Journal of
Functional Morphology and Kinesiology

MDPI

Communication

Long-Term Benefits of Adapted Physical Activity on Upper Limb Performance and Quality of Life in Breast Cancer Survivors

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Received: 25 July 2017; Accepted: 12 October 2017; Published: 16 October 2017

Abstract: Current evidence suggests that physical activity interventions can improve quality of life, fitness, and strength, reducing depression and fatigue in breast cancer survivors. However, in the long-term many survivors are insufficiently active. Here, the possible long-term benefits of a specific adapted physical activity (APA) intervention on upper limb functional performance and quality of life in breast cancer survivors were investigated. For this purpose, fifteen survivors were assessed by fitness tests (shoulder-arm mobility, range of motion, back flexibility) at the baseline and at eight weeks post-APA intervention. Quality of life and surgical shoulder and back pain intensity were evaluated by Short Form-12 and numerical rating scale questionnaires, respectively. Five participants, who continued to follow the APA protocol over time, were again evaluated after two years and compared to either five women who were inactive or five others who practiced general physical activity after ending the eight-week APA protocol. Shoulder-arm mobility and self-reported questionnaire data revealed the maintenance and/or improvement of the achieved benefits two years after the APA intervention. Our findings suggest that the long-term practice of APA tailored to individual characteristics should be recommended to breast cancer survivors in order to preserve quality of life and fitness.

Keywords: adapted physical activity; functional performance; quality of life; breast cancer survivors

1. Introduction

Breast cancer is currently the neoplasm with the highest incidence among women worldwide though the number of survivors is constantly increasing with progressive improvement in treatment strategies [1,2]. However, despite substantial advances in surgical techniques and therapy, these procedures are still associated with a high prevalence of complications of the ipsilateral upper limb. The main complications of breast cancer treatment can reduce the strength of the upper limb, range of motion (ROM) of the arm and shoulder, create pain, produce or exacerbate emotional disturbances

(i.e., anxiety, depression), and alter body image with a consequent reduction in the quality of life (QoL) [2,3]. Therefore, breast cancer is continuing to emerge as a major health issue as testified by the large number of studies on health-related QoL in survivors [4]. International evidence-based physical activity guidelines recommend exercise programs as a conditional part of care for all cancer survivors [5]. In particular, well-planned and structured physical activity, tailored to individual needs, has emerged as a viable intervention to attenuate and improve cancer- and treatment-related problems [6,7].

In a recent preliminary investigation, we carefully described the exercise methodology of a specific adapted physical activity (APA) protocol, providing evidence for its efficacy in reducing upper limb complications and improving overall QoL in breast cancer survivors [3]. In particular, the findings of that study demonstrated that a well-planned and structured APA protocol, taking into account the individual characteristics of breast cancer survivors, can significantly improve upper limb symptoms and QoL. Indeed, after APA intervention, breast cancer survivors significantly improved the functional mobility of surgical upper limbs as testified by a better shoulder ROM and decreased pain. The overall benefits included not only physical aspects, but also a reduction in psychological distress as assessed by a Short Form-12 (SF-12) questionnaire [3].

In the present study, we further investigated the possible long-term benefits of our specific APA intervention on upper limb motor function and QoL in breast cancer survivors in comparison with either physically inactive survivors or survivors practicing general physical activity after ending the specific APA protocol.

2. Materials and Methods

2.1. Study Participants

Fifteen out of 46 breast cancer survivors, in a stable clinical condition and regularly followed up at the Cancer Rehabilitation Center (Ce.Ri.On) in Florence, Italy, who completed an eight-week APA protocol at the same Center [3] were enrolled in this longitudinal study. Details on the eligibility criteria and participant recruitment have been previously described [3]. The participants were assessed at follow up (two years after the APA intervention) to investigate whether the APA benefits were still evident. Specifically, the study participants were divided into three groups according to the practice of physical activity after ending the eight-week APA protocol: (1) five women who continued to follow the APA protocol over time for one hour/day twice a week; (2) five women who practiced general physical activity for one hour/day twice a week (i.e., water gym, postural gym, swimming and yoga); and (3) five women who were physically inactive (i.e., not practicing any sport or physical activity in their leisure time). The local ethics committee approved the study and all women gave their written consent to participate in the study.

2.2. Study Procedures

Details on the exercise methodology of our specific APA protocol tailored to individual needs have been previously described [3]. Briefly, the eight-week APA protocol consisted of one-hour sessions performed during two nonconsecutive days per week. Participants only performed the APA intervention under the supervision of an exercise specialist. All sessions started with a 10-min warm-up of general exercises and ended with a 10-min cool-down of stretching exercises and muscle relaxation. The central specific phase included a structured exercise protocol to improve upper limb mobility, planned by an adapted exercise specialist and tailored to the specific needs of each subject on the basis of the results of the initial assessment. During some exercises, a theraband or stick was used to maintain the alignment and facilitate the coordination of the upper limbs. Moreover, mirrors were also used to increase the visual perception of the body during exercise performance. The APA protocol was organized into three phases. In the first phase (from the first to the fifth session), breathing exercises and exercises to mobilize the pelvis and stretching were proposed, including specific exercises to improve upper limb mobility. Each exercise was done for 30 s followed by a 15 s break and was

repeated for a total of three series. In the second phase (from the 6th to the 12th session), the upper limb mobility exercises of the first phase were replicated, increasing three-fold the working time. Postural exercises were also proposed according to the Active Posture Reeducation. Finally, the last phase (from the 13th to the 16th session) consisted of a circuit training workout including alternated low-intensity and higher workload exercises with an increasing working time up to two minutes. Postural exercises were also replicated [3].

At the baseline evaluation, clinical characteristics of patients (i.e., surgical treatment, adjuvant therapy, and lymphedema degree) were collected. Moreover, anthropometric parameters, such as height and weight, were measured using standard protocols and were used to calculate the body mass index (BMI, kg/m^2). All subjects, evaluated either at the baseline or after the eight-week APA intervention, underwent a battery of fitness tests to assess the mobility of upper limb joints (active ROM test and Muscle Length test) and the flexibility of the spine (sit and reach test) [3,8]. In particular, an active ROM test was evaluated with the subject standing by goniometry taking into account the extension (range 0°–45°), flexion (range 0°–180°), abduction (range 0°–180°), and external rotation (range 0°–90°). In addition, shoulder mobility was assessed with the Muscle Length test executed with the subject in a supine position by elevating the arm and measuring the distance (cm) from the lateral epicondyle to the surface (a smaller distance from the surface corresponding to a better mobility function). Moreover, all participants filled out the SF-12 [9] and the numerical rating scale (NRS) [10] questionnaires to assess their QoL and to quantify the shoulder and back pain intensity, respectively. Finally, two years after the end of the eight-week APA intervention, the participants were again evaluated as described above.

2.3. Statistical Analysis

All data are expressed as the mean ± standard error of the mean (SEM) or mean ± standard deviation (SD). For each group, a paired *t*-test was used to compare the baseline versus either the post-APA or follow up scores of fitness, pain, and QoL. The statistical significance of differences in the mean scores of fitness, pain, and QoL between groups at follow up was tested through an unpaired *t*-test. In order to take into account the longitudinal structure of the data, generalized estimating equation (GEE) models have been fitted both for the evaluation of the differences between groups over time and for the time component estimation. A p-value < 0.05 was considered statistically significant. SPSS Statistics version 24 and STATA 12.1 were used for the analyses.

3. Results

Fifteen women, aged 47–80 years, were enrolled in this longitudinal study. Baseline characteristics of the study participants are summarized in Table 1. Of note, according to their BMI value, six and two out of the 15 subjects were classified as overweight or obese, respectively.

Table 1. Baseline characteristics of study participants (n = 15).

Variables	Participants (n = 15)
Age, mean ± SD (range)	60.3 ± 10.5 (47–80)
Body weight, mean kg ± SD	66.9 ± 13.2
Height, mean m ± SD	1.6 ± 0.04
BMI, mean kg/m^2 ± SD (range)	25.7 ± 4.3
BMI category, n	
<25 (normal weight)	7
25–29.9 (overweight)	6
≥30 (obese)	2
Breast surgery, n	
Breast conservation surgery	6
Modified radical mastectomy	5
Radical mastectomy	4

Table 1. *Cont.*

Variables	Participants (n = 15)
Operated side, *n*	
Right	12
Left	3
Adjuvant treatments, *n*	
Chemotherapy	12
Radiotherapy	8
Endocrine treatment	12
Degree of lymphedema, *n*	
None	6
Mild	9

Abbreviations: BMI, body mass index; SD, standard deviation.

Data concerning the fitness evaluation of all study participants and their self-reported questionnaires (NRS and SF-12) at the baseline, post-APA intervention, and follow up (two years post-APA) are reported in Table 2. Using a GEE model fitted for the time component estimation, a statistically significant improvement over time was observed for some of the assessed variables, namely the flexion, abduction, and mobility of the surgical shoulder, as well as the perception of surgical shoulder pain (Table 2).

Table 2. Mean scores of fitness tests, pain intensity, and quality of life questionnaires at the baseline, after the APA intervention and at follow up (two years after the APA intervention) in all study participants (n = 15).

Variables	Baseline Mean (SEM)	Post-APA Mean (SEM)	Follow up Mean (SEM)	p-Value *
ROM surgical shoulder				
Extension	44.16 (0.08)	45 (0)	45 (0)	0.206
Flexion	148.75 (8.23)	161.25 (5.22)	165 (6.06)	0.006
External rotation	63.75 (5.54)	69.58 (6.35)	67.5 (5.88)	0.555
Abduction	141.66 (10.35)	165.25 (6.5)	171.66 (5.75)	<0.0001
Surgical shoulder mobility	18.33 (2.39)	14.33 (1.98)	12.08 (2.91)	0.022
Sit and reach	9.54 (3.76)	7.27 (2.73)	5.36 (2.83)	0.090
Perception of pain (NRS)				
Surgical shoulder pain	4.83 (0.56)	4.41 (0.63)	2.50 (0.60)	0.004
Cervical pain	3.58 (0.55)	2.66 (0.72)	3 (0.62)	0.398
Dorsal pain	2.41 (0.63)	3.25 (0.70)	2.41 (0.43)	1.000
Lumbar pain	4 (0.80)	3.41 (0.71)	3.08 (0.62)	0.170
Quality of life (SF-12)				
Physical	39.39 (2.03)	44.27 (1.79)	42.92 (2.67)	0.216
Mental	38.13 (2.61)	42.48 (2.06)	41.48 (2.01)	0.151

Abbreviations: APA, adapted physical activity; SEM, standard error of the mean; NRS, numerical rating scale questionnaire; SF-12, Short Form-12 questionnaire. * p-Value has been computed using a generalized estimating equations model fitted for the time component estimation.

The results of the fitness evaluation and self-reported questionnaires (NRS and SF-12) at baseline, post-APA intervention, and follow up (two years post-APA) for each of the three study groups are shown in Table 3. In women who continued to practice APA over time, the positive effects obtained with the eight-week APA intervention were further improved at the two-year follow up (Table 3). In particular, a significant improvement in surgical shoulder-arm mobility was observed (p = 0.024) (Table 3). Conversely, in participants who after the eight-week APA protocol practiced general physical activity, baseline data collection versus post-APA and follow up indicated that the positive effects of the APA intervention were still partially evident (Table 3). Indeed, the overall follow up outcomes showed intermediate average values between baseline and post-APA evaluation outcomes (Table 3). However,

a decrease in mobility of the surgical shoulder was present at the follow up (Table 3). In women who were physically inactive after two years from ending the eight-week APA protocol, follow up data revealed that the external rotation of the surgical shoulder was lost and that shoulder mobility and sit and reach were decreased (Table 3).

Table 3. Mean scores of fitness tests at baseline, post-APA, and follow up (two years post-APA) for each of the three study groups.

	APA Group			General PA Group			Non-PA Group		
Variables	**Baseline Mean (SEM)**	**Post-APA Mean (SEM)**	**Follow up Mean (SEM)**	**Baseline Mean (SEM)**	**Post-APA Mean (SEM)**	**Follow up Mean (SEM)**	**Baseline Mean (SEM)**	**Post-APA Mean (SEM)**	**Follow up Mean (SEM)**
ROM surgical shoulder									
Extension	42.1 (2.5)	45 (0)	45 (0)	45 (–)	45 (–)	45 (–)	45 (–)	45 (–)	45 (–)
Flexion	155 (18.92)	160 (11.54)	180 (0)	148.75 (12.31)	165 (9.57)	166.25 (6.25)	142.5 (14.50)	158.75 (8.26)	148.75 (14.19)
External rotation	73.75 (10.68)	67.5 (12.99)	90 (0)	58.75 (10.48)	78.75 (11.25)	62.50 (9.68)	58.75 (8)	62.5 (10.10)	50 (2.88)
Abduction	140 (17.79)	154.5 (15.17)	180 (0)	150 (21.21)	171 (8.75)	170 (10)	135 (19.36)	170 (10)	165 (15)
Surgical shoulder mobility	18.5 (4.36)	15.25 (2.13)	0 (0)	18.50 (1.32)	13 (2.54)	16.50 (2.98)	18 (6.48)	14.75 (5.58)	19.75 (3.11)
Sit and reach	12.5 (8.50)	8.25 (5.66)	0 (0)	6 (6)	4.5 (4.5)	6 (6)	10.33 (5.36)	9.66 (4.91)	11.66 (6)

Abbreviations: APA, adapted physical activity; PA, physical activity; SEM, standard error of the mean.

NRS questionnaire data on shoulder and back pain intensity at the baseline, post-APA intervention, and follow up for each of the three study groups are shown in Table 4. As far as women who continued to follow the APA protocol over time are concerned, the changes in NRS scores revealed a significant decrease in shoulder and cervical pain at the two-year follow up with respect to the baseline ($p = 0.044$ and $p = 0.030$, respectively) (Table 4). Moreover, it is noteworthy that a trend toward an improvement in the perception of surgical shoulder pain at the follow up compared with the baseline was observed in participants who after the eight-week APA protocol practiced general physical activity (Table 4). Finally, the perception of surgical shoulder and back pain improved, while that of cervical and dorsal pain worsened at the follow up versus the baseline in women who did not practice physical activity (Table 4).

Table 4. Mean scores of pain intensity questionnaire at the baseline, post-APA, and follow up (two years post-APA) for each of the three study groups.

	APA Group			General PA Group			Non-PA Group		
Variables	**Baseline Mean (SEM)**	**Post-APA Mean (SEM)**	**Follow up Mean (SEM)**	**Baseline Mean (SEM)**	**Post-APA Mean (SEM)**	**Follow up Mean (SEM)**	**Baseline Mean (SEM)**	**Post-APA Mean (SEM)**	**Follow up Mean (SEM)**
Perception of pain (NRS)									
Surgical shoulder pain	4.75 (0.47)	3.5 (0.95)	1.25 (0.75)	5 (0.91)	6 (1.22)	2.25 (0.85)	4.75 (1.54)	3.75 (0.85)	4 (1.22)
Cervical pain	4.25 (0.47)	2.25 (0.31)	1.75 (0.47)	4.75 (0.85)	3.75 (1.75)	4.75 (0.85)	1.75 (0.85)	2 (0.57)	2.5 (1.32)
Dorsal pain	2.5 (1.04)	3 (1.22)	1.5 (0.28)	3.25 (1.43)	4.75 (1.37)	3 (1.08)	1.5 (0.86)	2 (0.91)	2.75 (0.62)
Lumbar pain	3.25 (1.88)	3.25 (1.97)	2.75 (0.25)	6 (1.08)	4 (0.81)	5.5 (0.50)	2.75 (0.62)	3 (0.91)	1 (0.70)

Abbreviations: APA, adapted physical activity; PA, physical activity; SEM, standard error of the mean; NRS, numerical rating scale questionnaire.

As far as the assessment of QoL is concerned, physical and mental indexes displayed a trend toward improvement at the follow up with respect to the baseline in the group of women who continued to practice APA over time, while both indexes worsened in women who did not practice physical activity (Table 5). Conversely, in participants who after the eight-week APA protocol practiced

general physical activity, the mean physical score worsened at the follow up showing an intermediate value between baseline and post-APA evaluations, whereas the positive effects of the APA intervention on the SF-12 mental component were maintained over time (Table 5).

Table 5. Mean scores of the quality of life questionnaire (SF-12) at the baseline, post-APA, and follow up (two years post-APA) for each of the three study groups.

	APA Group			General PA Group			Non-PA Group		
Variables	**Baselin Mean (SEM)**	**Post-APA Mean (SEM)**	**Follow up Mean (SEM)**	**Baseline Mean (SEM)**	**Post-APA Mean (SEM)**	**Follow up Mean (SEM)**	**Baseline Mean (SEM)**	**Post-APA Mean (SEM)**	**Follow up Mean (SEM)**
Quality of life (SF-12)									
Physical	39.07 (3.74)	41.85 (2.61)	51.93 (2.29)	38.81 (4.03)	45.06 (4.81)	39.61 (3.46)	42.20 (3.11)	45.28 (0.87)	38.21 (3.76)
Mental	36.87 (6.39)	44.22 (6.39)	44.95 (3.55)	38.11 (3.39)	42.37 (1.04)	42.90 (4.21)	39.10 (4.86)	41.27 (4.02)	37.47 (2.01)

Abbreviations: APA, adapted physical activity; PA, physical activity; SEM, standard error of the mean; SF-12, Short Form-12 questionnaire.

The whole data concerning fitness tests, pain intensity, and QoL were further evaluated using a GEE model adjusted for age and BMI and fitted both for the evaluation of the differences between groups over time and for the time component estimation (Table 6). There was a significant over time increase in surgical shoulder flexion and abduction with GEE coefficients of 8.12 and 15.00, respectively, as demonstrated by the confidence intervals. Moreover, surgical shoulder mobility and related pain decreased by 3.12 and 1.17 points, respectively (Table 6). As far as the comparison between the three study groups is concerned, a statistical significance in the value of surgical shoulder external rotation with a GEE coefficient of 16.60 was found in the women who continued to follow the APA protocol over time with respect to those who did not practice physical activity (Table 6). Furthermore, the APA group seemed to have a reduced surgical shoulder extension of 1.14 points compared with the non–physical activity group. Because of this unexpected result, we studied the Time × Group interaction and found that it was not statistically significant ($p = 0.255$). Therefore, the aforementioned reduction in the extension of the surgical shoulder could be attributed to the GEE assumptions and should be interpreted carefully.

Table 6. Generalized estimating equations model for fitness tests, pain intensity, and quality of life questionnaires, adjusted for age and BMI.

Variables	Time	APA vs. Non-PA	General PA vs. Non-PA
ROM surgical shoulder			
Extension	0.41 (−0.22; 1.06)	−1.14 (−2.17; −0.11)	0.19 (−0.79; 1.19)
Flexion	8.12 (2.38; 13.87)	11.81 (−1452; 38.15)	7.92 (−17.38; 33.22)
External rotation	1.87 (−4.34; 8.09)	16.60 (1.42; 31.79)	13.92 (−0.67; 28.52)
Abduction	15.00 (7.28; 22.72)	−2.79 (−31.20; 25.61)	−.55 (−27.35; 27.24)
Surgical shoulder mobility	−3.12 (−5.80; 0.44)	−3.82 (−10.61; 2.96)	0.83 (−5.69; 7.36)
Sit and reach	−2.09 (−1.97; 0.38)	−4.45 (−17.63; 8.73)	−4.85 (−17.58; 7.88)
Perception of pain (NRS)			
Surgical shoulder pain	−1.17 (−1.97; −0.37)	−1.23 (−2.83; 0.37)	0.14 (−1.39; 1.68)
Cervical pain	−0.29 (−0.97; 0.38)	0.74 (−1.24; 2.71)	2.29 (0.39; 4.19)
Dorsal pain	NE	.68 (−0.79; 2.15)	1.66 (0.24; 3.07)
Lumbar pain	−0.46 (−1.11; 0.19)	1.17 (−0.94; 3.29)	2.59 (0.56; 4.63)
Quality of life (SF-12)			
Physical	1.77 (−1.03; 4.56)	−2.285 (−8.19; 3.63)	−2.40 (−7.25; 2.45)
Mental	1.67 (0.61; 3.96)	7.42 (−0.15; 15.00)	−0.14 (−6.37; 6.07)

Data are presented as regression coefficients (95% confidence intervals). Abbreviations: APA, adapted physical activity; PA, physical activity; vs., versus; NRS, numerical rating scale questionnaire; SF-12, Short Form-12 questionnaire; NE, not estimable.

Finally, significant results obtained by comparing the evaluation data at the two-year follow up between the three study groups are displayed in Figure 1. In particular, significant differences were found for surgical shoulder external rotation and mobility. Indeed, in the APA group, the scores were significantly better than in the group practicing general physical activity and in the inactive (non–physical activity) group. In addition, SF-12 analysis revealed that physical and mental mean scores were higher in APA participants than in the general physical activity and non–physical activity groups.

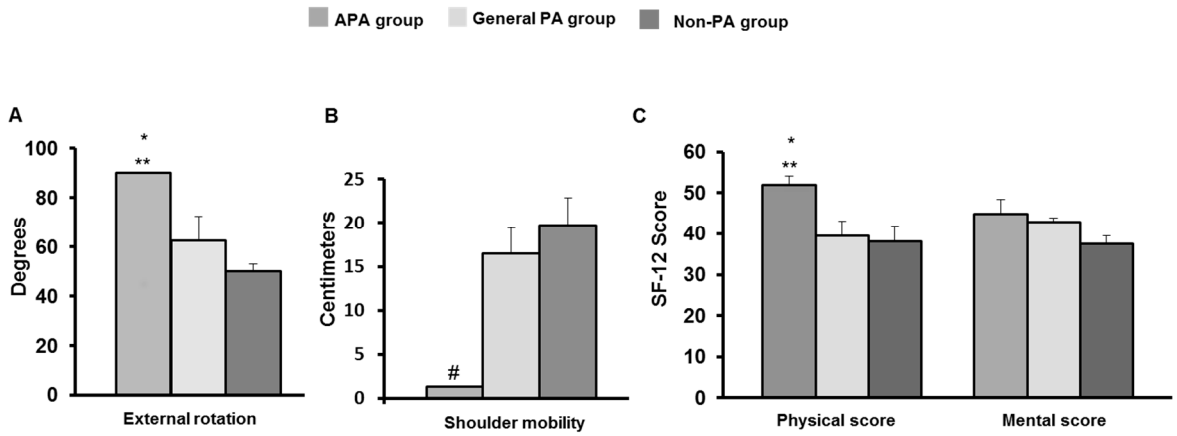

Figure 1. (**A**) Bar graphs illustrating mean ± SEM values of surgical shoulder external rotation in the three study groups at the two-year follow up (* $p = 0.030$ versus general PA; ** $p < 0.0001$ versus Non-PA); (**B**) Bar graphs illustrating mean ± SEM values of surgical shoulder mobility ($^{\#}$ $p = 0.001$ versus general PA and Non-PA); (**C**) Bar graphs illustrating the SF-12 physical component score (* $p = 0.042$ versus general PA; ** $p = 0.037$ versus Non-PA) and mental component score. Data are represented as mean ± SEM. APA, adapted physical activity; General PA, general physical activity; Non-PA, non–physical activity.

4. Discussion

In the present study, we investigated, for the first time, the possible long-term benefits of a specific APA intervention on upper limb functional performance and QoL in breast cancer survivors. In particular, we compared two-year follow up data from women who continued to practice APA over time with those from either women who practiced general physical activity or women who were instead inactive after ending the eight-week APA protocol.

First, our findings confirm that a structured APA protocol can improve the functioning of surgical upper limbs with decreased pain and better QoL in breast cancer survivors. Of note, our longitudinal assessment revealed a trend toward further improvement in all assessed parameters and QoL in the group of women who continued to follow the APA protocol over time. Conversely, women who after the eight-week APA protocol practiced general physical activity over time showed an overall decrease in benefits. In particular, in those women, the positive effects of APA intervention were still partially evident, though a worsening was found in surgical shoulder external rotation and mobility that are important in performing daily living activities [11]. It is noteworthy that the reduction in extra-rotation could be due to the patient tendency to take a protective postural attitude favoring internal shoulder rotation and reducing the use of the arm, finally resulting in muscle shortening and the loss of surgical upper limb mobility. According to these data, the SF-12 score for physical health decreased, reaching levels similar to those at the baseline. On the contrary, the SF-12 mental score was unchanged suggesting that a longer time from surgery may have a positive impact on psychological aspects of the QoL in breast cancer survivors. In fact, it is known that depression and anxiety are highest shortly after the diagnosis and then diminish over time [12]. Similarly, the trend toward improvement in the perception of surgical shoulder and back pain in our breast cancer survivors could

be related to increased pain tolerance. Therefore, it should be considered that general physical activity is not targeted to the functional re-education of upper limb ROM, but general wellness. In addition, our data support and confirm that a sedentary lifestyle has a general negative impact on QoL in breast cancer survivors [13,14]. In particular, shoulder mobility, sit and reach, and SF-12 scores all decreased in the inactive survivors at two years from the end of the APA intervention. Likewise, surgical shoulder flexion and abduction were worse and external rotation was compromised.

Collectively, our findings suggest that upper limb morbidity in breast cancer survivors can be improved with a specific APA program tailored to the individual patient's needs, and that the long-term adherence of subjects to APA is crucial for maintaining or improving the obtained benefits over time. Therefore, APA should be properly continued in breast cancer survivors. However, these findings should be interpreted in the context of the limitations of our study. Indeed, the present data are limited by the small sample size investigated. Therefore, further longitudinal investigations including higher numbers of participants will be necessary to confirm the interesting outcomes observed herein.

Acknowledgments: The authors are most grateful to all the women who took part in the study.

Author Contributions: Daniela Mirandola and Mirca Marini conceived and designed the experiments; Daniela Mirandola and Elisa Casini carried out the experimental procedures; Daniela Mirandola, Marco Monaci, Guido Miccinesi, Leonardo Ventura, Maria Grazia Muraca, Eleonora Sgambati, Mirko Manetti, and Mirca Marini analyzed and interpreted the data; Mirko Manetti and Mirca Marini wrote the paper; Daniela Mirandola, Marco Monaci, Guido Miccinesi, Leonardo Ventura, Maria Grazia Muraca, Elisa Casini, Eleonora Sgambati, Mirko Manetti, and Mirca Marini revised and approved the final version of the study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Ghoncheh, M.; Mirzaei, M.; Salehiniya, H. Incidence and Mortality of Breast Cancer and their Relationship with the Human Development Index (HDI) in the World in 2012. *Asian Pac. J. Cancer Prev.* **2015**, *16*, 8439–8443. [CrossRef] [PubMed]
2. Recchia, T.L.; Prim, A.C.; Luz, C.M. Upper Limb Functionality and Quality of Life in Women with Five-Year Survival after Breast Cancer Surgery. *Rev. Bras. Ginecol. Obstet.* **2017**, *39*, 115–122. [CrossRef] [PubMed]
3. Mirandola, D.; Miccinesi, G.; Muraca, M.G.; Sgambati, E.; Monaci, M.; Marini, M. Evidence for adapted physical activity as an effective intervention for upper limb mobility and quality of life in breast cancer survivors. *J. Phys. Act. Health* **2014**, *1*, 814–822. [CrossRef] [PubMed]
4. Mishra, S.I.; Scherer, R.W.; Geigle, P.M.; Berlanstein, D.R.; Topaloglu, O.; Gotay, C.C.; Snyder, C. Exercise interventions on health-related quality of life for cancer survivors. *Cochrane Database Syst. Rev.* **2012**, *15*. [CrossRef]
5. Kampshoff, C.S.; Jansen, F.; van Mechelen, W.; May, A.M.; Brug, J.; Chinapaw, M.J.; Buffart, L.M. Determinants of exercise adherence and maintenance among cancer survivors: A systematic review. *Int. J. Behav. Nutr. Phys. Act.* **2014**, *11*, 80. [CrossRef] [PubMed]
6. Short, C.E.; James, E.L.; Plotnikoff, R.C. Theory-and evidence-based development and process evaluation of the Move More for Life program: A tailored-print intervention designed to promote physical activity among post-treatment breast cancer survivors. *Int. J. Behav. Nutr. Phys. Act.* **2013**, *10*, 124. [CrossRef] [PubMed]
7. Desnoyers, A.; Riesco, E.; Fülöp, T.; Pavic, M. Physical activity and cancer: Update and literature review. *Rev. Med. Interne* **2016**, *37*, 399–405. [CrossRef]
8. Mirandola, D.; Monaci, M.; Muraca, M.G.; Catallo, R.; Gulisano, M.; Sgambati, E.; Marini, M. Role of dance as part of an adapted physical activity program in breast cancer survivors: A pilot study. *Med. Sport* **2015**, *68*, 591–599.
9. Apolone, G.; Mosconi, P.; Quattrociocchi, L.; Gianicolo, E.A.L.; Groth, N.; Ware, J.E., Jr. *Questionario Sullo Stato di Salute SF-12*; Associati, G.E., Ed.; Versione Italiana; Istituto di Ricerche Farmacologiche Mario Negri.: Milano, Italy, 2001.
10. Kendrick, D.B.; Strout, T.D. The minimum clinically significant difference in patient-assigned numeric scores for pain. *Am. J. Emerg. Med.* **2005**, *23*, 828–832. [CrossRef] [PubMed]

11. Khadilkar, L.; MacDermid, J.C.; Sinden, K.E.; Jenkyn, T.R.; Birmingham, T.B.; Athwal, G.S. An analysis of functional shoulder movements during task performance using Dartfish movement analysis software. *Int. J. Shoulder Surg.* **2014**, *8*, 1–9. [CrossRef] [PubMed]
12. Schwarz, R.; Krauss, O.; Höckel, M.; Meyer, A.; Zenger, M.; Hinz, A. The course of anxiety and depression in patients with breast cancer and gynaecological cancer. *Breast Care* **2008**, *3*, 417–422. [CrossRef] [PubMed]
13. Phillips, S.M.; Lloyd, G.R.; Awick, E.A.; McAuley, E. Correlates of objectively measured sedentary behavior in breast cancer survivors. *Cancer Causes Control.* **2016**, *27*, 787–795. [CrossRef] [PubMed]
14. Han, C.J.; Korde, L.A.; Reding, S.; Allott, K.; Van Doren, M.; Schwarz, Y.; Vaughan, C.; Reding, K.W. Investigation of a Lifestyle Intervention in Women at High Risk of Breast Cancer. *West. J. Nurs. Res.* **2017**. [CrossRef] [PubMed]