INFLUENCE OF A SPECIALIZED HOME-EXERCISE PHYSIOTHERAPY PROGRAM ON MUSCLE STRENGTH IN BREAST CANCER SURVIVORS

Mihaela Mitova
National Sports Academy "Vassil Levski", Sofia, Bulgaria

ABSTRACT
Introduction. Research shows that regular physical activity can improve the survival of breast cancer patients, as well as lower the risk of cancer recurrence and co-morbidities compared to those who are less active, regardless of the stage of their disease.
Aim. To examine the impact of a customized at-home physical therapy regimen on enhancing muscle strength in breast cancer patients in the latter stages of recovery.
Materials and methods. The study was conducted with 29 women who had undergone surgery at least 6 months ago and attended the 10-day course of treatment at "SHR" EAD, Bankya. Participants performed a set of specialized exercises aimed at improving muscle weakness and the functional capabilities of the affected upper limb, their ability to perform activities of daily living (ADL), and their overall quality of life. Outcomes were reported by measuring muscle strength using manual handgrip dynamometry of the affected upper limb.
Results. Statistically significant changes in muscle strength as measured using handgrip dynamometry were reported in the experimental group between the start of the home-exercise program and its end 12 months later, with a reported difference of 1.5 kg on average.
Conclusion. The muscle strength in the affected upper limb and its functional ability to carry out daily living tasks independently were both positively impacted by the home-exercise physiotherapy program implemented by breast cancer survivors. The use of a home physiotherapy program in breast cancer survivors requires more research.

ORCID
Mihaela Mitova
https://orcid.org/0000-0002-4333-7434

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INTRODUCTION

Breast cancer (BC) is the most common type of cancer among women worldwide and accounts for 11.7% of all cancer cases. Several national and international organizations have published guidelines to support professionals in their efforts to care for breast cancer survivors. With the increasing number of survivors, the individual, family, and social challenges for survivors of BC are becoming a critical issue in the public healthcare system and require thorough reorganization at local, regional, and national levels. Rehabilitation can be viewed as both a "general health strategy" and a "set of interventions" aimed at enabling individuals at risk or with physical and/or mental health impairments to achieve and maintain optimal functioning and strive for the best health-related quality of life in family and social contexts.

According to the International Classification of Functioning, disability and Health (ICF), adopted by the World Health Organization in 2001, cancer and its treatment affect the structures of the body and impact an individual's functions, activities, and participation in society. Subsequently, a set of specific, comprehensive, and concise core categories has been developed for survivors using the ICF to describe function and disability in patients diagnosed with breast cancer.

Breast carcinoma and subsequent treatment result in a range of physical and psychological side effects that persist for many years after diagnosis. Physiotherapy (PT) has been shown to reduce many of these side effects, but only a very small percentage of women participate in regular physiotherapy treatments.

A physiotherapy program should focus on three main areas: improving upper extremity function, restoring general health, and reducing the risk of or treating lymphedema. Early active-assisted or active range-of-motion exercises in the shoulder are key to restoring shoulder girdle mobility. When breast cancer-related complications occur, they often go unrecognized and untreated, eventually reaching levels that negatively impact overall functional capabilities. Patients are often referred to post-operative rehabilitation when disability and

functional limitations have already developed.
Regular physiotherapy has an impact on the survival of patients who remain physically active after treatment and have a lower risk of recurrence, exacerbation of comorbidities, and mortality. These benefits are highlighted in guidelines developed and published by international professional organizations, which provide detailed guidance on the application of PT to cancer survivors. Despite these recommendations, the majority of patients are not sufficiently physically active. (Short et al., 2013)
The American Institute for Cancer Research (2019) recommends that patients follow physical activity (PA) guidelines. PA has been shown to improve physical and emotional well-being, psychological adjustment, reduce fatigue, depression, and anxiety, and help maintain a healthy body weight. In addition, studies show that the immunological status of patients with BC improves after regular PA. However, physical activity levels among these patients are low. The application of a targeted PT program can lower circulating estrogen levels and potentially reduce the risk of new tumor proliferation. Physiotherapy procedures can be performed at home, offering a convenient and accessible option for women who wish to increase their physical activity and maintain a healthy lifestyle (Coughlin et al., 2019).
In a publication by the American College of Sports Medicine (2018) related to the application of physical activity for cancer prevention and control, a multidisciplinary expert group concluded that there is sufficient evidence to support the effectiveness of physiotherapy methods in dealing with cancer-related complications such as pathological fatigue, reduced quality of life, reduced physical capacity, anxiety, and depressive symptoms. Evidence has confirmed that resistance exercises are safe for patients with or at risk of lymphedema (Schmitz et al., 2019).
According to research by Smith-Turchyn et al. (2016), regular moderate-intensity exercise in various forms can help overcome many of the side effects associated with surgery, chemotherapy, radiation therapy, and hormone therapy (Smith-Turchyn et al., 2016).
For PT to be more widely recommended, there is a need for improved awareness of its benefits, the establishment of adequate administration programs, and trained physiotherapists to implement it. Implementation of home-based physiotherapy programs is effective in improving physical activity among breast cancer survivors who have completed surgery, chemotherapy, and radiotherapy. Currently, few of the effective interventions have been translated into community and clinical practice. This may be due in part to the insufficient resources required to conduct effective physiotherapy. On the other hand, community-based and home-based physiotherapy programs may be a solution to accelerate the inclusion of more people.
The aim of this study was to investigate the possible impact of a year-long specialized home-exercise physiotherapy program on the physical and psychological function of breast cancer survivors in the chronic postoperative period.

METHODOLOGY

Study organization and participants

The study covered a period of 3 (three) years (2019-2022) and was conducted at the “Specialized Hospitals for Rehabilitation - National Complex” EAD, city of Bankya branch, and at the participant’s home.
A total of 29 women who signed an informed consent participated in the study. They were divided into two groups based on their willingness to follow a home-based physiotherapy program for 12 months. The experimental group included 22 women, while the control group included 7 women. Patients from both groups underwent a 10-day physiotherapy program at the “Specialized Hospitals for Rehabilitation - National Complex” EAD, Bankya city branch, designed by specialists in the “Victoria” program. Table 1 shows the general characteristics of the participants in both study groups.
The mean age of the women in the experimental group was 61, and that of those in the control group was 56. We found no statistically significant difference in the mean age between the experimental and control groups, as well as in their demographic characteristics (p>.05).
The home-based physiotherapy program specifically developed for the purposes of the study was applied in a period of 12 months in breast cancer survivors in the chronic postoperative phase. The physiotherapy program adopted by the participants was designed for the purposes of the study. Its design is based on the basic physiological principles of the effects of physical exercise on the functional abilities of patients to perform activities of daily living and is consistent with international requirements for the appropriateness of the administration of physical activity in these types of patients.
The experimental group conducted a home reha-

bilitation program consisting of 35 exercises. The control group performed the usual activities and exercises that had been performed prior to the initiation of the study, with no predetermined sequence or amount of exercise.

The home-based physiotherapy program included stretching exercises for the upper extremities and upper torso, resistance exercises for the upper extremities, which we recommended be performed with the red elastic band provided to achieve moderate resistance, and instructions to perform light drainage self-massage techniques. When unable to perform resistance exercises, patients were instructed to use light hand-held items such as a scarf, towel, rolling pin, or other. Patients were encouraged to use the diary provided in the exercise booklet to keep track of the frequency of exercise performance as well as to perform the exercises at convenient times for them during the day, most days of the week.

The exercise program was provided to the enrolled patients in the form of a booklet with detailed, easy-to-follow photographs and, if desired, video demonstrations of each exercise. Each participant assigned to the experimental group received a booklet demonstrating the correct exercise execution and a place to keep a diary of the days the exercises were performed. Study participants were instructed to do the exercises at least 3 days a week. Exercise performance was monitored by telephone. The calls were made every two weeks for the first 3 months and every month thereafter until the investigator met with the patient at the outpatient clinic in the city of Bankya one year after their inclusion in the study.

To improve the participants' motivation and encouragement to implement the home-based rehabilitation program, the following strategies were used:

(1) the program was designed to be performed at home so that it can be in the context of the patient's natural living conditions; (2) the exercise program components were designed to be performed in one or in separated time intervals during the day; (3) the exercises were specifically selected to minimize possible injury or the occurrence of complications, starting with light and moderate intensity exercises that could be increased over time; (4) the program contained an exercise self-monitoring diary and telephone follow-ups to provide guidance regarding exercise-related issues and to encourage diary completion throughout the study period.

Main physiotherapy goal

To achieve an optimal level of patients' functional abilities and independence in the performance of daily activities, to improve their quality of life, and prevent complications.

Physiotherapy long-term and short-term goals: 1. To identify and treat any signs of lymphedema if it develops; 2. To prevent postural deformities. 3. To prevent muscle tension in the cervical musculature, interventions may include 4. To prevent upper limb mobility restrictions, interventions may include 5. To improve muscle strength and functional involvement of the affected upper extremity.

Methodological guidelines: Consider exercise parameters if a patient is at risk for lymphedema or has lingering weakness in the involved extremity.

Evaluation Methods

After voluntarily signing an informed consent and consulting their physician, the following evaluation methods were performed (twice during the one-year period): hand-grip manual dynamometry, manual muscle testing (MMT), goniometry, and circumference measurement.

General patient characteristics: sociodemographic data on age, sex, occupation, etc.; Information on clinical condition: diagnosis, age, type of treatment after surgery, rehabilitation interventions performed to date, etc.

Functional muscle strength testing – hand-grip strength (dynamometry)

Muscle strength of the upper limb can be quantified with a hand-held dynamometer. Dynamometry is a method to more accurately measure the force a muscle group can exert and it allows differences in strength to be measured more accurately over time. The dynamometer used in the study was a GIMA hand-held dynamometer with a capacity of up to 75 kg (Gima S.p.A. Via Marconi, 1 - 20060 Gessate (MI)). The muscle strength of both the affected and unaffected upper limbs was measured, but only the data for the affected side is included in the results presented. The minimally detectable change used in this study was 3 kg.

Statistical analysis

We analyzed the study results on an intention-to-treat basis, i.e., we did not consider participants' adherence to the intervention and used all available data from the self-reported measures filled out by participants in both experimental and control groups.

Statistical analysis was performed with SPSS software version 25 (IBM Inc., Chicago, IL, USA). Results are presented as the number of cases and (%) or as a mean standard deviation ± mean (SD). Statistical significance was determined at a *p*-value < .05.

RESULTS

Reduced physical activity in people with breast cancer has been found to have potentially negative consequences, such as muscle weakness and reduced aerobic capacity. The aim of our study was to promote healthy behavior in women following treatment for breast cancer. A home-exercise physiotherapy program including a variety of strengthening, flexibility, and functional exercises has the potential to improve muscle strength in these patients.

Statistically significant changes in muscle strength as measured using hand-grip dynamometry were reported in the experimental group between the start of the home-exercise program and its end 12 months later, with a reported difference of 1.5 kg on average (Table 1). No statistically significant differences were found in the control group and between the two groups at the beginning and end of the study.

Table 1. *Changes in muscle strength of the affected upper extremity measured using hand-grip dynamometry in both study groups at the beginning and at the end of the study.*

Muscle strength	Group	Beginning $Mean_1 \pm SD$	End $Mean_2 \pm SD$	*p*
Affected upper extremity	EG	15.9 ± 4.5	17.4 ± 4	***
	CG	14.9 ± 8.0	15.9 ± 7.7	
	p	.798	1.00	

*Notes. EG- experimental group; CG- control group; Mean±S_D – mean value and standard deviation, *** p < .001, ** p < .01, * p < .05 – statistically significant change between the starting and the end values between study groups determined using Wilcoxon Test; p < .001, p < .01,p < .05 – statistical significance of the change between both study groups calculated using Mann-Whitney's U-Test. An increase in hand-grip strength in kilograms shows improvement in the muscle strength of the affected upper extremity.*

The initial and final average muscle strength values measured in the participants in our study are lower (EG from 15.9 to 17.4 kg; CG from 14.9 to 15.9 kg) than those mentioned by some authors, but the statistically significant improvement achieved in the experimental group of 1.5 kg is greater than that achieved in the studies discussed below. The grip-strength values measured in patients in the experimental and control groups are lower than the average values in healthy women of the same age, as expected due to the complications resulting from the treatment for BC.

DISCUSSION

Rogers et al. (2009) investigated the impact of increasing physical activity through structured exercise therapy programs in women who had undergone hormone therapy for breast cancer. They led a sedentary lifestyle, with the aim of improving their overall condition and quality of life. Participants in the experimental group were enrolled in a 12-week kinesiotherapy program with face-to-face procedures and sessions with a psychologist to support adherence to an active lifestyle. When examining the muscle strength of the right and left upper limbs, they noted that the experimental group had a statistically significant improvement in muscle strength in the left upper limb from 26.4 kg to 26.5 kg, and in the right upper limb from 28.6 kg to 29.2 kg. In the control group, they observed a deterioration in muscle strength from 25.1 kg to 23.1 kg in the left upper limb and from 26.1 kg to 25.4 kg in the right upper limb (Rogers et al., 2009).

Luna-Heredia et al. (2005) studied grip strength in healthy adults aged 17–97 years. They found that the average muscle strength in healthy women aged 50 was 22.8 kg. The authors report that the average strength of women aged 50–59 in the dominant hand was 24.5 kg, and in the non-dominant hand, 21.6 kg. For women aged 60-69, the authors note a decrease in the average grip strength values to 19.5 kg for the dominant hand and 17.5 kg for the non-dominant hand (Luna-Heredia et al., 2005). These values are much closer to the averages measured in our study.

Grip strength is the most commonly used functional test for the upper extremity. The average grip strength according to the study by Neil-Sztramko et al. (2014) is 24.6 kg in women undergoing treatment and 22.8 kg in women who have undergone treatment. These values are below the median reported values of 27.7 kg for healthy adults aged 50 to 59 years (Neil-Sztramko et al., 2014).

In the study by Cantarero-Villanueva et al. (2012), the average measured values for muscle strength in the affected upper limb in women who had survived breast cancer were 18.3 kg. According to the authors, prospective studies show that muscle strength measured by hand dynamometry is inversely related to all causes of mortality. Some authors suggest that breast cancer survivors experience a decrease in muscle strength and cancer-related changes in motor control of the shoulder girdle muscles (Cantarero-Villanueva et al., 2012).

Their study shows significant correlations, ranging from moderate to strong, between hand dynamometry and mood, fatigue, pain, hypersensitivity, neck and shoulder mobility, and physical fitness levels in breast cancer survivors. These findings are consistent with other studies conducted on other malignant diseases. It is known that light-intensity resistance exercises increase muscle strength in these patients and are recommended for the treatment of cancer-related complications. In order to develop an adequate individualized PT program (form, duration, intensity, and frequency), it is important to know the initial strength levels of patients and to understand the potential positive effects of the program, such as increased muscle endurance, quality of life, and overall health (Cantarero-Villanueva et al., 2012).

The study by Son et al. (2020) tracks the muscle strength of women who have undergone surgery for breast cancer and are receiving chemotherapy. The authors measure muscle strength during chemotherapy and 6 months after it. The average values they obtained for the muscle strength of the affected upper limb were 21.71 kg at baseline, 22.70 kg 3 weeks after baseline, and 22.88 kg 6 months after the start of chemotherapy (Son et al., 2020).

In the study by DeNysschen et al. (2014), which tracked the impact of a physiotherapy program in patients undergoing treatment for breast cancer, the authors noted a 14% increase in muscle strength in the experimental group compared to the values measured before the start of the study (DeNysschen et al., 2014).

Due to the dysfunctions caused by breast cancer treatment, upper body function decreases and affects daily activities. TheraBand® graded exercises are effective in improving muscle strength and range of motion in the shoulder in breast cancer survivors and help to increase functional capacity. Early rehabilitation can be implemented to reduce pain and improve strength and flexibility, which will be beneficial in minimizing limitations in daily activities and improving quality of life. (Datar et al., 2019).

TheraBand® exercises have been shown to be effective in reducing fatigue levels, improving functional capacity and muscle strength, and inducing positive changes in metabolic processes, which have a direct impact on patients' quality of life. TheraBand® bands are cost-effective, easy to use, portable, and versatile. TheraBand® exercises are very easy and simple, so patients can do them easily at home (Datar et al., 2019). The home rehabilitation exercises we included and the TheraBand® elastic band with moderate resistance we provided demonstrated a statistically significant improvement in muscle strength in the EG at 12 months after the beginning of the study.

Other authors also conclude that progressive resistance exercises significantly improve muscle strength, muscle endurance, and quality of life. Relatively higher levels of muscle activation during exercise are achieved when training against resistance with elastic products than with weights, and this is an easily feasible alternative to training with fitness equipment. Although it is known that regular exercise and physical activity can improve the health of BC survivors, there is an urgent need to develop proper treatment and early rehabilitation protocols related to myofascial dysfunctions that have negative effects on patients' health. Graded exercises with TheraBand® are necessary to improve daily activity and quality of life (Datar et al., 2019).

Limitations of the study

"Willingness to participate" in the specialized home-exercise program as one of the inclusion criteria in the study may have created a selection bias, so we recommend further research to investigate the effect of home-based physical activity on their muscle strength and ability to perform more activities of daily living in breast cancer survivors.

CONCLUSIONS

The performed study, the analysis of the results, and our personal first-hand impressions of the twelve-month observation give rise to the following more important conclusions:

1. Taking an active part in a specialized physiotherapy home-exercise program over a twelve-month period was shown to maintain and improve the overall health and functional status of patients treated for breast cancer.

2. The applied physiotherapy program designed

specifically for breast cancer survivors has a positive therapeutic effect on the participants' muscle strength of the upper extremity affected by the systemic treatment.

3. The physiotherapy program designed for the purposes of the study demonstrates the need for daily, adapted home exercises to achieve lasting clinical results and improve the quality of life in patients undergoing treatment for BC. It is well accepted by the patients, and it is suitable for long-term, daily home use.

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Corresponding author:
Mihaela Mitova, PhD
Department of Kinesitherapy and Rehabilitation
National Sports Academy "Vassil Levski"
Sofia, Bulgaria
E-mail: mihaela.mitova@nsa.bg

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