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# EFFECT OF 36 COMBINED PHYSICAL EXERCISE SESSIONS ON THE RANGE OF MOTION AND HANDGRIP STRENGTH OF MASTECTOMIZED WOMEN UNDERGOING BREAST CANCER TREATMENT

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## ABSTRACT

Purpose: to verify the influence of 36 sessions of a combined exercise protocol (resistance exercise with dumbbells and flexibility exercises for upper limbs) on the range of motion of the glenohumeral joint and handgrip strength of mastectomized women undergoing treatment of breast cancer. Materials and Methods: 37 female volunteers aged between 31 and 76 years, physically inactive who were being treated for breast cancer through adjuvant therapies were randomized into 2 groups (experimental, n=17; control, n=20). The volunteers in the experimental group underwent 36 sessions of a combined exercise protocol (resistance exercise with dumbbells and flexibility exercises for upper limbs), whereas the volunteers in the control group only continued with conventional cancer treatment. Both groups were evaluated before the start (pre-test) and one day after the end of the 36 combined exercise sessions of the exercise group (post-test). Results: The Kruskal-Wallis non-parametric test demonstrated a significant improvement in the exercise group compared to the control group for the variables of handgrip strength, shoulder extension, medial shoulder rotation, and shoulder lateral rotation ($p<0.05$). Conclusion: The combined exercise protocol had a positive influence on the handgrip strength and improved flexibility for the movements of horizontal shoulder abduction, medial shoulder rotation, shoulder lateral rotation. However, there was no effect on the movements of shoulder flexion, shoulder extension, and horizontal shoulder adduction.

**Key words:** Breast cancer. Resistance training. Flexibility. Strength.

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## RESUMO

Efeito de 36 sessões de exercícios físicos combinados sobre a admireção de movimento e força de pensamento de mulheres mastectomizadas em tratamento de câncer de mama

Objetivo: verificar a influência de 36 sessões de um protocolo de exercícios combinados (exercício resistido com halteres e exercícios de flexibilidade para membros superiores) na amplitude de movimento da articulação glenoumeral e na força de preensão palmar de mulheres mastectomizadas em tratamento de câncer de mama. Materiais e Métodos: 37 voluntárias com idade entre 31 e 76 anos, fisicamente inativas, em tratamento de câncer de mama por meio de terapias adjuvantes, foram randomizadas em 2 grupos (experimental, n=17; controle, n=20). Os voluntários do grupo experimental realizaram 36 sessões de um protocolo de exercícios combinados (exercício resistido com halteres e exercícios de flexibilidade para membros superiores), enquanto os voluntários do grupo controle continuaram apenas com o tratamento oncológico convencional. Ambos os grupos foram avaliados antes do início (pré-teste) e um dia após o término das 36 sessões de exercícios combinados do grupo exercício (pós-teste). Resultados: O teste não paramétrico de Kruskal-Wallis demonstrou melhora significativa no grupo exercício em relação ao grupo controle nas variáveis força de preensão palmar, extensão do ombro, rotação medial do ombro e rotação lateral do ombro ($p<0,05$). Conclusão: O protocolo de exercícios combinados influenciou positivamente na força de preensão manual e melhorou a flexibilidade para os movimentos de abdução horizontal do ombro, rotação medial do ombro, rotação lateral do ombro. No entanto, não houve efeito nos movimentos de flexão de ombro, extensão de ombro e adução horizontal de ombro.

**Palavras-chave:** Câncer de mama. Treinamento de resistência. Flexibilidade. Força.

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## INTRODUCTION

Worldwide, cancer represents a serious public health problem. In addition to the negative impacts of an economic nature caused by various types of cancer, this chronic-degenerative disease with multifactorial genesis is one of the main causes of mortality in the world (Lahart et al., 2018), affecting mainly developed countries (Oliveira, 2018; Siegel, Miller and Jemal, 2020).

Unfortunately, projections made point to continuous and exponential growth in the incidence and deaths caused by different types of cancer for the coming (Ferlay et al., 2018).

Among women, breast cancer is one of the most recurrent and worldwide, in 2018 it represented 24.2% of the total new cases of cancer.

That same year, unfortunately, it was the fifth leading cause of cancer death in general and the most frequent cause of cancer death in (Ferlay et al., 2018).

Once established, breast cancer inevitably needs to be treated. In this case, adjuvant treatments can be applied, such as hormone therapy, radiotherapy, and chemotherapy whose objective is to control the spread of the disease and reduce its recurrence (Hill et al., 2018). Depending on the progression of the disease, surgical intervention will be necessary.

Although in some cases surgical treatment is inevitable to stem the progression of breast cancer, many women undergoing this surgical procedure have sequelae.

One of the most recurrent sequelae after mastectomy surgery is the decrease in range of motion that occurs due to axillary morphological alteration due to fibrosis in the pectoralis major muscle. This alteration can cause pain, joint limitation, in addition to muscle atrophy and decreased strength (Spindula et al., 2017).

Thus, this study aimed to verify the influence of 36 sessions of a combined exercise protocol (resistance exercise with dumbbells and flexibility exercises for upper limbs) on the range of motion of the glenohumeral joint and handgrip strength of mastectomized women undergoing treatment of breast cancer.

## MATERIALS AND METHODS

### Study characterization and ethical aspects

The present research is an experimental study, with 12 weeks duration and sampling for convenience.

Data collection took place between the months of October and December 2018, in 37 female volunteers aged between 31 and 76 years, living in the metropolitan region of the Brazilian city of São Paulo.

All procedures adopted in the research were approved by the Research Ethics Committee of the University of Mogi das Cruzes (Protocol 2.941.198).

### Inclusion criteria and experimental design

With the help of physicians specialized in the treatment of breast cancer, female patients who met the prerequisites of this study were identified.

The inclusion criteria to participate in this research were: 1- Being under treatment for breast cancer; 2- Be mastectomized in one of the breasts using the Madden technique; 3- not having undergone axillary lymphadenectomy; 4- Be physically inactive (do not practice physical exercises in a systematic way); 5- Have medical authorization to practice strength and flexibility physical exercises on upper limbs.

After the initial screening, patients were invited to participate in a lecture whose focus was to clarify the objectives, benefits and possible risks of the study.

Then, the patients who wished to participate in the study and signed the Free and Informed Consent Form, were randomly divided into two groups, in this case, Exercise Group (EG; n=17) and Control Group (CG; n=20).

Randomization occurred from a computerized allocation generated by the Random Allocation program available online (http://www.randomized.com).

The EG volunteers were submitted to 36 sessions of a combined exercise protocol (resistance exercise with dumbbells and flexibility exercises for upper limbs), whereas the CG volunteers only continued with conventional breast cancer treatment, as well as adjuvant therapies (chemotherapy, radiotherapy, and hormone therapy).

However, both groups were evaluated before the start (pre-test) and one day after the end of the 36 combined exercise sessions of the

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EG (post-test), that is, 12 weeks after the beginning of the study.

**Range of motion assessment**

For the analysis of the range of motion of the glenohumeral joint (mastectomized side), a universal portable goniometer from the Carci® brand was used.

This instrument consists of a protractor that allows you to check angular variations from 2° to 360°. Made of polyvinyl chloride plastics, with two longitudinal arms connected to a single axis, 22 cm long and 0.08 mm thick, this instrument is widely used by physiotherapists and other health professionals to measure the range of joint movement, as it is easy to handle, non-invasive and low cost (Marques, 2003).

Supplementary figure 1 shows the movements evaluated for the glenohumeral joint, according to Marques (2003) in this case, flexion (a), extension (b), vertical abduction (c), horizontal adduction (d), internal rotation (e), and external rotation (f).

**Handgrip strength assessment**

The handgrip strength (in the mastectomized side) was assessed on a 0.1 kilogram (kg) scale using a Jamar® handgrip dynamometer (Sammons Preston model), using a neutral grip (figure 2). With the handle in a neutral position, for each individual assessed, they were asked to perform the maximum handgrip strength. This procedure was performed in each of the evaluations (pre-test and post-test) 3 times, with the average of the 3 measurements as the final value.

**Protocol of applied exercises**

EG participants were submitted to 3 weekly sessions of combined exercises (flexibility exercises and resistance exercise with dumbbells) for a period of 12 weeks, thus totaling 36 sessions.

The sessions started with the flexibility exercises and then the resistance dumbbell exercises protocol was applied.

The approximate duration of a complete training session was approximately 60 minutes and throughout the protocol, the participants received the supervision and guidance of a Physical Education professional.

**Flexibility exercises**

Four Static flexibility exercises were performed by the EG participants. For each exercise, 3 stretches were performed at the maximum range of motion supported, and the subject should remain static for 15 seconds followed by a 15-second rest between each series. The exercises performed for the glenohumeral joint were flexion (a), hyperextension (b), vertical abduction (c), and lateral rotation (d), both in a bipedal position (Supplementary figure 2).

**Resistance exercises with dumbbells**

In the first two weeks (6 initial sessions) adaptation period, only a series of 06-12 repetitions was performed for each exercise. In the following 10 weeks (30 sessions remaining), 3 sets of 06-12 repetitions were performed for each exercise.

The cadence of movement during the exercises was approximately 3 seconds for the concentric phase and 3 seconds for the eccentric phase, whereas the rest time between sets was approximately 1 minute.

Four resistance exercises with dumbbells were performed by the research participants, in this case, simultaneous elbow flexion in a bipedal position (a), supine shoulder extension (b), simultaneous supine elbow extension (c), and simultaneous vertical abduction in bipedal position (d) (Supplementary figure 3). In exercise “b”, 2 dumbbells of 3 kg each were used, for the other exercises, each one of the dumbbells had 1 kg. This load was maintained during the 36 sessions of the exercise protocol.

**Statistical analysis**

The normality of the data was verified by the Shapiro-Wilk test. The homogeneity in the sample distribution for both groups (control and exercise) was verified using the non-parametric Mann-Whitney test.

The influence of the applied exercise protocol was verified between the groups using the non-parametric Kruskal-Wallis test with Post hoc Student-Newman-Keuls, when necessary. The results were considered statistically significant only when $p< 0.05$. All analyzes were performed using Bioestat version 5.3 statistical software.

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## RESULTS

The subjects characterization, Table 1, presents the variables of Age (years), Handgrip strength (kg), Shoulder flexion (°), Shoulder extension (°), Horizontal shoulder adduction (°), Horizontal shoulder abduction (°), Medial shoulder rotation (°), Shoulder lateral rotation (°). In both variables, the non-parametric Mann-Whitney test found no statistically significant difference between groups (p>0.05). This data demonstrates the homogeneity in the randomization of the groups.

**Table 1 -** Characteristics of subjects.

| | Control Group | Exercise Group | |
|---|---|---|---|
| n= | 20 (54.05%) | 17 (45.95%) | |
| Right side mastectomy | 14 (70.00%) | 8 (47.05%) | |
| Left side mastectomy | 6 (30.00%) | 9 (52.95%) | |
| | | | p-value |
| Age (years) | 48.55 ± 8.59 | 48.53 ± 5.75 | 0.62 |
| Handgrip strength (kg) | 21.25 ± 6.31 | 20.59 ± 5.47 | 0.70 |
| Shoulder flexion (°) | 65.50 ± 14.50 | 61.29 ± 13.60 | 0.43 |
| Shoulder extension (°) | 27.90 ± 7.32 | 26.82 ± 7.84 | 0.53 |
| Horizontal shoulder adduction (°) | 23.05 ± 6.03 | 23.47 ± 7.53 | 0.92 |
| Horizontal shoulder abduction (°) | 44.30 ± 11.04 | 39.18 ± 8.34 | 0.12 |
| Medial shoulder rotation (°) | 32.60 ± 6.62 | 34.47 ± 8.32 | 0.30 |
| Shoulder lateral rotation (°) | 35.30 ± 6.37 | 38.47 ± 10.19 | 0.17 |

Table 2 shows the influence of 36 sessions of a combined exercise protocol (resistance exercise with dumbbells and flexibility exercises for upper limbs) on the range of motion of the glenohumeral joint and handgrip strength of mastectomized women undergoing breast cancer treatment.

The Kruskal-Wallis non-parametric test demonstrated a significant improvement in the exercise group compared to the control group for the variables of handgrip strength, shoulder extension, medial shoulder rotation, and shoulder lateral rotation (p<0.05), for the other variables this positive effect was not observed.

**Table 2 -** Effect of the exercise protocol on the range of motion and handgrip strength.

| | CG (pre-test) | CG (post test) | EG (pre-test) | EG (post test) | p-value |
|---|---|---|---|---|---|
| Handgrip strength(kg) | 21.25±6.31 | 20.85±6.38 | 20.59±5.47 | 25.82±5.07€#¥ | <0.05 |
| Shoulder flexion(°) | 65.50±14.50 | 65.50±14.95 | 61.29±13.60 | 71.06±14.21 | ns |
| Shoulder extension(°) | 27.90±7.32 | 28.90±5.48 | 26.82±7.84 | 33.65±6.72€#¥ | <0.05 |
| Horizontal shoulder add.(°) | 23.05±6.03 | 22.50±5.58 | 23.47±7.53 | 29.18±8.43 | ns |
| Horizontal shoulder abd.(°) | 44.30±11.04 | 42.50±11.24 | 39.18±8.34 | 45.12±13.73 | ns |
| Medial shoulder rotation(°) | 32.60±6.62 | 30.60±6.93 | 34.47±8.32 | 43.18±7.97€#¥ | <0.05 |
| Shoulder lateral rotation(°) | 35.30±6.37 | 32.50±8.08 | 38.47±10.19# | 46.24±11.16€# | <0.05 |

**Legenda:** CG= Control group; EG= Exercise group; Add = adduction; abd = abduction; € = Indicates difference in relation to the control group in the pre-test; # = Indicates difference in relation to the control group in the post-test; ¥ = Indicates difference in relation to the exercise group in the pre-test.

## DISCUSSION

In terms of the positive influence of physical exercise in patients with breast cancer, several studies have shown promising results.

Mijwel et al., (2018) and Foley, Hasson and Kendal (2018) applied combined exercises to patients during the chemotherapy process.

The first study applied strength and aerobic exercises for 16 weeks in patients aged 38 to 54 years, the second study applied strength exercises in addition to aerobic, proprioception, and flexibility exercises for 12 weeks in patients over the age of 18 years.

Although the two studies cited applied different exercise protocols, the weekly application of the sessions occurred in the same

way, two sessions per week. Both studies demonstrated positive effects on parameters related to the patient's quality of life.

Paulo et al., (2019) also conducted a study in order to verify the influence of combined exercises on the quality of life of patients with breast cancer.

The applied protocol lasted nine months and included a sample of patients aged 50 to 80 years undergoing hormone therapy.

The experimental group performed strength exercises in addition to aerobic exercises, with application three times a week, totaling 108 sessions. The control group only applied stretches twice a week, totaling 56 sessions.

Each session lasted an average of 40 minutes. Aerobic exercises were performed on a treadmill with progressive intensity from mild to moderate.

The results demonstrated moderate to high impact effects for both groups when physical, psychological, and emotional aspects were evaluated, but with better results for the experimental group.

It is common for women who have undergone mastectomy surgery to have sequelae. One of the most recurrent sequelae after mastectomy surgery is the decrease in range of motion that occurs due to axillary morphological alteration due to fibrosis in the pectoralis major muscle. This alteration can cause pain, joint limitation, in addition to muscle atrophy and decreased strength (Spindula et al., 2017; Desantis and Siegel, 2015).

Despite this, our study showed very interesting results. After applying the 36 sessions of the proposed combined exercise protocol (resistance exercise with dumbbells and flexibility exercises for upper limbs), it was possible to verify a significant improvement for shoulder extension, medial shoulder rotation and shoulder lateral rotation movements.

This result is promising since such movements are directly related to the performance of daily physical activities, such as domestic physical activities.

Leal, Oliveira e Carrara (2016) applied a specific kinesiotherapy protocol to 35 volunteers who were undergoing radiotherapy treatment for breast cancer.

The volunteers were randomized into two groups, 18 for the control group and 17 for the experimental group. The exercise protocol was performed twice a week and among the exercises performed there were mobility exercises for the humeral glenoid joint, including flexion, extension, abduction, adduction, medial rotation, and lateral shoulder rotation, that is, the same movements evaluated in our study.

After the intervention period, it was possible to verify a significant improvement in the abduction, flexion, and lateral rotation movements for the experimental group. Interestingly, as in our study, it was not possible to observe significant improvement in all movements evaluated for the glenohumeral joint.

The study by Loudon et al., (2016) evaluated the effect of yoga classes on breast cancer patients with arm lymphedema. Using a sample of 23 volunteers, 12 from the exercise group and, 11 from the control group. The intervention lasted eight weeks with five weekly sessions of approximately 90 minutes.

The control group just continued with the usual medical care already applied. After the intervention period, there was a significant improvement, exclusively for the shoulder abduction movement in the experimental group.

Taken together, these studies point to the need to investigate exercise protocols for the treatment of breast cancer, especially in mastectomized women, who are able to improve the range of motion in the different planes and axes of movement of the glenohumeral joint, in view of the importance of this articulation for the performance of movements performed during activities of daily living.

Together with the decrease in range of motion, mastectomy surgery has a negative influence on muscle strength (Desantis and Siegel, 2015; Spindula et al., 2017).

Together, these losses directly impact the performance of movements and, consequently, the quality of life of mastectomized patients. Our study found, through the exercise protocol applied, a beneficial effect on the handgrip strength of the volunteers.

As in our study, Souza Filho et al., (2019) also found promising results in improving muscle strength, in this case in elderly women undergoing breast cancer treatment.

As a randomized clinical trial, this study evaluated the effect of 12 weeks of home physical exercise (without supervision by a professional) on the physical fitness of elderly women with breast cancer who were undergoing hormone therapy.

For the 35 volunteers who made up the experimental group, an instructional material developed by the researchers called “gymnastics to do at home” (printed manual with inserted DVD) was offered.

This manual contained a routine of 29 exercises, including 10 exercises to improve muscle fitness, which should be performed by the volunteers. In addition to the positive effect on the muscular strength of the upper and lower limbs of the women evaluated, there was also an improvement in flexibility, balance and aerobic resistance in the group submitted to the exercise protocol.

Taken together, the findings by Souza Filho et al., (2019) bring an important contribution to this area of investigation, as this study showed that shorter periods of intervention, in this case 12 weeks, already bring significant improvements in the physical fitness of elderly women undergoing breast cancer treatment.

Another crucial point that deserves to be highlighted is that even without the supervision of a professional, the instructional material provided by the researchers, by itself, was efficient in promoting the benefits previously mentioned.

Bearing in mind that the highest rates of breast cancer deaths are in women living in developing countries, who in turn have low per capita income (Oliveira, 2018; Siegel, Miller and Jemal, 2020) and, in the vast majority of times, do not have access to gyms and spaces for physical activity, initiatives like these should be considered by different countries. In this way, the side effects of breast cancer treatment could be mitigated, contributing to the better quality of life for patients.

In another study, Benton and Schlairet (2017) evaluated the effects of resistance training on the imbalance of strength between the upper limbs in breast cancer survivors with surgical mastectomy on the dominant side.

After eight weeks of training, the individuals obtained increased strength, as well as reversed the imbalance.

Battaglini et al., (2014) demonstrate that in addition to increased strength, resistance training can contribute to improvements in functional capacity and significant muscle mass gains.

Taken together, these studies reinforce the need for physical exercise programs to integrate the strategies used for the treatment of breast cancer, since in a very short period of intervention (a few weeks) significant results can already be seen.

Finally, it should be noted that our study has some limitations. For example, despite the use of non-parametric statistical tests in order to optimize the accuracy of the results, the sample used in this study is too small, in this case 37 mastectomized women undergoing treatment for breast cancer.

Another important gap through the combined exercise protocol that was applied (resistance exercises with dumbbells plus flexibility exercises) refers to the impossibility of measuring which of the two modalities applied had the greatest influence for each of the variables analyzed, that is, the grip strength manual and improved flexibility for movements of the glenohumeral joint.

We speculate that flexibility exercises alone would improve the range of motion for the glenohumeral joint but would not be able to increase muscle strength.

However, we believe that resistance exercises are not only efficient for improving muscle strength, as several studies point out (Artero et al., 2011; Hanson and Hurley, 2011; Battaglini et al., 2014; Dankel et al., 2016; Schmidt et al., 2016), but also, albeit to a lesser extent, they contributed to improving flexibility.

Furthermore, the fact that we use the same amount of overload for all individuals during the resistance exercise protocol, it is not possible to establish a dose-intensity relationship.

The same applies to flexibility exercises that occurred in the same way for all volunteers in the exercise group. These and other issues need to be explored in future studies.

## CONCLUSION

The 36 sessions of the combined exercise protocol (resistance exercises with dumbbells and flexibility exercises) had a positive influence on the handgrip strength and improved flexibility for the movements of horizontal shoulder abduction, medial shoulder rotation, shoulder lateral rotation.

However, there was no effect for the movements of shoulder flexion, shoulder extension and horizontal shoulder adduction.

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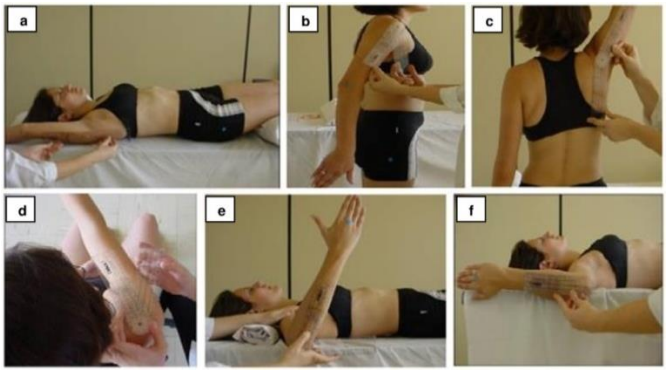
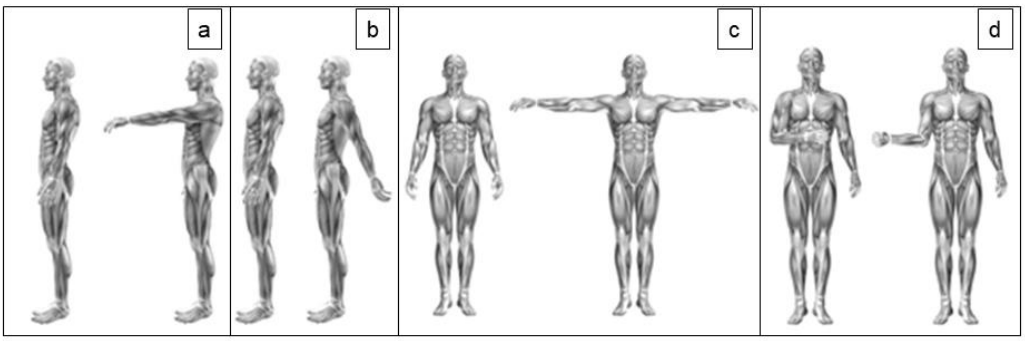
**Supplementary figures**




**Supplementary figure 1 -** Range of motion assessment.




**Supplementary figure 2 -** Flexibility exercises.


**Supplementary figure 3 -** Resistance exercises with dumbbells.

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