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O L L S C O I L L U I M N I G H

Title: The Effects of Exercise on Breast Cancer Post Diagnosis

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OLLSCOIL LUIMNIGH

Student Declaration:

I hereby declare that this project is entirely my own work other and that it has not been submitted for any academic award, or part thereof, at this or any other educational establishment.

Signed:

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Date:

11th April 2019



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O L L S C O I L L U I M N I G H

Abstract:

The purpose of this dissertation is to focus on the effects of exercise on breast cancer post diagnosis.

Research strategy began in October 2018 and was completed by March 2019, using a variety of databases including; Scopus, Web of Science, Ebsco and Google Scholar. As well as referencing other various sources such as; cancer organisations, associations and charities.

Reviewing the research in conjunction with; fitness components; cardiorespiratory/muscular endurance and flexibility and the various treatments currently being prescribed along with their associated side effects. While also evaluating the affect these areas have on exercise among breast cancer survivors and the key considerations among fitness professionals training this population.

The research has shown that breast cancer survivors are more sedentary than general population and overall positive outcomes have been linked to exercising following a breast cancer diagnosis.

Evidence has presented significant findings among; quality of life, decreased fatigue and cancer related side effects, improved cognitive function and psychological wellbeing. Research has also indicated improved mortality rates and decreased recurrence among survivors undertaking regular exercise.

Although more research is required within certain areas, such as; larger scale trials/follow up trials over longer time frames and among more diverse populations.

In summary, the evidence suggests that exercise is a useful tool in improving health outcomes among this demographic and should be recommended by doctors/clinicians to encourage increased exercise participation rates both during and after treatment.



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The Effects of Exercise on Breast Cancer Post Diagnosis

Introduction:

The purpose of this dissertation is to focus on the effects of exercise amongst post diagnosis breast cancer patients and survivors in the female population. For this assignment, the term ‘survivor’ will be used, and is classed as: ‘from the time of diagnosis until the end of life’ (Cancer Advocacy Organisation 2019).

Considering the various factors from; side effects, physical and mental health implications and treatment. The aim is to determine how exercise, ranging from aerobic, local muscular endurance to flexibility can impact the outcome of the disease both physically and mentally.

While also look at managing symptoms /treatment related issues and overall quality of life. The objective is to determine how much of an effect exercise has on the disease in relation to recovery, recurrence, mortality rates and wellbeing on women with a breast cancer diagnosis. As well as discovering the adequate frequency and type of exercise best suited to a breast cancer survivor and any contraindications to be aware of in this population.

Main research questions:

- How does cardiorespiratory fitness affect breast cancer throughout the various stages of the disease i.e. during treatment, post-treatment etc?
- How does muscular strength affect breast cancer post-diagnosis?
- Does resistance /aerobic training benefit the survivor physically and/or mentally?
- Is there a type or frequency of exercise best suited?
- What implications are there in terms of side effects?
- How does exercise effect recovery, recurrence and mortality rates among female breast cancer survivors?
- Are there specific exercises recommended post diagnosis or post treatment?

Much of this search strategy began in October 2018 and was conducted up until March 2019.

Databases used included: Scopus, Web of Science, Ebsco and Google Scholar. Keywords contained variations of the following terms: “breast cancer”, “exercise”, “fitness”, “physical activity”. Over 25 papers were researched, and valuable information was sought via the World Health Organisation (WHO), American College Sports Medicine (ACSM) and various cancer related organisations,

associations, charities and websites (full details in bibliography). All of which provided beneficial information and facts surrounding the disease itself, treatments available and associated side effects.

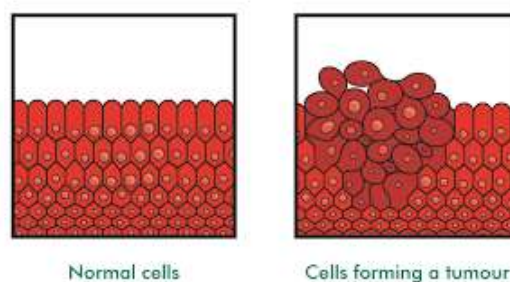
Aims & Objectives:

The objective of this paper is to examine the overall effect of physical activity on breast cancer. Looking at; treatment and post treatment. As well as analysing the effect of all types of exercise, from muscular and cardiorespiratory endurance to flexibility. What type of effect does physical activity have on breast cancer survivors in women of all ages, including both pre-menopause and post menopause? Do they improve or decrease the sides effects or symptoms associated with cancer treatment? If so, specifically, which ones? Should exercise be avoided at certain times during treatment or when experiencing certain symptoms? Does it improve mortality rate or decrease the chances of reoccurrence? Although it's commonly mentioned that physical activity improves quality of life, the purpose of this paper is to provide further information specifically to the breast cancer female population.

What is cancer?

Cancer is the second leading cause of death worldwide. In 2018 it was responsible for over 9.6 million deaths. Globally, 1 in 6 deaths are due to cancer (World Health Organisation 2018).

Cancer can be defined as; a “disease caused by an uncontrolled division of abnormal cells in a part of the body” (Oxford Dictionary 2018).



Picture: Macmillan Cancer Support.

Often referred to as ‘growths’ or ‘tumours’, tumours can be classed as; ‘benign’ (i.e. not cancerous and don’t spread to other body parts), or ‘malignant’ (i.e. cancerous tumours that can spread to other areas of the body). If these abnormal cells break away and invade another area of the body, transported via the bloodstream or lymph vessels this forms a secondary tumour, also known as metastasis (secondary cancer). Cancer is a word used to refer to a group of over 200 types of

diseases. Each cancer is named after the cell or organ that it originates from (i.e. breast cancer comes from the cell of the breast, prostate cancer begins in the prostate gland, lung cancer from the cells in the lungs and so forth) (Irish Cancer Society 2018).

These abnormal cells may develop from a pre-cancerous lesion to a malignant tumour and be caused by several factors:

The interaction of a persons' genetic make-up teamed with potentially three external factors:

1. **Physical carcinogens** (i.e. radiation or ultraviolet light),
2. **Chemical carcinogens** (for instance tobacco or asbestos).
3. **Biological carcinogens** (e.g. infections, virus or bacteria).

Some of the main cancer-causing factors globally include;

- Unhealthy diet.
- Tobacco
- Alcohol
- Physical inactivity

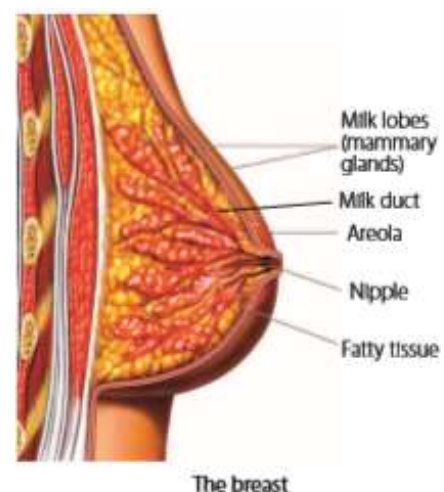
(Irish Cancer Society 2018).

The prevalence of cancer increases with age. This is most likely since there is an increased build-up of some of these factors combined with less effective repair mechanisms functioning in the body due to age related decline. (World Health Organisation 2018)

What is breast cancer?

Breast cancer arises in the mammary gland (Oxford Dictionary 2018) and is the most common form of cancer in women around the world. Representing up to 23% of all cancer cases (Zeng *et al.* 2014), it's the second most common cancer in women in Ireland affecting over 3000 women annually (Irish Cancer Society 2018) and in the United States it accounts for the second leading cause of cancer death (Zhong *et al.* 2014).

There are over 1 million women diagnosed with breast cancer every year globally (World Health Organisation 2018).



Picture: Irish Cancer Society 2018

Even though the 5-year survival rate for breast cancer patients increased from 75.1% (from 1975-1977) to 90% (2001-2007), Breast cancer still has the highest amount of cancer rates and deaths in women (Schmid and Leitzmann, 2014; Hayes *et al.* 2013).

Regular screening is recommended to women over 50 years for early detection. Should breast cancer be detected, other tests will be carried out to find out for more information, tests such as: Lymph node ultrasound scan, blood tests, x-rays, MRI scan, CT /CAT scan, Bone scan, Liver ultrasound scan or PET scan. Symptoms may include; changes/shape in the breast or surrounding skin/nipple, an unusual lump, swelling or pain in breast or armpit (Irish Cancer Society 2018).

Breast cancer recurrence can be described as: “Cancer that has recurred (come back), usually after a period of time during which the cancer could not be detected. The cancer may come back to the same place as the original (primary) tumour or to another place in the body. Also called recurrent cancer” (National Cancer Institute 2019).

Looking at this disease along with the various fitness components (i.e. aerobic, strength and flexibility) and type /stage of treatment (i.e. adjuvant/neoadjuvant, chemotherapy, radiotherapy, surgery, post-surgery etc.) will give us a clearer understanding of the importance of exercise with a breast cancer diagnosis.

To reduce the risk of breast cancer, recommendations include; maintaining a healthy weight and diet, regular exercise, limiting your alcohol intake, breastfeeding, don't smoke and attend regular screening. Although the exact cause of breast cancer is still unknown, there are various risk factors that can increase the chances of developing the disease.

These factors include:

- Gender (it's 100 times more common in women.).
- Age (approximately 41% of women with breast cancer are between 50-64 years old, with 23% of diagnosis occurring in the under 50 bracket) (Irish Cancer Society 2018).
- Medical history (i.e. previous breast disease)
- Previous radiotherapy
- Hormones
- Family history (i.e. hereditary)
- Lifestyle influences

(Irish Cancer Society 2018; MacMillan Cancer Support 2018).



Picture: Irish Cancer Society 2018



What is the Lymphatic System?

The Lymphatic system is a group of tiny vessels found in the armpit, groin, neck, armpit and tummy. Used to transport fluid and waste throughout the body, they protect the body from infection and disease. Lymph nodes are connected by these vessels and located under the skin. If cancer cells spread into these nodes, or even start in the nodes themselves, they become swollen

(Irish Cancer Society 2018; MacMillan Cancer Support 2018).

Picture: Irish Cancer Society:

Types of breast cancer:

Invasive and Non-invasive

There are two types of breast cancer: non-invasive and invasive.

Non-invasive is generally an early stage of breast cancer where cancer cells have not spread outside of the milk ducts of the breast. Often referred to as pre-cancerous or intraductal. The most common non-invasive cancer is known as ductal carcinoma in situ (DCIS).

Invasive is when the cells have transported past the lining of the milk ducts and surrounding breast tissue, with the possibility of spreading via the lymph nodes to other parts of the body. There are four main types of invasive breast cancer, as well as other rarer forms:

The most common one being *invasive ductal carcinoma* starting in the milk ducts and spreading to surrounding breast tissue, this accounts for approximately 8 out of 10 invasive breast cancers.

Less common is invasive *lobular breast cancer* that effects approximately 1 in 10 women. This type starts in the cells of the lobes in the end of the milk ducts.

Inflammatory breast cancer is quite a rare type of invasive cancer. Effecting only 1 or 2 in 100, which causes a reddened appearance due to cancer cells blocking the lymph channels.

Paget's disease of the breast is another uncommon type of breast cancer. It starts in the ducts but spreads to the skin of the nipple and areola.

(Irish Cancer Society 2018; MacMillan Cancer Support 2018).

Hormone receptors or Protein Receptors:

Breast cancer cells often contain receptors (hormone or proteins) on the surface of the cell which other hormones or proteins can attach to and stimulate cancer growth. Breast cancer treatment is often dependent on which categorisation the breast cancer falls under to allow doctors to determine the most effective method of treating the disease.

Hormone Receptors:

Also known as *oestrogen receptors* (i.e. ER Positive) and *progesterone receptors* (PR Positive).

Cells with no hormone receptors are called HR negative.

Protein Receptors:

Categorisation may include the protein HER2 (human epidermal growth factor 2). HER2 positive breast cancer affects 1 in 7 women with early breast cancer. Cells with no HER2 present are known as HER negative.

If the breast cancer doesn't have either hormone or protein positive receptors it is known as *triple negative* breast cancer affecting 1 in 5 women, this type is more common in younger women.

(Irish Cancer Society 2018; MacMillan Cancer Support 2018).

Staging:

This means determining the size of the cancer and whether it's spread to surrounding areas of the body. Staging can be categorised by the following TNM staging or number staging.

TNM Staging:

<i>T</i>	Refers to tumour size.
<i>N</i>	Describes its spread to the lymph nodes (i.e. N0, means it hasn't, N1 means that it's spread to 1-3 lymph nodes).
<i>M</i>	Is in relation to whether the cancer has spread (i.e. metastasised) to other body parts.

Number Staging:

Stage 0:	Non-invasive, cancer cells contained in the place of origin. DCIS (ductal carcinoma in situ) is the most common type with cancer cells starting in the milk ducts.
Stage 1:	Invasive, but often called 'early stage breast cancer.' Only found in your breast. The cancer (i.e. lump) is 2cm or smaller and hasn't spread to lymph nodes of the armpit.
Stage 2:	Invasive cancer is growing but still contained in the breast or extended to nearby lymph nodes.
Stage 3:	Invasive cancer sometimes referred to as 'locally advanced' has extended beyond immediate region to more lymph nodes.
Stage 4:	Invasive, also referred to 'Secondary' or 'Metastatic' cancer. The cancer has spread to other parts of the body (i.e. lungs, bones, brain etc.)

Grading:

Grading refers to the speed of how quickly the cancer is growing in the breast tissue.

Grade 1:	Low grade. Under the microscope cells look like normal cells. Slow growing and less likely to spread.
Grade 2:	Intermediate grade. Cells look more abnormal. Growing slightly faster than the previous grade.
Grade 3:	High grade. Cells look substantially different to normal cells. Growing faster than previous grades.

(Macmillan Cancer Support 2018; British Journal of Cancer 2018;
National Breast Cancer Org 2018; Irish Cancer Society 2018)

Mortality & Recurrence:

Mortality rate can be defined as; “the number of deaths during a particular period of time among a particular type or group of people” (Collins Dictionary 2019).

For instance, Schmid and Leitzmann (2014) strongly supports following the physical activity guidelines to improve survivorship. Following their research that looks at the association between physical activity and mortality among breast cancer survivors (as well as colorectal too). Their analysis showed that engaging in at least 150 minutes of moderate physical activity per week after diagnosis was associated with a 24% reduced risk of total mortality among breast cancer survivors. These significant findings were evident among both lean and overweight women, pre and post-menopausal and ER positive and negative tumours. Furthermore, pre-diagnosis exercise may improve the outcome of the treatment process as it leads to improved functional capacity and increased tolerance towards surgery and adjuvant treatment.

On the contrary, Zhong *et al.* (2014) found both pre-diagnosis and post-diagnosis physical activity is also associated with reduced breast cancer specific mortality and all-cause mortality. On the other hand, their results presented strong mortality reduction in overweight women as opposed to normal weight women. As well as among postmenopausal than premenopausal. Their meta-analysis results found that physical activity post diagnosis reduced breast cancer deaths by 34% and all-cause mortality by 41%. Overall there was a better prognosis among physically active patients among their research, however due to the findings being based on only sixteen studies, future research among a larger sample size is recommended.

Irwin *et al* (2011) used walking as their main form of exercise among its research. Irwin *et al.* (2011) focused their research among postmenopausal breast cancer survivors and looked at mortality as the main outcome. The results showed that women participating in moderate-vigorous-intensity activity before or after a breast cancer diagnosis may improve survival rates. It also reported improved outcomes in women that were reported low active prior to diagnosis and increased activity levels after diagnosis. Although lower levels of death risk were reported, they recommend that women diagnosed with breast cancer should be encouraged to initiate an exercise program however larger scale trials are also needed to fully support these findings.

While Schmitz and Speck (2010) reviewed both the risks and benefits of physical activity among this population. They noted that weight gain is quite common post diagnosis, with an average weight increase of up to 5kg. While Falcetta *et al.* (2018) shockingly reports that obese women and women that gain weight after breast cancer diagnosis have twice the risk of recurrence and death from breast cancer in 5 years and 60% higher risk of death over 10 years when compared to women with normal weight. Obesity is an area that requires attention among this population.

Falceta *et al.* (2018) reviewed a large volume of studies with just one focusing on mortality data. They concluded that exercise should be used as a protective intervention and suggests that physical activity can have a positive influence on survival rates. Courneya *et al.* (2014) similarly discusses that physical activity is linked to a lower risk of all-cause mortality. This study is a follow up from a previous paper: the supervised trial of aerobic versus resistance training (START). The purpose was to determine overall survival and recurrence free-interval however their recommendations are that a definitive phase three trial is necessary to correspond with this ongoing research. Although there was a meaningful difference, with slightly stronger effects observed for survivorship and the strongest effect among recurrence free interval rates.

Overall, the research suggests that increased physical activity upon a breast cancer diagnosis may improve survivorship rates. Therefore, should be recommended post diagnosis with this population. However further research is required in this area.

What is exercise?

Exercise can be described as a subcategory of 'physical activity'.

Physical activity is any bodily movement via skeletal muscles that result in energy expenditure, for instance; household chores, engaging in recreational pursuits, playing, working etc. Whereas 'exercise' is structured, planned or repetitive physical activity that has an end or intermediate objective of the improvement or maintenance of physical fitness components (ACSM 2018).

Oxford Dictionary define exercise as:

“Activity requiring physical effort, carried out to sustain or improve health and fitness.”

Exercise can be broken down into the following fitness components:

Cardiorespiratory Endurance

Also known as Aerobic training and is defined by the ACSM as “the ability of the circulatory and respiratory system to supply oxygen during sustained physical activity.”

Local Muscular Endurance:

Often referred to as resistance training, strength training/endurance. ACSM defines:

Muscular endurance as: the ability of muscle to continue to perform without fatigue.

Muscular strength: the ability of muscle to exert force.

Flexibility:

Flexibility can be defined as the range of motion available at a joint.

(ACSM 2018)

The research analysed frequently looked at these various fitness components. Both moderate and vigorous intensity physical activity can improve health. Regular physical activity has been linked to life longevity and proven to have a wide range of benefits and positive outcomes including: weight control, prevention of obesity, reduced risk of non-communicable diseases, type 2 diabetes, cardiovascular disease, heart disease and stroke etc. Improved bone density. Better psychological wellbeing and brain health, as well as; benefits to society by increased social interaction and community engagement.

(ACSM 2018; WHO 2018)

Cheema *et al.* (2014) focus was predominately surrounding resistance training but also included trials with flexibility too. Whilst looking at safety and efficiency among breast cancer survivors, treatment interventions for breast cancer can sometimes lead to upper body functional impairment, peripheral neuropathy, lymphoedema and more (discussed more in treatment section). Therefore, these adverse effects often have a domino effect that leads to decreased physical activity. Also giving consideration that there has been concern in the past regarding the safety of strenuous upper body activity in women at risk of lymphoedema and doctors often prescribing 'rest' as opposed to exercise. The results from this meta- analysis recommends that clinicians consider progressive resistance training for reducing the risk of breast cancer related lymphoedema. As well as improving upper and lower body strength and health related quality of life, considering the ACSM roundtable of guidelines with this population (Schmitz *et al.* 2010).

The current exercise guidelines from the ACSM (2018) recommend the following for general adult population:

- Adults should undertake at least 150 minutes (2 hours, 30 minutes) to 300 minutes (5 hours) moderate intensity exercise per week. Or 75 minutes (1 hour, 15 minutes) to 150 minutes (2 hours and 30 minutes) a week of vigorous intensity exercise.
- Preferably, aerobic exercise should be spread throughout the week.
- Adults should also undertake muscle strengthening activities on all major muscle groups 2+ days per week (moderate to greater intensity).

Globally approximately only 23% of adults and 81% of adolescents are not meeting the recommended guidelines. In Ireland it is estimated that only 33% of adults (i.e. over 18 years old) are achieving this recommended amount of exercise (WHO 2018).

Cancer and Exercise

In the past, doctors often prescribed cancer patients 'rest' and advised avoiding physical activity. However, it's been established in the last two decades that regular exercise can be used as both a preventative and control measure for cancer, with recent research presenting physical activity as a beneficial tool with cancer patients and survivors (Schmitz *et al.* 2010).

ACSM reports increased fitness levels, improved quality of life and physical functioning. There are now close to 12 million cancer survivors in the US with this number increasing each year (ACSM 2018).

How might physical activity be linked to reduced risks of cancer?

- Exercise can lower levels of hormones and certain growth factors associated with cancer development and progression.
 - Exercise prevents obesity and the effects of obesity, which can be associated with increased risk of breast cancer.
 - Exercise improves the immune system.
 - Reduction of inflammation.
 - Alters metabolism of bile acids which decreases exposure to carcinogens.
 - Improves digestion which limits gastrointestinal tract exposure to potential carcinogens.
- (National Cancer Institute 2019).

Breast Cancer and Exercise

Studies have shown that breast cancer survivors that engage in regular physical activity experience a decline in cancer treatment related fatigue (Hayes *et al.* 2012) an improved quality of life (Schmitz *et al.* 2010; Falcetta *et al.* 2018, Meneses-Echávez *et al.* 2015), psychological well-being (Aguinaga *et al.* 2017) and decreased risk of cancer recurrence (Kapila *et al.* 2018) and mortality rates (Sahin and Altundag 2018, Schmitz and Speck 2010).

Although physical activity has been proven to increase quality of life and improve cancer related fatigue, the effects and type of exercise themselves require more research (Meneses-Echávez *et al.* 2015).

Quality of life can be defined as: “the general well-being of a person or society, defined in terms of health and happiness, rather than wealth.” (Collins Dictionary 2019) Factors such as; fatigue, cognitive functionality, mental and physical health all fall under this category. Which is why, this dissertation will be analysing the various studies in relation to this topic, to gather a better understanding and learn more in relation to our research questions.

Notably, one of the most common cancer related symptoms in breast cancer survivors and patients is fatigue (affecting approximately 40-80% of patients undertaking treatment). Bearing this in mind, it's understandable that up to 70% of breast cancer survivors fail to undertake the recommended exercise guidelines of 150 minutes per week (moderate to vigorous intensity) (Phillips *et al.*, 2015).

It's also been reported that a sedentary lifestyle is commonly associated with decline in health outcomes amongst breast cancer survivors (Phillips *et al.* 2015; Falcetta *et al.* 2018). Relatedly, research from Kapila *et al.* 2018 suggests further awareness and improved patient education is required on the topic to encourage increased physical activity and that clinicians need to inform patients about the benefits and guidelines from the ACSM. While Schmid and Leitzmann (2014) recommend counselling cancer survivors to adopt a more physically active lifestyle bearing in mind patient physical condition and personal circumstance etc.

Philips *et al.* 2015 also concludes that breast cancer survivors are generally more sedentary with an average of 66.4% of their waking time sedentary, 31.1% light /lifestyle activity and just 2.6% moderate to-vigorous physical activity. They suggest that further research should be undertaken to explore methods to improve these behaviours and possible motivational factors to encourage exercise.

Another factor to be given consideration is; supervised versus unsupervised activity, Lemanne and Maizes (2018) suggest that supervised activity is a far more effective method. Their narrative notes that supervised exercise is more likely to result in long lasting benefits as opposed to unsupervised. Although they fail to mention specific reasons why, according to their review supervised leads to better completion rates. They advise that aerobic, resistance and yoga will provide several benefits including; decrease in recurrence, reduction in chemotherapy related side effects, reduced incidence and severity of lymphedema as well as improved survival rates.

Another study in agreement with supervised activity is Meneses-Echavez (2015). Their research suggests that cancer related fatigue may be considered a strong predictor of lower survivor rates amongst cancer patients. They reviewed a variety of training studies undergoing various cancer treatments and found that supervised aerobic training was more effective than conventional care in improving fatigue with similar results for resistance training too. This review discusses the possibilities on why supervision is deemed more beneficial and observe that it could be attributed to greater encouragement, more confidence while training with the guidance of a professional which in turn may lead to improved adherence and intensity.

While Zeng *et al.* (2014) examined quality of life using a variety of fitness components, it was noted that racially and ethnically diverse populations have decreased exercise levels and increased obesity occurrence, therefore socioeconomic status also plays a role among quality of life in relation to results and diverse populations should be considered for future research.

Travier *et al.* (2015) looked at the effects of a supervised aerobic and resistance programme starting early during breast cancer adjuvant treatment observing changes after 18 weeks and 36 weeks. Positive effects were presented on fatigue, submaximal cardiorespiratory fitness and muscle strength. The primary outcome of fatigue (after 18 weeks) was assessed along with quality of life validated. Key reports showed that the 18-week intervention reduced fatigue and improved cardiorespiratory and muscular endurance, however after 36 weeks effects weren't statistically significant. Travier *et al.* (2015) observes a possible explanation for this might be due to higher activity levels at this stage, however more research is required.

Similarly, research undertaken by Falcetta *et al.* (2018) discussed the long-lasting impact of breast cancer and presented positive findings with quality of life as well as looking at weight reduction among early stage breast cancer patients. Their research was aimed towards patients treated with curative intent, at the end of their adjuvant treatment (excluding hormone therapy). Overall their recommendation is for this population to avoid a sedentary lifestyle, often linked to this disease and seek regular exercise to not only stimulate a healthy weight but improve mental health and prevent other chronic diseases which this population is more vulnerable to.

Exercise and Mental Health

As mental health is also an important factor to consider with this population Aguinaga *et al.* (2017) and Pudkasam *et al.* (2018) both looked at the psychological well-being aspect of breast cancer survivors, including depression and quality of life factors in relation to physical activity.

Aguinaga *et al.* (2017) highlighted that low levels of physical activity during survivorship was often associated with increased fatigue, depression and lower quality of life. Whilst the study also looked at cross categories of activity levels among their group (including low and high active pre-diagnosis and post diagnosis). They acknowledged that most of their participants had a high socioeconomical status, therefore similar to Zeng *et al.* (2014) studies towards a more diverse population should be considered for future research.

Pudkasam *et al.* (2018) similarly reports on the various psychological distress and anxious symptoms associated with breast cancer. The purpose of this review was to present findings on the mental health element and effectiveness of physical activity using psychological change theories to enhance adherence to a more active lifestyle. With almost half of breast cancer survivors reporting psychological alterations from mood changes, spiritual and social distress. Including symptoms of

fear, anxiety and depression in relation to the outcomes of their cancer diagnosis, with all these stressors often linked to further illness. Whereas, survivors with a more positive attitude towards their diagnosis and better coping mechanisms often have an improved quality of life. Therefore, a consistent physical activity programme among survivors can help create a more positive approach to the illness. However, as Philips *et al.* (2015) also points out; this population will require additional motivation to adhere to an exercise program.

Although it's clear that physical activity is a beneficial tool in the fight against cancer for both physical and mental health, fitness professionals also need to be aware of the health implications and cancer related symptoms that come hand-in-hand when working with cancer survivors. Therefore, the ACSM has developed a roundtable of guidelines to facilitate the cancer population (Schmitz *et al.* 2010) and included information specific to breast cancer survivors.

Breast Cancer Exercise Guidelines:

Summary of the key guidelines include:

- Follow the 2008 Physical Activity Guidelines with specific programming adaptations and treatment related effects based on the disease.
- ACSM guidelines for exercise, testing, stopping/contraindications prior to exercise can all be followed.
- Evaluation of peripheral neuropathies, musculoskeletal morbidities recommended.
- If there has been hormone therapy, evaluation of fracture risk is required.
- Individuals with known cardiac conditions require medical assessment of the safety of exercise before starting.
- Evaluation of arm/shoulder morbidity before upper body exercise.
- Goals / Objectives will vary and often be specific to cancer related issues/side effects of cancer and /treatment.
- Allow adequate time to heal from surgery.
- Do not exercise individuals with extreme fatigue, anaemia or ataxia.
- For starting an exercise program follow cardiovascular and pulmonary contraindications. As the potential for an adverse cardiopulmonary event might be increased among survivors than age matched comparisons given the toxicity of radiotherapy and chemotherapy/long term effects of surgery.
- Women with immediate arm or shoulder problems should seek medical care before upper body work.
- Any changes in arm/shoulder swelling should result in reduced /avoidance of upper body work until a medical evaluation has been done.

Main Body:

Treatment & Side Effects:

As the ACSM mentions, it's highly important that a fitness professional understands the various treatments being provided as well being aware that cancer therapies are constantly changing, so in order to prescribe a safe and effective programme, the trainer will need to understand the patient circumstance. Likewise, understand the positive or negative implications associated with any cancer related symptoms they may be experiencing.

Treatment for breast cancer varies case to case, but may include some or a combination of the following (not necessarily in this order either);

- Surgery
- Radiotherapy
- Chemotherapy
- Hormone Therapy
- Biological therapies

Let's take a further look at the various treatments and side effects relating to them

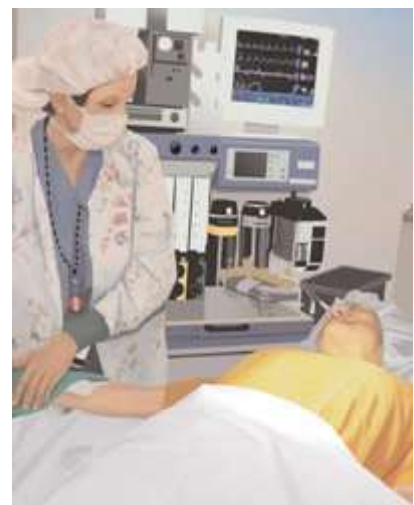
Surgery:

There are two main types of surgery: Breast conserving surgery (where part of the breast is removed). Or Mastectomy (when the whole breast is removed). Breast reconstruction surgery is an option at the time of surgery or at a later stage.

Conserving the breast may not be an option for all women.

Another part of surgery to consider is the removal of lymph nodes. In some cases, removing just the sentinel node or one or two other nodes may be enough to test if cancer has spread through the lymphatic system. (i.e. the first group of nodes normally in the armpit, same side as the breast cancer).

If cancer is found in the lymph nodes, an axillary clearance is required, i.e. some of the lymph nodes are removed, in some cases most of the lymph nodes in the armpit will have to be removed.



Picture: Breast Cancer. Org.

With this surgery there is an increased risk of developing a condition known as ‘Lymphoedema’. It’s a swelling which can be caused by the lymph fluid building up in the tissue of your arm (where the nodes were removed). This may happen after surgery, or in some instances, develops many years after treatment. Swelling, poor range of motion and/or a tingling/tightening sensation in the affected area is one of the main signs of lymphoedema.

Other breast cancer surgery may include: Ovarian ablation – i.e. used to remove your ovaries so no oestrogen is produced (used where cancers are sensitive to hormones). Or Ovarian suppression – surgery to stop your ovaries from working (again used with breast cancers sensitive to oestrogen or progesterone).

As well as possible lymphoedema, other surgery related side effects may include; numbness, tingling or build-up of fluid (i.e. seroma), pain, infection, stiff shoulder or arm, limited range of movement. (Macmillan Cancer Support 2018; Irish Cancer Society 2018)

Research by Hayes *et al.* (2012), commenced an intervention 6 weeks-post breast cancer surgery among invasive breast cancer patients. The aim was to maintain or progress towards exercising at least 4 days per week (accumulating 180+ mins weekly). Their aerobic and strength-based programme undertaken with a treatment group, reported significant improvements in quality of life, fatigue and fitness. Compared to the usual care group that experienced no change or worsening. Overall, this study highlights that implementation of an exercise programme 6 weeks after surgery is safe and effective in decreasing /preventing fatigue and optimising quality of life. Comparably, Yang *et al.* (2018) looked at the effects of preoperative exercise following breast cancer surgery and found Pre-habilitation that optimises shoulder range of movement, grip strength and general fitness may improve these areas as well as provide pain reduction and functional recovery following surgery. Although further studies are required in terms of protocol, overall results were significant.

The ACSM recommends that following surgery (once doctor’s clearance is given), the individual starts with a supervised program of at least 16 sessions and very low resistance. Progression made at very small increments and exercises stopped according to symptom response. If a break over a week or two is taken, resistance should be put back to the level they were at two weeks previous (i.e. if they take a two-week break, resistance back to where it was four weeks ago). They also suggest that individuals with cardiac conditions may require increased supervision for safety.

Post-surgery

After undergoing surgery, whether the patient has also undergone radiotherapy too, it's important to get the arm /shoulder moving again to get them back to normal activities. Increasing shoulder /arm motion can be usually started in a few days with exercises to improve strength added later.

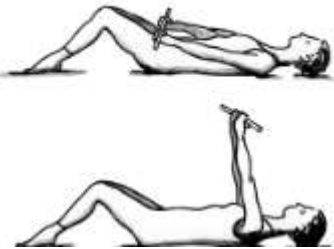


Breathing, relaxation exercises and walking can also be done too.

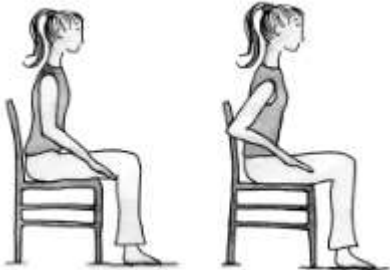



The following are some tips for up to the first week after surgery (following doctor's clearance).

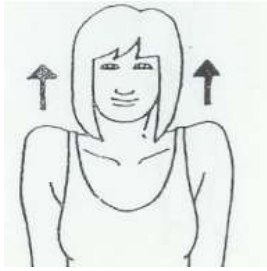
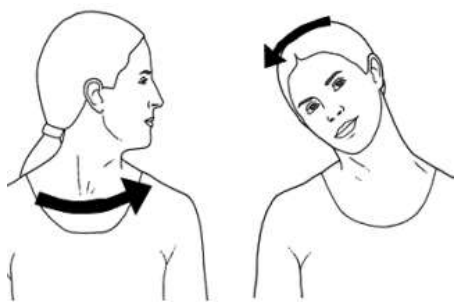

Should the individual have any trouble with exercise, develop any unexplained symptoms, get weaker, start losing their balance, have new heaviness, strange sensations, unusual swelling, dizziness/blurred vision etc, they should talk to their doctor. Strengthening and aerobic exercises are also recommended as part of the program but shouldn't be started until 4-6 weeks after surgery.

Tips post-surgery:

- Tightness in chest and armpit is normal. This should decrease as exercises are done.
- Burning, tingling, numbness or soreness back of arm/chest wall may develop, due to surgery irritating some of the nerves.) Continue with exercises unless you notice unusual swelling or tenderness.
- Doing exercise after a warm shower may help when muscles are warm and relaxed.
- Wear comfortable, loose clothing when exercising.
- Exercise slow, holding a stretch for up to 5 seconds at the end of the motion. Nice and gentle no sudden jerking movements.
- Aim to do the exercise correctly 5-7 times. Twice daily until your normal flexibility resumes.
- Ensure to take deep breaths.
- Start slow and increase as you improve.
- Use your affected arm for light tasks such as brushing your hair, using your phone etc.
- Remember good posture, back straight and stand tall.

SUITABLE EXERCISES:	INSTRUCTION:
<p data-bbox="365 309 576 338">Wand Exercise</p> 	<p data-bbox="810 320 1436 734">This shoulder exercise requires a broom handle or stick to use as a wand. Lie down on your back and bend your knees (feet flat). Placing the wand across your stomach using both hands (underhand grip). Lift the wand up over your head as much as you can. Using your unaffected arm to help lift until you feel a stretch in the affected arm. Pause for 5 seconds. Lower arms and repeat 5-7 times.</p>
<p data-bbox="368 801 572 831">Elbow winging</p> 	<p data-bbox="810 813 1420 1182">This movement will help increase movement front of chest and shoulder. It may take time to get good range on these. Lying on your back with bent knees and feet flat on the ground. Place your hands behind your neck (elbows pointing toward ceiling). Moving elbows apart and down toward the floor. Repeat from 5-7 times.</p>
<p data-bbox="316 1247 627 1276">Shoulder blade stretch</p> 	<p data-bbox="810 1258 1433 1765">This movement assists shoulder blade movement. Sitting in a chair very close to a table. Keeping back against the back of chair; with elbow bent and palm face down place the unaffected arm on table. Do not move this arm during this exercise. On the opposite arm place arm palm down with elbow straight. Keeping still slide the affected arm forward near to the opposite side of the table, moving your shoulder blade as you do so. Relax the arm and repeat 5-7 times.</p>

<p>Shoulder blade squeeze</p> 	<p>This move helps improve movement in the shoulder blades. Seated at a mirror (not resting against back of chair), arms by your side and bent elbows. Squeezing the blades together, bring your elbows behind you. Keeping shoulders level and away from ears. Back to starting position and repeat 5-7 times.</p>
<p>Side bends</p> 	<p>This will help improve movement of your trunk and body. Starting seated, clasping your hands in front, lift up your arms over your head slow, straightening out the arms. Once arms are past the head, bending the trunk to the right side, keeping arms overhead. Returning to the start and bend towards the left. Repeating exercise 5-7 times.</p>
<p>Chest wall stretch</p> 	<p>This will help stretch the chest. Standing towards a corner with toes approx. 8-10 inches from corner, bent elbows and forearms placed on the wall (one either side of the corner). Elbows as close to shoulder level as much as possible. Keeping arms and feet stable, moving the chest towards the corner. This will provide a stretch across chest and shoulders. Back to start position and repeat 5-7 times.</p>
<p>Making a fist – ball squeeze</p> 	<p>Using a soft ball or sponge, opening and closing your fist (squeezing and clenching your fist) Do exercise up to 10 times every hour during the day.</p>

<p>Shoulder Shrugs</p> 	<p>Sitting comfortably, raise shoulders up towards ears, squeezing shoulder blade together in the back. Then lower down away from ears and relax. Repeating 5-10 times.</p>
<p>Head turning and tilting</p> 	<p>With a nice tall neck, keeping in, turn head slowly looking over each shoulder as far as you can. Tiling the head to one side and then the other. Bring ear as close shoulder as much as comfortably possible. Repeat 5-10 times.</p>
<p>External arm rotation</p> 	<p>Seated or standing position, tucking your elbows into your side at right angles, turn forearms outwards keeping elbows in. Repeat between 5-10 times.</p>

American Cancer Society (2017), Beacon Hospital (2011) and University Health Network (2015).

Radiotherapy/Radiation Therapy:

“Radiotherapy is the treatment of disease using radiation” Irish Cancer Society (2018).

Radiation Therapy or X-rays as it's also called are used to kill cancer cells by using high doses of radiation on the tumour site. The aim is to destroy/shrink the cancer cells with as little damage as possible to the normal surrounding cells and requires careful planning prior to treatment. It can be given internally or externally.

With internal radiotherapy, the source of radiation is positioned inside your body on or near the tumour. Most radiation is provided externally, which entails the x-rays being directed and aimed at the site of the tumour via a special machine.

Radiotherapy may be used as a curative treatment (i.e. destroy cancer cells) or a palliative treatment (i.e. relieve pressure, pain or bleeding), depending on the type and stage of cancer be treated. It may also be given in conjunction with other treatments or by itself. In most cases, it's given after surgery to prevent the growth of cancer cells that might remain in the body (i.e. adjuvant therapy – which may or may not include chemotherapy too). A course of treatment is usually given up to 8 weeks. There are risks associated with radiotherapy, as it can temporarily damage or destroy healthy cells. Which can lead to short and long-term side effects usually associated with the region being treated. Short term side effects generally develop towards the end of treatment and may last a few weeks, including; skin changes, fatigue and indigestion.

Long term side effects may happen after treatment and in some instances much later. They can be permanent i.e. scar tissue damage, changes to the colour or feel of the breast, muscle tightness, and loss of movement in chest / shoulder, lymphoedema and swelling.

Side effects vary person to person.

(Macmillan Cancer Support 2018; Irish Cancer Society 2018)

In terms of research in relation to this treatment; Steindorf *et al.* (2014) looked at resistance training in patients receiving adjuvant radiotherapy on stages 0-3, with a broad age group (29-75 years) with the majority not undergoing chemotherapy beforehand i.e. 64%, 19% had completed neoadjuvant chemotherapy and 16% adjuvant chemotherapy. With significant improvements in fatigue, they concluded that resistance training should be an integral part of exercise prescription and works well running parallel to adjuvant radiotherapy.



Picture: Breast Cancer. Org

Chemotherapy:

This drug treatment is also used to kill cancer cells. There are several types which can be used on their own or sometimes in combination.

Chemotherapy can be administered directly into the vein intravenously (i.e. injection/drip) or via tablet form. Chemotherapy may be prescribed at different times with different objectives:

Neo-adjuvant treatment – before surgery or radiotherapy to shrink and reduce cancer risk /recurrence.

Adjuvant treatment – to reduce risk of cancer returning.

Primary chemotherapy – to treat cancer that has spread or returned.

Side effects vary on a case by case basis, dependent on drugs being used etc. however, may include:

- Nausea and or vomiting.
- Increased risk of infection – due to lowered white blood cell count from chemotherapy.
- Anaemia – bone marrow makes fewer red blood cells.
- Hair loss i.e. alopecia.
- Bleeding & bruising - bone marrow makes less platelets which means you may bleed or bruise easier.
- Mouth and throat problems – i.e. ulcers, infections, dry mouth etc.
- Menopausal symptoms – can bring on early menopause or affect your ovaries.
- Constipation /Diarrhoea – changes to bowel movements.
- Fatigue – chronic tiredness.
- Skin and nail changes- may be brittle/weak/sore.
- Peripheral neuropathy – causing a numbness or tingling sensation in hands or feet.
- Changes in kidney function
- Effect on fertility.
- Weight gain can also occur.
- Can lead to heart failure. (British Heart Foundation)

(Macmillan Cancer Support 2018; Irish Cancer Society 2018)



Picture: Breast Cancer. Org.

Gokal *et al.* (2018) research used a home-based intervention established around moderate intensity walking with patients midway through chemotherapy (adjuvant and neo-adjuvant). Looking at impact on productivity and psychological well-being and overall quality of life. Results concluded an overall positive effect on cognitive function. But did acknowledge that a larger sample size was required to objectively assess cognitive decline among this population. This self-managed, home-based, walking programme, was successful in decreasing self-reported cognitive issues experienced by patients going through chemotherapy over just a 12-week period.

While Hornsby *et al.* (2014) also examined the safety of aerobic training in patients undergoing chemotherapy (neo-adjuvant). Improvements in cardiopulmonary function and patient related outcomes were observed. It was presented that although sample size was small and trial duration short, the data supports once again, aerobic training as a prescription among this population and promotes moderate to high intensity aerobic training among patients undergoing neoadjuvant chemotherapy.

Schmidt *et al.* (2015) predominately looked at fatigue and quality of life while undertaking resistance training during adjuvant chemotherapy. They discovered significant and relevant benefits among their outcomes and suggest that by starting an exercise plan early diagnosis it may prevent fatigue, impaired muscle strength and the common cycle of physical inactivity among survivors undergoing treatment.

Another factor worth consideration among fitness professionals is the findings by Schmitz and Speck (2010). They mention that several of the chemotherapeutic agents used to treat breast cancer are associated with pulmonary damage. With this increased risk of cardiovascular outcomes and pulmonary toxicities, aerobic training (although deemed beneficial among this population), requires individual consideration in regard to programming. Ensuring guidance from the ACSM for exercise testing and prescription are used. Overall, their findings concluded that exercise can be helpful for cardiac rehabilitation and mending damaged body systems as a result of cancer related treatment, but again we need to be mindful of our client's individual circumstance.

Biological Therapies:

Biological therapy is used in women that have HER2 receptors on the surface of their breast cancer cells (i.e. HER2 positive). The aim is to block these receptors, so that HER2 proteins can't attach to the cells and encourage growth. This therapy also assists with improving the immune system to target and kill cancer cells. Different types of biological therapy may work in different ways. i.e. aiming to block chemical signals that encourage cancer growth. Monoclonal antibodies by triggering the immune system to attack the cancer cells or radioactive substance, boosting the immune system to fight the cancer etc.

The main one used is the monoclonal antibodies, targeted with a common drug Herceptin® (used for HER2 positive breast cancer). May be administered via a drip, injection or tablet form.

Usually biological therapies experience less side effects than other forms of treatment as they only attack cancer cells and stay away from normal cells. Again, dependent on the drugs used, may vary person to person, common effects include; flu-like symptoms, high temperature, headache, chills, or general nausea and sometimes diarrhoea.

Hormone Therapy:

If the breast cancer is sensitive to hormones (i.e. ER Positive), hormone therapy is often given:

- before surgery to try shrink the tumour (i.e. neoadjuvant treatment).
- After surgery to prevent it from spreading/returning.
- Instead of surgery (if surgery isn't an option).

They are designed to prevent the oestrogen from assisting cancer growth and work in a few ways: i.e. blocking the receptors (a drug called Tamoxifen® is often used here), preventing ovaries from making oestrogen (Zoladex® commonly prescribed), obstructing the production of oestrogen in body fat (Aromatase inhibitors used, may include; Arimedes®, Femara® or Aromasin®.)

These may be administered via tablet or injection, depending on the drug being prescribed.

Interestingly, research by Falcetta *et al.* (2018) found that pain reduction was observed among patients taking aromatase inhibitors undertaking a mixed exercise programme. However again, side effects for physical activity need to be considered with this treatment such as:

- Menopausal symptoms - (hot flushes, mood changes and other menopause related symptoms)
- Osteoporosis - (brittle bones).
- Blood clotting – increased risk in some treatments.
- Thickened womb – some may cause lining of the uterus to thicken.
- Bone loss and pain – pains and aches in muscle or bone joints.

(Macmillan Cancer Support 2018; Irish Cancer Society 2018)

Bone health was looked at by a trial ran by Dieli-Conwright *et al.* (2018) using a mixed programme of aerobic and resistance training. Their research was aimed towards overweight and obese breast cancer survivors. As breast cancer survivors are at an increased risk of developing conditions such as bone loss, osteoporosis and cardiovascular disease, these in turn; decrease quality of life and has a negative impact on health. Their trial over 16 weeks was compared to a usual care group and found that a combined exercise intervention performed within six months of treatment completion can improve patient outcomes. With noticeable improvements in sarcopenic obesity, bone health and quality of life. Although their findings did not find improvements in bone density over the short trial, it did however observe a significant improvement in osteocalcin and BSAP (biomarkers of bone foundation). They recommended a longer 6-month intervention is needed to elicit a positive effect on bone density, however overall results were significant.

Summary - Treatment and Side Effects

In summary, there's a large volume of side effects that may be experienced by breast cancer survivors often associated with treatment. These symptoms need to be given careful consideration when working with this population to ensure a programme that will improve or decrease these symptoms and assure safety, as opposed to aggravating them (Schmitz and Speck 2010).

As survivorship rates have now began to increase, so has treatment related side effects such as; fatigue, weight gain, depression, bone loss, inflammation and lymphedema to name but a few. Some survivors may also suffer from bone metastasis or osteoporosis, therefore have increased risk of fracture.

Many of these unpleasant effects from treatment are often linked with decreased exercise levels. Which sequentially can lead to greater mortality amongst this population (Cheema *et al.* 2014) Furthermore, survivors of breast cancer are at increased risk of secondary cancers, reoccurrence as well as premature death. So, it's crucial that treatment is specific to the individual to decrease mortality rate (Zhong *et al.* 2014).

It's also important to note that oncologists / clinicians need to provide adequate recommendations to improve patient outcomes and encourage increased physical activity so that survivors can work towards improving their quality of life (Sahin and Altundag 2018; Kapilla *et al.* 2018)

Following on from the ACSM Roundtable on exercise guidelines for cancer survivors, the following table highlights some of the areas that require consideration among this population. This summary table provides an overview of the side effects we just discussed and how they may impact exercise.

Doctor sign off is required before any exercise programme begins. It is also wise to consider your method of exercise with each client. i.e. if individual is fatigued, perhaps relaxation techniques, a lighter programmes or Pilates/Yoga may be more suitable at that time (as long as arm/shoulder morbidities are taken into consideration).

A clinical trial ran by Kurt and Kapucu (2018) found that relaxation exercises had a positive effect on symptoms. Including decreasing the severity of pain, fatigue, nausea, sadness, anxiety, sleeplessness, lack of appetite, feeling bad, shortness of breath, changes in skin and nails and mouth ulcers. Although my findings among flexibility training were limited; Pinto Carral *et al.* (2018) interestingly looked at Pilates as a strategy for rehabilitation among women with stage 0-3 breast cancer who had undergone surgery with or without adjuvant therapy. All exercises were based around core muscle strengthening, spine flexibility and shoulder range of motion. With progression increased over time. They concluded that Pilates can be safely prescribed to reduce cancer related symptoms, although, it's impact on upper limb pain, functionality and quality of life don't seem to be any more impactful than other forms of exercise programs, however depending on the individual, this method may be more suitable for the client should they be experiencing a wide range of symptoms at that time.

SUMMARY OF TREATMENT & SIDE EFFECTS IN RELATION TO EXERCISE:		
TREATMENT	SIDE EFFECTS	IMPACT ON EXERCISE
SURGERY	Lymphoedema Limited range of movement in arm/shoulder Decreased mobility & strength in upper body Scar tissue Build-up of fluid (seroma) Pain in arm/shoulder/breast Infection risk	Doctor sign off post-surgery will be required before exercising post-surgery. Upper body movement may need to be avoided where infection is evident. Changes in arm/shoulder symptoms/swelling should result in avoidance/reductions in upper body exercise until medical evaluation and treatment has been sought. Proactive injury prevention approaches encouraged.

TREATMENT	SIDE EFFECTS	IMPACT ON EXERCISE
RADIOTHERAPY	Skin changes Fatigue Indigestion Scar tissue damage Muscle tightness Loss of movement in chest/shoulder Lymphoedema Swelling	Do not exercise individual experiencing extreme fatigue. Decreased resistance, ROM, intensity and duration. Upper body movement may be avoided where Lymphoedema flare up is evident. Compression sleeve worn for lymphoedema patients. Client may be weaker than usual with Increased fracture risk.
CHEMOTHERAPY	Nausea/vomiting Infection Anaemia Alopecia Increased risk of bleeding/bruising Mouth/throat problems Menopausal symptoms Constipation/diarrhoea Fatigue Skin/Nail changes Peripheral neuropathy Kidney function changes Effect on fertility Weight gain Cardiovascular problems	Do not exercise individual experiencing extreme sickness, nausea, fatigue or anaemia. Individual may be dehydrated. Decreased resistance, ROM, intensity and duration. Medical evaluation may be required for peripheral neuropathy or cardiovascular issues.

TREATMENT	SIDE EFFECTS	IMPACT ON EXERCISE
BIOLOGICAL THERAPIES	Flu-like symptoms /High temperature Headache Chills Nausea Diarrhoea	Do not exercise individual experiencing extreme sickness. Individual may be dehydrated. Decreased resistance, ROM, intensity and duration.
HORMONE THERAPY	Menopausal symptoms Osteoporosis Blood clotting Thickened womb Bone loss and pain	Decreased resistance, ROM, intensity and duration. Modifications (to avoid bone fractures)

CONCLUSION:

Summary:

Overall, the evidence suggests that exercise participation breast cancer post diagnosis has a variety of positive benefits and outcomes for survivors. Whether the exercise is related to cardiorespiratory /muscular endurance or flexibility, research shows that physical activity following a breast cancer prognosis can be beneficial in decreasing cancer related side effects, improving quality of life, psychological wellbeing and decrease mortality and recurrence rates. Although further research is still required among a number of areas.

As discussed, there is a variety of treatments undertaken by breast cancer survivors, all of which come with their own range of side effects both short and /or long term, therefore the individual's circumstance will need to be considered when training this population.

Positive outcomes have been noted using a variety of cardiorespiratory /muscular endurance and flexibility training. Relaxation techniques have also been deemed beneficial during treatment. Several studies used a mixed training programme with some opting for just one fitness component. Although ACSM recommends a programme consisting of aerobic, resistance and flexibility, generally outcomes were positive amongst all types. It was also noted that often exercise will be dependent on how the individual feels or whether their experiencing any extreme cancer related side effects at that time, as this may determine the type of exercise best suited, or whether it's not suitable for them to exercise at that time. For example; post-surgery, there will be a rehabilitation phase and doctor clearance will be required before exercise commences with limitations in terms of programming.

The following table summarises the key areas /themes presented in the research:

Quality of Life	Overall reduction in Cancer related side effects.
	Decreased Fatigue
	Improved Cognitive Function
	Improvements with Psychological wellbeing
Mortality /Recurrence	Decrease in all-cause mortality
	Decrease in cancer specific mortality
	Decreased recurrence rates

Let's revisit our main research questions and our outcomes in relation to them:

How does cardiorespiratory fitness affect breast cancer throughout the various stages of the disease i.e. during treatment, post-treatment etc?

Research has presented positive findings in conjunction with cardiorespiratory based exercise during treatment as well as post treatment, as per summary table above.

How does muscular strength affect breast cancer post-diagnosis?

Papers relating to muscular strength-based training presented positive findings after breast cancer post-diagnosis as per summary table above.

Does resistance /aerobic training benefit the survivor physically and/or mentally?

Yes, various physical and mental health implications were presented in the research to suggest that both styles of fitness are of benefit to the survivor. However further research is required in some areas.

Is there a type or frequency of exercise best suited?

Yes. ACSM advises following the 2008 exercise recommendations and has also developed a roundtable of guidelines suitable for cancer survivors. However, it's worth considering the client's individual circumstance in relation to treatment undertaken. This is to ensure a programme best suited to them and their needs i.e. they may be experiencing cancer related side effects that might impact exercise etc. Another area to bear in mind is post-surgery patients - following surgery, patients also have an initial rehabilitative phase following their procedure and doctor clearance is always required.

What implications are there in terms of side effects?

There are indeed various implications to consider with this population. As there is a variety of possible long/short term side effects relating to cancer treatment (which can begin straight after treatment or develop years later), implications can range from; arm/shoulder mobility, increased risk

of bone fracture to extreme fatigue/nausea to cover just a few. ACSM guidelines recommend evaluation of peripheral neuropathies, musculoskeletal morbidities in advance of starting a new training programme. If survivor is experiencing any extreme side effects such as fatigue/ataxia/nausea, don't exercise. Likewise, follow cardiovascular and pulmonary contraindications with this population.

How does exercise effect recovery, recurrence and mortality rates among female breast cancer survivors?

Following the research for this dissertation, evidence has shown that exercise can help improve recovery and decrease treatment related side effects, thus improving quality of life in breast cancer survivors. Improved recurrence and mortality rates were presented in multiple papers, however further research is required.

Are there specific exercises recommended post diagnosis or post treatment?

ACSM recommend following the 2008 activity guidelines using a mixed programme of aerobic/resistance and flexibility-based exercises. While also taking into consideration the roundtable of recommendations relating to this population. Post-surgery patients will also need to undergo rehabilitative exercises following their procedure.

RECOMMENDATIONS

From the literature review there are a few areas that require more research:

More research is needed into the reasons behind the high physical inactivity rates among this population. How can breast cancer survivors be motivated to exercise more frequently following a diagnosis? As well as, why supervised activity seems to work more effectively than unsupervised.

Zeng *et al.* (2014) and Aguiñaga *et al.* (2017) mentioned the differences in obesity rates between diverse populations. Suggesting that more research is required in terms of racial and economic status to determine exercise impact among various cultures and backgrounds.

Larger sample sizes seemed to be a common theme among the mortality and cancer recurrence research, therefore it seems more work on this area is needed to get more accurate statistics over a much wider scale over a more prolonged period.

Doctors/clinicians need to encourage patients to exercise more and educate/counsel them on the benefits and importance following a breast cancer diagnosis. Perhaps further training is needed among medical staff too, so that they are fully aware of its impact on a diagnosis. They could also recommend referrals such as cancer exercise specialists or trainers that specialise in breast cancer exercise.

Similarly, trainers and fitness professionals should also be aware of the implications among this population and kept up to date with all the latest treatments and related side effects, to ensure that they can provide survivors with an appropriate programme following a breast cancer diagnosis.

Bone health seems to be another important area requiring further research, especially since many of the breast cancer related treatments impact this. Dieli-Conwright *et al.* (2018) focused on this area, however recommended more research over a longer timeframe.

Similarly, work by Yang *et al.* (2018), examined pre-operative exercises and the impact exercise has prior to surgery in terms of recovery and mobility following their procedure. This potentially is another area that could be looked at to prepare patients in advance of surgery.

Although during the research of this dissertation there was a broad amount of literature on this topic available (and even more time could have been spent going through more papers,) With this in mind, there are most definitely areas (such as the above) that require more attention/trials in the future. Thus, to determine more accurate statistics and guidelines to improve the outlook of a breast cancer diagnosis and improve physical activity rates in the future.

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