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THE IMPACT OF MAXIMAL STRENGTH TRAINING ON QUALITY OF LIFE AMONG WOMEN WITH BREAST CANCER UNDERGOING TREATMENT

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Cancer rehabilitation programs mainly involve endurance training while little attention has been paid to strength training. Breast cancer (BC) patients lose muscle strength while undergoing adjuvant treatment, thus affecting daily activities and quality of life. Maximal strength training, with an emphasis on velocity in the concentric phase, improves maximal strength and muscle force development characteristics. However, the effect of maximal strength training on quality of life for BC patients undergoing treatment remains elusive. Consequently, the *aim* of this study was to evaluate the effectiveness of maximal strength training in Health related quality of life in women with newly diagnosed BC. *Materials and Methods*: 55 BC patients with disease stage I–III were randomized into a training group and control group. The training group performed maximal strength training twice a week for 3 months, whereas the control group followed prescribed treatment without strength training. Overall quality of life was measured by The European Organization for Research and Treatment of Cancer Core Quality of life Questionnaire-C30 and additional BC module BR23 before and after the intervention. *Results*: The results obtained from pre-tests and those obtained after 3 months of intervention revealed that patients in the training group significantly increased one repetition maximum, by 20.4 kg (20%) ($p = 0.001$, d = 0.9). Simultaneously, statistically significant alterations were observed in this variable for the control group, one repetition maximum decreased by 8.9 kg (9%) ($p = 0.001$, d = 0.5). The overall quality of life improved significantly by 13% for the training group with large effect ($p = 0.002$, d = 0.6), but no relevant changes were observed in the control group ($p = 0.44$, d = 0.2). Results revealed remarkable changes in overall quality of life after 3-month post-test period between the two groups with large effect ($p = 0.002$, d = 0.9). The training sessions had helped in diminishing the sense of fatigue by 24% ($p = 0.03$, d = 0.6), while it had got worse by 25% ($p = 0.02$, d = 0.4) for the control group. Again, the data on large effect were noticed to differ between the groups ($p = 0.01$, d = 0.6). *Conclusion*: Maximal strength training for BC patients was well tolerated, safe and feasible and showed strength improvements that led to improved muscle strength and improved overall quality of life. These data certainly support the therapeutic role for maximal strength training in the treatment of BC.

***Key Words*: breast cancer, muscle strength, rehabilitation, quality of life, physical activity.**

The incidence of breast cancer (BC) increases with age, the median age for diagnosis being 61 years [1]. Studies in the field have indicated the link between improved cancer treatment and prolonged survival — 5 year survival rates for non-metastatic BC exceed 84% [2]. However, the majority of patients are to encounter a wide range of symptoms and side effects. The treatment of cancer and the disease itself are often associated with adverse physical side-effects, the most prominent being muscular atrophy, decreased muscle strength, reduced aerobic capacity, leading towards the decrease of the quality of life [3].

As a countermeasure, exercise training has been increasingly implemented in the oncology for the last 3 decades. Until recently, reduction in the amount of physical activities has been recommended as treatment for fatigue [4]. Such a practice has led to a physiological paradox as the lack of activities induces muscle catabolism and further deconditioning, which incites even more fatigue [5]. Rehabilitation programs are becoming an important part of the care of cancer patients [5, 6]. Recently, the effect of physical activities in cancer patients has been described in several literature reviews [3, 7–11]. Most of the studies conclude that physical training programs were beneficial for cancer patients' physical or psychosocial capacity. The improvements in muscle strength, body composition, aerobic capacity, the quality of life and fatigue reduction have been noticed [12–16]. However, several intervention studies discussed in the literature proved to have shortcomings. Most of the studies applied aerobic exercises like walking or stationary cycling, while strength training appeared to be a component of a small number of trials [13, 17]. The majority of the interventions correspond to the form of a training complex combining endurance training with strength training and relaxation therapies, making it difficult to evaluate the effect of a training type [18]. Also, training programs usually last no longer than 12 weeks and involve less than 40 participants. The after-treatment exercises are of a light to moderate training intensities. Relevant to the present discussion, the proportion of studies on BC patients being exposed to high intensity strength training is low in spite of muscle atrophy

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Abbreviations used: ACSM – American College of Sports Medicine; BC – breast cancer; CG – control group; EORTC – the European Organization for Research and Treatment of Cancer; MST – maximal strength training; QLQ-BR23 – EORTC Breast Cancer Module; QLQ-C30 – EORTC Core Quality of Life Questionnaire-C30; QoL – overall quality of life; TG – training group; 1RM – one repetition maximum.

being a common problem for this target group [19]. It postulates strength training a relevant choice for the physical training program.

Muscle atrophy originates from a sedentary lifestyle and prolonged bed rest. Unfortunately, the presence of tumors and side-effects of medication (e.g. glucocorticoids or chemotherapeutic agents) makes it even worse for cancer patients as the skeletal muscle structure and function happens to be affected [5, 10, 20]. Yet even in cases of severe fatigue and muscle atrophy skeletal muscle has indicated considerable adaptability with appropriate training stimuli [5].

Progressive strength training has proved to increase lean body mass, muscle protein mass and contractile force. It improves physical function in healthy, young and elderly people [21]. Higher-intensity training has demonstrated excellent results among patients suffering from Chronic Obstructive Pulmonary Disease (COPD), peripheral artery disease, coronary artery disease and schizophrenia [22–25]. As claimed by Brill *et al*. (2000), a great proportion of evidence suggests that there is a strong connection between the ability to engage in physical task performance in daily activities and the threshold level of muscular strength [26].

Strength training has the potential of targeting muscles. Increased muscle strength may contribute to comprehensive participation in daily life and its quality. However, the optimal type, intensity and frequency of strength training that enhances muscle strength the most is yet unknown. The suggested exercise intensities happen to vary from rather low or moderate, as proposed by the American College of Sports Medicine (ACSM) [27], to more intense as described in recent publication about the fundamentals of resistance training [28]. Therefore, in order to observe strength improvements, it is essential to ensure optimal intensity of training.

Studies have shown that training with high loads — known as maximal strength training (MST) — induces greater adaptations in neural system. Training intensity of 85–90% of one repetition maximum (1RM) has proved to lead towards greater improvement in maximal strength than conventional training programs [29]. To boost maximal strength, it is beneficial to apply a program characterized by loads ⩾ 85% of 1RM, few repetitions ⩾ 4, and maximal mobilization of force in the concentric phase with maximal intentional velocity [30] and long resting periods ⩾ 3 min [31].

Therefore, the objective of the present study was to investigate the effect of a 12-week MST under supervision in the training group (TG) of BC patients compared to the control group (CG) of BC patients undergoing treatment without strength training. We hypothesized that women with BC undergoing adjuvant treatment benefit from MST in terms of muscle strength and improved overall quality of life (QoL) immediately after the intervention.

MATERIALS AND METHODS

The study was conducted in Oncology Centre of Latvia, Riga. The project was approved by the Ethics Committee of the Riga Stradiņš University and the Scientific Department of Riga East University Hospital. Oncologists recruited patients and informed consent was obtained from all patients involved.

The criteria for inclusion in the study were: treatment with breast conserving surgery/mastectomy and/or radiation therapy and/or chemotherapy with/without hormone therapy; age 18 to 63 years; patients were newly diagnosed with stage I–III BC. Patients being unable to perform such basic skills as sitting or lying down, having cognitive disorders or severe emotional instability, suffering from other serious diseases that might diminish physical performance capacity (e.g. heart failure, COPD, neurological disorders) were excluded from the study.

57 consecutive patients were initially referred to the study. Patients were randomized into a TG and CG. During the intervention period 2 patients dropped out (mean age 52 years) due to family or work circumstances. Therefore, 55 patients (N = 27 in TG, N = 28 in CG) completed the entire program. Patient characteristics at the beginning of the study are indicated in Table 1.

***Training intervention*.** The participants randomized into the TG received supervised MST twice a week for 12 weeks. The training took place at the BC surgery department and began 2–3 weeks after a breast surgery. Each training session consisted of 2 warm-up sets followed by MST in 4 sets with 4 repetitions in each set applying horizontal dynamic leg press (Figure). The exercise followed the sequence of putting emphasis on stopping the eccentric phase with a 90° in the knee joint, a short pause (~ 1 s), and emphasis on the maximal mobilization of force in the concentric action. The initial workload was set at 85–90% of the individual 1RM and adjusted during the progression of training. The workload was increased by 2.5 kg when the patients were able to complete all sets and repetitions. One training session lasted for approximately 20 min including 3 min of resting periods between the sets. The patients trained in groups of 3–5 people. Safety of the training sessions was ensured by exercise physiologist. The participants' heart rate was continuously monitored with heart rate transmitter (Polar F7, Finland).

Table 1. Patient characteristics and clinical data of the study population

	TG (N = 27)	CG (N = 28)	
Continuous variables	Mean ± SD	Mean ± SD	*p* value
Age (years)	48.2 ± 6.7	49.0 ± 8.0	0.69
Weight (kg)	77.0 ± 15.2	72.3 ± 17.4	0.29
Height (cm)	170.4 ± 6.1	167.4 ± 6.2	0.07
Categorical variables	Number (%)	Number (%)	
Disease stage			
I	9 (33%)	13 (46%)	
II	12 (44%)	9 (32%)	
III	6 (23%)	6 (22%)	
Treatment			
Breast surgery	27 (100%)	28 (100%)	
Chemotherapy	25 (92%)	22 (79%)	
Radiation therapy	23 (85%)	26 (92%)	
Hormone therapy	21 (78%)	17 (61%)	

Note: Data are presented as mean (SD). Stage of cancer: present patient distribution at diagnostic stage. Treatment: number of each treatment type prescribed for the included patients.

The CG was following standard care regime of prescribed cancer treatment supervised by an oncologist. The CG received phone call once a week and advice to perform chair stands twice a week with 3 sets and 10 repetitions, in order to keep them motivated and close to study.

One repetition maximum testing. 2 warm-up sets (8 repetitions at ~50% of 1RM and 5 repetitions at ~70% of predicted 1RM) were performed. Next, the patients were tested for the maximal strength in the lower extremities by 1RM in a dynamic horizontal leg press machine (Cybex Eagle, USA). Starting with an extended leg position, the subjects were instructed to slowly move down until the knee joint angle was positioned at 90°. The movement was followed by a short fraction of the second pause, then by a concentric action with the emphasis on maximal mobilization — the position during which the patients were instructed to focus on maximal intended velocity. Finally, the patients were asked to get back to the starting position [32].

Verbal supervision and encouragement were provided in order to reach the appropriate angle, avoid hyperextension in the knees, and keep the knees and toes on the line to minimize the risk of injury. 1RM was measured in 3–6 trials by successively increasing the load for each lift by 2.5–7.5 kg, until the patients were no longer able to complete the lift. Rest periods of about 4 min were applied between each trial [23].

Measurements of quality of life. The primary outcome measure was the QoL measured by The European Organization for Research and Treatment of Cancer Core Quality of Life Questionnaire-C30 (EORTC QLQ-C30) and additional BC Module (QLQ-BR23). EORTC QLQ-C30 and QLQ-BR23 is an integrated system for assessing QoL of cancer patients participating in clinical trials. The QLQ-C30 is composed of multi-item scales and single-item measures. These include 5 functional scales, 3 symptom scales, a global health status/QoL scale, and 6 single items. Each of the multi-item scale includes a different set of items — no item occurs in more than one scale [33].

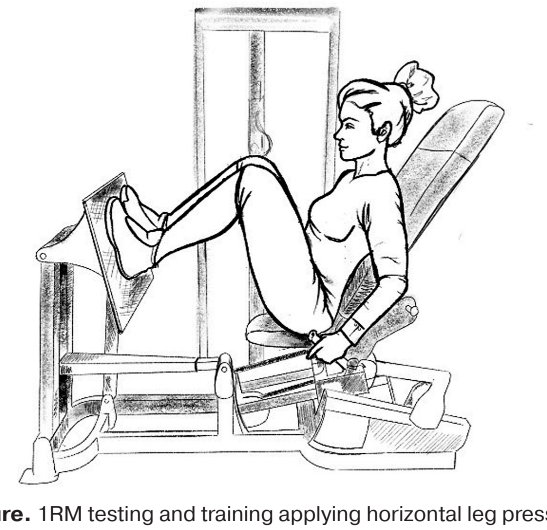

Figure. 1RM testing and training applying horizontal leg press

The QLQ-BR23 module comprises 23 questions assessing disease symptoms, side effects of treatment (surgery, chemotherapy, radiotherapy and hormonal treatment), body image, sexual functioning and future perspective.

All of the scales and single-item measures range in scores from 0 to 100. A high score represents a higher response level. Thus, a high score for a functional scale represents high/healthy level of functioning, a high score for the global health status/QoL represents high QoL, but a high score for a symptom scale/item represents high level of symptomatology/problems.

Tolerance of exercise intervention. Although the training intensity was high, the program was tolerated well by all the patients. None of the patients dropped out claiming the program being too intense; neither had they complained about muscle soreness. The average attendance was 23 of 24 planned training sessions.

Statistics. Data were analyzed using IBM SPSS Statistics (v. 24.0). All values are expressed as mean ± standard deviation (SD) for descriptive data and tables. To test for differences in changes of variables from pre-to posttest between groups, independent sample t-test was applied. Within-group differences in variables were assessed from pre- to posttest by paired sample t-tests. Statistical level of significance was set at $p < 0.05$. Cohen's d: value effect, 0.1–0.2 small, 0.3–0.5 medium, 0.6–0.8 large, 0.9–1.10 + Extreme large.

RESULTS

Adherence and baseline characteristics. The study was completed by 55 patients. 27 patients from the TG and 28 from the CG were monitored for 12 weeks. There were no significant differences in age, weight and height between the participants from both groups ($p > 0.05$). The patients were exposed to a breast surgery, chemotherapy, radiation and hormone therapy as the treatment for illness.

Effects on muscle strength. Results obtained from pre-tests and those obtained after 3 months of intervention period revealed that patients in the TG significantly increased 1RM, by 20.4 kg (20%) ($p = 0.001$, d = 0.9) and statistically significant alterations were observed in this variable for the CG — 1RM had decreased by 8.9 kg (9%) ($p = 0.001$, d = 0.5) (Table 2). The analysis of the tests performed at the beginning of the study and after 3 months revealed statistically remarkable difference with extreme large effect ($p = 0.001$, d = 1.6). There were no significant changes between the members of both groups in terms of the body weight measured in pre- and post-test ($p = 0.43$).

Effects on HRQOL C-30

Global health status/QoL. Changes in The EORTC C-30 are listed in Table 3. No significant differences in baseline values between the groups were observed ($p > 0.05$). The QoL improved significantly (by 13%) for the TG with large effect ($p = 0.002$,

Table 2. Body weight and muscle strength of BC patients before and after of control period and maximal strength training

Variables	Baseline Mean ± SD	After 12 weeks Mean ± SD	Estimated means difference (95% CI)	*p* value and Cohen's d value after intervention
Weight (kg)				
Exercise	77.0 ± 15.2	76.7 ±14.5	−0.4 (−0.8 to 1.5)	0.56 (0.1)
Control	72.3 ± 17.4	73.3 ±16.5	1.0 (0.1 to 2.2)	0.08 (0.1)
p value and Cohen's d value between the groups	0.29 (0.3)	0.43 (0.2)		
1RM (kg)				
Exercise	106.8 ± 22.8	127.2 ± 26.4	20.4 (17.3 to 23.6)	0.001 (0.9)
Control	98.9 ± 20.7	89.9 ± 20.9	−8.9 (−11.0 to −6.9)	0.001 (0.5)
p value and Cohen's d value between the groups	0.19 (0.3)	0.001 (1.6)		

d = 0.6), but no relevant changes were observed in the CG (p = 0.44, d = 0.2). The results obtained from the post-test revealed significant changes with extreme large effect size in QoL between the groups (p = 0.002, d = 0.9) (Table 3).

Functional scales. Noticeable improvements after MST were observed in the TG: role functioning increased by 23% (p = 0.001, d = 0.7), social functioning — by 12% (p = 0.01, d = 0.5), emotional functioning improved by 13% (p = 0.001, d = 0.5), while it decreased by 11% (p = 0.02, d = 0.4) in the CG. After the post-test, important differences with large effect size were observed in emotional functioning (p = 0.005, d = 0.7) and social functioning (p = 0.004, d = 0.9). In other functional scales — physical functioning was significantly higher with large effect size for TG that CG after post test (p = 0.002, d = 0.9), and cognitive functioning — no statistically significant changes were observed between both groups.

Symptom scales. Fatigue diminished by 24% (p = 0.03, d = 0.6) in the TG, while it became worse by 25% (p = 0.02, d = 0.4) in the CG. Differences with large effect size were observed between the groups after post-test (p = 0.01, d = 0.6). Other symptoms are not associated with physical training effects rather than with the elapsed period of time after treatment.

QLQ-BR23

Functional scales. Changes in the EORTC QLQ-BR23 supplementary model are listed in Table 4. At the end of the intervention significant decrease in body image with medium effect size (p = 0.05, d = 4) was noticed in the CG. This variable had not altered in the TG, but showed medium effect size (p = 0.2, d = 0.3).

Symptom scales. Systemic therapy side effects deteriorated with large effect size for the CG (p = 0.001, d = 0.8), while there were no statistically considerable changes for the TG indicating medium effect size (p = 0.4, d = 0.3). Significant differences with large effect size (p = 0.04, d = 0.5) were observed between the groups after post-test performed after 3 months.

DISCUSSION

This is the first study applying MST in BC patients during adjuvant treatment. The major finding of this study is that MST considerably enhanced strength in patients with BC resulting in (13%) increase in the QoL. In addition, MST indicated improvement in role

Table 3. Changes in the EORTC QLQ-C30 before and after the intervention

Variables	Baseline Mean ± SD	After 12 weeks Mean ± SD	Estimated mean difference (95% CI)	*p* value and Cohen's d value after intervention
Global health status/QoL				
Global health status				
Exercise	67.2 ± 15.6	76.2 ± 14.3	9.0 (3.6 to 14.3)	0.002 (0.6)
Control	66.3 ± 16.5	63.5 ± 14.7	−2.7 (−10.0 to 4.4)	0.44 (0.2)
p value and Cohen's d value between the groups	0.84 (0.1)	0.002 (0.9)		
Functional scales				
Physical functioning				
Exercise	88.6 ± 8.2	90.6 ± 6.4	2.0 (−1.0 to 4.9)	0.17 (0.3)
Control	84.2 ± 14.6	81.6 ± 13.2	−2.5 (−5.3 to 0.2)	0.07 (0.2)
p value and Cohen's d value between the groups	0.18 (0.3)	0.003 (0.9)		
Role functioning				
Exercise	70.0 ± 26.7	85.9 ± 18.2	15.8 (6.7 to 24.9)	0.001 (0.7)
Control	69.1 ± 25.5	77.0 ± 19.5	7.9 (−2.6 to 18.5)	0.13 (0.4)
p value and Cohen's d value between the groups	0.89 (0.01)	0.09 (0.01)		
Emotional functioning				
Exercise	72.4 ± 21.1	82.1 ± 18.8	9.7 (4.1 to 15.4)	0.002 (0.5)
Control	74.4 ± 23.9	66.3 ± 21.3	−8.1 (−14.7 to −1.3)	0.02 (0.4)
p value and Cohen's d value between the groups	0.76 (0.1)	0.005 (0.8)		
Cognitive functioning				
Exercise	86.3 ± 15.4	87.0 ± 14.1	0.7 (−5.9 to 7,4)	0.83 (0.1)
Control	86.2 ± 18.2	80.8 ± 19.5	−5.3 (−11.8 to 1.2)	0.11 (0.3)
p value and Cohen's d value between the groups	0.99 (0.1)	0.19 (0.4)		
Social functioning				
Exercise	76.4 ± 24.1	85.7 ± 16.4	9.2 (2.1 to 16.4)	0.01 (0.5)
Control	74.3 ± 27.3	70.2 ± 20.9	−4.1 (−11.8 to 3.6)	0.29 (0.2)
p value and Cohen's d value between the groups	0.76 (0.1)	0.004 (0.8)		
Symptom scales				
Fatigue				
Exercise	33.5 ± 17.1	25.5 ± 15.5	−7.9 (−1.0 to −14.9)	0.03 (0.6)
Control	29.5 ± 18.5	36.8 ± 16.7	7.3 (1.4 to 13.1)	0.16 (0.4)
p value and Cohen's d value between the groups	0.41 (0.2)	0.01 (0.6)		

Note: Data are presented as mean (SD).

Table 4. Changes in the EORTC QLQ-BR23 before and after the intervention

Variables	Baseline Mean ± SD	After 12 weeks Mean ± SD	Estimated means difference (95% CI)	*p* value and Cohen's d value after intervention
Functional scales				
Body image				
Exercise	64.9 ± 25.9	72.1 ± 24.7	7.1 (−3.0 to 18.3)	0.19 (0.3)
Control	72.4 ± 24.6	62.9 ± 25.4	−9.5 (−19.4 to 0.3)	0.05 (0.4)
p value and Cohen's d value between the groups	0.27 (0.3)	0.18 (0.4)		
Symptom scales				
Systemic therapy side effects				
Exercise	24.2 ± 14.7	21.5 ± 9.9	−2.6 (−9.5 to 4.3)	0.46 (0.3)
Control	17.1 ± 14.1	29.3 ± 17.0	12.2 (5.9 to 18.5)	0.001 (0.8)
p value and Cohen's d value between the groups	0.74 (0.5)	0.04 (0.6)		

Note: Data are presented as mean (SD).

functioning (23%), emotional functioning (13%), social functioning (12%), simultaneously reducing the sense of fatigue by 24% for the TG (according to core questionnaire QLQ-C30). The supplementary module QLQ-BR23 pointed to improvements in body image and reduction in side effects experienced during and after treatment for the TG, while they worsen for the CG.

Strength training in cancer rehabilitation. General conclusion regarding strength training interventions for cancer patients is that training programs were well tolerated, safe and feasible. They showed improvements in strength leading towards enhanced physical functioning and better quality of life [15, 34].

Recognizing intensity during strength training the key factor for increasing maximal muscular strength, strength training with intensity higher than the adaptive threshold of 66–70% of 1RM may have been preferable to induce great physiological adaptations, thus stimulating faster recovery from specific cancer treatment [35]. There are only several studies discussing higher training intensities for BC patients. ACSM suggests exercise intensities of 50% of 1RM with 2–3 sets of 3–5 repetitions evolving to 10–12 repetitions [27]. As claimed by Kraemer *et al*. (2002) and Kraemer and Ratamess (2004), these might be insufficient for an optimal training effect. A possible reason for the insecurity is the hesitance to expose these patients to risks — muscle and joint injuries — when applying higher intensities. Besides, since cancer patients are subjects to intense psychological and physical stress, the treatment should be gentle, thus patients being exposed to low intensity exercises only. Since the guidelines were developed in 2003 and the knowledge about strength training was only at its very beginnings, such a situation appears to be logical. Studies of healthy subjects have proved strength training programs to be more effective when applying higher intensities. Kraemer and Ratamess (2004) continue by acknowledging that essential benefits in maximal strength and the subsequent hypertrophy can only be attained by recruiting the maximal number of motor units, guaranteeing high training loads. Simultaneously, heavy loads initiate more favorable responses in other tissues, e.g. bone. It is especially vital for BC patients due to the bone material density being lower than normal. Strength training helps preventing further bone loss [36].

Tolerance of the high-intensity program. The TG performed MST twice a week for 12 weeks, each training session lasting only 20 min. None of the patients dropped out because of overloading or injuries. The adherence rate was 96% which is far above the average indicators for quality of life interventions. High adherence rate could be explained by several reasons: extensive intake procedure by oncologists, individualization of training loads based on pre-test, supervision by exercise physiologist during training. These factors contributed to the safety and efficiency of the program. The training program is found to be motivating as muscle's strength increased by 20% after MST and the results correspond to other studies that have applied MST in healthy subjects and patient groups [22, 23, 31].

Quality of life and clinical relevance. Even though the benefits of strength training have been adhered in healthy subjects, its role in rehabilitation is hardly explored. In cancer rehabilitation, one of the main goals is to fight the side-effects of the disease and treatment procedure to improve the QoL. The present study proved that MST is capable of improving different aspects of QoL and reducing the sense of fatigue. Various biopsychosocial mechanisms could explain the improvements in BC patients' QoL. They result from strength training, including neuromuscular adaptations, endorphins distraction, mastery achievements, positive feedback, and social interaction [37]. According to EORTC QLQ-C30 core questionnaire, changes in role functioning, emotional functioning and social functioning after intervention have considerably improved and have indicated significant difference between the groups. Patients in TG were more socially active during treatment phase, and that could potentially explain improvement in the QoL. These findings prove that clinical strength training could keep patients socially active during the treatment period. As BC affects women's identities, improved QoL is especially vital for women going through complex treatment . As 1RM improves, other submaximal activities become more cost effective. Improvements in absolute strength indicate reduction in relative effort. Thus, work can be performed at a lower percentage of one's maximum capacity [38]. Due to improved muscle strength patients decide to do more, thus maintaining the life style they practiced prior to the treatment.

Typically, the patients of the study started adjuvant chemotherapy 4 weeks after breast surgery. On average, MST started 2 to 3 weeks after surgery. So, the patients had > 4 training sessions before the first chemotherapy. As a result, the patients already had improved muscle strength when engaging in adjuvant treatment. Our observations verify the positive effect of starting training as early as possible — the muscle strength is upgraded even before the chemotherapy process. The muscle strength improves from 1–3% after every training session [29, 39].

Clinical implications. It is generally acknowledged that reduction in exercise capacity and attenuation in maximal work rate is typical for BC patients. In addition, it cannot be denied that the ability to engage in physical activities is strongly affected by loss of muscle strength and reduction of muscle mass [40, 41]. These factors lead towards inactivity, muscle disuse, and even worse health condition. The current findings indicate that MST is appropriate for patients suffering from BC as the patients of the present study demonstrate 96% compliance and completion of training. The current data show that the inclusion of MST in a BC rehabilitation program could increase muscle strength for about 20%, while the QoL could be improved by 13%. Reduction of therapy side effects and fatigue seem to be logical consequence. The patients are to demonstrate the potential of performing significantly more work or accomplishing the same work with reduced effort.

CONCLUSION

Finally, this study demonstrates a considerable improvement in muscle strength, QoL and reduction of fatigue after 12-week high-intensity strength-training program in BC patients. These findings give a reason for the authors of the study to recommend incorporating high-intensity strength training in cancer rehabilitation, accompanied by careful screening and supervision of patients during training period.

DISCLOSURES

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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