Another research study has further demonstrated that the influence of post-diagnosis physical activity on the disease outcomes of colorectal and breast cancer patients is in a dose-dependent manner.¹⁷

Despite having effective functions in the therapy of cancer, the administration of chemotherapy and radiation therapy will simultaneously cause some treatment-related side effects.¹⁸ The side effects generated by chemotherapy

significantly decrease the patients' functional capacity and QoL. During both chemotherapy and radiation therapy, exercise interventions are illustrated to have a variety of benefits in both physiological and psychological conditions in cancer patients.^{7,19} Currently, the recommended exercise treatment modality includes aerobic exercise and resistance exercise, and both are found to improve the musculoskeletal and cardiovascular functions of cancer patients.^{20,21} It is illustrated that patients with advanced gastrointestinal cancer prefer resistance exercise training since resistance exercise training has a higher potential for individualization,

Table 4. Effects of Resistance Exercise (EX) on Quality of Life (EORTC-QLQ-C30).

Outcomes		Study group		P-value
		Resistance exercise (n=94)	Relaxation control (n=96)	
Quality of life-EORTC QLQ30 (scale 0–100)				
Global QoL	Baseline	56.8 ± 19.5	58.6 ± 20.3	.486
	Post-intervention	60.3 ± 21.7	55.2 ± 22.6	.116
	P-value	0.427	0.271	
Physical function	Baseline	83.6 ± 15.7	84.7 ± 18.2	.724
	Post-intervention	86.3 ± 17.4	72.4 ± 15.9	.035
	P-value	0.458	0.026	
Emotional function	Baseline	69.2 ± 22.7	67.5 ± 19.9	.552
	Post-intervention	68.3 ± 18.6	68.7 ± 21.6	.528
	P-value	0.637	0.485	
Role function	Baseline	62.3 ± 24.7	64.1 ± 21.3	.52
	Post-intervention	66.7 ± 19.4	54.9 ± 17.9	.041
	P-value	0.624	0.036	
Cognitive function	Baseline	79.4 ± 19.5	81.7 ± 20.6	.316
	Post-intervention	74.1 ± 22.7	78.3 ± 21.8	.411
	P-value	0.226	0.396	
Social function	Baseline	72.2 ± 24.1	68.9 ± 20.3	.363
	Post-intervention	75.8 ± 23.4	60.1 ± 19.2	.047
	P-value	0.393	0.058	
Sleep disturbance	Baseline	29.7 ± 17.8	32.2 ± 22.3	.227
	Post-intervention	27.2 ± 19.3	34.5 ± 21.0	.378
	P-value	0.496	0.525	
Dyspnea	Baseline	25.1 ± 16.8	22.4 ± 18.5	.117
	Post-intervention	26.7 ± 17.9	31.9 ± 20.3	.165
	P-value	0.615	0.038	
Nausea and vomiting	Baseline	22.5 ± 10.9	23.2 ± 9.8	.341
	Post-intervention	19.5 ± 11.3	26.6 ± 12.5	.287
	P-value	0.373	0.416	
Appetite loss	Baseline	18.3 ± 8.9	17.6 ± 7.5	.663
	Post-intervention	12.2 ± 7.1	22.6 ± 6.9	.012
	P-value	0.195	0.274	
Fatigue	Baseline	21.4 ± 9.7	19.9 ± 8.7	.438
	Post-intervention	14.1 ± 7.3	24.3 ± 10.3	.024
	P-value	0.044	0.142	

QoL, quality of life.

Values were expressed as mean (SD). Bold values indicate $P < 0.05$.

variability, and diversification than aerobic exercise training.¹³ The function of resistance exercise in patients with advanced gastrointestinal cancer has been reported and the effects of resistance exercise on biological parameters, physical performance, and QoL were evaluated.¹³ But the research is only restricted to the gastrointestinal cancer patients undergoing palliative chemotherapy. We aimed to investigate the effects of resistance exercise on symptoms, physical function, and QoL in gastrointestinal cancer patients undergoing chemotherapy. In our research, the participants were treated by different chemotherapy protocols, including oxaliplatin + capecitabine, fluorouracil + leucovorin, oxaliplatin + leucovorin + fluorouracil, and

others. In this research, 5 different kinds of cancer were involved, including rectal, cholangiocellular, colon, gastric, and pancreatic cancer. Since the adherence rate was not influenced by the performance of resistance exercise training, it was suggested that the high potential for individualization, variability, and diversification in resistance exercise made it equally acceptable as relaxation.

Enormous psychological and physiological stress is experienced by cancer patients after the performance of chemotherapy. Chemotherapy impairs the immune system, weakens the resistance of body, and causes several symptoms.²² A research has reported the complex network of toxic effects generated by radiation and chemotherapy in

patients with gastrointestinal tumors.⁵ In this research, we focused on 9 different side effects induced by chemotherapy, including loss of appetite, lack of energy, nausea, mouth ulcers, acid reflux, cough, back pain, fever, and alopecia. Results of this research showed that resistance exercise training could reduce the incidence of symptoms induced by chemotherapy in gastrointestinal cancer patients.

Anorexia, metabolic abnormality, and physical functionality reduction can be generally observed in cancer patients and result in persistent loss of weight and skeletal muscle mass.²³ In cancer patients, the reduction of physical performance and QoL can be found during chemotherapy.^{24,25} Another research also reports that colorectal cancer patients who perform supervised exercise intervention during chemotherapy have greater physical functioning than those in a usual care group.²⁶ In this research, we investigated whether resistance exercise training could improve the physical functions of gastrointestinal cancer patients undergoing chemotherapy. The lower body muscular strength and muscular endurance was significantly enhanced by resistance exercise training. It seemed that resistance exercise had a better effect on improving the lower body muscular strength and muscular endurance. Participants' performance in 6-m fast walk, 6-m backwards walk, and chair rise were significantly improved compared to the participants in relaxation control group. These results demonstrated the potential benefits of resistance exercise in improving physical function of gastrointestinal cancer patients undergoing chemotherapy.

In breast cancer patients, resistance exercise can alleviate physical fatigue and maintain QoL during chemotherapy.¹² In another study, resistance exercise increased the global QoL score in advanced gastrointestinal cancer patients undergoing palliative chemotherapy but had no significant difference when compared with the baseline.¹³ In our research, the global QoL score was also elevated in the resistance exercise group after the 12-week training but had no significant difference when compared with the relaxation control group. Participants in the resistance exercise group had a relatively stable physical function and role function during chemotherapy. Several studies have illustrated that physical activity has beneficial effects on QoL, physical function, and fatigue levels.^{27,28} Resistance exercise training also showed benefits in alleviating fatigue and appetite loss in gastrointestinal cancer patients during chemotherapy.

There is no research on the influence of resistance exercise on chemotherapy efficacy in rodent models. However, in carcinoma rodent models, resistance exercise reduces histopathological grade, causes less nuclear pleomorphism and fewer mitotic cells, decreases viable tumor area, and decreases tumor cell proliferation.²⁹ In rats, the performance of resistance exercise is effective in reducing oxidative stress, increasing antioxidant capacity, decreasing protein degradation, and regulating growth factor expression in

skeletal muscle.³⁰ The molecular mechanism of resistance exercise in regulating symptoms, physical function, and QoL in cancer patients undergoing chemotherapy is still unknown. Since resistant exercise reduces the toxic effects in gastrointestinal cancer patients caused by chemotherapy, the molecular mechanism during this process is needed to be further investigated.

There were some limitations in the current study. To get a more accurate conclusion, the sample size in this research should be larger. The participants in this research did not include all types of gastrointestinal cancers, and it was possible that the effect of resistance exercise training might vary among different kinds of cancers. Furthermore, the effects of aerobic exercise should also be investigated. The comparison between resistance exercise and aerobic exercise will help us to find the best physical exercise in gastrointestinal cancer patients during chemotherapy. Last, this study was a quasi-randomized trial. Further exploration of the contributions of resistance exercise during chemotherapy for gastrointestinal cancer should be done using well-designed randomized trials.

Conclusion

In conclusion, we demonstrate the effects of resistance exercise on symptoms, physical function and QoL in gastrointestinal cancer patients undergoing chemotherapy in this quasi-randomized trial. Resistance exercise training reduced the incidences of nausea and acid reflux, improves physical functions, and alleviated fatigue and appetite loss in gastrointestinal cancer patients during chemotherapy.

Authors' Contributions

Yijin Hong, Chunmei Wu and Biyu Wu performed the experiments, analyzed and interpreted the data. Chunmei Wu was the major contributors in writing the manuscript. All authors read and approved the final manuscript.

Declaration of Conflicting Interests

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