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Effect of physical activity levels on oncological breast surgery recovery: a prospective cohort study

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After breast cancer (BC) surgery, women may experience a physical decline. The effect of physical activity (PA) on the course of recovery after BC surgery has not yet been thoroughly examined. To analyze the impact of physical activity performed by women undergoing breast cancer surgery on measures of function, range of motion, and self-efficacy. A prospective study was carried out in 157 patients who underwent surgery for BC between October 2018 and April 2019, divided into four groups according to the intensity of PA with 6 months follow-up. 50 sedentary patients and 107 active patients were enrolled; the mean age was 52.6. Women who performed physical activity, moderate to vigorous, demonstrated lower function disabilities (QuickDASH 2.22) compared with inactivity or light physical activity (QuickDASH 7.0, $p < 0.001$), with better shoulder flexion (159.0° vs. 150.7° , $p = 0.007$) and abduction (159.5° vs. 152.2° , $p = 0.008$). Higher PA levels, displayed in higher self-efficacy reports (9.5 vs. 8.8, $p = 0.002$), and return to prior job status (0.005). The PA level does not influence pain at one, three and 6 months postoperatively ($p = 0.278$, $p = 0.304$ and $p = 0.304$ respectively). High PA levels increase the risk of axillary web syndrome ($p = 0.041$), although, it reduces the incidence of chronic pain ($p = 0.007$). Women who practice physical activity recover better from BC surgery than sedentary women. The higher the intensity and frequency of training, the better the results. Vigorous activity cause axillary web syndrome, despite, it has a beneficial effect on lowering the rate of chronic pain.

Abbreviations

ABD	Abduction
ALND	Axillary lymph node dissection
BMI	Body mass index
BC	Breast cancer
FLEX	Flexion
NPRS	Numeric pain rating scale
PA	Physical activity
QOL	Quality of life
ROM	Range of movement
°	Degrees

Evidence for the health benefits of different sport disciplines was either inconclusive or tenuous¹. While research has traditionally focused on the association between cardio-respiratory fitness and health outcomes, the association between muscular fitness and health status has recently received increased attention².

The effects of physical or sport activity, frequency, and intensity in the recovery process of patients that underwent breast cancer (BC) surgery have not been analysed in depth.

In recent decades there was progress in prevention, diagnosis, and treatment of women with BC³⁻⁶. Nonetheless, surgery remains today one of the pillars in the treatment of breast carcinoma that has implications for postoperative quality of life (QOL).

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Pain is the most frequent impairment after BC treatment with a strong relationship to perceived disability reported by 60% of the patients⁷. Additional impairments include reduction of grip-strength in 40% and restrictions of arm and shoulder movement in 35%, all of which have a negative impact on patients' QOL^{8–10}. Physical activity (PA) has been found to be beneficial for women in improving postoperative function and reducing the restriction of movement¹¹. Furthermore, exercise reduces the side effects of oncologic treatments including fatigue, depression, anxiety, sleep disturbances, and nausea associated with disease treatments¹². Moreover, PA has been found to reduce the risk of recurrence of the disease, and a higher level of physical fitness was found to reduce the risk of mortality rates^{13,14}.

Earlier studies examining the effect of regular exercise and the level of activity have been found to improve range of motion (ROM)¹⁵, reduce the length of hospitalization and sick leave after surgery¹⁶. While, women engaging in exercise preoperatively had greater shoulder flexion ROM at 1 month, which persisted over a year¹⁷. Furthermore, a higher preoperative level of PA is associated with a faster recovery three weeks post BC surgery¹⁸. Patients that did not exercise preoperatively are at higher risks for developing more severe pain at 1 and 3 months after surgery¹⁹. Moderate to vigorous PA may mitigate C-reactive protein levels that in the low inflammatory response is associated with morbidity and mortality in BC patients²⁰. In contrast, vigorous exercise during the end of treatment can cause concerns specifically in regards to anemia, and weight loss²¹.

The purpose of this study was to examine the effect of different levels of preoperative and postoperative PA on shoulder function, flexion and abduction ROM, and self-efficacy in women after BC surgery.

Material and methods

A prospective trial was conducted in a single medical center in women that underwent BC surgery between October 2018 and April 2019. The trial was approved by the Helsinki Assuta Medical Center Review Board (approval number: 0122-17 ASMC) and was registered on the National Institutes of Health's website (ClinicalTrials.gov; study identifier NCT03389204). All patients provided written informed consent before enrollment. All methods were carried out in accordance with relevant guidelines and regulations.

Sample. The study includes 188 women that underwent BC surgery. Inclusion criteria included women 18 years of age and older with functional independence, a diagnosis of BC, and planned surgical intervention. Exclusion criteria for participation were: Benign disease of the breast, cognitive disorders, fibromyalgia or chronic pain disorders, neurological disorders causing permanent disability, previous breast surgery, lymphedema before the surgery, previous shoulder surgery or injuries causing limited ROM, severe systemic diseases.

Study procedures. Subjects were evaluated using questionnaire for their activity levels and outcome measures before surgery and 1 month, 3 months, and 6 months after surgery. PA levels were recorded, using a self-reported adapted questionnaire, developed for the study. Participants were asked whether they exercise regularly, about the intensity of the activities (inactive, light, moderate, vigorous), and how many hours on average are they training, 1–2 per week, 3–5 per week, more than 5 h per week. The questionnaire is partially based on the international PA questionnaire²² and metabolic rate intensities (METs) that evaluate physical activities intensity²³. Light PA (METs 1.1–3.0) included casual walking, stretching, Feldenkrais, Tai chi. Moderate PA (METs 3.0–6.0) included Pilates, Yoga, jogging, aerobics, bicycling, etc. Rigorous PA (METs > 6.0) included running, high-intensity fitness training, heavy lifting, swimming, and competitive sport such as basketball and football²⁴.

Outcome measures. The QuickDASH score²⁵ was used for assessing the physical function and upper limbs activity. ROM (abduction and flexion) were evaluated using DrGoniometer application²⁶. Self-efficacy which represents how much the participant felt that she returned to preoperative function on a scale of 1 (unable to carry out activities by themselves) to 10 (able to perform all activities by themselves). Additional measures included the number of sick days and if returned to the same job status. Pain levels were measured in each follow-up, using the numeric pain rating scale (NPRS), in values ranging 0–10²⁷. Number of sick days and if the patients returned to prior job status.

Statistical analysis. To calculate sample size estimation the PS Power and Sample Size Calculations software (Version 3.0, January 2009) was used. QuickDASH instrument was the main outcome measure used to evaluate shoulder functional disability. QuickDASH score²⁸ after BC surgery (43.2 ± 18) was compared with the general population²⁹ (10.1 ± 14.6) to estimate the sample size. Using this data and the probability of type I error was 0.05, and the probability of type II error was 0.2, 30 experimental subjects, and 30 control subjects were needed to reject the null hypothesis. Since 4 different groups were evaluated, with a probability of up to 20% dropping out of the study, 160 patients were planned to enter the study.

Statistical analysis was performed using the SPSS statistical package, Version 21 (SPSS Inc, Chicago, IL, USA). The significance level was set at $p < 0.05$.

The non-parametric Mann–Whitney rank-sum test for independent samples was applied for testing the statistical significance of the difference between continuous parameters. Nominal variables were evaluated by the chi-squared test. A repeated measures approach (mixed ANOVA) was used for analyzing study groups as well as group by time interactions.

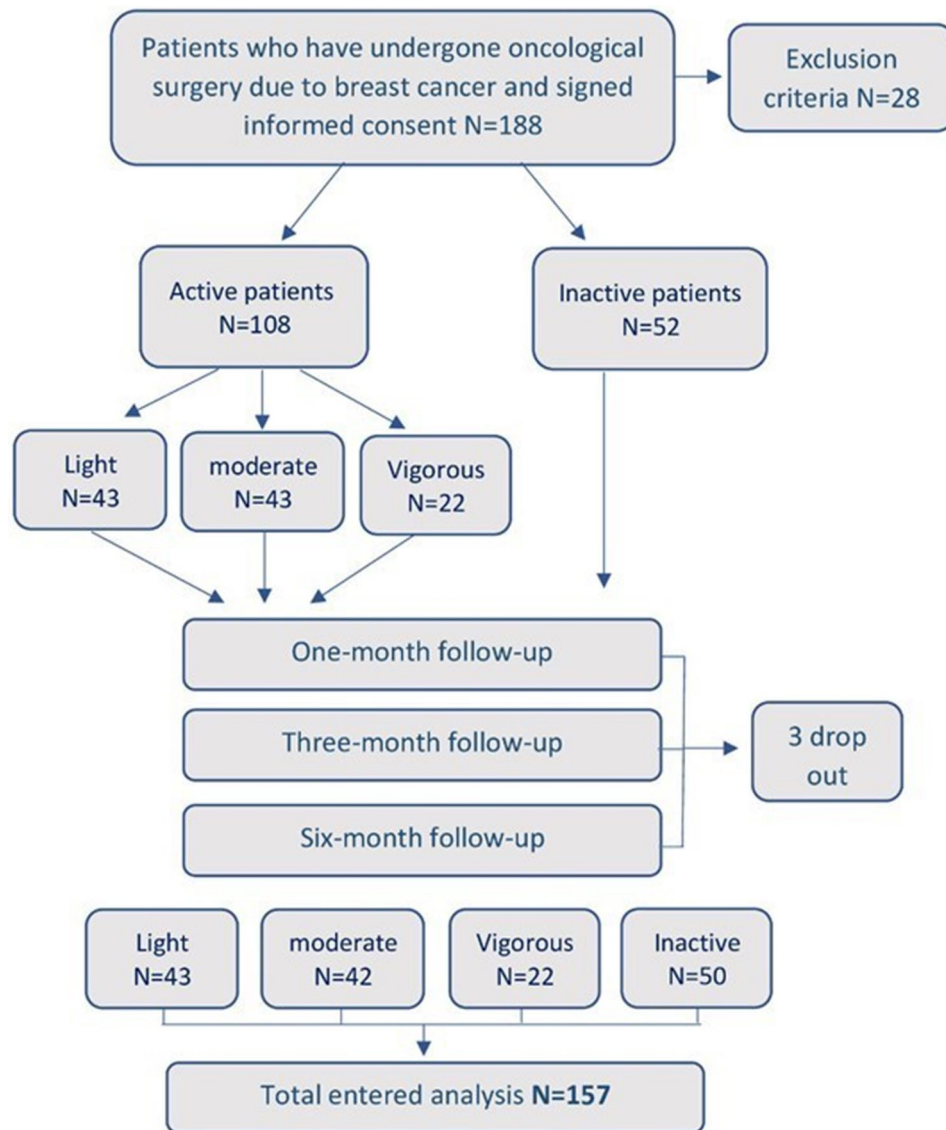


Figure 1. Study flow chart.

Results

A total of 157 patients were eligible for inclusion (Fig. 1). Twenty-eight patients (14.89%) were excluded: one (3.6%) had a non-malignant fibroadenoma, 17 women (60.7%) had previous breast surgery, five (17.9%) had limited shoulder ROM mostly rotator cuff tears, two (7.1%) had lymphedema and three (11%) had fibromyalgia. Three patients were dropped out of the study due to incomplete data.

The study sample included 50 (31.8%) sedentary and 107 subjects that routinely exercise. The level of PA was divided according to the MET into light 43 (27.4%), moderate 42 (26.8%), and vigorous 22 (14.0%).

The mean patients' age was 52.2 and the mean BMI was 25.0 kg/m². Most patients 77 (47.1%) had low stage cancer 1A, and the most common surgical procedure was a lumpectomy and sentinel lymph node biopsy 89 (56.7%), while 54 (34.4%) of patients had breast reconstruction procedures (Table 1). Patients in the inactive group received on average more neoadjuvant and radiation treatments compared with the active group ($p = 0.023$ and $p < 0.001$, respectively). Six months postoperative, mastectomy surgeries resulted in more functional limitation (QuickDASH 7.2 ± 11.1), pain (NPRS 1.1 ± 1.2) and decreased shoulder flexion ($147.9^\circ \pm 22.5^\circ$) compared with lumpectomies (QuickDASH 3.6 ± 6.2 , NPRS 0.5 ± 0.9 and $156.7^\circ \pm 12.6^\circ$), $p = 0.022$, $p = 0.002$ and $p = 0.026$ respectively.

Axillary lymph node procedures resulted in more pain (NPRS 1.4 ± 1.1), functional decline (QuickDASH 9.5 ± 8.7) and decreased shoulder abduction ($149.8^\circ \pm 19.3^\circ$) compared with sentinel lymph node biopsy (NPRS 0.7 ± 1.0 , QuickDASH 4.5 ± 8.3 and $155.8^\circ \pm 17.0^\circ$) or no axillar involvement (NPRS 0.0 ± 0.0 , QuickDASH 0.0 ± 0.0 and $171.0^\circ \pm 10.1^\circ$), $p = 0.016$, $p = 0.002$ and $p = 0.007$ respectively.

	Inactive N = 50	Active N = 107	P value
Age (yrs.)	53.8 ± 13.8	51.4 ± 12.4	0.321
BMI (kg/m ²)	25.1 ± 4.1	24.9 ± 4.5	0.396
Dominance (RT)	42 (84.0%)	94 (87.9%)	0.335
Smokers	11 (22.0%)	13 (12.1%)	0.089
Hospital stay (days)	1.6 ± 0.8	1.5 ± 0.7	0.850
Surgical treatments			
Mastectomy	16 (32.0%)	39 (36.4%)	0.360
Lumpectomy	34 (68.0%)	68 (63.6%)	
ALNB	7 (14.0%)	7 (6.5%)	0.164
SLNB	43 (86.0%)	97 (90.7%)	
Reconstruction	15 (30.0%)	40 (37.4%)	0.236
Non-surgical treatments			
Neoadjuvant. C	17 (34.0%)	18 (16.8%)	0.023*
Chemotherapy	24 (48.0%)	36 (33.6%)	0.061
Radiation therapy	40 (80.0%)	56 (52.3%)	<0.001*
Number of sick days			
1–7	4 (8.0%)	12 (11.2%)	0.901
8–14	7 (14.0%)	13 (12.1%)	
15–21	13 (26.0)	26 (24.3%)	
22–30	6 (12.0%)	18 (16.8%)	
More than 30	16 (32.0%)	32 (29.9%)	
Postoperative complications			
Infection	5 (10.0%)	6 (5.6%)	0.317
Seroma	5 (10.0%)	6 (5.6%)	0.317
Revision surgery	3 (6.0%)	1 (1.0%)	0.061
AWS (6 MNTH)	2 (4.1%)	14 (13.1%)	0.081
Lymphedema (6 MNTH)	6 (12.2%)	6 (5.7%)	0.334

Table 1. Baseline characteristics of the study population. Continuous variables are presented as mean and standard deviation (SD) and categorical variables are presented as number and percentage. Significant p value* $p \leq 0.05$. YRS, Years; BMI, Body mass index; kg/m², Mass in kilograms divided by the square of the body height in meters; RT, Right; Neoadjuvant. C, Neoadjuvant Chemotherapy; ALND, Axillar lymph node dissection; SLNB, Sentinel lymph node biopsy; BRCA1-2, Breast Cancer gene; NPRS, Numeric pain rating scale; AWS, Axillar web syndrome; MNTH, Month.

The effect of physical activity level on functional disabilities. Throughout the study period, a higher preoperative intensity of the activity was associated with higher postoperative functional improvement. Three months postoperatively, patients performing vigorous PA before surgery, had less function disabilities (QuickDASH 4.6) compared to moderate PA (QuickDASH 7.2), light PA (QuickDASH 9.9), and inactive patients, (QuickDASH 11.0), $p = 0.025$, reported in Table 2. The trend was maintained 6 months postoperatively, $p = 0.020$. No significant differences were found regarding the influence of routine PA on function in the first month postoperative (Fig. 2).

Flexion and abduction ROM. The different preoperative exercise levels had a significant effect on the course of recovery in the values of shoulder ROM. Women who did not exercise measured lower ROM throughout the three follow-ups. After 1-month, inactive patients reported lower abduction ranges (134.8°) compared with light (143.8°), moderate (152.1°), and vigorous activity (154.5°), at the significance level of $p < 0.001$. After 6 months, the differences between the groups narrowed and remained significant $p = 0.007$ (Fig. 3).

The shoulder flexion ROM improved in the same trend, so women who exercised preoperatively improved their ROM largely in the months after surgery compared with inactive patients. The moderate and vigorous activity levels had similar effect (152.2° and 151.2°), with the main differences being between the moderate activity (144.8°) and inactive patients (132.9°), at significance level of $p = 0.006$. Similar differences were found after 6-months, $p = 0.010$.

Pain and self-efficacy scores. Pain was not found to be affected by the level of women's PA throughout the study at 1, 3, and 6 months postoperatively ($p = 0.278$, $p = 0.304$, $p = 0.304$, respectively), reported in Table 2.

Self-efficacy, improved as expected over time. Even though, the level of preoperative PA was found to affect self-efficacy only at 6-months follow-up with a significance level of $p = 0.005$.

Variable	Inactive N = 50	Light PA n = 43	Moderate n = 42	Vigorous n = 22	<i>p</i> value
Function disabilities by (QuickDASH)					
1 month	21.9 ± 17.3	18.3 ± 15.8	20.4 ± 18.3	12.8 ± 15.7	0.138
3 months	11.0 ± 14.0	9.9 ± 12.0	7.2 ± 7.6	4.6 ± 9.6	0.025*
6 months	7.4 ± 10.8	5.1 ± 8.6	3.4 ± 5.2	1.4 ± 3.7	0.020*
ABD ROM					
1 month	134.8 ± 27.0	143.8 ± 20.5	152.1 ± 19.3	154.5 ± 17.1	<0.001*
3 months	146.0 ± 25.9	147.0 ± 18.9	158.8 ± 12.1	161.1 ± 11.7	<0.001*
6 months	150.9 ± 18.2	151.4 ± 22.1	161.9 ± 9.0	161.2 ± 11.2	0.007*
FLEX ROM					
1 month	132.9 ± 33.0	144.8 ± 22.4	152.2 ± 19.1	151.2 ± 14.5	0.006*
3 months	144.3 ± 27.1	149.0 ± 19.6	155.6 ± 14.5	154.9 ± 13.4	0.079
6 months	150.7 ± 17.7	149.4 ± 18.3	157.7 ± 17.4	159.7 ± 9.8	0.010*
Pain by (NPRS)					
1 month	1.9 ± 1.3	1.7 ± 1.2	1.9 ± 1.4	1.3 ± 1.3	0.278
3 months	1.3 ± 1.1	1.3 ± 1.1	1.2 ± 1.2	0.8 ± 1.0	0.304
6 months	1.0 ± 1.1	0.6 ± 1.1	0.7 ± 1.0	0.6 ± 0.8	0.304
Self-efficacy					
1 month	7.7 ± 1.6	8.0 ± 1.8	7.5 ± 1.9	8.4 ± 1.8	0.133
3 months	8.5 ± 1.5	8.6 ± 1.3	9.0 ± 1.1	9.1 ± 1.1	0.153
6 months	8.7 ± 1.3	9.3 ± 1.0	9.3 ± 0.9	9.7 ± 0.5	0.005*
Return to prior Job status					
No	17 (34.0%)	14 (32.6%)	7 (16.7%)	5 (22.7%)	0.229
Yes	33 (66.0%)	29 (67.4%)	35 (83.3%)	17 (77.3%)	
Number of sick days					
1–7	4 (8.7%)	4 (10.0%)	6 (15.0%)	2 (9.5%)	0.467
8–14	7 (15.2%)	3 (7.5%)	3 (7.5%)	7 (33.3%)	
15–21	13 (28.3%)	11 (27.5%)	11 (27.5%)	4 (19.0%)	
22–30	6 (13.0%)	9 (22.5%)	7 (17.5%)	2 (9.5%)	
More than 30	16 (34.8%)	13 (32.5%)	13 (32.5%)	6 (28.6%)	

Table 2. The effect of the physical activity intensity on function, ROM, pain, self-efficacy, job status and sick days classified by intensity levels. Continuous variables are presented as mean and standard deviation (SD) and categorical variables are presented as number and percentage. Significant *p* value* $p \leq 0.05$. PA, Physical activity; ABD, Abduction; FLEX, Flexion; ROM, Range of motion; NPRS, Numeric pain rating scale.

The influence of intensity of physical activity. To examine separately the effect of training intensity on outcome measures, vigorous and moderate PA were compared with light PA or inactivity. Six months after surgery, women who performed moderate to high-intensity PA reported less functional limitation (QuickDASH 2.2 ± 4.2) compared to women who did not exercise or performed light PA (QuickDASH 7.0 ± 10.2) with a significance of $p < 0.001$. The abduction ranges were better ($159.5^\circ \pm 13.4^\circ$) relative to the light activity or inactivity ($152.2^\circ \pm 19.4^\circ$), at significance level $p = 0.008$. Furthermore, the flexion ROM was higher of active patients ($157^\circ \pm 17.9^\circ$) compared to low activity ($150.7^\circ \pm 15.9^\circ$), significance level $p = 0.007$. In addition, self-efficacy was higher in active women at higher intensity and pain levels were lower, relative to women in the light or inactive group ($p = 0.002$ and $p = 0.014$, respectively). Moreover, the more active women also returned to the same job status in higher percentages ($p = 0.005$).

The influence of frequency of physical activity. The frequency of PA had a positive effect on patients' recovery. Six months postoperatively, sedentary women reported greater shoulder functional limitations, resulting in QuickDASH 8.5 ± 11.8 . Training 1–2 h per week reported QuickDASH 4.4 ± 6.4 ; those who trained 3–5 h per week had QuickDASH of 2.1 ± 4.3 . No functional limitations were reported by women who exercised more than 5 h per week resulting in QuickDASH 0 ($p = 0.002$), reported in Table 3.

Similarly, the higher the frequency of training, the higher the ROM of flexion and abduction ($p = 0.002$ and $p < 0.001$, respectively). Furthermore, self-efficacy was higher for women who had frequently trained ($p < 0.001$). Moreover, it was found that the higher the frequency of PA, the need for sick days decreased ($p = 0.047$) and the percentage of patients return to the preoperative job increased ($p < 0.001$). The frequency of activity did not affect pain values and number of sick days.

Physical activity trends during the study period. Comparing between the women who were inactive and active throughout the study period (regardless of the type of activity), it was found that 6 months postop-

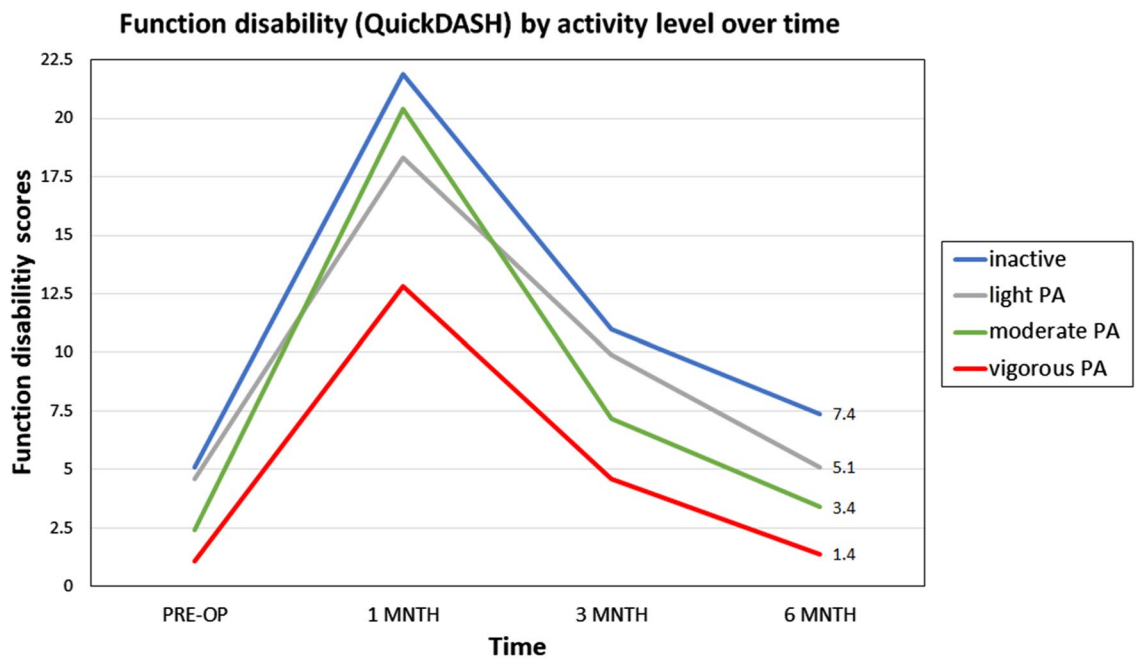


Figure 2. The effect of physical activity on function disability scores by activity level over time.

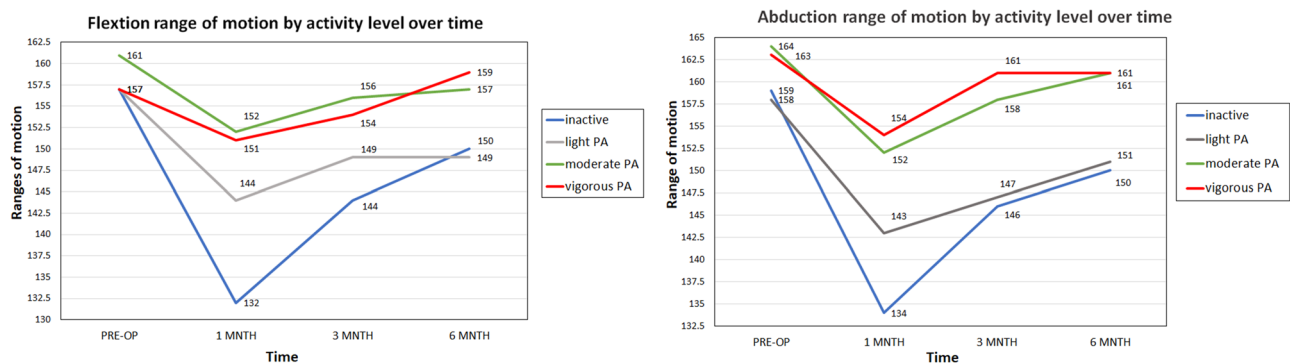


Figure 3. The effect of physical activity on abduction flexion range of motion by activity level over time.

eratively, women in the PA group recovered better in measures of function QuickDASH 4.4 ± 2.9 compared with inactive patients QuickDASH 9.3 ± 12.5 ($p = 0.006$). Their abduction and flexion ROM were better $158.6^\circ \pm 14.1^\circ$ and $155.4^\circ \pm 16.2^\circ$ compared with inactive patients $149.5^\circ \pm 20.0^\circ$ and $148.8^\circ \pm 20.5^\circ$ ($p = 0.007$ and $p = 0.044$ respectively). Similar results were obtained for self-efficacy, active 10.4 ± 8.6 compared with inactive 8.6 ± 1.4 ($p < 0.001$) and even returned in higher percentages to the same work status ($p < 0.001$).

Adverse effects of physical activity. No effect on exercise intensity was found on the incidence of seroma, infections, and lymphedema. However, high PA levels increase the risk of axillary web syndrome ($p = 0.041$). On the other hand, the higher the intensity of training, the risk of chronic pain (lasting more than 3 months) decreases significantly ($p = 0.007$), reported in Table 4.

Discussion

Preoperative and pre-diagnosis sport activity had a major positive effect on the recovery process of oncologic BC surgery³⁰. Following what was reported by Nilsson that a higher intensity of the preoperative PA level is associated with a faster self-reported physical recovery¹⁷, in this cohort preoperative PA improved functional disabilities, abduction and flexion ROM during the 6 months postoperatively, compared to sedentary women. In addition, the higher the intensity of the exercise, the better the recovery.

Sedentary patients needed more radiotherapy and neoadjuvant treatments, which may indicate that physically active patients have an earlier diagnosis of the disease or a less aggressive presentation, which is an important point for future research. Physical activity can reduce cancer recurrence, mortality³¹ and improve health outcomes of BC survivors³². Additionally, among tamoxifen treated BC survivors, high PA levels before and after diagnosis were found to improve overall survival compared with inactive patients³³.

Variable	Duration of PA (weekly training hours)				p value
	0	1–2	3–5	<5	
QuickDASH	8.5 ± 11.8	4.4 ± 6.4	2.1 ± 4.3	0 ± 0	0.002*
ABD ROM	151.1 ± 22.0	151.9 ± 16.4	161.9 ± 10.5	164.0 ± 6.3	0.002*
FLEX ROM	150.2 ± 20.4	148.0 ± 18.9	160.7 ± 10.5	162.0 ± 7.1	< 0.001*
Self- efficacy	8.4 ± 1.3	9.2 ± 0.8	9.6 ± 0.5	10 ± 0	< 0.001*
Pain	1.0 ± 1.1	0.7 ± 1 s.2	0.6 ± 0.9	0.6 ± 0.8	0.323
Return to Job					
No	24 (47.1%)	11 (23.4%)	7 (12.7%)	0	
Yes	27 (52.9%)	36 (76.6%)	48 (87.3%)	4 (100%)	< 0.001*
Sick days					
1–7	5 (10.6%)	3 (6.7%)	7 (13.5%)	0	
8–14	9 (17.6%)	1 (2.2%)	10 (19.2%)	0	0.047*
15–21	12 (25.5%)	18 (40.0%)	8 (15.4%)	2 (50.0%)	
22–30	3 (5.9%)	8 (17.8%)	13 (25.0%)	1 (25.0%)	
over 30	18 (38.3%)	15 (33.3%)	14 (26.9%)	1 (25.0%)	

Table 3. The influence of frequency of physical activities. Continuous variables are presented as mean and standard deviation (SD) and categorical variables are presented as number and percentage. Significant p value* $p \leq 0.05$. PA, Physical activity; ABD, Abduction; FLEX, Flexion; ROM, Range of motion; NPRS, Numeric pain rating scale.

Variable	Inactive N = 50	Active N = 105			p value
		Light n = 36	Moderate n = 49	Vigorous n = 20	
Seroma	4 (7.8%)	3 (8.3%)	3 (6.0%)	1 (5.0%)	0.950
Infection	4 (7.8%)	3 (8.3%)	4 (8.0%)	4 (8.0%)	0.632
Lymphedema	5 (12.5%)	3 (8.3%)	7 (14.0%)	0 (0%)	0.336
AWS	2 (4.1%)	2 (5.6%)	10 (20.4%)	2 (10.0%)	0.041*
Chronic pain	1.1 ± 1.3	0.6 ± 0.9	0.8 ± 1.0	0.2 ± 0.5	0.007*

Table 4. Postoperative adverse effects. Continuous variables are presented as mean and standard deviation (SD) and categorical variables are presented as number and percentage. Significant p value (< 0.05). AWS, axillar web syndrome.

Postoperative exercises for BC patients are effective in reducing pain and improving ROM^{11,34–36}. The results from this study are a continuation of previous publications and attempt to give a broader picture of the effect of exercise on the course of recovery. Six months postoperatively, a return to exercise contributed to an improvement in function limitations and ROM. Unlike previous findings¹¹, it was not found that PA had an effect on pain reduction. This finding can be explained because, during hospitalization, patients were instructed to report any type of pain and the to receive appropriate treatment³⁷. Furthermore, the patients received instructions on how to cope with pain during daily activities and physical affair. Both can contribute to pain reduction, due to the emphasis in pain management.

Pickett et al. reported that women who exercised regularly before receiving a BC diagnosis, attempted to maintain their exercise programs, and therefore BC survivors who lead sedentary lifestyles are the ones that may benefit more from a structured exercise program³⁸. In our results, women who were sedentary before surgery and started PA postoperatively did not improve their function, ROM and pain levels, or self-efficacy significantly, compared to sedentary women, although this may be attributed to the small sample of patients given for comparison, further studies may be necessary to corroborate this issue.

The effect of high intensity PA evaluated during chemotherapy, showed that vigorous training was more beneficial than moderate or low PA in preventing side effects of treatment in terms of QOL, strength, fatigue, body weight and return to routine activities^{39,40}. Our results are consistent, finding that the higher the intensity of training, the greater the effect on recovery from surgery.

Another aspect is the effect of the duration of PA rather than intensity, as previous study found that higher duration of PA was associated with better improvement in shoulder ROM⁴¹. Our results demonstrated that the longer duration of PA was associated with fewer functional limitations, higher self-efficacy, better flexion, and abduction ROM, and the need for less sick days.

Moreover, regular PA helped patients to return to previous job status compared with inactive women. Lee et al. have reported similar results, finding patients who exercise before, during, and after treatment for BC are more likely to return to prior work⁴².

The results of the study did not show associations between the level of PA and the degree of acute postoperative short-term complications such as seroma, bleeding, infections and nor the long-term complication of lymphedema. Until recently, intense PA has been associated with the development of lymphedema after BC⁴³. New studies have examined the effect of intense training including weight lifting after breast surgery and have found no direct link to the development or exacerbation of lymphedema^{44,45}.

Axillar web syndrome (AWS) is a self-limiting complication of axillar surgery⁴⁶. In this study, we found an association between vigorous PA performance and risk of developing AWS. The authors who previously examined risk factors for developing AWS found no relationship between training level and increased risk of AWS^{47,48}, with the exception of a case report that described AWS development after physical effort⁴⁹. Moreover, among the risk factors for the development of AWS should be considered younger age, greater time elapsed since surgery and number of resected lymph nodes⁵⁰, but PA was not considered.

Chronic pain in BC surgery appears after 3 months, the risk factors being extension of the surgery, intensity of acute pain and radiotherapy⁵¹. A positive association was found between the level of intensity of the PA and of chronic pain, the higher the activity levels the lower the incidence of chronic pain, and the severity of the pain. These results are a continuation of the results of Forsythe et al. who reported that weight gain and lack of PA place BC survivors at risk for pain long after treatment ends⁵². In addition, Galiano-Castillo et al. found that performing tailored online training for 8 weeks improved pain severity, compared with control⁵³.

The limitations of the study are based on the complexity and possible variations of the pre- and post-operative treatments. Long-term follow-up is necessary to verify the effect of sport on chronic disabilities.

The strength of the study was in a broad examination of the effect of exercise before and after surgery on the course of recovery that allows us to affirm that sport is beneficial in the postoperative recovery and can be practiced without fear of causing complications. Furthermore, the separation into groups of patients according to intensity and frequency of PA provides relevant data from the present study.

Conclusion

Physical activity improves recovery in patients who underwent surgery for breast cancer. Physical activity resulted in improved function, range of motion, self-efficacy, pain, with higher return to prior work. The higher the intensity and frequency of training, the greater the was the improvement. Vigorous exercise may cause more cases of axillar web syndrome, however also reduce the incidence of prolonged postoperative pain.

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Author contributions

I.K. and L.K. design the Study, I.K. did the statistical calculations, I.K. and S.S. wrote the manuscript and data acquisition and figure-tables preparation, N.C. did manuscript review, All authors reviewed and accept the final manuscript preparation.

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