THE PHYSICAL ACTIVITY LEVELS AND PREFERENCES OF SOUTH AFRICAN BREAST CANCER SURVIVORS: A PILOT STUDY

BY

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DECLARATION

I, Belinda Campbell, hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work or any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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ABSTRACT

Introduction: Breast cancer is currently the most commonly diagnosed cancer in South African women. Physical activity has proven to have preventative, treatment and management benefits for breast cancer and other cancers and exercise has been found as both viable and safe during cancer treatment and recovery. However, there is limited research on breast cancer and the levels and preferences of physical activity and sedentary behaviour in a South African context. Therefore, the purpose of this study was to identify levels of physical activity and sedentary behaviour of South African breast cancer survivors and to investigate the physical activity advice and participation preferences of these participants.

Methods: A cross-sectional research design was implemented to identify the physical activity, sedentary behaviour levels and exercise preferences of 48 South African breast cancer survivors (age range 45 years). An online survey comprising demographic and anthropometric questions, the *Godin leisure-time activity questionnaire* (GLTPAQ), the *International Physical Activity Questionnaire* (IPAQ) and an exercise preference questionnaire was presented to participating breast cancer survivors in order to i) identify the levels of physical activity and sedentary behaviour engaged in, ii) obtain demographic and anthropometric information and iii) identify exercise preferences. A linear mixed model regression was used to examine potential associations between demographic and anthropometric variables and physical activity levels. Chi-squared and Pearson's Product-Moment correlation tests were used to identify relationships between categorical and numerical variables. A correlation matrix was generated to further explore any correlations. Statistical significance for all measures was set at $p<0.05$.

Results: The mean age of the group was 49 ± 9.87 years. The most common time since diagnosis was <5 years ago and the most common stage of breast cancer was stage I. The mean BMI was 27.87 ± 5.53kg/m^2. The most common treatment combination was surgery with either chemotherapy or radiation. According to the leisure score index (LSI) the majority of the group (56%) was active and according to IPAQ data 60% were meeting physical activity guidelines. The highest physical activity levels were seen in the average weekly minutes of moderate-intensity activity, and there was a strong, non-significant positive correlation ($p>0.05$, $R^2 = 0.95$) between moderate-intensity physical activity and total physical activity levels. High levels of

weekly sedentary behaviour and sitting time (302.60 ± 169.96 minutes) were reported. A weak, non-significant, positive correlation was found between total sedentary time and BMI ($p>0.05$, $R^2 = 0.1$). A weak, non-significant, negative correlation was found between age and sedentary time ($p>0.05$, $R^2 = 0.002$). More participants below 50 years were insufficiently active compared to above the age of 50 years. 1.7 to 2.6 years since diagnosis saw the greatest number of insufficiently active survivors and the category over 2.6 years since diagnosis saw the most active survivors. Most breast cancer survivors (71.10% & 82.05%) indicated being interested in and feeling capable of participating in an exercise programme ($p>0.05$, $R^2 = 0.72$). The favoured preference for receiving physical activity advice was face-to-face with an exercise specialist at a cancer centre before treatment. Participation preferences included starting a programme immediately after treatment, in a home-based setting with one or two other people, where walking and a moderate exercise intensity were the preferred exercise type and level of intensity. Data collection occurred both immediately prior to (42% of participants) and during (56% of participants) the South African Covid-19 lockdown, so the results should be seen in light of this context.

Conclusion: The current study is one of the first to explore physical activity rates and preferences of South African breast cancer survivors. As a group and individually these survivors were meeting public physical activity guidelines and engaging in the recommended weekly minutes. The high sitting time coupled with the high overweight and obesity levels highlight the need for positive behavioural changes including improved levels of physical activity and reduced sedentary behaviour. These changes need involvement from the numerous levels of society that affect health. Broad physical activity guidelines need to be developed not only to improve physical activity levels in breast cancer survivors but to work as a preventative measure by facilitating physical activity promotion in the general population. The findings of this study demonstrate that this group of South African breast cancer survivors is open to physical activity advice, to programmes and to improving physical activity levels.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

- **Black:** People of African descent
- **BMI:** Body mass index (weight(kg) / height(m)^2)
- **CANSA:** Cancer Association of South Africa
- **Coloured:** People of mixed race or descent
- **Communicable disease:** infectious or transmissible disease
- **GLTPAQ:** Godin Leisure-time Physical Activity Questionnaire
- **High-income country:** Countries with a GNI per capita of $12,736 or more
- **IPAQ:** International Physical Activity Questionnaire
- **Indian:** People of Indian descent
- **Low-income country:** Countries with a GNI per capita of $1,045 or less
- **Low to middle-income:** Countries with a GNI per capita of between $1,045 and $4,125
- **MET:** Metabolic equivalent of task
- **Middle-income country:** Countries with a GNI per capita of between $1,045 - $2,736
- **Non-communicable disease:** non-infectious, chronic condition
- **White:** People of European descent

CHAPTER 1

INTRODUCTION

"Lack of activity destroys the good condition of every human being, while movement and methodical physical exercise save it and preserve it." [i]

1.1 BACKGROUND TO THE STUDY

In comparison to previous years, a greater proportion of the overall disease burden in South Africa is now attributable to cancer[1]. Breast cancer constitutes 18% of all female cancers and is the leading cause of cancer-related deaths worldwide[2-5]. It is currently the most commonly diagnosed cancer in South African women, with approximately 19.4 million women aged 15 years or older at risk of a breast cancer diagnosis[6-8]. Although there is a high risk of developing breast cancer, there is also a higher chance of timely diagnosis and treatment through the development of diagnostic tools, treatment and interventions[9,10]. Globally, breast cancer survivors make up one of the largest groups of cancer survivors with a high likelihood of long-term survival and high rates of cure for localised disease[11,12]. The term '*Survivor'* includes anyone who has been diagnosed with breast cancer and has thereafter suffered from cancer from the time of diagnosis through to remission and recovery[13,14].

Several factors contribute to the risk of developing breast cancer. Being female and increasing age are two of the strongest associated risk factors[2,4]. Breast cancer risk and incidence doubles almost every ten years of age until the start of menopause, where the increase in risk slows down[2,4,15]. Starting menstruation early and experiencing late menopause have been linked to an increased risk, and a first pregnancy when relatively older can also increase the likelihood of developing breast cancer[2,4,10,15]. Having a family history of breast cancer can also increase breast cancer risk[2,10]. Differences in breast cancer incidence between racial groups are prevalent in the South African context where White South African women are at a greater risk of developing breast cancer than Black South African women[4,6]. This difference could link to evidence that Black women in South Africa typically start menstruation later and have a relatively earlier age at first pregnancy[6]. Significant variation has also been found in age and concomitant disease stage at diagnosis between rural and urban populations in South Africa[6]. In particular, rural Black women are affected more than urban women by socioeconomic and cultural determinants and availability of traditional healers[a] (may forgo cancer-specific medical help to use a traditional healer instead) and geographic accessibility to medical and oncologic

facilities[6]. These determinants can affect their decisions to access early medical help and necessary treatments[6]. Evidence of environmental risk factors has been seen globally amongst migrant groups, where studies have shown that breast cancer rates in migrants assume the rate of the host country in successive generations[2]. There is also evidence of geographical variation as a risk factor, where different age-adjusted incidence and mortality has been recorded between countries[2]. Lifestyle factors such as physical activity and body mass are particularly important to consider[2,10]. Obesity in premenopausal women has been linked to a decreased incidence whereas, conversely, obesity in post-menopausal women is associated with increased risk[2]. High levels of physical inactivity and sedentary behaviour are significant predictors of cancer, making both of these important modifiable risk factors[16,17].

Physical inactivity is ranked as the fourth leading cause of death globally and is linked to an increased risk of various adverse health conditions including cancer[16,17]. In particular, physical inactivity causes an estimated 10% of breast cancers[18]. An individual is classified as insufficiently active if they fail to meet the physical activity guidelines[19]. Despite the known positive links between physical activity and health, more of the world's population is falling into the insufficiently active category[20]. In South Africa specifically, approximately 45% of the population older than 15 years is not sufficiently active[21]. Globally women are generally less active than men and older adults are more sedentary than younger adults[20,22]. Although the levels and effects of physical inactivity differ between age groups, socioeconomic status, ethnicity and sexes, all individuals will be healthier by adopting a physically active lifestyle[17]. There is an urgent need to reduce levels of sedentary behaviour and move towards increased trends of physical activity[22]. The prophylactic, treatment and the management benefits of physical activity are well-established and supported by scientific evidence[17,23,24]. These health benefits are seen in both the general population and diseased populations[25,26]. Evidence arising out of research is what has led to the '*exercise as medicine*' approach[25,26]. For example, epidemiological evidence shows that physical activity can reduce the risk of coronary heart disease, of certain types of diabetes, of obesity, osteoporosis, anxiety and depression[25].

The general importance of physical activity and exercise for people affected by cancer is becoming more recognised. This has been seen in well-established evidence that links habitual physical activity to reduced cancer risk[27,28] and in exercise being found to be safe and viable during cancer treatment and recovery, while also improving fitness[32]. The most consistent findings linking physical activity and cancer occurrence have been found for colon cancer[25].

There is also increasing evidence of the inverse association between breast cancer risk and an active lifestyle[29], with a reduced relative risk of between 20-40% of developing breast cancer[29]. Evidence of a dose-response relationship suggests increasing levels of physical activity show greater reductions in breast cancer risk and faster recovery following treatment[29-32]. Courneya and Friedenreich[31] suggest that it is not the absolute level of activity at any one time that is important, but rather the overall change in exercise behaviour to following a physically active lifestyle[33,34]. This promising evidence has led to increased research investigating the effects of physical activity in the cancer recovery process[30-32]. Resulting from exercise post-cancer treatment, associations have also been found in reduced severity of side effects, improved overall quality of life through reduced anxiety and depression in addition to better sleep and physical functioning[12,35-39]. With the number of cancer diagnoses and cancer survivors increasing in South Africa, investigating how to improve access to diagnosis, treatment, knowledge and enhanced survivorship is key[40]. Furthermore, with breast cancer survivors making up one of the largest groups of cancer survivors, research into survivorship accompanied by potential interventions for improving recovery are essential[29,30]. Physical activity is becoming a more popular intervention choice, as it is a modifiable lifestyle factor[41,42]. A further incentive to researching and using physical activity is the holistic approach it offers to aiding in cancer recovery due to the varied positive effects exercise has on the human body, both mentally and physically[30]. Being physically active has the potential to improve co-morbidities along with a person's general health and well-being, which can aid in better preparing a person for the cancer recovery process[30].

Effective physical activity interventions cannot be developed without an understanding of the needs and preferences of breast cancer survivors[43]. These factors can be affected by the survivor's personal exercise preferences and by their individual experience of cancer as well as their ability to be physically active following treatment and side effects[44,45]. The evidence base around the preferences has been built on reports from several cancer types[44-53]. Many cancer survivors expressed interest in receiving advice about physical activity, typically face-to-face or through brochures[50]. The most popular interventions were those that included moderate-intensity walking and resistance training. Many favoured a home-based setting[46,50,53].

While much research has been conducted on the effects of physical activity in cancer survivors, there is a gap around physical activity levels, sedentary behaviour levels and exercise preferences in breast cancer survivors in South Africa. This research is further complicated by

the complexity of health problems in different populations[3,5]. Cancer and breast cancer more specifically, is emerging as an increasingly critical health problem in South Africa, placing a more significant burden on the individuals and their families, as well as on health services and society at large[8,54]. In South Africa, along with other low- to middle-income countries, the adoption of a sedentary lifestyle is a prevalent problem that needs to be addressed[55]. Establishing the determinants, indicators and outcomes of physical activity can aid in developing solutions along with interventions aimed at addressing the low levels of physical activity[16]. Social inequities in health coincide with limited access to physical activity participation is widespread in South Africa[7,56-59]. Thus, physical activity in South Africa is a multifaceted issue affected by many intersecting factors, including age, sex, socioeconomic status and ethnicity.

The high number of breast cancer survivors, in itself, warrants research focused on enhancing the health and quality of life of this group – aspects on which physical activity can impact positively. Gaining an understanding of the multifaceted nature of physical activity participation in South Africa and the various factors that constrain or influence it in the context of cancer is important. These factors need to be considered in this understanding[6] which will aid in the development of interventions and programmes tailored to appropriate groups of women. A better understanding could influence the standard of breast cancer survivorship.

1.2 STATEMENT OF THE PROBLEM

Despite the extensive evidence base that exists around the positive effects of physical activity linked to breast cancer, and the high number of breast cancer survivors in South Africa, there is little to no knowledge, of which the author is aware, concerning the behavioural and lifestyle risk factors of South African breast cancer survivors. This includes physical activity and sedentary behaviour levels. There is also a gap around the knowledge of the potential relationships between these levels and the demographic, medical and anthropometric variables of this population. Furthermore, the lack of knowledge of the exercise preferences of South African breast cancer survivors needs to be addressed.

1.3 STUDY AIM

The purpose of this study was to identify the prevalence of and to characterise the physical activity and sedentary behaviour levels of South African breast cancer survivors. This study also

aimed at identifying associations between the reported levels of physical activity and the participant variables of the individuals, while at the same time gathering information on the preferred physical activity interventions amongst this group.

1.4 STUDY OBJECTIVES

1. Identify the prevalence and profile of the physical (in)activity and sedentary behaviour of South African breast cancer survivors.
2. Identify potential associations between the physical activity and sedentary behaviour levels and their associated demographic, medical and anthropometric variables.
3. Build an evidence base around the physical activity preferences (both interventions and advice) of South African breast cancer survivors.

1.5 OUTLINE OF THE THESIS

Following this chapter, the rest of the thesis includes a literature review (Chapter 2) discussing the wider global burden of disease and then focuses on how breast cancer in South Africa forms a part of this burden. There follows a further focus on physical activity and sedentary behaviour levels in breast cancer survivors and investigates the factors that may improve or inhibit these levels in a South African context. The thesis goes on to include an assessment of the current knowledge about physical activity and exercise preferences of breast cancer survivors.

Chapter 3 covers the methods used to conduct the study; including research design, participant recruitment and sampling; and the measures used for data collection and statistical analyses.

Chapter 4 analyses the findings of this study. It also identifies and acknowledges some of the limitations of this study's methodology.

Chapter 5 provides a discussion of the major findings of this study compared to the literature reviewed.

Concluding comments in Chapter 6 present practical applications and recommendations for future research.

CHAPTER 2

LITERATURE REVIEW

This chapter focuses on the burden of cancer, specifically breast cancer. It starts with a broader focus on the global burden of disease and how particularly breast cancer in South Africa is a part of the global burden. There is a further focus on the lifestyle behavioural factors of physical (in)activity and sedentary behaviour in a South African context and how they relate to breast cancer risk.

2.1 THE GLOBAL BURDEN OF DISEASE

Non-communicable diseases are responsible for the majority of global death across low- to high-income countries. They also constitute significantly to the global disease burden[5,60]. Non-communicable disease mortality is projected to rise to 52 million, from 40.5 million in 2016, by 2030[61] while 80% of this increase is predicted to occur in low- and middle-income countries[57]. This statistic highlights the disproportionate effect in low- and middle-income countries when compared to high-income countries[7,62,63,64].

A description of the burden of injuries and disease and the risk factors that cause them, is important for informing health decision-making and planning processes[62,64]. According to the World Health Organisation[65], in recent years approximately 70% of global deaths from all causes are due to non-communicable diseases. These include cardiovascular diseases, cancers, respiratory diseases and diabetes[65]. They constitute a major public health challenge, accounting for over 80% of all premature deaths[65].

Cancer ranks as the leading cause of death within this category and is considered a prominent barrier to increasing life expectancy worldwide[5]. Non-communicable diseases have a major effect in low socioeconomic areas[62,63]. Vulnerable and disadvantaged populations become sicker and die sooner than those of higher socioeconomic status[65]. They have limited healthcare access and a higher likelihood of exposure to harmful products and poor nutrition and dietary practices[65].

Empirical evidence suggests an inverse relationship between socioeconomic status and education level on the one hand and unhealthy behaviours such as physical inactivity and tobacco use on the other hand[62,66]. Estimates indicate that physical inactivity is directly responsible for 7% of the global burden of type 2 diabetes, 6% of coronary heart disease and

10% of breast cancer[22]. Additionally, in low socioeconomic households and populations, household finances and resources are drained by disease-related costs which include treatment or loss of a breadwinner[65]. Evidence is showing that people born into a low-income household are already more vulnerable to non-communicable diseases, before even being exposed to these other factors[62,65].

2.1.1 The burden of disease in South Africa

The burden of disease in South Africa and the resources available to deal with it differ from other countries. There are also disparities in resource availability within the country, between different provinces[180]. Post-apartheid 1994 the former homelands in South Africa were reintegrated, and the country was split into nine different regions called provinces (Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape, North West, Western Cape)[179,180]. As a result of the apartheid history in South Africa, there are large regional and socioeconomic disparities present in the population, as well as segregation and inequality of access to healthcare resources[7,57-59,180]. Additionally, the majority of healthcare spending tends to be allocated to the wealthier provinces who have better health infrastructure as they are perceived as being more capable of utilising the resources more efficiently and effectively[180]. These disparities, as well as the middle-income status of South Africa[59], have created a unique context for the disease burden to occur. The lower socioeconomic bracket in South Africa is made up largely of non-White South Africans, with the legacy of past discrimination maintaining the affluence of White South Africans[67]. Additionally, those of lower income typically live in rural areas more so than those of a higher income[58,67].

Post-apartheid 1994, the South African health system was fragmented between the public sector which mainly served the low-income, Black population and the private sector serving the high-income, White population[58]. As a direct result, many non-White South Africans had less access to facilities and resources to counter the burden of disease than their White counterparts[58]. This is further exacerbated by the inadequate infrastructure and limited resources in the South African health sector as a whole[57].

Non-communicable diseases make up a large part of the South African disease burden[60,65], accounting for 39% of total deaths in 2010 (over a third of them before the age of 60) and 51% by 2016[60,65]. Until recently there has been a lack of focus on non-communicable diseases due

to the government's commitment to tackling communicable diseases such as HIV/AIDS[57]. The AIDS epidemic drains the South African health services as it affects many people[15]. Thus, commitment to improving access to screening, diagnosis and treatment that is directly related to this disease has been prioritised[57]. Since 2009, due to the problems associated with non-communicable diseases and pressure for inclusive national development to formulate disease-specific policies, there has been evidence of heightened focus on the control and prevention of non-communicable diseases[57,68]. This needs to be sustained and strengthened to effectively mitigate and see a real change in the trend of the non-communicable disease burden[68].

Table 1 shows the proportional mortality in South Africa attributed to various causes. The increases in mortality rate for specific non-communicable diseases in South Africa reflect the diverse and changing risk and lifestyle factors of the South African population[60]. For example, although non-communicable diseases affect all South African population groups, those of a lower income and living in rural areas are at a greater risk due to exposure to environmental and structural factors which they cannot control[68]. This group highlights the need for a greater focus on non-communicable diseases - cancer being the case in point - in South Africa[61,69]. The proportion of overall disease burden attributable to cancer within South Africa is rising, with statistics from 2014 revealing that 115,000 South Africans are diagnosed with cancer annually with only a 6/10 survival rate[1]. Addressing the non-communicable aspect of the disease burden requires making the combination of prevention and control an established part of sustainable socioeconomic development[68]. Addressing this burden is key to improving public health outcomes and economic growth[69].

Table 1: Proportional Mortality in South Africa[65]

Cause	Proportional Mortality (%)
*Cardiovascular diseases	19%
*Cancers	10%
*Chronic respiratory diseases	4%
*Diabetes	7%
*Other NCDs	11%
Communicable, maternal, perinatal and nutritional conditions	40%
Injuries	9%

*Non-communicable diseases; (NCD = non-communicable diseases)

2.1.2 Risk factors associated with non-communicable diseases

The causes of non-communicable diseases are multifactorial, and all have a link with lifestyle-associated risk factors. A combination of physiological, behavioural, genetic and environmental risk factors contribute to the South African burden of disease[65]. Importantly, many of the risk factors are addressable, which opens up opportunity for intervention[68]. The main risk factors include physical inactivity, harmful alcohol intake, tobacco use, and sodium intake with overall poor nutrition and dietary habits[61]. Raised blood pressure, obesity and diabetes make up some of the metabolic risk factors[61]. Ambient and household air pollution, urbanisation, mechanisation and increased motorised transport constitute a number of environmental risk factors[20,61].

It is crucial to focus on mitigating and modifying the risk factors associated with non-communicable diseases in order to control them and reduce the disease burden[57,65]. Combining population-based and individual-level strategies to reduce the risk of and prevent non-communicable diseases is important[60,69]. Additionally, addressing individual behavioural risk factors in conjunction with the structural environment in which they occur, and are shaped, is crucial to changing risk and mortality trends[68]. The multifactorial nature of non-communicable disease risk factors highlights the need for an approach aimed at many levels and factors, and the socioecological model matches this. Physical inactivity is one of the main modifiable behavioural risk factors[61]. One approach that may be useful in enhancing the focus on non-communicable diseases in an effective way is the socioecological model. Being an

approach aimed at many levels that affect health[182], it could encompass prevention and control, through policymaking, into socioeconomic development and allow this to filter down to the individual level. The socioecological model proposes that behaviour is affected by numerous levels of different aspects and highlights the potential interaction of a number of factors from varying levels in explaining and influencing physical activity[183]. This model has been shown to be effective for behavioural change such as increased physical activity[182,183]. In the period between 1994 and 2015, over forty policies have been developed by the South African Department of Health, focusing on key risk factors, which aim to prevent and manage non-communicable diseases[57].

Working towards slowing the rise of and preventing non-communicable diseases is more effective and less costly than working to treat all those individuals who become sick[60]. Strengthening and improving non-communicable disease surveillance will also help to provide more robust, accurate information when planning and monitoring[60,69].

2.2 PHYSICAL ACTIVITY, PHYSICAL INACTIVITY AND SEDENTARY BEHAVIOUR

2.2.1 Physical activity

Physical activity is defined as any "bodily movement produced by skeletal muscles that require energy expenditure"[65]. It is evident in the workplace as an integral part of occupational tasks, is seen during leisure and recreational activities, is evident during active transport (i.e. walking, cycling), and is evident during planned physical activity and exercise sessions such as physical education at school, or during other organised sport[65,70,71]. Physical activity can be performed at varying intensities, categorised as *light* (<3 METS), *moderate* (3-6 METS) and *vigorous* intensities (>6 METS) [71,72]. Self-report measures in the form of physical activity questionnaires are the most common method of ascertaining physical activity levels[71]. In order to assess physical activity and determine whether individuals are meeting guidelines, four parameters are used: namely frequency, intensity, time and type[71]. These components form the foundation of physical activity and exercise recommendations/programmes[71].

2.2.2 Physical activity guidelines

The 2018 public guidelines for physical activity recommend accumulating 30 minutes of moderate-intensity physical activity at least five days of the week, 20 minutes of vigorous-intensity physical activity on at least three days of the week, or an equivalent combination of the two to meet the required number of minutes per week[20,65,70,73,177]. This includes aerobic

(ten-minute bouts or more), muscle strengthening (involving all major muscle groups) and bone-strengthening physical activities on two or more days a week[65,70]. As of very recently, 2020 guidelines on physical activity and sedentary behaviour were released[181]. For adults, these include at least 150-300 minutes of moderate-intensity physical activity, at least 75-150 minutes of vigorous-intensity physical activity, or an equivalent combination of the two, throughout the week[181]. These general recommendations have been developed to give people a guide to a physically active lifestyle; however, these guidelines can be tailored to their specific needs in order to attain and maintain a high standard of health[74].

2.2.3 Benefits of physical activity

Scientific evidence highlights the health benefits of being physically active; these benefits including preventative, treatment and management of health[17,23,24]. In 2012 The Lancet named physical activity as the foundation for combating non-communicable diseases[17]. Despite disparities in levels and effects of physical inactivity between sex, age, socioeconomic status and ethnicity, every individual will be healthier if they adopt a physically active lifestyle[17]. In addition to enhancing the health of an individual who is already physically active, physical activity works to reduce the harmful effects of physical inactivity[70,74]. For example, it can aid in decreasing the risk of contraction of non-communicable and chronic diseases or of slowing their rate of progression, the risk of both contraction and progression being increased as a consequence of being physical inactive[22,70,74]. Physical activity is positively associated, for instance, with many breast cancer-related factors, including alleviating symptoms, lowering body mass index and improving quality of life[46]. Due to physical activity being a modifiable risk factor, it is a highly recommended treatment or prevention for some non-communicable diseases[75].

In promoting the benefits of physical activity, it is important to note that there is a dose-response effect[71,76,77]. Different levels and volumes of physical activity will yield varied health benefits across the disease spectrum[76-78]. For example, dose-response curves will vary in shape for different levels of physical activity linked to different cancer types; that is, there is a greater dose-response effect of physical activity on the risk of certain cancers as compared to other cancers[77]. Research into physical activity types found that the largest reductions in breast cancer risk were in household activities (21%), in recreational environments (21%) and in occupational involvements (18%)[71]. Moderate and vigorous intensities were the two activity types yielding the greatest reductions in risk[71].

2.2.4 Prevalence of physical Inactivity

Physical inactivity is generally defined as very low levels of physical activity in all areas of life, requiring 1.5 METS or less energy expenditure[21,70]. A person is considered inactive if they fail to meet criteria based on existing physical activity guidelines[19], being the required number of minutes of a combination of walking, moderate and vigorous activity[19].

Physical inactivity has become a defining characteristic of modern, urban life, making important both the monitoring of its prevalence and the factors contributing to it[68,79]. The progress in monitoring seen in the past decade means physical activity levels can now be reported on more accurately and this information can be used to develop interventions[20]. Globally there is a high prevalence of physical inactivity, with decreasing trends of available leisure-time activity. There is a need to reduce sedentary behaviour and increase physical activity levels[22]. Establishing the determinants, indicators and outcomes of physical (in)activity can aid in developing solutions and interventions aimed at addressing the low levels of physical activity[16]. At least 31% of the world's population is not meeting the guidelines for physical activity[16,20,80,81]. Four-fifths of adolescents and a third of adults in 2012 were not meeting the guidelines and there is evidence to suggest that these numbers have since increased[20]. In South Africa physical inactivity is estimated to be prevalent in between 43-49% of individuals aged 15 years or older[21].

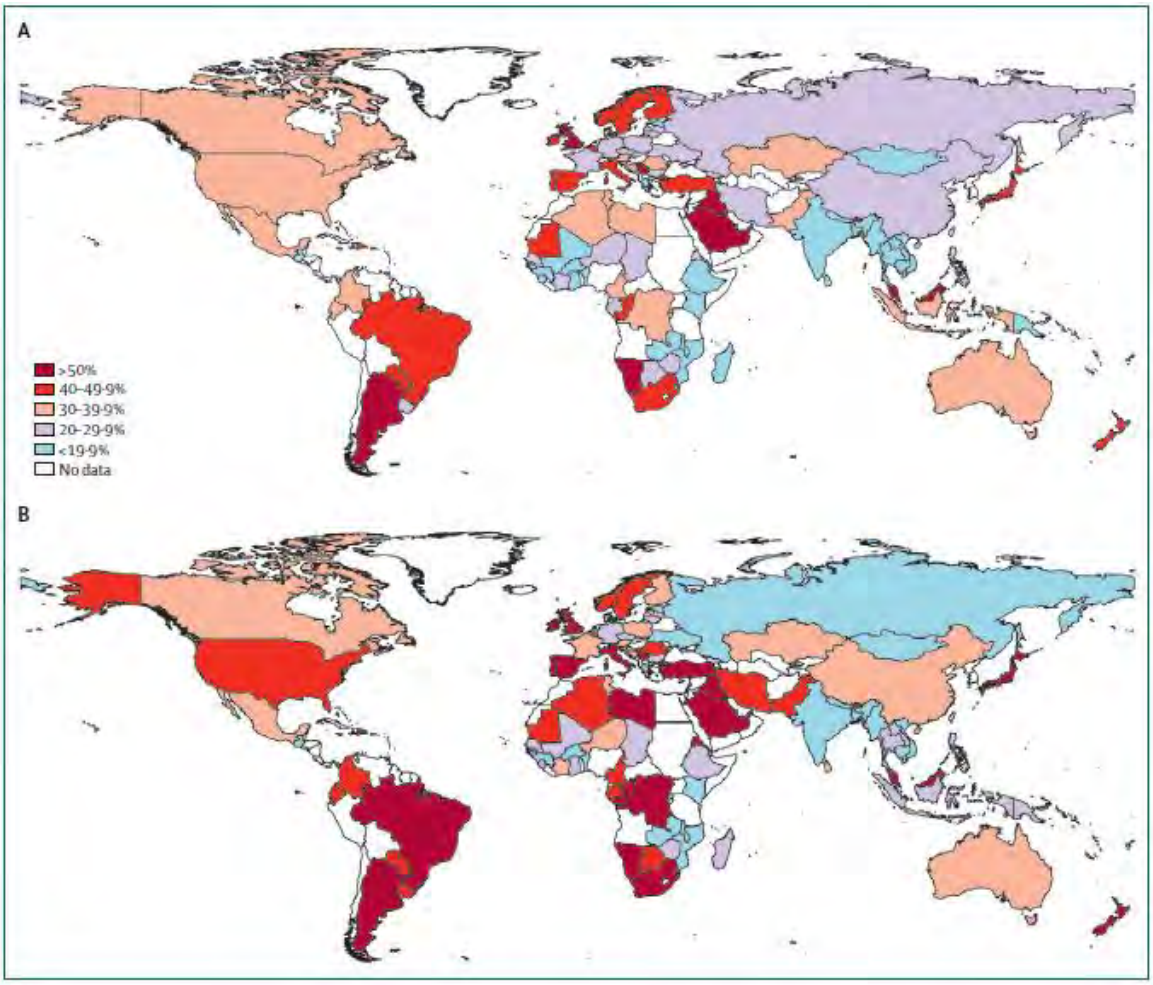


Figure 1: Prevalence of physical inactivity in adults (15+ years) worldwide for men in the upper map (A) and for women in the lower map (B)[20]

There are disparities in physical inactivity levels globally. Across most countries, women are generally slightly less active than men are, and older adults are less active than younger adults[20,22]. Physical inactivity has also been more commonly found in high-income countries compared to those of lower income levels[20]. However, as some middle to low-income countries are experiencing considerable social and physical transitions, the concern of increased physical inactivity levels is growing[17]. A study on an ethnically diverse group of South African children found physical activity was consistently lower for girls than boys; and sedentary behaviour increased, along with decreases in physical activity, across all age groups as the children moved up in school[55]. Sex differences tend to be less pronounced in adults than in younger groups, but those with a higher level of education and higher family income are typically more physically active[82]. Significant increases in physical inactivity have been noted with increasing age[20]. These findings suggest that there may be both gender and ethnic disparities in physical activity and sedentary behaviour levels which could have roots in cultural and biological factors[55]. These are important considerations in a South African context due to

the diverse range of ages and ethnic groups. It is important to establish levels and predictors of physical (in)activity in children and adolescents because physically inactive children are more inclined to become physically inactive adults[80,81]. This can predispose individuals to certain diseases and other issues in adulthood[20,80,81]. Promoting physical activity and avoiding physical inactivity at younger ages is important in increasing the number of healthy adults later in life.

In adults, rapid economic development and urbanisation may contribute to the reduction in physical activity[16,17]. Mechanisation and industrialisation in the workplace, along with the development of labour-saving devices, has contributed to less occupational physical activity[16,17,20]. Additionally, an increase in motorised transportation has reduced levels of active transportation[16,17,20]. Social changes can also lessen the physically active demands of daily life, which may be the only way some people are achieving physical activity[16]. Increased screen time through television viewing, gaming and the requirement of a laptop for homework and school assignments has led to reductions in the physical activity levels of the youth[16]. Additionally, the role that physical activity can play in disease treatment or rehabilitation is still undervalued which may add to the continued low physical activity levels as people are not aware of the wide-reaching health benefits[16,79]. Many health physicians may underestimate the value of physical activity and this is evident in the encouragement of bed rest and immobile recovery[79]. Mitigating or removing the unhealthy lifestyle behaviour of physical inactivity could lead to substantial improvements in health[18].

2.2.5 Physical inactivity and non-communicable diseases

Physical inactivity is the fourth leading cause of death worldwide[16] and is a significant predictor of an increased risk of several adverse health conditions[16,17]. Due to its global reach, adverse health effects and prevalence, physical inactivity has been described as a pandemic[16]. It is a particularly important modifiable risk factor for chronic diseases such as cardiovascular disease and various cancers and can be integrated into interventions for prevention and management purposes[19,68]. It causes an estimated 10% of breast cancers and 6-10% of major non-communicable diseases[16-18,79]. The challenge of physical inactivity is augmented by the wide-reaching repercussions it can have beyond health, in the environmental, economic and social sectors[16]. For example, considering the hidden and increasing loss of productivity and cost of medical care, inactivity creates a burden on society[79]. It is useful to investigate why some people are active and others not and to establish current levels of physical activity and quantify

the impact of physical inactivity on major non-communicable diseases[18]. It allows us to make associations and predictions with diseases, such as cancer, in South Africa.

2.2.6 Sedentary Behaviour

Collectively the world's population is becoming more and more sedentary, sitting more and moving less[20]. Evidence of this is seen in a country level report on sitting time which found a mean of 4.7 hours per day of sitting time across all countries[83]. This is true in South Africa and other low-to-middle-income countries[55] and is important to acknowledge as it adds to the burden on an already under-resourced healthcare system[55,84]. Sedentary behaviour, which refers to behaviours and activities that don't increase energy expenditure levels above those at rest, contributes to physical inactivity[20,55] and is associated with a number of adverse health outcomes[83]. It can occur in many different domains, similar to physical activity[20,55,85]. Sitting time is a significant sub-component of sedentary behaviour and is frequently used to measure sedentary behaviour levels[83]. Guidelines suggest breaking up long periods of sitting and limiting time spent sedentary, limiting electronic media for entertainment and adopting active transportation in school, home and occupational settings[70]. Replacing sedentary time with physical activity of any intensity has health benefits and exceeding the recommended levels of moderate- to vigorous-intensity physical activity can work to reduce the detrimental effects of high sedentary behaviour levels on health[70,181]. A growing body of evidence is suggesting links between sedentary behaviour and cancer risk, however more research is needed into associations with specific cancer types[85].

It is clear that there are links between physical activity, physical inactivity, sedentary behaviour and non-communicable diseases. There is a strong evidence base for both the adverse effects of sedentary behaviour and physical inactivity as well as for the beneficial outcomes of physical activity, in relation to certain chronic diseases, specifically cancer risk, management and recovery.

2.2.7 Measuring physical activity and sedentary behaviour

There are various objective and subjective measurement tools that can be utilised to measure physical activity levels[177,178]. The selection of a measurement approach for physical activity and sedentary behaviour typically depends on the purpose and budget of the research[177]. Subjective measures are still favoured, however objective measures are being integrated. A

systematic review comparing the frequency of use of objective and subjective measures found 69.9% of articles used subjective measures and only 30.1% used objective tools[178].

Objective measures include direct observation of physical activity participation, and wearable devices such as pedometers, accelerometers, and heart rate monitors[177,178]. These tools and devices are useful for precisely quantifying physical activity behaviour through capturing data on a variety of metrics including number of steps, minutes of activity and activity intensity[177,178]. Pedometers for example are useful when walking is the metric for physical activity, and they allow for capturing of physical activity at the lower end of the continuum which is useful when investigating typically sedentary populations[177]. This is also a limitation however as data captured for any other activities is, to an extent, inaccurate and unreliable[177]. Accelerometers are a more accurate device and are also useful for capturing physical activity at the lowest end of the continuum, however they come at a high cost both in unit cost and the data management skills required[177,178]. Limitations in technological advancement and device capabilities are limitations of the wearable monitors, as well as the burden of wear time for participants[177,178].

Subjective measures of physical activity typically come in the form of self-report questionnaires and self-report physical activity diaries[177,178]. Self-report questionnaires have become popular for use in cancer studies[171]. The Godin Leisure-Time Physical Activity Questionnaire (GLTPAQ)[170], International Physical Activity Questionnaire (IPAQ)[173] and Global Physical Activity Questionnaire (GPAQ) are popular self-report questionnaires used to measure physical activity. The GLTPAQ is one of the most frequently used questionnaires in physical activity and oncology research[45,50,139,171,172], and the validity and reliability of the leisure score index has been found to compare favourably to other measures of physical activity and fitness[50]. This questionnaire assesses levels of leisure-time physical activity by asking how many times in a typical week an individual participates in physical activity (>15 minutes) in their free time. The individuals are then given a score according to the leisure score index which corresponds to a physical activity category (active, moderately active, insufficiently active).

The IPAQ and GPAQ are both self-report questionnaires developed for comparison between countries. They are used to gather physical activity and sedentary behaviour prevalence data by asking questions about physical activity intensity and frequency in different categories (job, transport, house and family care, recreation), and sitting time and sedentary behaviour.

Although similar, the GPAQ calls for an individual to focus on a 'typical week' where the IPAQ requires recalling physical activity 'within the last seven days'. A further discrepancy is that the GPAQ includes walking in moderate-intensity activity, where the IPAQ considers it as separate. The IPAQ is not typically used in cancer research, although many physical activity and cancer studies use modified versions/questions similar to the IPAQ, obtaining similar data about physical activity frequency in different categories and at different intensities. Most of these cancer studies use the mean minutes of physical activity and discuss the percentage of the group meeting guidelines, only a few more recent physical activity and cancer studies have begun to use median minutes of physical activity. Additionally, some physical activity and cancer research look just at the average minutes of physical activity at each intensity, and not in specific categories. The IPAQ and GLTPAQ have been used together in previous research[171], as a way of comparing the results within one study's sample to check validity. Additionally, using the two in conjunction is useful in research on physical activity and chronic diseases such as cancer. The IPAQ allows investigation of physical activity across many categories allowing a more holistic view of physical activity levels and sedentary time in diseased populations. Further, the focus on leisure-time physical activity in the GLTPAQ is important in diseased populations as leisure-time physical activity is more volitional than other types[171] and so may play a big role in the type of physical activity performed by someone with a chronic disease. Additionally, leisure-time physical activity is becoming a bigger part of programmes and interventions[178], so identifying and understanding the current prevalence of leisure-time activity is important. The limitations of these subjective tools relate to poor reliability and validity of data due to participant recall bias, misinterpretation of questions and a failure to capture low-intensity activities besides walking[177,178]. Additionally, the examples of physical activity at each different activity may not always be directly relevant or relatable to people completing the questionnaires globally, however these can be modified. However, self-report measures are considered practical for collecting data on larger samples[171] such as in research requiring population-level surveillance[177,178]. They generally require once-off participation from a participant and are versatile and cost-effective[171] due to ease of administration and distribution in both online and hard copy formats[177,178]. Further, internet-based self-report surveys are a time-efficient method of collecting data from a geographically diverse group of people[46,171].

2.3 CANCER

Cancer refers to a collection of diseases that result from genetic changes in the body and can occur in a range of different anatomical locations[3,86-88]. These genetic changes can be hereditary or occur as a result of certain environmental exposures such as the chemicals in tobacco smoke or as a result of radiation[86-88]. They cause abnormal cells in the body to divide uncontrollably and to spread to surrounding tissues[86-88]. There are over one hundred types of cancer: breast, prostate, lung and colorectal being the most commonly diagnosed[5,86,88].

Cancer staging is a description of how far a cancerous tumour has grown and spread[89,90]. It is useful for informing the type of treatment needed and other possible interventions that could aid in treatment and recovery, for instance, physical activity[89,90].

Cancer can be categorised in four stages; the first two typically mean the cancer is mostly contained[89,90]. The second two stages mean that the cancer has grown and started to spread to surrounding tissues and possibly to other body organs, with stage four being the most severe[89,90]. The most frequently diagnosed cancer type and the one with the highest mortality rate differs both across and within countries depending on the level of economic development and the lifestyle and social factors[5]. In South Africa, men are most commonly diagnosed with prostate, colorectal, lung, origin unknown and Kaposi sarcoma cancer[8]. In South African women, the five most diagnosed cancers are breast, cervical, origin unknown, colorectal and uterus cancer[8]. Breast and cervical cancer are amongst those with the highest mortality rates in South Africa, 8.20% and 9.80% respectively[91]. The main adult risk factors for cancer in South Africa are tobacco smoking, alcohol consumption, physical inactivity, obesity and household solid fuel use[1]. Table 2 shows the participation in each risk factor by males and females in South Africa[1].

Cancer is one of the main causes of morbidity and mortality worldwide and presents a prominent global health issue[92]. Cancer incidence and mortality are increasing rapidly, in part reflecting the growth and ageing of the global population and also in changes in the prevalence of primary risk factors (many associated with socioeconomic development)[5] The GLOBOCAN[5] results indicated that 14.1 million new patients were diagnosed with cancer and 8.2 million deaths were due to cancer (with a projected rise by at least 70% by 2030).

Table 2: Risk factors for cancer in South Africa[1]

Risk factor	Males	Females	Total
Current tobacco smoking (2011)	27.7%	7.7%	17.6%
Total alcohol per capita consumption (litres of pure alcohol) (2010)	18.4L	4.2L	11L
Physical inactivity (2010)	40.5%	53.1%	47.1%
Obesity (2014)	14.6%	36%	25.6%
Household solid fuel use (2012)	-	-	13%

2.3.1 Cancer survivors

Although there are many new cancer diagnoses, there are also greater numbers of survivors both in South Africa and globally, due to developments in diagnostic tools[54], treatments and interventions. A cancer survivor is anyone who has been diagnosed with cancer, encompassing the time from diagnosis through the rest of their life[13,14]. The trajectory of cancer survivorship has been categorised into three phases; 1) active treatment and recovery; 2) living after recovery (disease-free or living with the disease), and 3) advanced cancer and end of life[13]. There has been an increase in cancer survival rates in recent years, with up to 62% of females and 56% of males surviving the disease[93]. The largest constituency of cancer survivors is made up of breast cancer survivors who have a high likelihood of long-term survival[11,12]. This is due to improvements in early detection and treatments and high rates of cure for localised disease[4,11,12]. Prostate and testicular cancers also have high survival statistics if diagnosed timeously[11].

The increasing number of survivors in South Africa warrants a focus on enhancing survivorship and quality of life and maintaining optimal health following diagnosis and treatment[40,53,94]. There is a growing need to address the unique health issues that people living with and in recovery from cancer face every day[40,43]. Investigating how to improve access to diagnosis, treatment and knowledge is also key[40]. Enhancing health and quality of life can be achieved

through various interventions and positive changes in lifestyle behaviours to improve the daily living ability of those affected by cancer[45]. Physical activity is one such intervention suggested for cancer survivors and we need to better understand how exercise can help prevent and control cancer and aid in the recovery process[43]. There is no conclusive data on these factors for South African cancer survivors, making it important to conduct research in these areas to gain insight into survivorship in a South African context.

2.3.2 Quality of life

There are various domains of quality of life to be considered and addressed including general, physical and psychological well-being, familial relationships, sex drive, economic well-being, patient-physician relationship, body image and self-esteem[92,95]. Quality of life is increasingly being used to measure the effectiveness of treatment alongside more objective measures such as blood pressure and lipoprotein levels[95]. A quality of life measure estimates effects on outcomes that will be important specifically to the survivor and their individual needs and functioning. Cancer survivors often make healthcare decisions using this measure[95].

2.3.3 Demographic variables and quality of life

There may also be links between quality of life and demographic and disease-related variables, including type, stage and duration of illness and treatment[92,95]. Most studies indicate that quality of life is independent of demographic variables and have observed, for example, that quality of life is unaffected by cancer type[92,95]. Contradicting findings have seen a significant relationship between cancer type, pain intensity and fatigue; and have found income status to be significantly associated with quality of life[92,95]. Several studies have also found that approximately 80% of cancer survivors fall into the *'average'* or *'below average'* quality of life categories, with many aspects of quality of life being affected by reported symptoms[92,95,96].

2.4 BREAST CANCER

According to the 2019 CANSA report[8], breast cancer is the most prevalent cancer diagnosis in South African women currently[54] and there are roughly one million new cases globally each year[6,7]. Breast cancer makes up 18% of all female cancers, being the most commonly diagnosed malignancy in women and the leading cause of cancer-associated death worldwide[2-5,54,78,97]. For example, there were 3033 deaths recorded globally due to breast cancer in 2013[4]. According to 2012 statistics, women in less developed countries are at a higher mortality risk amongst women globally, with a lack of access to early detection and to treatment[54].

2.4.1 Risk factors

Several risk factors have been identified for breast cancer[2]. Breast cancer incidence increases with age[4], doubling about every ten years until menopause starts (here rate of increase slows)[2]. A breast cancer diagnosis is rare before the age of 25 years; the risk increases significantly after 50 years and typically declines after 70 years[4,15]. Geographical variation constitutes another factor, with age-adjusted incidence and mortality varying between countries by up to a factor of five[2]. Additionally, breast cancer incidence varies between ethnic and racial groups[4].

In South Africa, the lifetime risk of developing breast cancer ranges from one in 13 in White women, to one in 81 in Black women[6]. Both stage and age at diagnosis vary significantly between different populations (rural vs urban) and different races in South Africa[6]. Various determinants including socioeconomic, cultural, geographic accessibility to oncological facilities and the availability of traditional healers contribute to the differences in cancer factors between urban and rural populations[6]. Due to the large geographical area of South Africa and the population distribution, cancer oncological services are typically located in the main cities[6]. Rural Black women are affected more than urban women by these factors and this in turn can affect decisions about accessing medical help and treatment courses[6].

Studies in migrants indicate that breast cancer rates in these individuals assume the rate of the host country in successive generations, which suggests environmental factors are of great importance in the risk and development of breast cancer[2,5]. Certain reproductive and hormonal factors can also play a role[4]. Women who started menstruating early in life or experienced late menopause are at greater risk of being diagnosed with breast cancer[2,4,15]. Age at first pregnancy can also factor in, where nulliparity and late age at first birth increase the lifetime incidence of breast cancer[2,4,15]. The highest risk group is made up of those who have their first child after 35 years of age[2]. The lower incidence of breast cancer in Black South African women could be attributed, in part, to a typically later menarche and relatively early age at birth of the first child[6]. Furthermore, anthropometric factors, including body fat distribution, weight gain during adulthood and being overweight have been identified as important in the epidemiology of breast cancer[5,6]. Data from over one hundred epidemiological studies show a 5% decrease in breast cancer risk for every one year delay in menstruation onset; a 2.90% risk increase for every year older at the start of menopause; and 43% excess risk of developing breast cancer for premenopausal women compared to those post-menopause[4].

In Western countries up to 10% of breast cancer cases are due to genetic predisposition through a family history of breast cancer[2,4]. The risk is doubled if a first-degree relative has/had breast cancer, but this also varies based on the age at which the affected relative was diagnosed and the number of affected relatives[4]. Breast cancer can be spread through either sex; and some family members could transmit the abnormal gene without developing cancer themselves[2]. Severe atypical epithelial hyperplasia results in proliferative changes in a woman's breasts[2]. Despite being a benign breast disease in itself, it can increase the risk of breast cancer development by four to five times[2]. Exposure to radiation during adolescence (the period of active breast development) could intensify the effects of radiation exposure – this has been identified as another risk factor[4]. Oral contraceptives can result in a slight and transient increased breast cancer risk for women[2,4]. On the other hand, breastfeeding and physical activity have been identified as protective factors against the development of breast cancer[5].

Roughly 35% of cancer deaths globally are attributable to the combined effect of avoidable lifestyle-related risk factors[71]. A number of these are linked to breast cancer risk. Weight is one, with the link between risk and adiposity varying by menopausal status[4]. Obesity in post-menopausal women is associated with a twofold increase in risk[2,4]. Contrastingly, there is an inverse link between obesity and breast cancer risk in premenopausal women[2,4]. There is also substantial evidence of a link between poorer prognosis and disease outcome in women with early-stage breast cancer and an elevated body mass index (BMI)[4,9]. Additionally, body mass index has been identified as having a strong, inverse association with levels of physical activity[9], thus a higher body mass index could indicate lower physical activity levels and lead to higher risk. Physical activity is a key determinant of body weight[68] and diet could also have a function in helping with weight maintenance. Inconsistent findings have been recorded for adult diet and risk, some suggesting beneficial effects of a dietary intervention on breast cancer survival and others finding no effect on incidence rate[4]. Physical activity, on the other hand, is a modifiable lifestyle risk factor for breast cancer and is the lifestyle factor most consistently inversely associated with incidence and outcome[4,97]. Leading a sedentary lifestyle could increase cancer risk through mechanisms such as increased insulin resistance and inflammation and reduced immune system functioning, both significant role players in breast cancer development specifically[78].

There is evidence for a decreased risk (25-30%) of developing breast cancer linked to increased physical activity[98,99]. This could be due in part to physical activity acting to increase immune

cell components (improve immune system functioning) and to reduce metabolic hormones (such as insulin resistance) and systemic inflammation[78]. The decrease in breast cancer risk linked to physical activity is greater in certain population sub-groups (non-White racial groups, post-menopausal women, women with a normal body mass index) and with certain parameters of activity (vigorous, recreational and lifetime activity)[98]. This evidence is stronger for post-menopausal women compared to premenopausal women[4,97]. Being physically inactive can increase a woman's risk of breast cancer, thus leading a lifestyle with a combination of healthy lifestyle factors, including physical activity, can decrease this risk[97,98,100]. A link has also been demonstrated between high post-diagnosis physical activity levels and fewer all-cause and breast cancer-related deaths[4,79]. More research is being done into the timing of physical activity in relation to diagnosis[4]. Alcohol and tobacco intake are further lifestyle risk factors[1,4,64]. Mixed results and weak associations have been found between smoking and breast cancer risk[4]. Regarding alcohol intake, compared to women who didn't drink, those women who consumed 34-44g of alcohol daily experienced a 30% increase in risk[4].

2.4.2 Treatments and side effects

Both cancer itself and its subsequent treatments are associated with a combination of acute and chronic side effects that can negatively affect a person's health, quality of life and physical activity levels after a cancer diagnosis[78,95,101-103]. Acute side effects generally occur during treatment and can be resolved within months following treatment completion[101,102,104]. Late side effects are typically experienced after treatment and can have effects that last years[101,102,104]. The longer-term side effects can negatively affect an individual's quality of life after a diagnosis of breast cancer and need to be mitigated to reduce the adverse outcomes on life after diagnosis and treatment[102]. Additionally, depending on the severity of the side effects experienced, adherence to therapy can be adversely affected[105]. The side effects of breast cancer and its treatments can include bone health problems, loss of muscular strength in skeletal and cardiac muscles, early onset of menopause, reduced mobility, depression and emotional distress, fatigue, insomnia, fear of recurrence, intimacy issues, pain, nausea, changes in the look and feel of the breasts and weight gain[78,106,107]. These side effects can compromise daily functioning, sexual function, physical and psychological recovery which all contribute to quality of life following diagnosis and treatment[101,106,107]. A cancer survivor can also experience psycho-emotional side effects such as intimacy issues, fear of recurrence and depression[93]. Treatment courses for breast cancer range from local treatments such as

radiation therapy and surgery (to reduce the likelihood of recurrence), to chemotherapy and hormonal therapy as adjuvant treatments, to further reduce recurrence risk and overall mortality from breast cancer[4,101,102,104,108]. Many breast cancer patients are placed on a long course of medication such as Tamoxifen or Letrozole following primary treatment (i.e., chemotherapy and surgery), or once they are in recovery, so they are still technically classified as undergoing treatment[109]. Certain treatments reduce physical functioning, including the ability to exercise and be physically active, due to certain side effects[32,45,110]. The choice of treatment depends on the stage of breast cancer. The treatment type chosen can, in turn, affect correlates of physical activity and other aspects of a survivor's life through the side effects experienced[109]. Although treatments such as adjuvant chemotherapy may improve chances of survival, they may also cause negative changes in a survivor's quality of life[37]. Maintaining a high level of quality of life and managing these symptoms and side effects thus become a significant concern for cancer survivors[92].

2.4.3 Breast Cancer in a South African context

Different countries and populations have diverse cancer profiles and differing rates of incidence and mortality[3,5]. This is due to the different phases of social and economic development that they occupy as well as to the various risk factors and barriers to health that exist locally[5]. Although in developed countries the incidence and mortality rates of breast cancer have somewhat stabilised, in developing countries there appears to have been a rapid increase[3]. Breast cancer is the most common cancer worldwide, with slightly more cases in less developed countries[4]. In South Africa, a developing country, cancer is emerging as a more critical health problem, placing a substantial burden on the individuals themselves, their families and on health services and society at large[8,54]. Although the government has, in the past, started active clinic-building programmes in previously underserved areas, the needs in these areas still outweigh the resources[15]. Additionally, as South Africa is a resource-constrained country it does not have a national mammography screening programme so women with breast cancer symptoms typically self-present to primary healthcare facilities rather than being diagnosed through regular screening[54]. This fact coupled with deficits in breast self-awareness and knowledge of breast cancer symptoms can lead to a delayed interpretation of abnormal body changes and result in later diagnosis than necessary[54]. There is evidence in South Africa that indicates a stark difference in access to service upon diagnosis between the private and public health sectors, and regional and socioeconomic disparities are

very apparent[7]. Only 15% of women diagnosed with breast cancer have private healthcare available to them and receive service on diagnosis, such as treatment options and other care and intervention options[7,57,58]. In contrast, the remaining 85% of those diagnosed with breast cancer can only afford public healthcare and access to service upon diagnosis is unlikely[7,57,58]. Clinical trials illustrating the safety and efficacy of therapies has seen improvements in the standard of breast cancer care[4]. However, there is a gap in research and knowledge in a South African context.

2.4.3.1 Barriers

Social inequities in health and access to physical activity participation are widespread in South Africa[56]. It is important to look at cancer in the South African context compared to globally as there may be differences in barriers to diagnosis, treatment, lifestyle, behavioural and risk factors, as well as interventions that can aid in treatment and recovery.

In the context of breast cancer specifically, several determinants can affect patients[6]. These include cultural and socioeconomic determinants, availability of traditional healers (which may result in dismissing cancer-specific services) and geographic accessibility to medical centres with oncological services[6]. South African breast cancer survivors in 2016 reported several barriers to diagnosis and treatment, including structural factors, finances, perceptions of the care provided, and personal safety regarding physical location of the services[54]. These can go on to affect their decisions to get early medical help, the treatment choices they make and other decisions related to the disease[6]. For instance, only 5% of women in developing countries undergo cervical cancer screening compared to 40-50% of women in developed countries[111]. Incidence trends could also differ based on age and ethnicity in different populations, but with such high diversity in South Africa, this could factor into cancer trends[3]. Additionally, if there are ethnic differences in mortality rates, this could be associated with issues such as poor insurance coverage which could result from, or be linked to, low socioeconomic status.

Due to the large geographical area of South Africa and the population distribution, oncologic services are generally situated in urban areas and the larger cities[6,7]. Thus, those outside the cities without the means to reach these centres have less access to knowledge of or access to treatment options and interventions, which leads to less exposure to cancer screening which decreases the chance of early diagnosis and treatment[7]. Delayed diagnosis can also be due to lack of knowledge of symptoms and also of cancer screening[7]. Related to time of diagnosis,

Vorobiof et al., (2001) found only 22% of Black female patients presented early stages (I and II) of breast cancer compared to 69% of non-Black patients. 77.70% of Black women presented with stages III and IV[6]. More recently however, changes in awareness and access to care have seen the percentage of women presenting with stage II or lower having doubled[7].

Due to a combination of barriers to screening, education, awareness and medical centres, women of certain races or socioeconomic status in South Africa are unable to catch the disease early[6,7,54]. Educational and cultural beliefs around breast cancer and treatment courses could contribute to the differences in decisions about receiving treatment and other disease-related choices[6]. These can differ both across races and ethnicities as well as between people of one race living in different areas. For example, in South Africa, Black patients living in a rural area may first go to a traditional healer for help[6,15]. In contrast, Black patients living in an urban area with exposure to Western medical standards may have a greater knowledge of and access to medical attention[6]. Awareness about cancer and cancer screening is important. A study investigating poor attendance at cervical screening programmes found this to be due to a lack of knowledge both about the significance of cancer screening and cervical cancer itself[111].

Although exercise and physical activity present as both an effective and potentially low-cost intervention[75] in relation to breast cancer there are potential barriers to participation in physical activity in South Africa. Over 80% of the world's population, including South Africa, live in low- to middle-income countries[17]. It is essential to focus more research on physical activity in these countries where roughly 80% of the global burden of disease is experienced[17] and where interventions are thus crucial to changing these trends. Although there may be some government programmes to encourage a move away from sedentary living, these are limited and there are challenges in a country like South Africa to effective implementation of these programmes.

Barriers to participation in physical activity experienced by cancer survivors globally are those related specifically to cancer, its treatments and its side effects[45]. The most frequently reported barriers in the context of the disease have been illness/health problems, fatigue, pain, joint stiffness, lack of facilities, lack of interest and motivation, and weather extremes[45,112]. A lack of advice and poor patient education around the benefits of exercise participation have also been reported as inhibiting factors[45,112]. One study found breast cancer survivors to report awareness of the importance of exercise more frequently than other cancer types, however

results indicated that most nurses and oncologists did not provide this information throughout cancer treatment[112]. Uncertainty about the safety or suitability of exercise for a specific patient, a need for skills development in making referrals and a belief that referrals are not in the scope of their practice, are reasons which underlie oncologists lack of encouraging physical activity in cancer patients[113-116]. Linked to this is a breast cancer survivor's preference for how they would like to receive advice and their preferences for physical activity programmes. Understanding cancer survivor preferences is crucial in developing advice and physical activity programmes[44]. If a programme doesn't match these preferences, it can lead to a lack of interest and motivation, which can ultimately create a barrier to being physically active[44,117]. Although South African breast cancer survivors will also experience these barriers, there are further barriers to consider in a South African context. Research has explored patterns and associations of physical activity related to household, socioeconomic status and maternal education, which in some contexts in South Africa could create barriers to physical activity[21]. These factors can predispose those individuals to be either physically active or inactive later in life[21].

A further barrier to physical activity in a South African context is the complexity of health problems in different populations[84]. As a result, different populations require different types, volumes and levels of interventions to address the health issues specific to and prevalent, in their group. White populations of higher socioeconomic status have been found to live more physically active lifestyles and thus potentially be healthier than other populations in some ways[21,56]. Less affluent people are generally more vulnerable to communicable diseases which can further limit physical activity[21,56]. Within different South African populations, other behavioural risk factors may accompany low physical activity levels[84]. These can include high smoking and alcohol consumption in Coloured communities and high levels of obesity and diabetes in White and Indian populations[84]. This will affect the types of health issues, as well as the levels and types of physical activity interventions that could be implemented.

So, both breast cancer and participation in physical activity in South Africa are multifaceted issues affected by many intersecting factors, including age, sex, socioeconomic status and ethnicity.

2.4.3.2 The social aspect

There is a social aspect to the patterning of disease during different periods[118]. Disease patterns typically change as an epidemiological transition is seen when there is economic development[118]. Patterns of breast cancer evolution in South Africa may be linked to periods of economic development that have occurred. These can further be connected to advances or transitions in epidemiological knowledge[118]. These changes may be reflected in changes in the numbers of breast cancer diagnoses, the types of treatments chosen and breast cancer-specific mortality. Additionally, within a South African context, there may be social disparities in health. For example, certain environmental factors and exposures may lead to a higher risk of developing breast cancer. However, the socioeconomic status could present barriers to knowledge or diagnosis and service after diagnosis, so the number of diagnoses may not accurately reflect social disparities in health.

Health social movements are important political forces that can work to improve access to health care and improve the quality of care for breast cancer survivors[119]. This can be through challenging and changing medical policies, belief systems and research around breast cancer and through adjusting public health policies[119]. Mass media is another platform that may affect health patterns to a slight degree[120]. For example, news coverage of breast cancer in America increased during the period from 1974-2003, with increased reporting on prevention and treatment[120]. This provides useful health information to those with access to news coverage and increases general public awareness of the risk of breast cancer[120]. Key to note here is that not everyone will have access to this news.

2.4.3.3 The financial aspect

Cancer can have a significant financial impact and the subsequent economic stress can have other effects. With a cancer diagnosis comes the direct medical costs of the diagnosis and the treatment[121,122]. Direct non-medical costs also need to be considered, including transport to and from treatment sessions, domestic help, nutritional supplements and special foods and childcare[121-123]. Loss can also be experienced through indirect costs. A loss of income due to lowered productivity at work, absence from work, or loss of employment and all related benefits, directly related to cancer, are indirect costs[121,122]. The extent of the resulting financial burden is affected by factors including insurance status, severity and stage of cancer, household income and socioeconomic status (where financial hardship may precede diagnosis)[122,123]. Even those with comprehensive health insurance policies feel the financial

loss as insurance only covers some costs, so those without health insurance will feel the impact even more.

The financial impact can be devastating in more than just money-related issues[122]. Patients who are economically affected by a cancer diagnosis are more likely to delay or forgo further medical treatment[122,123]. Recently an association between increased economic stress and burden on the one hand and the overall reduced quality of life for cancer survivors on the other hand, has been found as a direct result of cancer[122,123]. Financial stress and low income can also be associated with anxiety and depression in cancer survivors[122,123]. This could exacerbate already-present side effects and further adversely affect a survivor's quality of life[122,123]. High treatment costs have been linked to reduced adherence to treatment which could have severe consequences, including less effective treatment, disease recurrence and shorter survival[123]. Survivors who report financial problems also report a higher likelihood of delaying/foregoing prescription medication, mental and dental healthcare, specifically because of cost concerns[123].

In South Africa, certain survivor groups delay treatment and other healthcare due to cost. For example, women with cancer have been found to have a higher likelihood of poor family support, being without a spouse and paying for house cleaning, transport and nursing care compared to men with cancer[121]. It is important to look into how breast cancer can bring financial hardship about and how it can be alleviated. Furthermore, the diverse socioeconomic statuses of South African women who are breast cancer survivors will affect how severely they feel the resulting financial hardship. This may affect their survivorship and quality of life even years after remission.

2.5 PHYSICAL ACTIVITY AND CANCER

Increasing evidence suggests regular physical activity could yield positive effects throughout the stages of cancer care[28,46,53,71], and its protective effect is undisputed[85]. It is important for cancer-specific and overall survival[85], for maintaining functional health and as an indicator of functional independence[46].

Physical therapy focuses on improving functional mobility, which is a person's ability to perform daily activities and move around[103]. Increasing muscular strength through some form of physical therapy could prevent antioxidant loss and improve daily activity[78]. Using large skeletal muscle groups improves oxidative capacity and oxygen uptake during aerobic exercise.

Muscle mass is restored and resting metabolic rate increased through resistance exercise[78]. Despite varying evidence for the benefits of exercise for different cancer subtypes, cohorts, stages of disease and outcomes of interest[124], this evidence is reducing concerns about prescribing and encouraging exercise for cancer patients[125,126]. As such, physical therapy should support a cancer care plan and be an integral part of comprehensive rehabilitation, however, the use of exercise in cancer care is still lacking[103]. This could be due to a continued lack of awareness of the benefits of physical activity in rehabilitation, and the health system barriers that inhibit the integration of physical therapy into cancer rehabilitation services[103]. Courneya & Friedenreich[127] proposed the Physical Activity and Cancer Control Framework, categorising four time periods post-diagnosis in which physical activity and cancer variables can be examined. Stevinson et al.[28] proposed a similar framework identifying key stages of cancer care. Stages include pre-treatment (prehabilitation), treatment (symptom control), post-treatment (rehabilitation) and then either survivorship (health promotion) or palliative care (quality of life)[28]). Although the effects at each stage may be different, evidence suggests that physical activity could play a key role at all points along the cancer survivorship trajectory[28,46,53,71].

Evidence supports that there are several biologically plausible mechanisms through which physical activity can influence cancer risk[128,129], suggesting that physical activity is beneficial for preventing certain cancers, including breast (particularly post-menopausal), colon, endometrial, bladder, stomach, kidney and oesophageal[27,43,77,128,130,131]. For breast and colon cancer, this protective effect may be linked to reduced insulin levels, reduction of both obesity levels and lessening of overexposure to sex hormones[132]. All of these can, in isolation or together, lead to sex-hormone related breast or prostate cancer[132]. These mechanisms can be countered, in part, by regular lifetime physical activity, specifically pre- and post-diagnosis for these types[27,128,130,131.] Minimising sedentary behaviour is also important for lowering the risk of lung, endometrial and colon cancers[128]. It should be noted that some research has found physical activity to be associated with a higher risk of melanoma, typically related to a lack of sun-safe practices during physical activity[128].

Due to the diverse effects of exercise on the body, interventions involving physical activity have the potential to positively impact recovery and quality of life[30]. Exercise oncology experts recommend that fitness professionals and healthcare workers include an *'exercise prescription*' when designing interventions and programmes[43]. These should aim to lower the risk of the

development of certain cancers and meet the needs, abilities and preferences of cancer survivors[43]. The musculoskeletal, cardiovascular, immune and neurological systems are all influenced to some extent by exercise[30]. Physical activity provides a holistic approach to enhancing physical and emotional recovery as well as improving general health and well-being[30]. Physical activity plays a role in metabolic, cardiovascular, psychological and musculoskeletal disorders[28]. This is important for cancer survivors as they are at risk of experiencing these comorbidities[28]. This emphasises the need for cancer survivors to lead healthy and active lifestyles, not just for cancer-specific benefits but to see positive changes in other areas too[28]. There is also a need for continued research that will lead to the integration of exercise and physical activity into the standard of care for cancer survivors[43].

2.5.1 Prevalence of physical activity amongst cancer survivors

The positive links between cancer and physical activity have made it necessary to investigate physical activity participation rates of cancer survivors[133,134]. There is a discrepancy in physical activity levels found based on the different definitions of physical activity, thus prevalence has been found to range between 9% and 74%[133,134]. Exercise patterns have been identified to categorise breast cancer survivors into different activity level groups[33,34,135]. '*Maintainers*' are active throughout the cancer experience; '*temporary relapsers*' are active pre-diagnosis, inactive during treatment and then active post-treatment; '*permanent relapsers*' are active pre-diagnosis and inactive thereafter, following diagnosis and treatment completion; '*non-exercisers*' are inactive throughout, and '*adopters*' are inactive before diagnosis, but active post-treatment[33,34,135].

Despite evidence of the benefits of physical activity, cancer survivors are more likely than those without cancer to become sedentary[32]. Survivors typically reduce physical activity levels after diagnosis and continue lower levels of activity throughout the disease and into remission[32,45]. Another contributing factor could be that exercise and its benefits are not spoken about enough with cancer survivors[45]. The HEAL study recorded an 11% reduction in the total activity of breast cancer survivors in a 12-month period post-diagnosis, with treatment type having a strong influence on the survivor's activity levels[110]. Also, for some types of cancer, such as breast cancer, physical inactivity constitutes a risk factor[32]. As such, some survivors will have been sedentary pre-diagnosis already[32,136]. A study of 9000 cancer survivors revealed that only between 30-47% survivors met current physical activity recommendations[137]. Other research

found only 45% of the survivor cohort reporting regular physical activity[138]. This finding differed with cancer type (32% and 53% for breast and prostate cancer respectively)[138].

There are also differences in physical activity prevalence between the different phases of the cancer experience[33,34,139]. Physical activity levels typically drop during active treatment, then increase post-treatment again, but not necessarily to pre-diagnosis and pre-treatment levels[33,34,139]. In breast cancer survivors specifically, studies have found 20% of women to be sufficiently active eight months after diagnosis, 23% sufficiently active 1.6 years post-diagnosis, 32% sufficiently active for 2.6 years following diagnosis and 23% for 10 years post-diagnosis[133,140-142]. Courneya and Friedenreich[34] observed a definite pattern of change with a 43% drop in the number of women reporting physical activity during active treatment, followed by a 47% increase after treatment completion. In contradiction, others have found no significant differences in physical activity levels among breast cancer survivors[133].

A combination of the pre-existing lack of fitness and strength together with the new stresses of diagnosis, treatment and recovery, can create a challenge to cancer survivors wanting to increase their physical activity levels[32]. A higher body mass index, advancing age and stage II diagnosis are negatively associated with exercise participation following diagnosis[133,134,143]. Factors positively associated with exercise participation include an exercise partner, higher income and higher levels of affective and social support[133,134,144]. Although physical activity effects and capabilities will differ between survivors relative to their diagnosis, stage, treatment and other factors, it is nevertheless important that they remain as physically active as possible[32]. Much of this research was conducted in Canada and America, so it is important to examine these same factors in a South African context.

2.5.2 Physical activity guidelines for cancer survivors

International recommendations for cancer survivors suggest minimising inactivity as much as possible[145], maintaining some physical activity during treatment and building towards pre-diagnosis physical activity levels as soon after treatment as possible[28]. There are guidelines specific to cancer survivors, outside of public recommendations[146]. These recommendations are based on evidence that specific doses of resistance, combined aerobic and resistance and/or aerobic training could improve cancer-related health outcomes[145,146]. Aerobic exercise should be performed three times a week, at a moderate intensity, for 30 minutes per session[73,145-147]. The recommendation for resistance exercise is two to three times per week,

with two to three sets of exercise in 30-minute sessions targeting large muscle groups[145,146]. Participating in a combination of resistance and aerobic exercise is a further recommendation, as well as engaging in multicomponent physical activity that enhances functional capacity and prevents falls[146]. Guidelines for adults in the general population include at least 150 minutes of moderate activity, 60 minutes of vigorous activity or an equivalent combination of both per week[20,65,70,73].

These recommendations serve as a guide for those working with cancer survivors. They should be adjusted and tailored to individual survivors based on age, ability, cancer type, status, exercise preference and treatment course[128]. There are important safety precautions to consider, such as avoiding high-intensity activity when experiencing pain, intense fatigue and compromised bone density and health[28]. Additionally, any activities requiring balance should be avoided when a survivor is particularly frail, dizzy or experiencing peripheral sensory neuropathy[28].

2.5.3 Physical activity and cancer risk

There is extensive evidence linking habitual physical activity to primary prevention of cancer and reduced risk[71]. Also, the general importance of physical activity for people affected by cancer is becoming more recognised[27,28,148]. Physical activity seems to play a big role in reducing breast cancer risk both pre- and post-menopause and is one of the most important lifestyle risk factors linked to breast cancer[27]. Although physical activity has been found to decrease the risk of the development of breast cancer, more research needs to be carried out to clarify how to bring about this reduced risk[27]. These details include the minimum intensity and duration required for risk reduction, as well as the optimal time period for physical activity occurrence, i.e. pre- or post-menopause or during the reproductive period[27]. Gathering more evidence on how these factors vary in different populations could help in identifying those at a higher risk of developing breast cancer or experiencing more severe side effects during survivorship[27]. McCullough et al. [27] found a non-linear dose-response association between breast cancer risk and recreational physical activity during both reproductive and post-menopausal periods. Those participating in the greatest amount of physical activity were observed to yield the greatest benefits[27]. Additionally, a joint assessment of recreational physical activity, body size and weight gain was conducted to work out the mechanisms through which physical activity acts and has an influence[27]. Those women with unfavourable energy balance profiles had an increased risk of developing breast cancer; particularly in the

case of considerable post-menopausal weight gain, which could compromise the benefits of physical activity[27]. Effects were stronger in post-menopausal women which is consistent with previous evidence and suggests that the timing of weight gain is an important consideration[27]. Additionally, recreational physical activity is most critical for reducing risk in the reproductive and post-menopause periods, reflecting the role of physical activity and obesity mechanisms which typically manifest after adolescence[27].

2.5.4 Physical activity pre-treatment

Physical activity pre-treatment is useful for increasing a person's fitness before undergoing any treatments or surgeries to ensure, as far as possible, that they can tolerate difficult therapies and reduce possible complications[28]. Currently, evidence shows some exercise is feasible and important to improve physical functioning leading up to surgery or the start of treatment[28]. The exact intensity, type and duration of exercise still need to be identified[28].

2.5.5 Physical activity as an adjunct treatment

Increased body mass and body fat at the time of a breast cancer diagnosis have been associated with reduced survival rates and an increased risk of recurrence[110]. Weight gain often occurs in the first year following a breast cancer diagnosis, particularly in women undergoing systemic adjuvant therapy[110]. This weight gain usually ranges between 2.5-6.2kg[110]. Decreased physical activity, receiving adjuvant therapies such as chemotherapy and increased calorie intake have been suggested as possible reasons for this[110]. As physical activity is linked to weight maintenance in healthy women, increasing physical activity levels after a breast cancer diagnosis could minimise post-diagnosis weight gain[110].

Exercise yields benefits for a variety of cancers when integrated into active treatment[9,99,124]. An exercise programme following diagnosis typically aims to influence many outcomes, including management of the disease and any treatment-related side effects[124]. The intervention must focus on mitigating the issues and complications that have the biggest impact on the health and survival of the cancer survivor[124]. Certain factors still, however, need to be considered with physical activity during cancer treatment. The survivor's capacity and intervention suitability need to be ascertained[124]. Those who were active pre-treatment may temporarily have to exercise at a lower intensity and advance more slowly during treatment, although the main goal should be to maintain activity as far as possible[32]. Survivors who were sedentary before diagnosis need to consider beginning with low-intensity activities[32].

Furthermore, older survivors also experiencing other impairments such as peripheral neuropathy and arthritis need to take care with balance and safety to avoid falls and injuries[32].

2.5.6 Physical activity post-treatment

Exercise and physical activity can be important in helping restore well-being and physical function to pre-cancer treatment levels[28,32] as far as possible, and to alleviate and manage long-term symptoms and side effects of treatment as well as to improve prognosis[9,71,85]. Amongst other benefits, physical activity can help to reduce depression and anxiety, as well as to improve sleep and physical functioning following treatment[12,35-39,127].

Short term exercise programmes have led to small but significant improvements in various outcomes. The most promising evidence for physical function outcomes has been found for lung and colorectal cancer survivors, where small to moderate increases in cardiorespiratory fitness have been seen after aerobic exercise training[149,150]. There is also a strong evidence base within a breast cancer setting suggesting that exercise following treatment is effective in improving quality of life, cardiorespiratory fitness and neuromuscular strength[124]. Moderate reductions in post-treatment fatigue after participating in some form of exercise and physical activity[151] have also been noted in cancer survivors. Moreover, breast cancer mortality risk has been found to be higher in sedentary survivors compared to those who were physically active, thus further encouraging survivors to engage in physical activity to reduce side effects and improve prognosis[78]. Although only preliminary evidence, some changes in post-treatment well-being have been reported[28]. Small increases in quality of life and slight reductions in depression in breast cancer survivors were found, linked to physical activity after treatment[152].

Increasing evidence indicates that leading a physically active lifestyle after a cancer diagnosis is associated with a reduced risk of disease progression and increased survival time[28]. This evidence is preliminary as only a small number of studies, the majority observational in nature, have investigated the link between physical activity and survivorship[28,32]. Regular physical activity is also important to help prevent or manage other health conditions that a survivor may experience, including cardiorespiratory and psychiatric disorders[28]. In examining cancer survival and recurrence as an outcome, preliminary evidence suggests some benefits of regular physical activity in survivorship in a number of different cancers[28]. Decreased rates of recurrence or disease progression, all-cause mortality and breast cancer mortality have been associated with higher levels of recreational physical activity[153]. In prostate cancer survivors a

decreased risk of disease progression has been linked to brisk walking, and regular physical activity has been linked to both all-cause and prostate cancer mortality[154,155]. For both brain and lung cancer, some studies have observed slightly longer survival time for those who reported being more physically active compared to those with lower physical activity levels[156,157]. Higher levels of post-treatment physical activity are associated with a 26-40% reduction in the risk of breast cancer-specific mortality, risk of recurrence and risk of all-cause mortality[32]. This risk reduction was observed after as little as one to three hours of moderate-intensity physical activity per week; and greater reductions were seen in those participating in three to five hours per week[32].

2.5.7 Effects of activity on cancer survivors

Research conducted by Courneya et al.[37] investigated the effects of supervised aerobic training versus supervised resistance training on aspects affecting quality of life of breast cancer survivors receiving adjuvant chemotherapy. These variables ranged from chemotherapy completion rates to psychosocial functioning and also to fatigue and physical fitness[37]. Both aerobic and resistance training were compared to '*usual care*', referring to the course of treatment prescribed by the patient's physicians. Participants exercised for the duration of their chemotherapy and continued for a few weeks after the completion of therapy with exercise duration being increased gradually every few weeks[37]. Of the patient-rated outcomes, self-esteem was found to be significantly improved in both exercise groups compared to those in the usual care group[37]. Additionally, improvements were seen in some physical fitness factors in the exercise groups that were not observed in the usual care group[37]. Chemotherapy completion rates were better in both exercise groups compared to the usual care group, where higher percentages of survivors received over 85% of their planned relative dose intensity in the exercise groups[37]. This indicates that exercise, particularly resistance exercise, may increase a survivor's ability to withstand a higher relative dose intensity of chemotherapy and thus yield better treatment outcomes[37]. Clinical trials show how important maintaining full-dose intensity is for early-stage breast cancer, and how receiving less than their originally planned relative dose intensity has been linked to poorer outcomes[37,158]. Other research has shown that increasing muscular strength through physical activity could improve daily functioning of cancer survivors and prevent/reduce antioxidant loss[78]. Aerobic activity uses large skeletal muscle groups which improves oxidative capacity and as a result improves

oxygen uptake[78]. Resistance exercise can restore muscle mass and increase resting metabolic rate[78].

During a treatment course, survivors become physically deconditioned and experience fatigue, losing muscular and cardiovascular fitness through inactivity[28]. Traditionally, bed rest has been recommended for combatting fatigue and other cancer-related side effects[28,32]. This is counterproductive, as excessive rest and inactivity, in combination with treatment, exacerbate loss in physical function[28]. Combining the right balance of rest and physical activity during treatment helps to control fatigue and maintain physical function[28,32]. For example, breast cancer survivors undergoing treatment in addition to partaking in either resistance or aerobic exercise reported moderate improvements in physical function[159]. These were seen through increases in cardiorespiratory fitness and muscular strength[159]. Small reductions in fatigue were also observed following an aerobic or resistance exercise training programme[159]. Small reductions in fatigue have been observed following an exercise programme during both radiotherapy and chemotherapy[151]. Improvements in daily tasks requiring upper body function have been observed in women undergoing breast cancer treatment following increased fitness levels resulting from regular physical activity[160]. Several studies examining the effect of exercise on women's aerobic capacity during adjuvant breast cancer treatment have found significant improvements of up to 15% in aerobic capacity, suggesting benefits of exercise during adjuvant treatment as well as positive associations with health-related quality of life[161-164].

2.5.8 Adherence to physical activity

'*Patient factors*' can influence adherence to an exercise programme[124]. These can include patient preferences, patient circumstances, available finances, health literacy, exercise self-efficacy, a support network, the severity of side effects and also motivation to achieve health-related goals through exercise[105,124]. This is important because the efficacy of any intervention is directly related to adherence to the therapy course, regardless of the type of intervention. Tailoring advice and exercise programmes to each survivor's individual needs and abilities is important in encouraging adherence, however it doesn't always lead to maintained adherence to a physical activity or healthy dietary plan, for example[28,46]. Within the general population, there is already poor adherence and compliance to physical activity guidelines for maintaining a healthy lifestyle[165-167]. All individuals diagnosed with cancer are found in this context with the result that many who are diagnosed are already inactive[45,53]. For example, Blaney et al.[45] found

less than 29% of cancer survivors in America meet the minimum recommendation of 150 minutes of physical activity per week. Similarly, the majority of lung cancer survivors in a study by Philip et al.[53] were not meeting the physical activity recommendations.

Certain cancer treatments can compromise exercise participation levels[110]. Irwin et al. [110] found women with localised and regional breast cancer decreased their physical activity participation by 13.80% and 8.90% respectively post-treatment compared to pre-treatment. An additional finding indicated that those undergoing adjuvant therapy along with surgery showed greater reductions in pre- to post-treatment physical activity levels[110]. Courneya and Friedenreich[33] found similar results where treatment negatively affected physical activity levels, activity that was not completely recovered post-treatment[33]. There are suggestions that a lack of understanding and knowledge around the cancer-specific benefits of physical activity, particularly post-diagnosis and post-treatment, may contribute to the lack of compliance sometimes seen to physical activity interventions[132].

2.6 EXERCISE PREFERENCES OF CANCER SURVIVORS

Research examining cancer survivors, in general, reiterates that many survivors are interested in, and feel capable with taking part in an exercise programme[28,45,46]. Of an American breast cancer survivor cohort, 90% indicated they felt they could participate in an exercise programme, and 67% were interested in receiving exercise information[46]. In some cases, this advice and encouragement leads to a physically active and healthy lifestyle and can effect changes in behaviour and attitudes[28,44]. An individual's perception of their exercise ability combined with their information and knowledge of physical activity can increase or inhibit how physically active they are[46].

There is evidence that exercise and physical activity are safe and beneficial to cancer survivors, so it is useful to get reports on preferred frequency, intensity and type of exercise, group or individual sessions and the preferred setting for the activity[12,27,39,46,53,127]. Evidence of these preferences has been taken from reports given predominantly by breast, ovarian, bladder, prostate, colorectal, primary brain and lung cancer from America, Ireland, England and Canada[44-50,52,53,168]. Age, concerns about body image such as dramatic weight changes and surgery scars, variability in self-efficacy, confidence and psychological factors, are some factors that may affect survivor preferences[48,129].

In a study on African American breast cancer survivors, most participants indicated they would participate in an exercise programme and would be interested in receiving information about exercise and physical activity[46]. These findings did not differ based on age, levels of physical activity or time elapsed since diagnosis[46]. Generally, the participants preferred to receive information via email, websites, or through a clinic[46]. It was found that more women meeting physical activity guidelines were interested in resistance training; and younger women and those diagnosed within the past five years preferred cardiovascular-type exercises[46]. Interventions that promoted walking and resistance training were the most popular overall[46]. This corroborates findings of other studies investigating bladder, endometrial, ovarian and breast cancer[46]. A study examining the preferences of Canadian ovarian cancer survivors recorded over half of the women being interested in participating in an exercise programme, with a general preference for walking[50]. The preferred method of receiving physical activity advice was from a fitness expert at a cancer centre, through brochures, videos, or face-to-face counselling[50]. Roughly half the participants indicated a preference of home-based physical activity starting within six months of treatment completion, and there was an equal number of responses preferring exercising alone or with friends and family[50]. Walking was also found to be the preferred exercise type in the findings of a study with Canadian colorectal cancer survivors[44].

In early-stage lung cancer survivors in America most wanted to receive physical activity advice predominantly from a physician and before treatment[53]. Nearly half reported walking as their preferred form of physical activity[53]. This preference is further supported by other research[49]. There were some differences noted in age, where younger cancer survivors preferred to exercise at a gym or exercise centre (related to a cancer centre) more so than survivors over the age of 70 years[53]. This is corroborated by research on older breast cancer survivors who preferred gentle, home-based activities in groups, tailored specifically to their age group and cancer-related abilities, with an instructor who was familiar with breast cancer and ageing[48]. Swimming, walking and pilates are examples of the types of exercise the participants suggested[48]. Regarding sex, female lung cancer survivors showed more interest than their male counterparts while in an exercise programme tailored to lung cancer survivors specifically[53]. Blaney et al[45] observed that of the survivors interested in an exercise programme, moderate-intensity exercise was recorded as the most popular; and walking was the most preferred exercise type, followed by strengthening and flexibility exercises, swimming and yoga[45].

Generally, there was no preference for exercise setting, but about 40% of participants indicated wanting to exercise in a group with other cancer survivors[45].

An interesting finding in some investigations has been a strong preference for a variety of activities and types of exercise, rather than repeating the same routine[168]. The desire for variety was reported most highly in Canadian kidney cancer survivors[168]. Evidence has also been found suggesting that some cancer survivors prefer independence and flexibility in their physical activity and thus would rather have unsupervised exercise sessions[169]. Bladder cancer survivors were particularly clear on this preference[169].

Programmes need to be tailored to fit a survivor's personal preference for physical activity and exercise, and the individuality of the experience of cancer, treatment and side effects[44,45]. Exercise preference correlates with compliance to physical activity and exercise, considering that cancer survivors are more likely to comply with advice and programmes in line with their own preferences and ability[44,105].

2.7 SUMMARY

Exercise and physical activity can be used before, during, and after treatment to assist women with breast cancer both in physical and psychological aspects of recovery[9]. More evidence is emerging around how best to integrate physical activity into the cancer care process, and how to tailor it to the needs, preferences and abilities of individual breast cancer survivors. However, there is still a greater knowledge base needed in this regard. With physical inactivity constituting a risk factor for developing breast cancer, for breast cancer recurrence and for experiencing side effects more severely[4,35,36,37,100], research into how to increase physical activity participation in the safest and most beneficial way is imperative. There is no research of this kind in a South African context. It is important to investigate the physical activity levels, needs, preferences and barriers for South African breast cancer survivors as aspects of their experience may be unique to other countries. Being cognisant of cancer being a component in the South African disease burden, and of breast cancer being a common diagnosis amongst South African women, there are both scientific and financial imperatives to embark on this research.

2.8 IMPORTANT NOTE

Notably this research started at the beginning of 2019 with the reading of the literature and contextualization of the problem as well as the development of the method. However, the data collection part of the study, an online survey, occurred in the context of the Covid-19 pandemic. The data collection phase overlapped with the strict South African Covid-19 lockdown (26/03/2020-01/05/2020) which was put in place to curb the rise of the virus and allow time for medical facilities to be ready once the number of cases started to rise. As the survey was open both before and during the lockdown, some participants completed the survey pre-lockdown, and others will have only completed it during the lockdown phase. This is important as it may have impacted the sample size and the data collected. Subsequent results of the research may have been affected, specifically regarding physical activity levels and sedentary behaviour reported by participants. This is noted as a limitation of the study. Additionally, the data analysis period of this study occurred prior to the release of the new 2020 guidelines on physical activity and sedentary behaviour. The new guidelines have been acknowledged; however, the results were written in the context of, and in comparison, to the previous guidelines from 2018 as those were the guidelines available at the time the results were written up.

CHAPTER 3

RESEARCH METHODS

This chapter outlines the research design, ethical considerations, recruitment process, measures and materials, participant characteristics, data collection and preparation methods and statistical analyses to be considered while researching this subject.

3.1 RESEARCH DESIGN

The study followed a cross-sectional design to identify the levels of physical activity and sedentary behaviour in South African breast cancer survivors and to investigate the physical activity and exercise preferences of this group of participants. An online survey was created and made accessible via Google Forms. The survey consisted of both closed and open-ended questions and was used to gather anthropometric and demographic details about the participants. It also obtained information on the frequency and types of physical activity undertaken by the participants and the time spent in sedentary behaviour. Other information obtained concerned preferences for physical activity and how they would like to receive (or previously would like to have received) physical activity and exercise advice.

3.2 ETHICAL CONSIDERATIONS

The Rhodes University Ethical Standards Committee approved this study for research on human participants, reference 2019-0292-2084 (Appendix A). During the advertising and recruiting phase, an information letter was provided to potential participants which explained the purpose of the study and stated that all data will be collected for research purposes and will be kept strictly anonymous and confidential (Appendix B). All participants were made aware that participation was voluntary and that they could withdraw from the study at any time without prejudice. Permission to advertise the study through cancer-related organisations was also obtained from the Rhodes University Ethics Committee (Appendix C). Based on this, gatekeeper permission was obtained from the Cancer Association of South Africa (CANSA) for their involvement in advertising the research (Appendix D). Informed consent was procured through the first question of the online survey, as it was required to gain access to the survey with participants only able to continue if they indicated that they gave consent. Anonymity was ensured through assigning each participant a participant number as soon as they volunteered to participate for identification in the study, in place of their name. All

information was kept confidential, and participants were assured of this in the participant information letter.

3.3 PARTICIPANT SAMPLE AND RECRUITMENT

Of the 59 people who showed interest in being a part of the research, 48 completed and submitted the survey. Eligible participants were recruited through the distribution of a leaflet advertising the research (Appendix E). This leaflet was distributed by CANSA to their regional offices and cancer care homes and was posted on all their social media platforms. The Reach for Recovery breast cancer organisation distributed the leaflet to their volunteers, all breast cancer survivors, via email. The study team also advertised the research and recruited participants more locally through multiple media and social media platforms and word of mouth. The leaflet was distributed through social media platforms again later in the data collection period both by organisations involved and by the study team in an attempt to recruit more participants and increase the sample size. People interested in participating or getting more information were asked to contact the study team by telephone or email to check eligibility, ask any questions and obtain the link to the online survey.

Participants had to meet the following inclusion criteria:

- Female
- 21 years and older (to exclude childhood cancers)
- South African nationality
- Currently undergoing breast cancer treatment; or have been treated for breast cancer and now in recovery

The focus was on female breast cancer survivors as breast cancer is the most common diagnosis in South African women, and has one of the highest mortality rates[8,91]. South Africa is a multicultural society that includes many different nationalities; however, breast cancer survivors of South African nationality were explicitly targeted for two reasons. Due to the limited data about South African breast cancer survivors, it is important to increase the knowledge base around their physical activity and sedentary behaviour levels, and their preferences, to inform the development of interventions. Secondly, there could be no control over how long breast cancer survivors of other nationalities have resided in South Africa, thus, no control over whether they had experienced the same South African-specific barriers, risk

factors and environmental factors. Breast cancer survivors both undergoing and having completed treatment were included as 'survivor' refers to anyone diagnosed with cancer, from time of diagnosis through the rest of their life[13,14].

3.4 STUDY SETTING

The setting in which the surveys were completed was dependent on the participants. As the survey was in an online format, it allowed participants to complete it wherever they had access to the internet and a smartphone/computer. If required, participants were emailed a hard copy version of the survey instead of the link to the online version.

3.5 MEASURES AND MATERIALS

The survey was compiled of self-report questionnaires. The data collected included information on the physical activity and sedentary behaviour levels of breast cancer survivors, and the physical activity intervention preferences, and physical activity information needs of these participants. The questionnaires used were chosen based on a review of other cancer-related studies, to choose valid and reliable measures, and for comparison purposes both within the results of this study and with other research. The individual questionnaires were compiled into one main survey document, and both hardcopy and online versions of the survey were produced (Appendix F). The survey was made up of 53 questions and took approximately 20 minutes to complete. It was opened on the 01/03/2020 and closed for responses on the 03/05/2020.

3.5.1 Demographic and anthropometric questions

Several questions relating to anthropometric, and medical demographic information were compiled to make up the first section of the questionnaire. The demographic questions included age and the province they live in; medical information included time elapsed since diagnosis, stage of cancer at the time of diagnosis and treatment course; and stature and mass made up the anthropometric questions. Obtaining data on race/ethnicity would have been useful due to the diversity in South Africa, however it is still a sensitive topic in post-apartheid South Africa and people often aren't willing to report their race. Thus, this was not asked in the survey to maintain social and political sensitivity.

3.5.2 Godin leisure-time activity questionnaire (GLTPAQ)

The Godin leisure-time activity questionnaire[170] was used to assess current levels of leisure-time physical activity (including organised exercise, sport and recreational physical activity). The questionnaire asks how many times during a typical seven-day week a person participates in >15 minutes of strenuous, moderate, or light exercise. The number of days, as stipulated by the leisure score index (LSI), is then multiplied by nine, five and three, respectively, and the totals are added up. The overall score obtained at the end places the respondent into one of three categories: 'sedentary/insufficiently active' (<14 units), 'moderately active' (14-23 units), and 'active' (>23 units). Leisure-time physical activity is an important physical activity subtype for research into behaviour change in an oncology context[171]. This questionnaire has been used in other oncology research investigating links between cancer and physical activity[45,139,171,172].

3.5.3 The International Physical Activity Questionnaire (IPAQ)

The International Physical Activity Questionnaire[173] was used to obtain data on health-related physical activity. The IPAQ aims to determine the type and intensity of physical activity individuals do in their everyday lives and how often they do it in a typical seven-day week. The questionnaire asks a series of questions under different physical activity categories. These categories are job-related physical activity, transportation-related physical activity, housework, house maintenance and family care physical activity, recreational and leisure-time physical activity and time spent sitting (weekend and weekdays). The IPAQ is a reliable tool used by Welch et al.[172] and used by others in similar oncology research[174]. It is used to gather data for the prevalence of people meeting guidelines, and the prevalence of physical inactivity and sedentary behaviour[16,20].

In this study the International Physical Activity Questionnaire and the Godin Leisure-Time Physical Activity Questionnaire were used in conjunction. The different focuses of the two questionnaires allowed a focus specifically on leisure-time physical activity, an important physical activity category in oncology research[171], and allowed a more holistic image of physical activity prevalence to be gained through the questions asked in the IPAQ.

3.5.4 Exercise and Physical Activity Preference Questionnaire

The Exercise and Physical Activity Preference Questionnaire[53] first covers several questions on the physical activity advice preferences of breast cancer survivors. It gains information on how, from whom, at what stage, and in which setting they would prefer to receive advice on exercise and physical activity if they are interested in receiving advice. The second section asks

questions about physical activity preferences, targeting information such as type, intensity, frequency, group/individual, setting and at what phase of the cancer continuum they would want to participate in any physical activity. Variations of this questionnaire have been used in other breast cancer research, as well as research on survivors of different cancer types, including early-stage lung cancer, ovarian cancer and bladder cancer[46,49,50,51,53].

3.6 PROCEDURE

A leaflet advertising the research was reviewed by both the Rhodes University Ethics Committee and the social media coordinator at CANSA and then distributed and posted to social media platforms. All breast cancer survivors who responded to the advertisement were sent a participant information letter which gave more details regarding the research, including the purpose and protocol of the study and the risks and benefits of participating. All participants that consented to being a part of the study (indicated by the consent question before the survey questions) completed the online questionnaire. This determined how often, what types and intensities of physical activity each person participates in, the amount of sedentary behaviour they participated in and preferences regarding physical activity advice and interventions. As their completed surveys were received, the participants were assigned participant numbers in place of their names to ensure anonymity. A spreadsheet with participant names, corresponding participant numbers and participant information was created. All information and responses from the completed questionnaires were recorded on either a descriptive or numerical Microsoft Excel spreadsheet by the researcher.

3.7 DATA TREATMENT

Data was collected over two months in order to allow time to recruit more breast cancer survivors to respond to the survey and as such get a bigger sample. The data were interpreted quantitatively, supplemented with some descriptive analyses. Descriptive statistics were produced to show the demographic (age, province), medical (stage, time since diagnosis, treatment) and anthropometric (stature, mass) characteristics of the participant sample. The demographic and medical variables of age, province, time elapsed since diagnosis, stage at diagnosis and treatment courses were expressed in frequencies (N) and percentages (%). Age categories of <50 years and >50 years were used for comparison purposes within this study's sample group. These categories were chosen based on categories used in previous research[9,46,112], and because differences in breast cancer morphology and risk factor profiles

are generally agreed upon to occur around 50 years (at menopause)[9]. The mean, standard deviation and coefficient of variation for stature, mass and body mass index (BMI) and the anthropometric characteristics have been presented. Physical activity participation preferences and the preferred methods for receiving physical activity advice and information were expressed in frequencies and percentages. The participant's physical activity and sedentary behaviour levels were based on the self-reported levels obtained through the responses to the Godin Leisure-Time Physical Activity Questionnaire (GLTPAQ) and the International Physical Activity Questionnaire (IPAQ). All questions about levels of physical activity in the IPAQ asked about the weekly amount of physical activity being done. So, to calculate the amount of weekly physical activity in each of the four categories (IPAQ), the number of specified days per week was multiplied by the number of minutes per day (**frequency = number of days x duration*). The responses to the IPAQ are traditionally analysed and presented as median minutes or median MET-minutes, and individuals who have self-reported physical activity levels using this tool are placed into one of three domains: 'inactive', 'minimally active' and 'HEPA active' (health enhancing physical activity). For this study, due to the use of mean data in other physical activity and cancer research, mean minutes of physical activity at different intensities and in different physical activity categories were used instead of median minutes, for comparison purposes. The average minutes of total physical activity at each intensity, across all physical activity categories was also obtained for comparison purposes with studies that presented their data in this way. The mean minutes were then compared to physical activity guidelines. Responses to the GLTPAQ were presented as percentages representing the proportion of the cohort who fell under each physical activity level (active, moderately active, insufficiently active). Additionally, the average number of days on which participants engaged in each physical activity intensity was calculated.

3.8 RESEARCH AND STATISTICAL HYPOTHESES

3.8.1 Research Hypotheses

- Hypothesis 1: South African breast cancer survivors do not meet the physical activity guidelines.
- Hypothesis 2: South African breast cancer survivors do not meet the recommendations for the amount of time spent being sedentary.
- Hypothesis 3: The demographic, medical and anthropometric variables of South African breast cancer survivors are significantly associated with their physical activity and sedentary behaviour levels.
- Hypothesis 4: South African breast cancer survivors prefer receiving physical activity information/advice either face-to-face or via brochures along with preferring low-intensity, home-based interventions.

3.8.2 Statistical hypothesis

The statistical hypothesis is relevant to research hypothesis three.

Statistical hypothesis 1

Null hypothesis 1: There are no significant correlations between physical activity and sedentary behaviour levels, and demographic, anthropometric and medical variables.

H_0: $\mu_{1,2,3} = 0$

H_1: $\mu_{1,2,3} \neq 0$

Where μ_1 = breast cancer survivor physical activity levels; μ_2 = breast cancer survivor sedentary behaviour levels; μ_3 = demographic, anthropometric and medical variables.

3.8.3 Statistical analyses

Statistical analyses were done using the statistical programme *RStudio* (Version i386 3.6.3). The dataset was tested for normality using the *Shapiro-Wilks* test. To examine potential associations between demographic, medical and anthropometric variables, against physical activity levels, a linear mixed model regression was run. This accounted for both fixed and random effects on the dependent variables. If significance was found after the linear mixed model was run, a *Tukey* posthoc ANOVA test was performed to determine which combinations in each category were contributing to the significant result. Chi-squared tests and Pearson's

Product-moment correlation tests were used to identify relationships between categorical and numerical variables. The *Kruskal-Wallis* test was run on any variables found not to be normally distributed, followed by *Pairwise* comparisons using the *Wilcoxon Rank Sum* test. A correlation matrix was generated in Microsoft Excel to further explore and determine any correlations between variables. The coding of the variables used in the correlation analysis are summarised in Table 3 and the results of the correlation matrix are seen in Appendix G.

Table 3: Coding of variables for the correlation matrix

Variable	Variable Coding
Age	Individual age reported by participant
Stage at diagnosis	Stage reported by participant (1-4)
Time elapsed since diagnosis	Four categories: 1: ≤8 months 2: 9 months – 1.6 years 3: 1.7-2.6 years 4: >2.6 years
Body mass index	Three categories: 1: <25 2: 25-29.9 3: ≥30
Leisure score index	1: Active 2: Moderately active 3: Insufficiently active
Meeting vigorous intensity activity guidelines	0: Yes 1: No
Meeting moderate intensity activity guidelines	0: Yes 1: No
Meeting total physical activity guidelines	0: Yes 1: No
Interest in advice	0: Yes 1: No 2: Maybe
Interest in participation in a programme	0: Yes 1: No 2: Maybe
Feel capable of participation in a programme	0: Yes 1: No 2: Maybe

3.9 FEEDBACK

Feedback was provided to CANSA and to *Reach for Recovery* to be used and distributed to breast cancer survivors, physicians, oncologists and any other parties they deemed relevant. This feedback was compiled from the broad findings of the study, as stated in the information

letter. Should the participants require individual feedback, they will be able to contact me directly - this is explicitly stated in the letter of information.

CHAPTER 4

RESULTS

This chapter outlines the results collected from the online survey.

Firstly, the participant's demographic, anthropometric and medical characteristics are summarised. The treatment(s) received by the participants are presented next. Following that, the results from the Godin Leisure-Time Exercise section of the survey are presented and the participant's sedentary behaviour levels are detailed. Subsequently results from the International Physical Activity Questionnaire section of the survey and associations between participant characteristics and physical activity levels are summarised. A summary of the physical activity advice and participation preferences follow that.

It is important to note that the results displayed are seen in the context of the study's broader limitations. Most notably the subjective nature of the data may have resulted in an over/underestimation of physical activity levels and sitting time. Additionally, in general all required questions were answered, and the surveys were completed fully. However, some items were answered incorrectly or left incomplete by some participants. Notably, the questions about stature and mass were most frequently left unanswered, with 25% and 17%, respectively, of the participant sample leaving these out. Further, due to data collection occurring during the South African Covid-19 lockdown, the physical activity and sedentary behaviour patterns and levels reported by participants may not reflect the typical levels that they usually participate in, as the lockdown restricted physical activity outside of one's home. As a result, the type, intensity and frequency of physical activity had to be adjusted, evidence of which has been seen in some countries[184,185,186]. Thus, sedentary behaviour and physical activity levels may have differed, and results potentially have been affected based on this context.

4.1 PARTICIPANT CHARACTERISTICS

Forty-eight female breast cancer survivors above the age of 21 years participated in the study and completed the survey. Forty two percent of participants responded before the start of the South African Covid-19 lockdown, and 58% completed the survey during the lockdown period; this must be considered a limitation of the study.

Table 4 details the participant's demographic and medical information. The mean age of the respondents was 49 ± 9.87 years (CV: 20.15%), with the majority (56.25%) aged below 50 years. Most of the sample (73%) stated that they had been diagnosed with breast cancer less than five years ago, with a diagnosis of stage I (38.30%) and stage II (34.04%) being the most commonly identified. The most commonly lived in province was the Western Cape (35.29%).

Table 4: Participant's demographic and medical characteristics (n=48).

Characteristic	n (%)
Age (years) (n=48)	
<50 years	**27 (56.25%)**
50-60 years	16 (33.30%)
>60 years	5 (10.42%)
Province (n=34)	
Eastern Cape	4 (11.76%)
Western Cape	**12 (35.29%)**
Northern Cape	1 (2.94%)
North West	0
Free State	2 (5.88%)
Kwa Zulu Natal	3 (8.82%)
Gauteng	10 (29.41%)
Limpopo	0
Mpumalanga	2 (5.88%)
Time since diagnosis (years) (n=48)	
Less than 5 years	
5-15 years	**35 (72.92%)**
>15 years	10 (20.83%)
	3 (6.25%)
Stage at diagnosis (n=47)	
I	**18 (38.3%)**
II	16 (34.04%)
III	11 (23.40%)
IV	2 (4.26%)

Bold text indicates the majority response.

The respondent's mean body mass index (BMI) was 27.87 ± 5.52kg/m^2 (CV: 19.82%), and the majority of respondents (approximately 65%) were classified as overweight or obese (Table 5).

Table 5: Mean (± standard deviation) anthropometric data.

Measure	n (%)	Mean	SD	CV (%)
Stature (cm)	37 (77.1%)	162.89	8.11	4.98
Mass (kg)	39 (81%)	75.94	15.09	19.87
BMI (kg/m^2)		27.87	5.52	19.82

*BMI = Body Mass Index, SD = Standard Deviation, CV = Coefficient of Variation

There was a weak, non-significant, negative correlation (p=0.06, R^2 = 0.04) between age and stage at diagnosis (Figure 2).

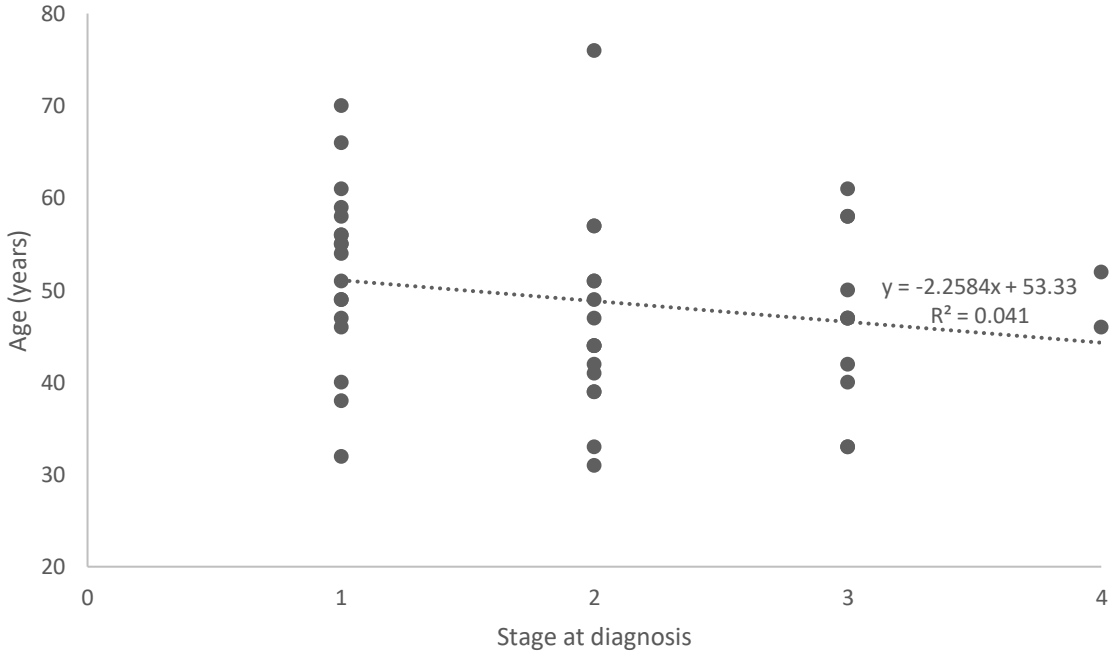


Figure 2: Age of participants and stage of cancer at diagnosis.

4.2 TREATMENT COURSES

All of the sample indicated undergoing cancer treatment following their diagnosis of breast cancer; however, the treatment courses and combinations received by survivors differed (Table 6). Surgery combined with either a course of radiation, or a course of chemotherapy, was most frequently reported (22.92%), followed by a combination of surgery, radiation and chemotherapy (20.83%).

Table 6: Treatment received by participants (n=48).

Treatment type	n (%)
Surgery	4 (8.30%)
Surgery, Chemotherapy, Radiation, Hormone therapy	8 (16.70%)
Surgery, Hormone therapy	6 (12.50%)
Surgery, Chemotherapy/Radiation	**11 (22.92%)**
Surgery, Chemotherapy, Radiation	10 (20.83%)
Surgery, Hormone therapy, Chemotherapy/Radiation	3 (6.25%)
Chemotherapy, Radiation, Hormone therapy	4 (8.30%)
Hormone therapy, Chemotherapy/Radiation	2 (4.20%)

Bold text indicates the majority response.

4.3 PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR LEVELS

4.3.1 Findings from the Godin leisure-time physical activity questionnaire

Figure 3 details the participant's physical activity levels based on their Leisure Score Index (LSI) score obtained through the questions in the Godin Leisure-Time Physical Activity questionnaire (GLTPAQ).

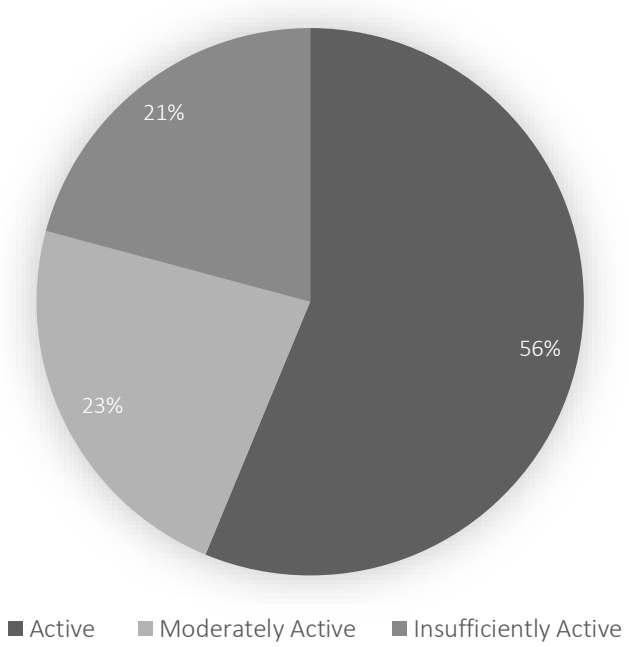


Figure 3: Percentage of participants in each physical activity category.

The majority of the participants reported high levels of leisure-time physical activity and thus were classified as active (56%) (Figure 3). Similar numbers of participants were classified as both moderately active (23%) and insufficiently active (21%) based on their reported levels of physical activity and their LSI score. Of the group, 50% reported participating in strenuous activity, 69% in moderate-intensity activity and 79.20% reported mild physical activity as part of their overall leisure-time physical activity participation. The average number of days on which participants engaged in strenuous activity was 1.58 ± 2.05 (CV: 129.52%) days per week, the mean number of days for moderate-intensity activity was 2.19 ± 1.99 (CV: 91.26%) days per week, and light intensity activity was engaged in on an average of 2.83 ± 2.23 (CV: 78.86%) days per week. However, there was large variability in their reports.

Figure 4 illustrates the number of participants categorised into each Leisure Score Index category of active, moderately active and insufficiently active based on their number of years since diagnosis.

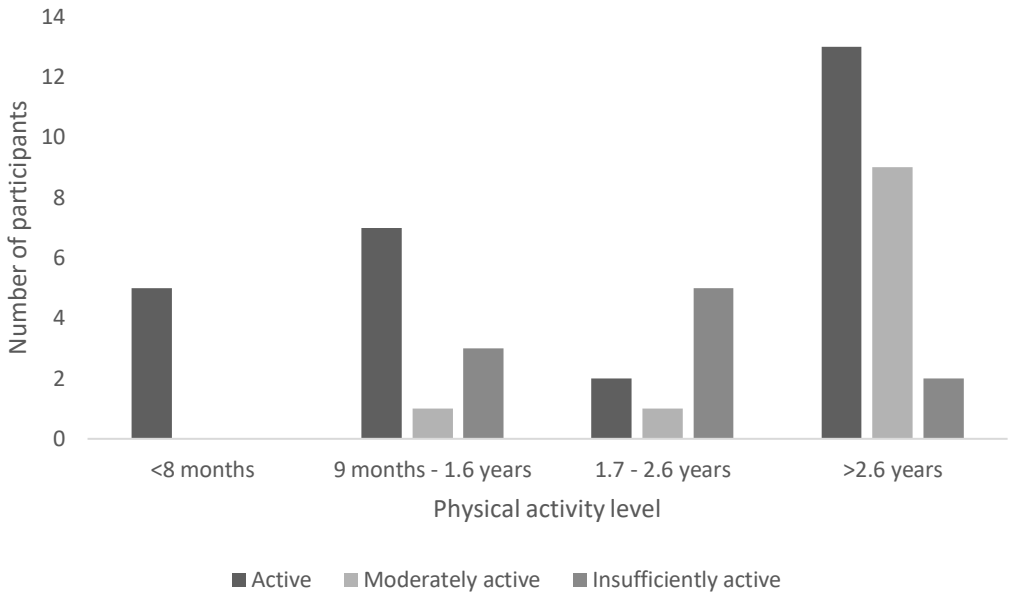


Figure 4: Number of participants in each Leisure Score Index category according to their time since diagnosis.

In this group of breast cancer survivors, the greatest number classified as insufficiently active were diagnosed between 1.7 and 2.6 years ago (Figure 4). The lowest physical activity levels were also seen in this group, with the smallest proportion of survivors being active, compared to the other categories of time since diagnosis. Those diagnosed over 2.6 years ago reported the highest levels of activity, resulting in the greatest number of participants in this category being classified as moderately active and active. There were weak, non-significant positive correlations between time since diagnosis and participants meeting vigorous (R^2 = 0.25) and moderate (R^2 = 0.21) physical activity guidelines.

4.3.2 Sedentary behaviour

The highest sedentary time was seen in time spent sitting over weekends (Table 7), with an average frequency of 315 ± 155.79 minutes per day reported (5.25 hours). High levels of sedentary time were also seen in weekday sitting time (312.17 ± 156.89 minutes (5.2 hours)) and time spent in a vehicle (249.58 ± 267.62 minutes (4.2 hours)). In total, participants spent an average of 292.02 ± 202.16 minutes (4.87 hours) per day being sedentary across all categories of sedentary behaviour. Notably there was high variation in all three categories of sedentary time, particularly sedentary transport time.

Table 7: Mean (± standard deviation) minutes of sedentary time.

Measure	Mean	SD	CV (%)
Weekday sitting time	312.17	156.89	50.26
Weekend sitting time	315.64	155.79	49.36
Sedentary transport time	249.58	267.62	107.23
Total sedentary time	292.02	202.16	69.23

*SD = Standard Deviation, CV = Coefficient of Variation

Figure 5 shows the physical activity levels of the participants based on their answers to the International Physical Activity Questionnaire (IPAQ) section of the survey; namely, duration, frequency and intensity of physical activity. The total average minutes of weekly activity was calculated for vigorous, moderate and low-intensity physical activity.

4.3.3 International physical activity questionnaire findings

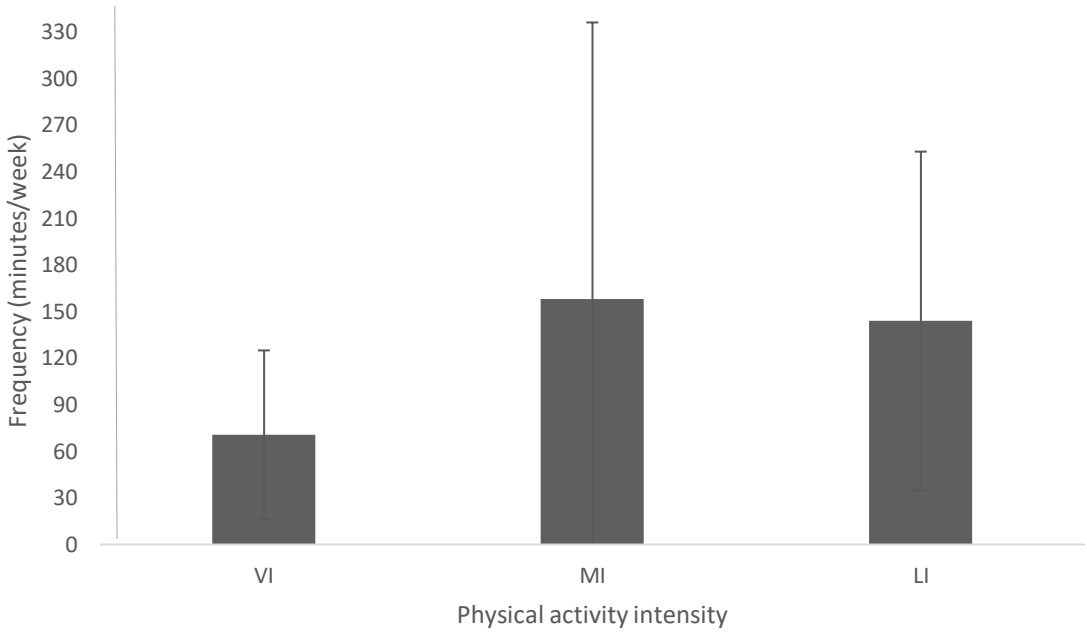


Figure 5: Mean (± standard deviation) minutes of vigorous, moderate and low physical activity performed per week.

*Frequency = number of days x duration, VI = Vigorous Intensity, MI = Moderate Intensity, LI = Low Intensity

The highest mean weekly minutes of physical activity were seen at a moderate intensity (158 ± 178.19 minutes, CV: 112.89%), followed by low-intensity physical activity (144 ± 109.04 minutes, CV: 75.77%), This finding was similar to the findings of the Godin questionnaire (GLTPAQ) which found a high percentage of the group to engage in moderate and low-intensity physical activity (69% and 79.20% respectively) on approximately 2 or 3 days of the week. The lowest amount of physical activity reported in the IPAQ was in the vigorous-intensity category (70.54 ± 54.36 minutes, CV: 77.06%), also supported by the GLTPAQ findings which showed the smallest percentage of the group (50%) reported vigorous-intensity activity on approximately one day per week. As a group, comparing their average weekly minutes of activity at each intensity to the public physical activity guidelines, they are meeting the guidelines for vigorous and moderate intensity activity. Looking at the participant's individually, however, only 60.42% of the participant group were meeting or exceeding the guidelines

(N=29). The high standard deviation and coefficient of variation reflect the large inter-individual variation in physical activity levels.

There was a strong, non-significant, positive correlation ($p>0.05$, $R^2 = 0.95$) between moderate-intensity activity levels and total physical activity levels (Figure 6). The clustering at the lower spectrum of moderate-intensity activity in relation to total physical activity suggests the group spent more time engaging in moderate-intensity physical activity, compared to other intensities, in relation to their overall physical activity participation. The small number of outliers reiterate the homogeneity of high moderate-intensity physical activity participation in total physical activity levels.

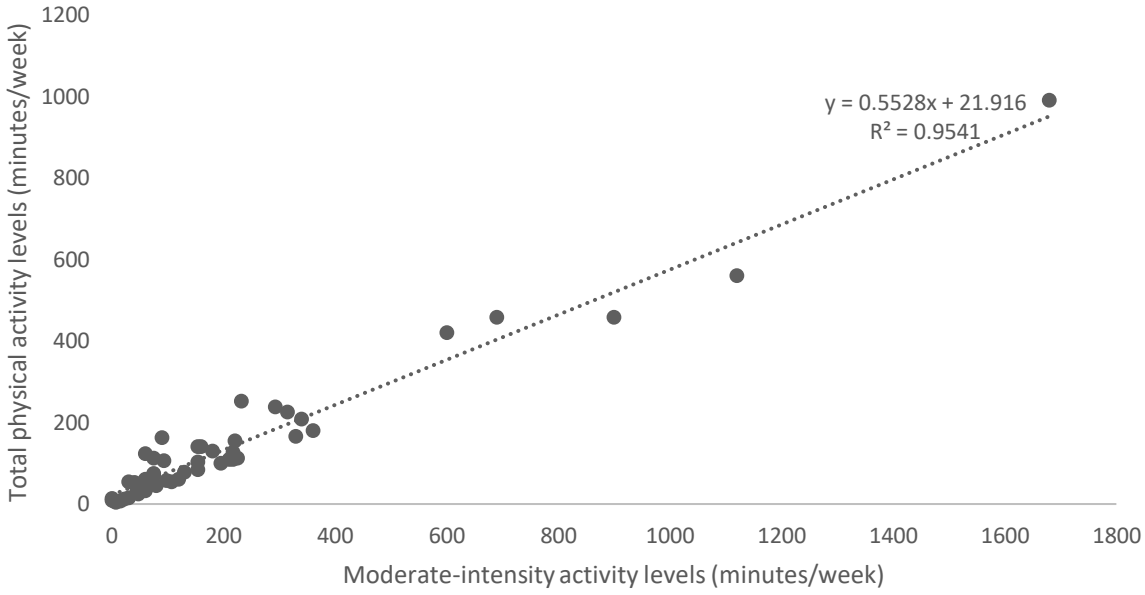


Figure 6: Individual data for minutes of moderate-intensity physical activity and total physical activity levels per week.

Figure 7 shows the average minutes per week of physical activity performed at each intensity in each physical activity category.

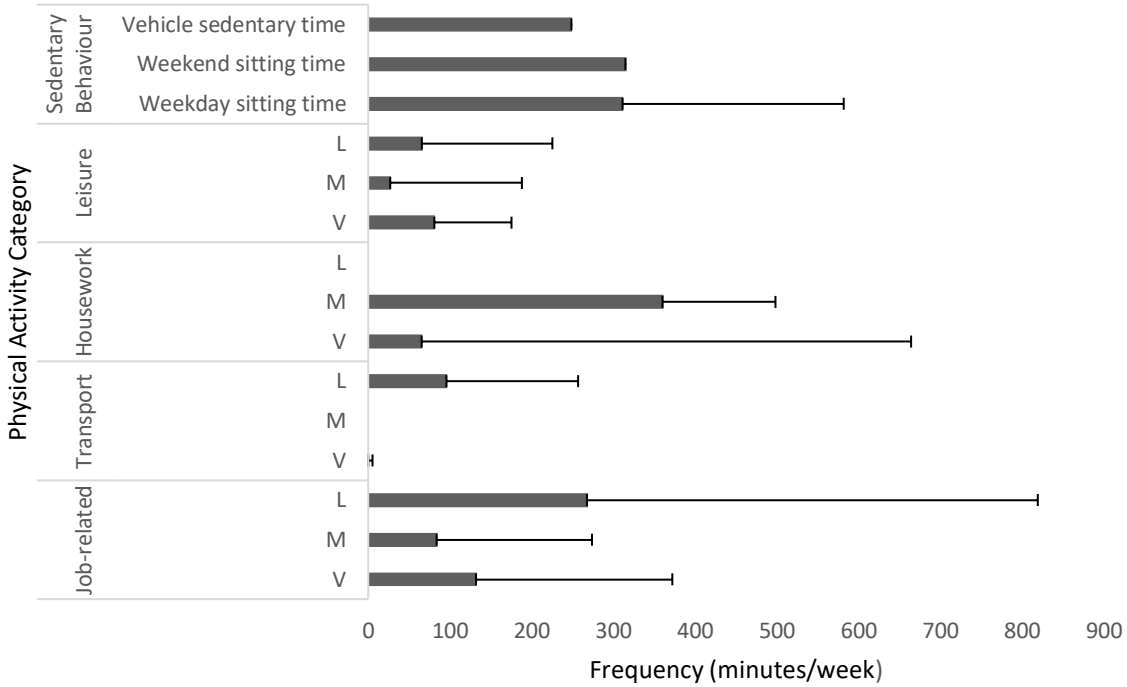


Figure 7: Mean (± standard deviation) minutes of physical activity and sedentary time per week in each category.

*V = vigorous intensity; M = moderate intensity; L = low intensity

Table 8 shows the minutes of weekly physical activity and sedentary behaviour by category and intensity, including the minimum and maximum minutes engaged in.

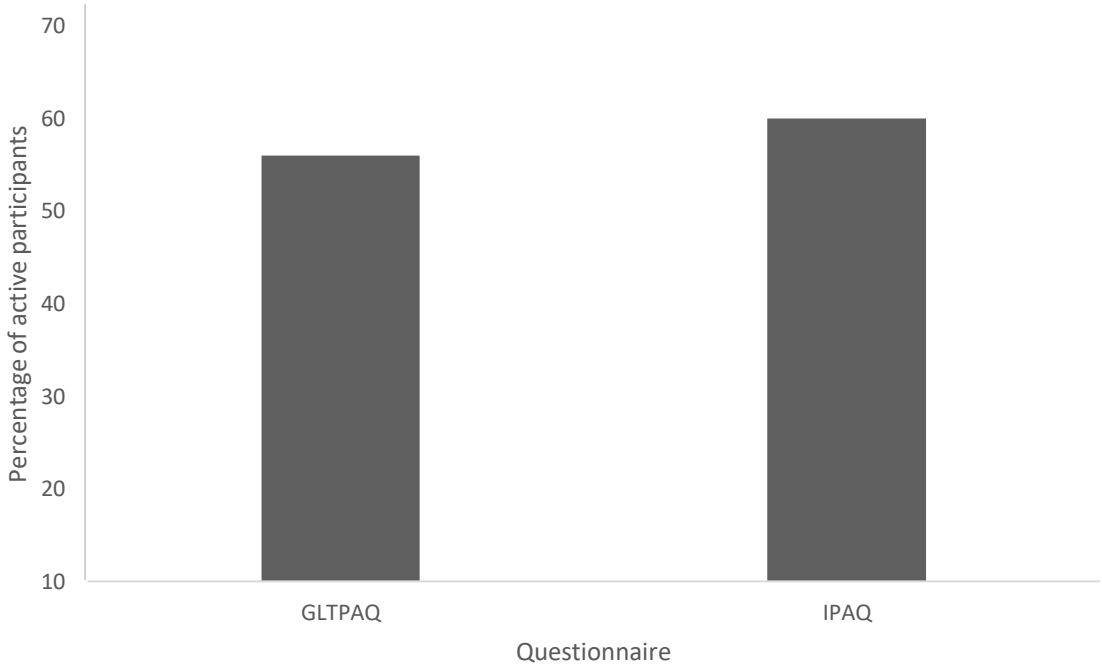
Table 8: Minutes of weekly physical activity by intensity, in each physical activity category.

	Physical Activity Category			
	Job	Transport	Housework	Recreation
Vigorous Intensity				
Mean	132.91	1.04	66.35	81.85
(min & max)	(0 & 960)	(0 & 20)	(0 & 720)	(0 & 600)
n	45	48	48	48
Moderate Intensity				
Mean	84.65		360.99	27.92
(min & max)	(0 & 900)		(0 & 3360)	(0 & 420)
n	45		48	48
Low Intensity				
Mean	268.61	96.66		66.46
(min & max)	(0 & 2940)	(0 & 960)		(0 & 480)
n	45	48		48

It is evident that the highest average frequencies of vigorous and low-intensity physical activity were seen in the job-related category (133 ± 239.17 minutes, CV: 179.95 and 268.61 ± 550.66 minutes, CV: 205.01% respectively), although the greatest variation was also seen in this data. The participants participated most frequently in moderate-intensity physical activity through housework related activities, both in the house and in the garden (361 ± 597.86 minutes, CV: 165.62%). The low-intensity activity refers to walking, and this group reported an average of over 60 minutes of weekly walking in all categories where walking was reported. The greatest amount of time spent being sedentary was in the reported number of minutes of sitting time over weekends (315.64 ± 158.86, CV: 50.33%). Although referring to Figure 7 the group meets physical activity recommendations, they are, on average, also participating in a similar frequency of sedentary time.

4.3.4 Comparison between the GLTPAQ and IPAQ findings

Figure 8 represents the percentage of the participant group who were meeting physical activity guidelines based on their answers to the GLTPAQ, and those meeting guidelines based on their IPAQ responses.



*GLTPAQ = Godin leisure-time physical activity questionnaire, IPAQ = International physical activity questionnaire

Figure 8: Percentage of participants meeting guidelines according to the GLTPAQ and the IPAQ.

According to responses to the Godin leisure-time physical activity questionnaire, 56% of participants were meeting physical activity guidelines (Figure 8). Similarly, 60% of participants

were meeting guidelines based on the responses to the International physical activity questionnaire section of the online survey (Figure 8).

4.4 PHYSICAL ACTIVITY, SEDENTARY BEHAVIOUR AND PARTICIPANT CHARACTERISTICS

4.4.1 Age, physical activity and sedentary behaviour

Table 9 shows the number of women above or below the age of 50 years that, according to their reported physical activity levels, were active or not (based on GLTPAQ data), and met the recommended levels of physical activity (based on IPAQ data). There were very similar numbers who were active in the older and younger age groups according to the LSI, but interestingly, there was a higher number of survivors in the younger group who were insufficiently active. A similar number of women in both age groups were meeting the recommended minutes of vigorous-intensity activity, but a greater number of the <50 years age group were not meeting guidelines. For moderate-intensity and total physical activity, a greater number of women in the younger group were meeting guidelines than in the older group, but similar numbers were not meeting guidelines in these categories.

Table 9: Number of participants meeting physical activity guidelines in different age categories.

	LSI Interpretation			Meeting VI Guidelines		Meeting MI Guidelines		Meeting TPA Guidelines	
	A	MA	IS	Y	N	Y	N	Y	N
< 50 years (n=27)	13	6	8	8	19	14	13	17	10
≥50 years (n=21)	14	4	2	9	12	8	13	10	11

*LSI = leisure score index; VI = vigorous intensity; MI = moderate intensity; TPA = total physical activity*A = active; MA = moderately active; IS = insufficiently active; Y = yes; N = no

There was a weak, negative, non-significant correlation (p=0.96, R^2 = 0.002) between total minutes of sedentary behaviour and participant age (Figure 9).

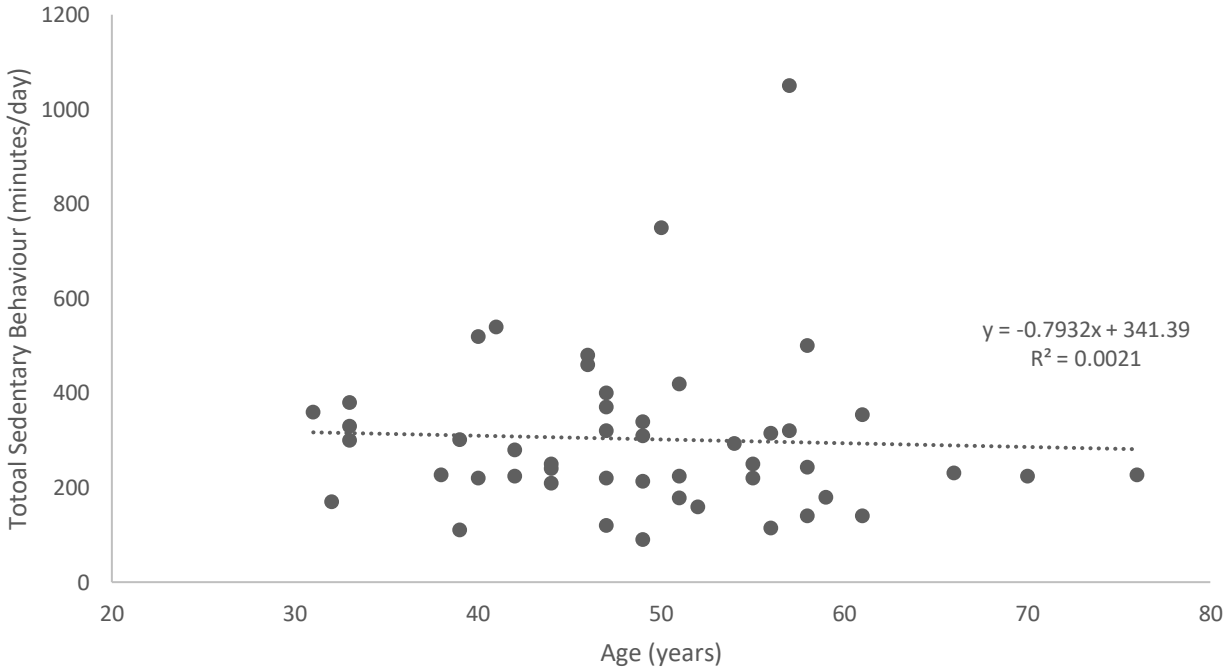


Figure 9: Participant age and total minutes of sedentary time.

4.4.2 Physical activity, sedentary behaviour and body mass index

There was a weak, non-significant, positive correlation (p=0.38, R^2 = 0.05) between body mass index and moderate-intensity physical activity levels (Figure 10).

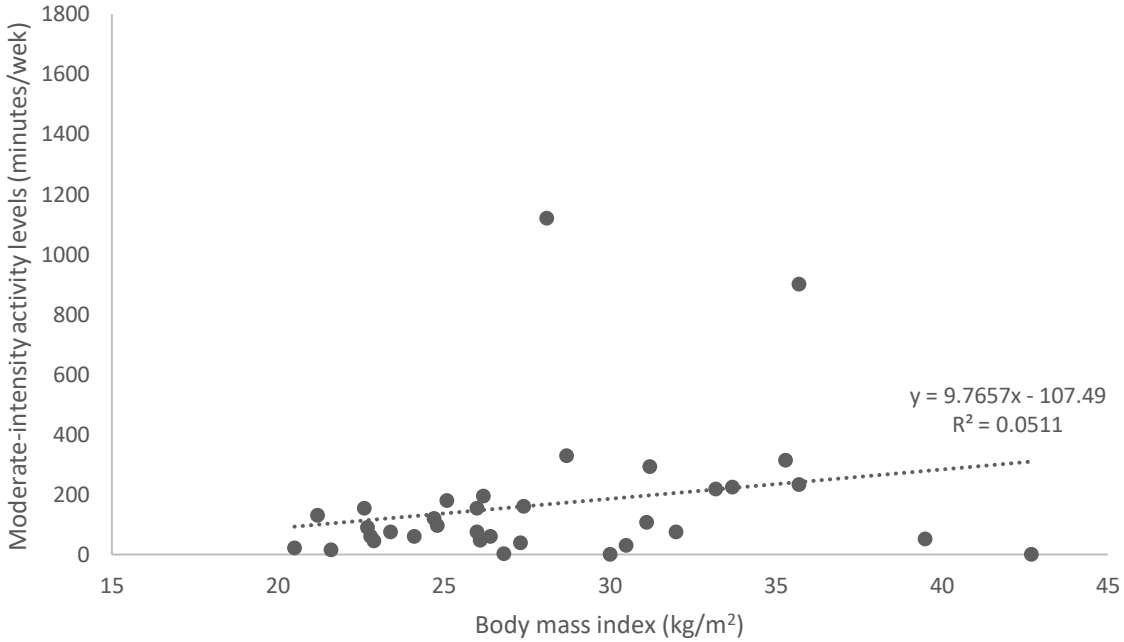


Figure 10: Participant body mass index and weekly minutes of moderate-intensity physical activity.

There was a weak, non-significant, positive correlation (p=0.09, R^2 = 0.1) between participant body mass index and their total sedentary behaviour minutes (Figure 11).

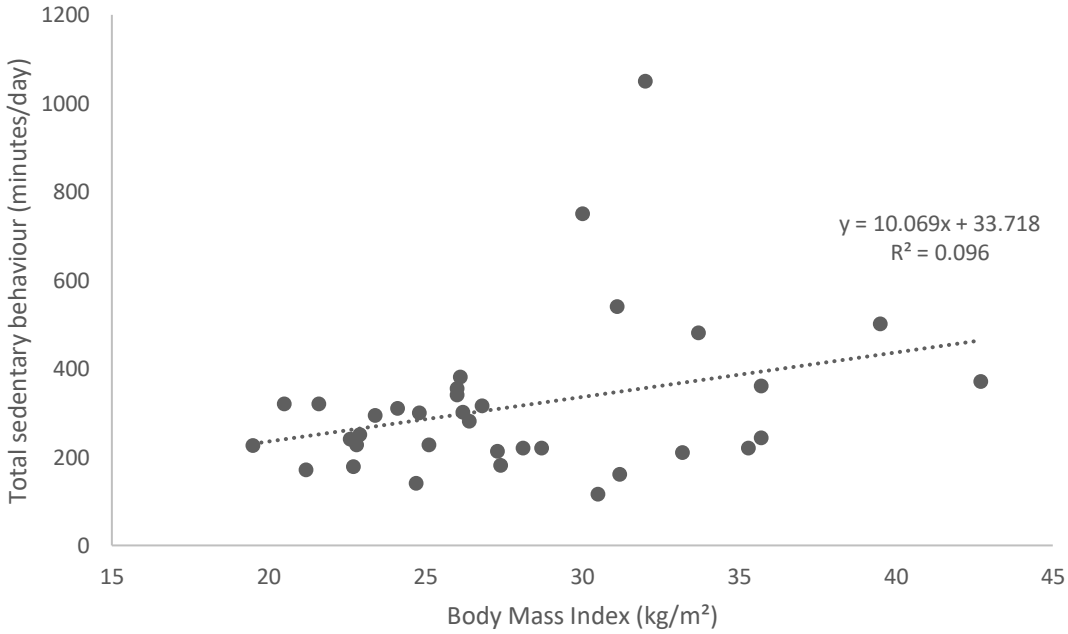


Figure 11: Participant body mass index and total minutes of sedentary behaviour.

4.4.3 Medical characteristics, physical activity and sedentary behaviour

There was a weak, negative, non-significant correlation (p=0.20, R^2 = 0.04) between participant's cancer stage at diagnosis and their weekly minutes of moderate-intensity physical activity (Figure 12).

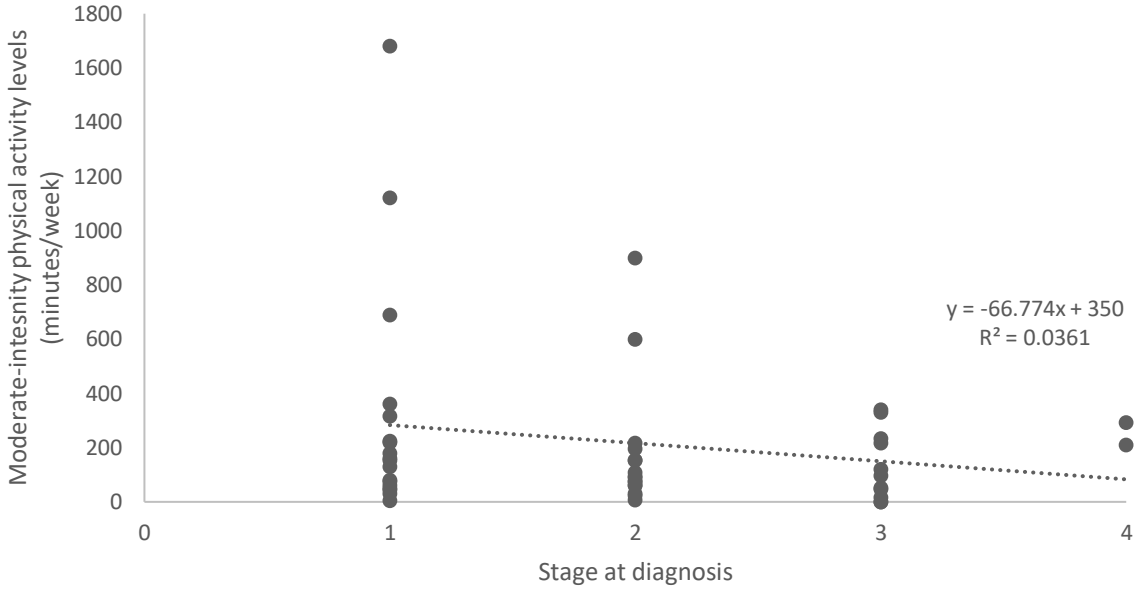


Figure 12: Weekly minutes of moderate-intensity physical activity and cancer stage at diagnosis.

There was a weak, non-significant, negative correlation (p=0.23, R^2 = 0.01) between the participant's weekly vigorous-intensity physical activity levels and their stage of cancer at diagnosis (Figure 13).

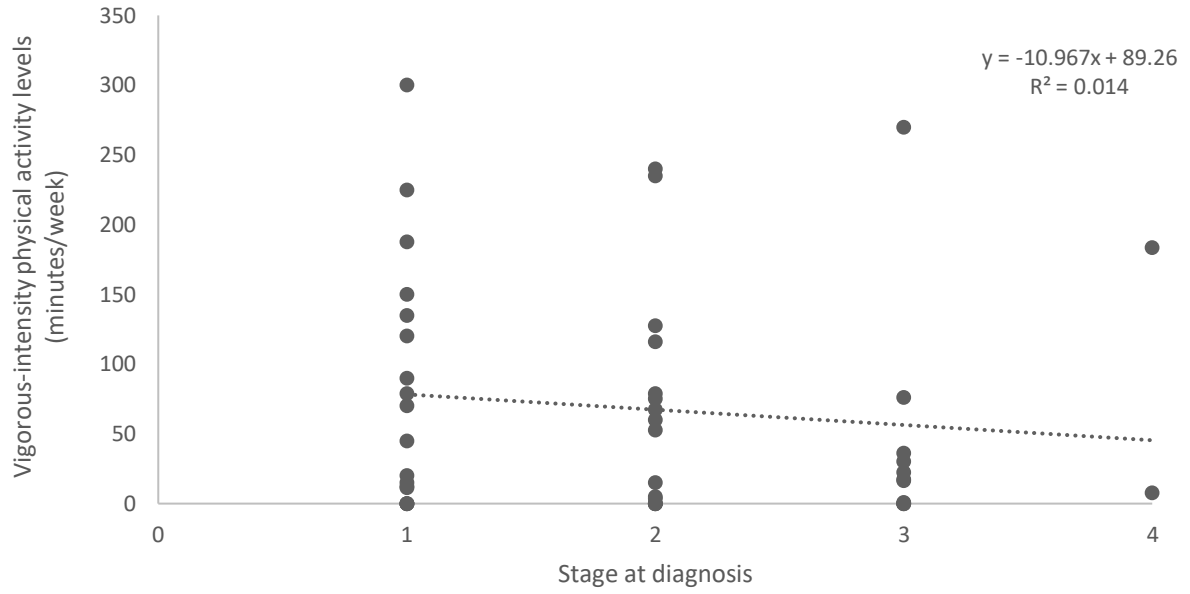


Figure 13: Weekly minutes of vigorous-intensity physical activity and cancer stage at diagnosis.

There was a weak, non-significant, positive correlation (p=0.40, R^2 = 0.02) between the participant's stage of cancer at diagnosis and total time spent sedentary (Figure 14).

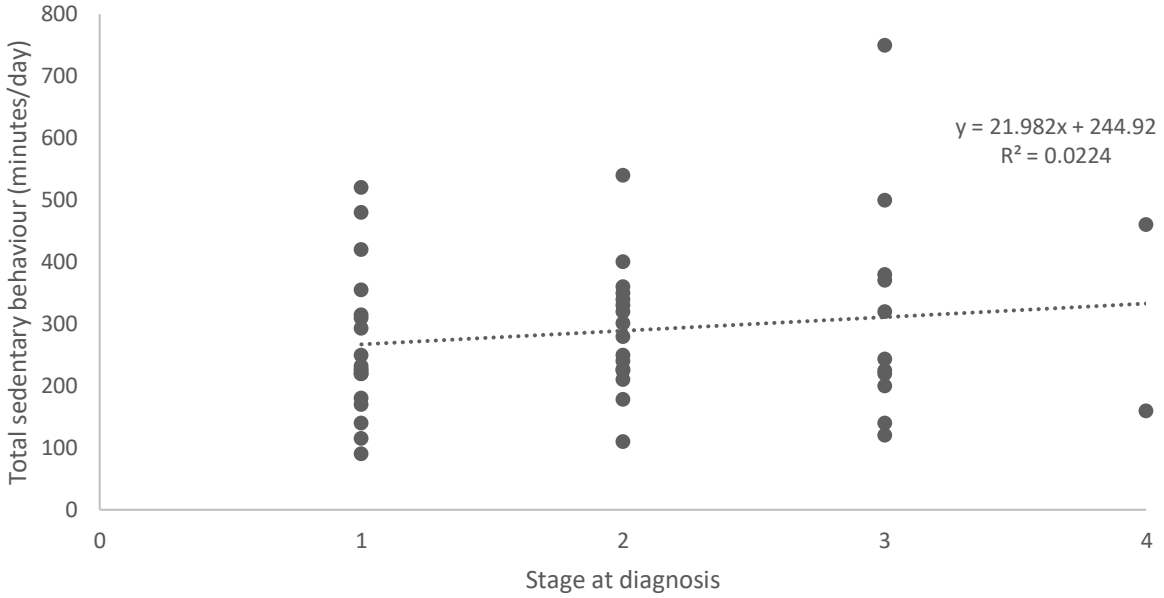


Figure 14: Average minutes of time spent sedentary and cancer stage at diagnosis.

4.5 PHYSICAL ACTIVITY ADVICE AND PARTICIPATION PREFERENCES

Of the 48 respondents, 34 (70.83%) expressed interest in receiving (or wishing they had received) physical activity advice after being diagnosed with breast cancer (Table 10). They

indicated preferring to receive information from an exercise specialist at a cancer centre (41.50%) or having no preference for who gave them the advice (24.40%). The face-to-face medium for receiving advice was most frequently chosen (60.98%), followed by a brochure/pamphlet (29.27%). Receiving information at a cancer centre (65%) and before treatment began (57.50%) were the preferred setting and time to obtain physical activity advice.

Table 10: Breast cancer survivor's preferences for receiving physical activity advice.

Preference variable	n (%)
Would have liked physical activity advice after diagnosis (n=48)	
Yes	**34 (70.83%)**
No	6 (12.50%)
Maybe	8 (16.67%)
Preferred person to receive advice from (n=41)	
Physician	7 (17.10%)
Nurse	0
Exercise specialist in cancer centre	**17 (41.50%)**
Exercise specialist in gym	3 (7.30%)
Cancer patient/survivor	4 (9.76%)
No preference	10 (24.40%)
Preferred medium for receiving advice (n=41)	
Face to face	**25 (60.98%)**
Videotapes	4 (9.76%)
Brochure/pamphlet	12 (29.27%)
Preferred setting in which to receive advice (n=40)	
Cancer centre	**26 (65%)**
Gym/community centre	4 (10%)
Home	10 (25%)
Preferred time to receive advice (n=40)	
Before treatment	**23 (57.5%)**
Immediately after treatment	6 (15%)
3-6 months post-treatment	6 (15%)
At least 1-year post-treatment	5 (12.50%)

Bold text indicates the majority response.

The majority of the group (71.10%) expressed interest in participating in a physical activity programme, and 82.05% felt capable of taking part in an exercise programme (Table 11). The most popular time to commence a programme was immediately after treatment (30.78%),

followed by 28.21% indicating a preference for starting before their treatment course began. The most commonly preferred exercise type was walking (65%). A home-based programme, or no preference for exercise setting, were the most frequently reported setting options (27.50% for both). Of the group, 32.50% preferred exercising with one or two other people, and a total of 57.50% of respondents chose moderate-intensity physical activity. There was a strong, positive, non-significant correlation ($p>0.05$, $R^2 = 0.72$) between the participant's interest in participating in an exercise programme and feeling capable of being part of one.

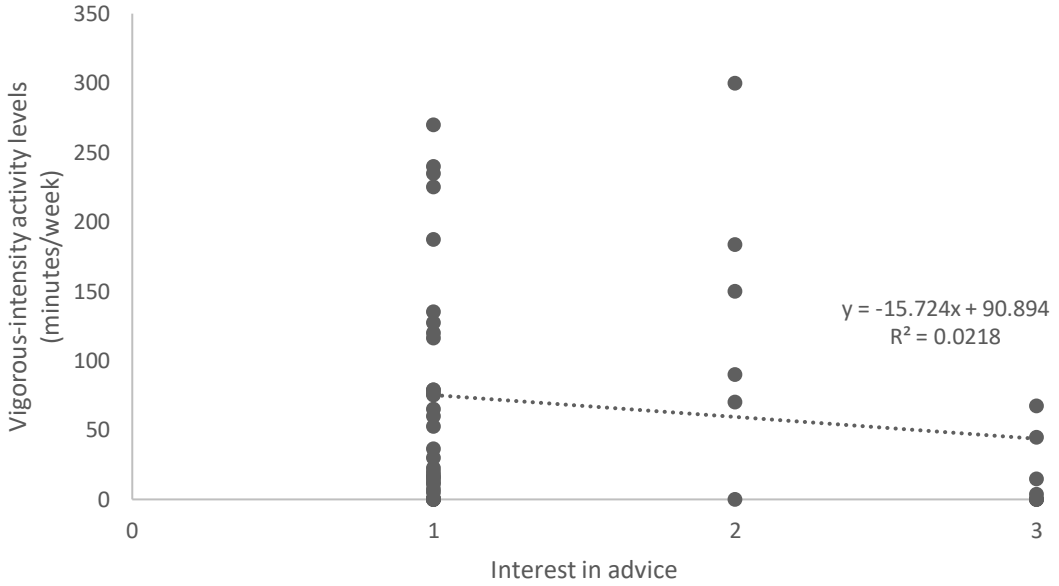
Table 11: Breast cancer survivor's preferences for participating in a physical activity programme.

Preference Variable	n (%)
Interested in participating in physical activity programme (n=45)	
Yes	**32 (71.10%)**
No	6 (13.30%)
Maybe	7 (15.60%)
Preferred time to commence a programme (n=40)	
Before treatment	11 (28.21%)
Immediately after treatment	**12 (30.78%)**
3-6 months post-treatment	4 (10.26%)
At least 1-year post-treatment	2 (5.13%)
No preference	10 (25.64%)
Preferred type of exercise (n=41)	
Walking	**26 (65%)**
Swimming	3 (7.50%)
Preference	11 (27.50%)
Preferred setting in which to exercise (n=41)	
Home	**11 (27.50%)**
Gym	4 (10%)
Outdoors	9 (22.50%)
Cancer centre gym	5 (12.50%)
No preference	**11 (27.50%)**
Preferred company during exercise (n=41)	
Alone	7 (17.50%)
Family member	5 (12.50%)
1 or 2 people	**13 (32.50%)**
Large group	5 (12.50%)
No preference	10 (25%)
Preferred intensity of physical activity (n=41)	
Low	7 (17.50%)
Moderate	**23 (57.50%)**
High	5 (12.50%)
No preference	5 (12.50%)
Feel capable of participating in a physical activity programme (n=41)	
Yes	**32 (82.05%)**
No	4 (10.26%)
Maybe	3 (7.69%)

Bold text indicates the majority response.

4.5.1 Physical activity levels and interest in receiving physical activity advice

There was a weak, negative, non-significant correlation ($p>0.05$, $R^2 = 0.22$) identified between reported vigorous-intensity activity levels and interest in receiving physical activity advice (Figure 15).



*Interest in advice: 1 = Yes, 2 = No, 3 = Maybe

Figure 15: Participant's interest in receiving advice and reported minutes of vigorous-intensity activity per week.

4.6 SUMMARY OF KEY FINDINGS

A large proportion of this cohort were active and meeting physical activity guidelines. The greatest physical activity levels were seen further from diagnosis, and more women in the <50 age group were insufficiently active (GLTPAQ) and not meeting guidelines (IPAQ). High sedentary time was reported, despite participants meeting physical activity guidelines, through weekday and weekend sitting time, and time spent in a vehicle. Moderate-intensity activity was the most frequently reported, matching the majority preference for physical activity at a moderate intensity. High levels of interest in receiving physical activity advice and participating in an exercise programme were observed, and the majority of the participants felt capable of participation. The main preference findings included participants wanting to receive physical activity advice before treatment and begin a home-based programme immediately after treatment completion.

CHAPTER 5

DISCUSSION

Cancer makes up a significant portion of both the global[5,60] and South African burden of disease[60,65] and is responsible for a large number of deaths in the non-communicable disease category[5]. The burden of disease in South Africa is unique to other countries due to the disparities in resource and health-care availability within the country[7,57-59,180]. The overall burden attributable to cancer in South Africa is rising[1], and breast cancer plays a significant role, being the leading cancer in South African women[8,54]. While the benefits of physical activity through the course of breast cancer are well established, and the physical activity levels and preferences of breast cancer survivors well researched in developed countries, there is a gap in research of this kind in a South African context. The protective effect of regular physical activity in cancer is undisputed[85], highlighting the importance of further research into physical activity and cancer globally.

The findings of this study aimed to address the following objectives: 1) Identify the prevalence of physical (in)activity and sedentary behaviour in South African breast cancer survivors; 2) Profile physical activity behaviour of South African breast cancer survivors in terms of type, intensity and frequency of physical activity; 3) Build an evidence base around the physical activity preferences (both interventions and advice) of South African breast cancer survivors.

This chapter aims to compare and explain the exercise preferences, and the physical activity and sedentary behaviour levels of a group of South African breast cancer survivors in relation to literature and to breast cancer survivors globally. To the author's knowledge this is one of the first studies which examines the physical activity and sedentary behaviour levels and physical activity preferences of South African breast cancer survivors.

The main finding of this study was that, as a group, these South African breast cancer survivors were meeting the physical activity guidelines. When looking at the individual data, 60% of the participants met the guidelines. However, the results also show high levels of sedentary time both in those who did and didn't meet the guidelines. Further, a majority of the participants indicated an interest in receiving physical activity advice, and of feeling both capable, and interested in, participating in a physical activity programme.

5.1 PARTICIPANT CHARACTERISTICS

There are both similarities and differences when comparing this group of South African breast cancer survivors to other cancer survivors globally. The mean age of the participants was 49 years, with over half (56%) aged below 50 years. This is interesting considering that research has found breast cancer risk to increase significantly after the age of 50[4,15], so one might expect a greater number to fall into the 50-60 years age category. It is possible that the younger average age of this group compared to other survivor groups is due, in part, to the online nature of the research. Older participants may not have felt as comfortable having to complete the survey online or may not have the social media platforms through which much of the research advertising happened so were not aware of it. These findings differ from some studies on other cancer types, including colorectal cancer[44], which found the average age to be 61 years, and a majority of the participants to be above 65 years[44,45]. Previous breast cancer research has found a mean age of 66.30 years[142] and 55 years[141] which is older than the mean age of these participants. Other research on a mixed group of cancer patients found approximately equal numbers to fall both above and below 50 years[112]. These South African participants were also younger than a group of Korean cancer survivors, where a majority were aged over 60 years, and only a small percentage were below the age of 50 years[117].

The most common stage identified at diagnosis in the current study was stage I breast cancer, followed closely by a stage II diagnosis, corroborating other studies on a variety of cancers which found that, of those aware of their staging, stages I and II were the most commonly identified at diagnosis[44,45,46,112]. A weak, negative, non-significant correlation ($p=0.06$ $R^2 = 0.04$) was found between cancer stage at diagnosis and age. It is encouraging that so many women in this sample detected the disease at an early stage due to the potential barriers present in the South African context. As a resource-constrained country, South Africa does not have a national mammography screening programme so women with breast cancer symptoms typically self-present to primary healthcare facilities[54]. However, deficits in breast self-awareness and knowledge of breast cancer symptoms can lead to a delayed interpretation of abnormal body changes and result in later diagnoses than necessary[54]. With only approximately 15% of women with breast cancer having private healthcare available to them in South Africa, there are many barriers to screening, education and access to medical centres for those women in the remaining 85%, which can lead to diagnosis only at a later stage of the

disease[6,7]. There is evidence of significant variation between age and stage at diagnosis between rural and urban populations in South Africa[6]. Rural black women in particular are affected more than urban women by cultural and socioeconomic determinants, and accessibility to medical facilities, which can affect their decision to get early medical help[6]. Differences in race and rural vs. urban populations were not investigated in the current study and is something that should be considered in the future. More recently, changes in awareness and access to care have seen the percentage of women presenting with stage II or lower, doubled[7]. The results suggest that the women who participated in this study had greater exposure to knowledge, screening and oncologic services. Treatment choice can often depend on the stage of breast cancer[109], so participants in this study who had been diagnosed at an earlier stage may have been more inclined to choose a certain treatment course compared to those who were diagnosed at a later stage of cancer.

The majority (72.92%) of this group of cancer survivors were diagnosed less than five years ago which is similar to colorectal cancer survivors where the majority of the group was observed to have been diagnosed less than five years ago[44]. In contrast, another study of breast cancer survivors classified their group as long-term survivors with an average of 10.1 years since diagnosis[142], where only 6.3% of the current group would be classified as long-term survivors, having been diagnosed over 15 years ago. This difference could be based on recruitment method, where the current study stipulated that participants could be undergoing treatment or have completed their treatment course, the other study was looking specifically for post-treatment breast cancer survivors so were likely to recruit more longer-term survivors[142]. Compared to only 20.80% of these survivors reporting a diagnosis five or more years ago, the majority of a mixed group of cancer survivors reported having been diagnosed five or more years ago[117].

5.2 PHYSICAL ACTIVITY LEVELS

The findings in this section reject, to an extent, the first research hypothesis, as they provide evidence of South African breast cancer survivors meeting the physical activity guidelines. These findings don't wholly contrast research hypothesis one however as a percentage of the participants were not active enough to meet guidelines. They also reject research hypothesis three as none of the demographic or medical variables were found to be significantly associated with physical activity.

Based on the group's average physical activity levels, the guidelines for moderate and vigorous-intensity physical activity are being met (Figure 5); at least 150 minutes of moderate-intensity activity, 60 minutes of vigorous activity, or an equivalent combination of both, per week[3,4,20,65,70,73]. However, as not every person in the participant group is meeting these recommendations (40% of the group), it emphasises the importance of taking an individual approach. The Cancer Association of South Africa, as an organisation, promotes physical activity in South African cancer survivors through running online challenges on their website encouraging frequent exercise engagement; and by posting articles explaining how survival can be increased through staying active[8]. Being a well-recognised cancer organisation in South Africa, cancer survivors may be motivated by these challenges and information, understanding the benefits to their cancer outcomes and survival. As some of the study's participants were recruited through CANSA, this could explain, in part, why many in the group are already physically active. Although 60% of the participants were meeting physical activity recommendations, this was occurring concurrently with high levels of sitting time through the week and weekend, as well as through sedentary behaviour in non-active transportation (i.e., time spent in a vehicle) (Table 7). This interaction is interesting, as people can both be meeting physical activity guidelines and exceeding recommendations for time spent being sedentary. It needs to change, as the adverse effects of physical inactivity and sedentary behaviour are far-reaching[16,17,18]. In these cases, physical activity levels need to be high enough both for the health benefits of exercise to be felt and to reduce the harmful effects of the sedentary behaviour[70,74]. The most evident limitation of the current study is that all data obtained about physical activity levels, sitting time and preferences was self-report, subjective data gathered through an online survey. It is possible, when considering the juxtaposition of high levels of sedentary time and high levels of physical activity, that through the self-report measures, participants may have over-reported their physical activity levels. The absence of significant correlations between vigorous and moderate-intensity activity levels and body mass index, for instance, highlight the seemingly absent effects of physical activity on this measure, and could thus explain what is described as over-reporting[9,175]. The lack of significant correlations could also be explained, in part, by the high variation in the data due to the small sample size. As the online survey was open both before and during the South African Covid-19 lockdown, some participants reported on physical activity levels prior to this period, and some reported on their physical activity levels during the lockdown period. This presents a limitation of the study and

may explain the high variability in the data. Gathering objective data in conjunction with the subjective methods would be a useful way for future research to supplement the data and gain more accurate and reliable findings. Subjective measures are practical[177] and allow for physical activity information directly from the individual at any one time, such as duration, frequency and intensity of their activity. Additionally, subjective methods such as self-report questionnaires can be modified to suit the target participant group. Objective methods will allow for a more continuous evaluation of physical activity and an evaluation of metrics such as heart rate to verify the intensity at which the individual perceived they were exercising[178].

Previous research consistently reports low levels of physical activity in cancer survivors generally, despite the extensive evidence base of the associated health and quality of life benefits[32,45,50,112]. Reasons for this range from physical barriers including fatigue and pain, to financial and environmental barriers such as high cost and weather extremes[45,112-116]. A lack of motivation and interest in physical activity on the part of the individual, and a lack of exercise advice and encouragement from oncologists and physicians can also create barriers to being physically active[45,112-116]. Typically, physical activity rates of cancer survivors decline post-diagnosis and during treatment[32,34,44,45,110], and most cancer survivors are not meeting physical activity guidelines[45,50,110,137], which matches the 40% of the current sample who don't meet guidelines. However, the findings from the current study conflict this research as 60% of the sample met guidelines, making this group of breast cancer survivors more physically active than others. The focus of this study included the phases that occur post-diagnosis, so there is no pre-diagnosis data available. As such we cannot discern whether these breast cancer survivors became less physically active post-diagnosis, or if they were also inactive beforehand. There could be a number of reasons for the differences seen between the current group of breast cancer survivors and those from the previous studies. Most notably, many of the previous studies distributed their surveys by post[34,44,45,50,112], thus access to the internet was not necessary as it was for this study. The surveys from previous studies may have reached cancer survivors with a broader range of socioeconomic status and thus a greater range in cancer experiences and subsequent physical activity engagement. Additionally, although the current study was assisted by CANSA in advertising the research, participation was voluntary, requiring interested survivors to contact the research group themselves which resulted in a smaller sample size. This fact coupled with the sole focus on female breast cancer survivors means the findings may not be generalisable to the wider cancer population. In many previous

studies the participants were recruited through their physicians[112], a cancer registry[34,44,45,50], or through involvement in previous cancer studies[137] which resulted in much larger participant groups of different cancer survivors and could account for the different physical activity levels reported. A further contributing factor was that these previous studies investigated survivors of a range of cancer types[34,44,45,50,112,137], and with breast cancer survivors often demonstrating higher physical activity levels than other cancer types[78,112], it could suggest why this participant group reported more physical activity. Another underlying reason could be the context of the South African Covid-19 lockdown. A decrease in step counts and physical activity levels were seen immediately in many developed countries following the declaration of Covid-19 as a pandemic, and further following the various lockdowns put in place worldwide[184,185]. However, increases in physical activity levels were seen in many countries before lockdown restrictions were fully lifted[185] as people began to be allowed to walk and run outside their homes between certain times. Additionally, through restrictions on movement outside one's home, people chose alternate home-based exercise in an effort to stay active[186]. So the breast cancer survivors in this study, some responding to the survey during the lockdown, may in fact have increased their physical activity levels through having more time to engage in home-based physical activity, and through more walking once the exercise ban was lifted in South Africa.

Time elapsed since diagnosis is a medical variable that may be underlying the range in physical activity levels and those meeting the guidelines or not. Only weak, positive, non-significant correlations were found between time since diagnosis and participants meeting vigorous and moderate physical activity guidelines in this study ($p=0.28$, $R^2= 0.25$ and $p=0.10$, $R^2 = 0.21$ respectively). They suggest a tentative link between a longer time since diagnosis and increased numbers of survivors meeting physical activity guidelines. Cancer survivors typically increase activity levels with increasing time since diagnosis[110,133,142]. This is reflected in the current study where the category over 2.6 years since diagnosis saw the least inactive and most active survivors. When grouping the participants into post-diagnosis time categories and linking them to the number of sufficiently active survivors in each category, previous breast cancer research reported higher levels of activity in each phase of time since diagnosis (eight months, 1.6 years, 2.6 years and 10 years post-diagnosis)[110,133,142] compared to the current study. In this study only 8.3% of survivors were active in the first eight months after diagnosis, 16.7% were active 1.6 years post-diagnosis, 4.2% of survivors were active at 2.6 years and 27.1% active over 2.6 years following diagnosis (Figure 4). Based on the number of active

survivors in each phase of time since diagnosis in this study, it seems breast cancer survivors diagnosed both more recently and a longer time ago are interested in physical activity and how it could play a role in the course of their disease and their recovery. This is important and could increase interest in, and adherence to, physical activity programmes for breast cancer survivors or be a target for education in the 'middle' group. Stage of cancer at diagnosis is another medical characteristic that could play a role in physical activity. In the current study, weak, non-significant, negative correlations were found between minutes of moderate-intensity ($p=0.20$ $R^2 = 0.04$) and vigorous-intensity ($p=0.23$ $R^2 = 0.01$) physical activity and stage at diagnosis. It would be expected that diagnosis at a later stage of cancer could warrant stronger treatment, which could in turn yield more severe side effects and thus compromise a survivor's ability to be physically active[110]. Very weak, non-significant correlations were found here possibly as a result of the small sample size, so future research should incorporate this into their investigation with bigger sample sizes to identify whether cancer stage has a significant effect on physical activity levels.

Race is another contributing factor to physical activity levels, specifically when considering the South African context and the great ethnic diversity present. Along with other low- to middle-income countries, the adoption of a sedentary lifestyle is prevalent in South Africa[55], but perhaps more predominant in some populations compared to others. White populations of higher socioeconomic status generally have more physically active lifestyles than less affluent South Africans[21,56], and a higher education and family income are also typically linked to higher levels of activity[82]. A greater vulnerability to communicable diseases can also inhibit physical activity participation and is more prevalent in certain South African populations[21,56]. Different leisure time preferences between ethnic groups could also play a role here[55], where culturally some ethnic groups spend less time in physical activity during leisure-time, which lowers their overall physical activity levels. Additionally, people living in lower income households may have reduced leisure time due to needing to work more in order to provide. These are amongst a number of factors that could affect some cancer survivors meeting physical activity recommendations and demonstrate that there could be ethnic disparities in physical activity and sedentary behaviour levels in South Africa[55]. The differences seen in the current group of breast cancer survivors may have underlying links to these factors, however this study did not investigate race in an attempt to maintain social and political sensitivity. Future research in the

South African context should include race to identify whether there are significant links here as this could be considered a limitation of the study.

Based on responses to the Godin Leisure-Time (GLTPAQ) and International Physical Activity Questionnaires (IPAQ), over half of the survivor group were classified as active and meeting guidelines (56% and 60% respectively) (Figures 3, 5 & 8), compared to between 30-47% of cancer survivors in other studies achieving the recommended levels[44,50,138,142]. Studies on American mixed cancer survivors found that levels of physical activity differed based on cancer type, with only 32% of breast cancer survivors reporting regular activity[110,138]. The scenario in the Irwin[110] study may have been linked to the high numbers of overweight and obese individuals, as they showed that those with a higher body mass index did less physical activity. The lower percentage of survivors in the current study who were overweight and obese (65.72%) could explain their higher levels of activity. Further, breast cancer survivors are more likely to maintain any moderate-intensity activity and to increase their physical activity levels post-treatment compared to other forms of cancer[112]. Limited previous research has shown breast cancer survivors are more aware, and agree, that regular physical activity can act to reduce cancer risk compared to cervical, prostate, melanoma, colorectal and endometrial cancer survivors[138]. This could influence their likelihood of being more active. Of those participating in physical activity in this breast cancer group, a greater proportion were engaging in exercise at each intensity compared to a mixed group of cancer survivors[45]. Where over half of the current participants reported strenuous activity, 68.7% moderate activity, and over 70% mild activity; only 9.4% in the mixed survivors engaged in vigorous activity, 44% in moderate-intensity activity, and 66% in mild activity[45]. Breast cancer survivors being the group most likely to maintain or increase activity levels[112] could be one reason underlying the difference seen here. The other study investigated a mixed group which may have included cancer types who are typically less physically active. Additionally, the survivors in the mixed group were asked explicitly about barriers to exercise participation[45], and so could have been more likely to report lower levels of activity because they were reminded to account for any barriers.

The high levels of moderate-intensity physical activity in the GLTPAQ and IPAQ findings, particularly in housework-related activity reported in this study (Figure 7), has been shown by others[9,45,78,141]. In the current study, 68.75% reported engaging in moderate-intensity activity, with an average of 361 minutes of weekly moderate-intensity physical activity in the house and

garden. This suggests that housework-related moderate-intensity physical activity could be comfortable and match the capabilities of many breast cancer survivors. On the other hand, stereotypically women do more around the house which could explain why this category demonstrates the highest levels of activity for this group. Interestingly, there were higher levels of activity reported by this group of participants in the job-related category (at all intensities) than in the leisure activity category. Based on the Godin Leisure-Time results where over half of the group were active through leisure-time activity, this result is unexpected. However, the majority (87.50%) of the sample indicated still being employed, so it makes sense that there would be some physical activity engagement in this category. Similar research has found varying results for the numbers of survivors still employed, some reporting only 31% of the group to be employed[44], and another observing the majority to be employed[9]. Some research makes a distinction between white and blue collar employment[9,117], where others just look at employment status generally[12,44]. Importantly, a limitation of this study is that the type of employment was not asked, thus the types of occupational physical activity performed in the workplace cannot be identified. It is important that future research includes a question on the type of work, following a question about employment status. A further limitation of this study was the use of mean data from the International Physical Activity Questionnaire (IPAQ), as opposed to median data, for comparison purposes with other physical activity and cancer research. As such, the IPAQ results cannot be compared to general physical activity research using the IPAQ, as typically median data is used in research on physical activity in the general population.

Comparing women above and below the age of 50 years (Table 9), a greater number in the younger age group were meeting guidelines for moderate and total levels of physical activity based on their IPAQ responses. This is expected because increasing age is associated with reduced levels of activity[9,141,142]. In contrast, similar numbers in both age groups reported sufficient vigorous-intensity activity (IPAQ) to meet the guidelines, and which is contrary to evidence demonstrating lowered activity levels with age[9,141,142]. Interestingly, more women below 50 years were insufficiently active based on their LSI score (GLTPAQ) compared to those 50 years and older, which is in contrast to another study done on breast cancer survivors showing that older women were more likely to be insufficiently active[9]. It could be that the older women are retired, and no longer having an office bound job opens up time for leisure activities such as gardening, which add to leisure-time physical activity levels. This is speculative

however and needs to be investigated further. No significant relationship was found between age and physical activity level of any intensity, possibly due to the small sample size which constitutes a limitation of the research. This result is unexpected due to the repeated findings of other studies which have shown reduced activity levels with increasing age[9,141,142]. A larger sample size would increase statistical power and allow insight into a greater proportion of the South African breast cancer survivor population.

5.3 TREATMENT AND PHYSICAL ACTIVITY

Every participant in this group reported undergoing some form of treatment after their breast cancer diagnosis, resulting in a broad range of treatment combinations in the findings.

The most frequently reported treatment was surgery in conjunction with either radiation or chemotherapy, followed closely by a combination of all three treatment courses, similar to a mixed sample of cancer survivors who indicated surgery with either radiation or chemotherapy to be the most common course[45]. In contrast, other research observed surgery alone to be the most common treatment course[112], while other breast cancer survivors reported radiation alone to be the treatment most often undergone[110] and ovarian cancer survivors reported chemotherapy and surgery to be the most frequent treatment courses[50].

Literature suggests that physical activity participation rates can be negatively affected by cancer treatment and side effects, which can affect quality of life and how people feel, and subsequently the energy they have to be physically active[9,32,45,78,89,101,103,109,110]. For instance, breast cancer patients who underwent surgery, radiation, and chemotherapy reported more significant decreases in activity levels following treatment than those who only underwent surgery, or surgery together with radiation[110]. Some treatment courses can reduce physical functioning, so various treatments can determine how physically active a survivor is capable of being[32,45,109]. This is interesting in the context of this study, as the broad range of treatment courses and subsequent side effects could play a role in the physical activity levels reported by the participants. With the treatment combination of chemotherapy, surgery and radiation being the second most common course amongst the survivors in this group, there could be a link with the low activity participation rates reported by some participants due to previous links found between this particular course, quality of life and exercise ability[110]. The current study didn't employ a quality of life measure, but future research should as it will be useful to see

how physical activity can play a role in enhancing quality of life following diagnosis, and how quality of life can be affected by treatments and side effects, and in turn affect exercise ability.

5.4 SEDENTARY TIME

The following findings support the second research hypothesis as they provide evidence of high levels of sedentary behaviour, exceeding recommendations for sedentary time, amongst South African breast cancer survivors. On the other hand, they reject research hypothesis three as none of the demographic or medical variables were found to be significantly associated with sedentary behaviour levels.

Initial research indicates that cancer survivors spend up to two-thirds of their waking hours sitting[85], and the current South African group of survivors demonstrate this, reporting high levels of average sitting time in the IPAQ section of the survey (weekdays: 312.17 minutes; weekend: 315.64 minutes). The IPAQ is a tool often used in research gathering data about levels of sitting time, thus raising the validity of the consideration of this parameter in the current study. Typically, there would be a considerably higher average sitting time expected over the weekend, so these findings could indicate more sitting time in the workplace during the week. Lower levels of occupational physical activity and greater sitting time at work could be as a result of the introduction of mechanisation and labour-saving devices in workplaces[16,17,20], and technological advances automating many daily tasks where minutes of physical activity might have been gained[85]. Although in 2012 trends showed greater decreases in occupational physical activity in high-income countries[20], more recently low- to middle-income countries such as South Africa are facing this risk through the social, technological and economic transitions and developments that could decrease the physically active demands of daily life and work[16,17,85]. Once again, however, the lack of questions about work type mean the specific types of sedentary behaviour engaged in by the participants in their workplace cannot be identified. The high variation in weekday sitting times further necessitate the need to ask about job type, as the variation could be explained by how sitting time occurs in individual jobs. Further, the participants reported an average of 250 minutes per week of sedentary behaviour by way of time spent sitting in a vehicle, which could be accounted for by the increases in motorised transportation and the subsequent move away from active transportation[16,17,20]. Sedentary behaviour seems to be largely driven by sedentary transport, so incorporating more standing and moving into the work and home environment may work

to offset the effects of this. Due to the online nature of this research and the necessity of access to a laptop/smartphone, the current participant group may be of a higher socioeconomic status, as alluded to earlier. As a result, more of the group may have cars which could underlie the high sedentary time seen through time spent in a vehicle. Thus, although this participant was meeting the physical activity guidelines, this was offset by high levels of sitting time which has been shown previously[20,55,83]. These findings are important given the fact that sitting time and sedentary behaviour can play a negative role in recovery from, and prognosis of, breast cancer (and other cancer types)[28,78,85,152-155].

A weak, negative, non-significant correlation ($p=0.96$ $R^2 = 0.002$) was identified between age and total time spent sedentary by this group of breast cancer survivors. Research has shown positive outcomes in interventions delivered to reduce sitting time amongst older adults, which suggests that the sedentary behaviour of cancer survivors is likely to be amenable to change too[85]. Additionally, older breast cancer survivors may be retired and have more time for leisure activities, increasing overall leisure-time physical activity and leaving less time to be sedentary. This is speculative in the context of the current study due to the lack of significance. Nevertheless, this idea, coupled with successful interventions to reduce sedentary behaviour in older adults[85], warrants further research to identify whether older breast cancer survivors are less sedentary and, if so, why. There was a weak, non-significant, positive correlation ($p=0.40$, $R^2 = 0.02$) found between stage of cancer at diagnosis and the participant's total sedentary behaviour. Cancer survivors are more likely than those without cancer to become sedentary[32], and this could be exacerbated by a higher stage of cancer at diagnosis. Certain cancer treatments can compromise exercise participation levels[110]. A higher stage of cancer could mean greater treatment doses which could result in more severe side effects, further compromising physical activity. Additionally, less time spent in physical activity opens up time to be sedentary. These factors warrant further research with a bigger sample size to increase statistical power to gain more knowledge about the link between cancer stage and sedentary behaviour.

Although high sitting time and sedentary behaviour levels have only been directly linked to a moderate risk of breast cancer, the wider negative health outcomes of being sedentary make it necessary to reduce these levels[85]. Targeting sedentary behaviour through breaking up long periods of sitting could be an effective way of reducing the adverse side effects for certain

cancer survivor groups[85]. In particular, encouraging light-intensity physical activity such as walking, standing, and general daily activities could be less daunting for older cancer survivors or survivors of certain cancers[85]. Those with high sedentary behaviour levels need to be educated about reducing sedentary behaviour alongside being encouraged to engage in higher levels of physical activity as there is a double health effect. This is a potential area of intervention that needs to be targeted by organisations and researchers working with cancer survivors.

5.5 PHYSICAL ACTIVITY IN THE SOUTH AFRICAN CONTEXT

Although 60% of this group of breast cancer survivors were meeting the physical activity guidelines, 40% were not, and the group reported high sedentary behaviour levels. This suggests that physical activity interventions around education on simple ways to incorporate physical activity into daily activities, how to prioritise exercise and show it is safe, and how to reduce sedentary behaviour in all areas of life, are important. In South Africa there is a need to create more opportunities for people to be physically active and to make physical activity a priority - its successful promotion being reliant on the involvement of various sectors[182]. Applying the socioecological model, which addresses health by acknowledging the mutual effects of different levels on each other[183], could be an effective way of addressing the issue of physical inactivity and sedentary behaviour in South Africa. This approach aims to address levels right from the individual level, to the social and physical environments, through to public policymaking[183]. It facilitates interactions across these multiple levels of influence to bring about attitude and behaviour change[182].

There are numerous barriers to health that exist locally in South Africa[5], including barriers to physical activity. At the individual level, in relation to breast cancer, there are barriers related specifically to treatment and side effects that can inhibit being physically active[45]. One outcome of a post-diagnosis exercise programme is to manage disease and treatment-related side effects[124], so encouraging physical activity that matches the survivor's capabilities, in consideration of their side effects. This could help to manage and mitigate the severity of side effects and in turn increase a person's exercise ability and enhance their self-efficacy and motivation. Interventions are effective when suited to the target population/individual and matched to the intended health behaviour[182]. Increasing the safety of the physical environment in which people exercise in South Africa would address another barrier, by

building cycle lanes and parks and making areas more walkable[183], where people can be physically active and safe. Increasing access to other sports facilities such as gyms and sports fields in rural, under-resourced areas, rather than limiting them to urban areas, could promote physical activity in a greater sector of the South African population. Easy access to sports facilities and organisations has been shown to contribute to increased physical activity levels[183]. Addressing the social level, developing community-based programmes, creating time to be physically active and encouraging family support can all promote physical activity[183]. Integrating physical activity into interpersonal interactions[183] and developing culturally sensitive interventions that match preferences[46] in South Africa could work to increase physical activity levels. A lack of advice and inadequate patient education around the benefits of exercise participation have also been reported as inhibiting factors[45,112] and are likely to present barriers in South Africa due to the unequal access to health facilities and knowledge[56] and disparities in education levels amongst those of different socioeconomic status[82]. These are factors that can be changed at a public policy level. Fernandez et al.[112] emphasise the importance of thorough and consistent education for cancer survivors to increase awareness of the benefits and reduce apprehension towards exercise. This education can be applied to the general population as well, through health education and public policy, in an attempt to encourage physical activity as part of a preventative measure against cancer. This fits into the policy level of the socioecological approach, where there needs to be policy change around creating a better and safer environment for physical activity promotion in South Africa. Additionally, at this level, there needs to be a shift in public health messages to include education on what physical activity is and show where and how opportunities for physical activity can be created, both in organised exercise and in activities of daily living. For instance, showing people effective methods of being physically active and reducing sedentary time in their normal day is important, such as through gardening and playing with children, or choosing to stand more at work/at home. Fitting physical activity into one's daily activities and is often perceived as easier and less time-consuming, so making people aware that there are easy ways to be active in their normal schedules could effectively improve physical activity levels.

The barriers discussed are part of a broader societal problem in South Africa and need to be addressed through a multi-level intervention to bring about changes such as increased physical activity. Interventions based on the socioecological model have been shown to positively affect physical activity levels through health education and physical activity promotion in various

areas of life[183]. Health promotion and behaviour change programmes are important both in decreasing inactivity levels and promoting suitable physical activity[182]. Broader public health messages and education need to be targeted at everyone in the population, diseased or not. Increasing physical activity levels amongst breast cancer survivors (to prevent reoccurrence), other diseased populations, as well as the general population as a preventative measure, is crucial. The South African healthcare system is already over-burdened and under-resourced[57,84] - the adverse effects of physical inactivity and sedentary behaviour could add to this burden.

5.6 PHYSICAL ACTIVITY, SEDENTARY BEHAVIOUR AND BODY MASS INDEX

The results in this section are contrary to research hypothesis three as no significant correlations ($p>0.05$) were identified between body mass index (BMI) (anthropometric variable) and the breast cancer survivor's physical activity and sedentary behaviour levels.

Increased body mass index and a greater risk of specific comorbidities, including diabetes and cardiovascular disease,[85] constitute some of the adverse health outcomes that can occur as a result of being sedentary. The majority of this participant group were classified as overweight (31.43%) or obese (34.29%) according to their BMI, with the mean body mass index being 28.1kg/m^2. This is partly in line with the findings of other cancer studies where the majority were classified as overweight or obese[9,44,45,50], and similar means of body mass index were calculated (28.5 kg/m^2 [142] and 27.1 kg/m^2 [50]). Physical activity is associated with weight maintenance in healthy women[110], so increasing levels of physical activity could benefit breast cancer survivors who currently fall into higher body mass index categories as it could prevent unhealthy weight gain, decrease obesity and reduce their risk of breast cancer recurrence and increase survival rates[32,141]. Exercise may not however be the key to weight control and needs to be supplemented with dietary changes and other lifestyle changes such as reduced alcohol consumption[32] which were not investigated in the current study. This is reflected in the fact that so many survivors in the current study are meeting physical activity guidelines but are also overweight or obese. A combination of healthy lifestyle behaviours including being physically active and following a healthy diet can help to maintain a healthy weight and reduce the risk of breast cancer[32,97]. Previous research posits that there is decreasing time spent in moderate or vigorous physical activity with an increasing body mass index[9,46,110], wherein fewer obese survivors met recommendations than did normal or overweight survivors[46,110,141]. Interestingly,

in the current study, there was no significant result found in the relationship between BMI and physical activity levels at any intensity, despite inverse associations found previously[9,46,110,141]. Weak, non-significant, positive correlations were found between BMI and sedentary time (p=0.09 R^2 = 0.1), and between BMI and minutes of moderate-intensity physical activity (p=0.38) R^2 = 0.05). The lack of significance may be an artefact of the small sample size, a limitation of this study. These results warrant further investigation as they could suggest that body mass index may not play such a limiting role on physical activity participation and that people exercise in spite of it, and should be encouraged to be active. It would be expected that those, particularly in the obese category, would have lower physical activity levels than individuals with a lower body mass index[9,110,141]. However, those meeting and falling below activity recommendations in this study ranged from a normal body mass index through to obesity. It is well-established that an increased body mass index has a negative influence on the prognosis of patients with breast cancer, and that being overweight, obese and inactive contributes to the risk of developing certain cancers[2,4,71,85,110,141]. Interestingly there is evidence for contrasting effects of obesity on breast cancer risk based on menopausal status[2,4]. In postmenopausal women, obesity is associated with an increased risk[110], where in pre-menopausal women, an inverse link has been identified[2,4]. Many of the women who fell into the overweight or obese category in the current study may have been overweight/obese before their breast cancer diagnosis, which could have put them at greater risk. Additionally, results from other research imply a potential for greater weight gain in women who were already obese[110]. This could have adverse effects on their recurrence and survival rates, combined with the frequently reported drops in physical activity following diagnosis. Increasing levels of physical activity through maintaining an optimal energy level balance post-diagnosis[71] is important for minimising post-diagnosis weight gain[110] and thus has positive effects along the spectrum of cancer prevention and survivorship[71]. The high numbers of obese individuals in this group of participants highlight a need to investigate this further due to the far-reaching negative effects of obesity linked to several health conditions[9].

5.7 PHYSICAL ACTIVITY ADVICE AND PARTICIPATION PREFERENCES

The current study assessed the preferences of South African breast cancer survivors for receiving physical activity advice and participating in an exercise programme. The results in this section support research hypothesis four in that they provide evidence of South African breast

cancer survivors preferring to receive advice face-to-face or via brochures, and to participate in home-based programmes. However, they don't wholly support this hypothesis as moderate-intensity, not low-intensity, was found to be the favoured intensity for physical activity.

The physical activity advice and participation preference questions used in this study have been used in other studies of exercise preferences in different cancer populations, increasing the validity of their use here[44,46,50]. The results reflect that not all breast cancer survivors in this group are motivated to be physically active, although it was only a small percentage that reported not wanting advice nor to engage in a programme at all, similar to other studies on cancer survivors[44,46,50,53]. Exercise safety is a consideration post-treatment[45], and comorbidities in older adults could play a limiting participation role here[44], thus inhibiting interest in an exercise programme. This group of survivors was, however, on average younger than many other cancer survivors involved in physical activity research[44,45,117,141,142], which is perhaps why a small number reported no interest in participating in an exercise programme. Considering that a percentage of participants reported relatively low levels of physical activity, it is encouraging that the majority of the survivors indicated the desire for receiving physical activity advice (70.83%) and for participating in a physical activity programme (71.10%) (Figure 10), which is supported by previous studies on American breast cancer survivors and survivors of other cancer types[44-46,50,53]. This may be due to increased awareness of the health benefits of being physically active[175], and the appeal of receiving advice and instructions on safe ways of attaining or maintaining the recommended amount of physical activity. A strong, non-significant, positive correlation ($p>0.05$, $R^2 = 0.72$) was found between feelings of being capable of and interest in a programme. The strong positive correlation indicates that the more a person felt capable of physical activity, the more interested they were in putting it into practice. A weak, negative, non-significant correlation ($p=0.62$ $R^2 = 0.22$) was identified between vigorous-intensity activity levels and interest in receiving physical activity advice (Figure 16). Although speculative, this indicates less vigorous-intensity exercise with a higher likelihood of being interested in getting advice. Other studies have also found high interest in a programme with lower self-reported physical activity levels[44,45,46]. This interest in advice suggests there is the potential for physical activity levels to be increased. A cancer diagnosis can act as a potential initiator to behaviour change, creating a 'teachable moment' where cancer survivors are more open to behavioural and lifestyle change that can lead to improvements in health and well-being, such as increased exercise[9,85]. The 'teachable moment'

is reflected in 70.83% of the current participant group wanting to have received physical activity advice after diagnosis, and 57.5% wanting the advice and information before treatment began. Previous research has found less than half of survivors to be meeting physical activity guidelines[137,138]. Following diagnosis, a survivor may be informed of how leading a physically active lifestyle can act as primary prevention for cancer and lead to reduced risk[71]. This could initiate greater interest in exercise advice and intervention so a survivor can increase physical activity levels and engage in habitual physical activity to yield the health benefits[71]. It could also be linked to a desire to know how to safely stay active throughout and after treatment. to gaining knowledge on cancer prevention through physical activity. Oncologic research has shown that cancer survivors are motivated to adopt behavioural and lifestyle changes to improve their quantity and quality of life[85] and the findings of this study suggest this could be true of South African breast cancer survivors too. The results reiterate that, similar to previous research[28,44-46], there are high levels of interest in being physically active and knowing more about exercise post-diagnosis for cancer survivors. It is also important to note that most of the sample perceived themselves as capable of exercise; this, in conjunction with receiving information on how beneficial physical activity can be, and following a programme, could effect changes in behaviour and attitudes which could contribute to increasing levels of physical activity[28,44].

Similar to previous studies[9,44-46,49,50,52,53,78,169], walking was by far the most popular exercise type (65%), and over half of the survivor group chose moderate intensity as their preferred intensity of exercise. The consensus within literature is that walking at a moderate intensity is the most popular activity type and intensity, particularly for breast cancer survivors[9,46,78], and also amongst ovarian, early-stage lung and colorectal cancer survivors[44,45,49,50,52,53,169]. The moderate-intensity preference matches this group's self-reported high levels of moderate-intensity activity and is further supported by an average of more than 60 minutes of weekly walking. This suggests that perhaps some who indicated walking as their preferred exercise type were already walking in order to stay physically active. Studies have suggested that walking could yield many health benefits for a variety of cancer types including breast[78] and colorectal cancer[44]. Walking is thus a promising intervention[44] and an effective way of increasing physical activity levels in breast cancer survivors as it is popular amongst cancer survivors[9,46,78], can be low-cost, home-based, and easily adapted to be participated in with or without company.

Within this study's sample, the preferred time for commencing an exercise programme was immediately after treatment, which is corroborated by the number of women active soon after diagnosis (<8 months), and suggests some women are already active straight after, before and through the treatment course. This differed to research on mixed survivors which found that the large majority wanted to start a programme a year or more after treatment[45] which could be linked to the different treatments and side effects and subsequent varied exercise abilities experienced by those with different cancer types. The sample of mixed survivors[45] were also older than the breast cancer survivors from the current study, so perhaps needed a longer time for recovery after treatment before being ready for an exercise programme. Similarities were found with other research which reported colorectal and bladder cancer survivors wanting to start immediately after treatment[44,169].

The same proportion of participants (27.50%) indicated either having no preference for the exercise setting or preferred a home-based environment, which contrasts a previous study on Irish breast cancer survivors which posits that a leisure centre was the preferred setting option[45]. All participants in the Irish study were service users of a supportive care cancer charity which could be collaborated with certain leisure and exercise centres to promote physical activity[45], thus the difference could be due to greater access to such facilities compared to the survivors in the current study. Exercising from home was however a popular setting choice for colorectal, ovarian, bladder and brain cancer survivors in similar studies[44,49-52] suggesting, along with this study, that creating home-based programmes could be beneficial. Older colorectal cancer survivors who were not meeting activity guidelines have been found to prefer home-based, walking interventions[44]. The group of breast cancer survivors in this study had similar preferences but were younger and meeting guidelines, so perhaps there could be underlying links to treatment side effects such as weight gain, depression and lack of mobility that cause these survivors to prefer programmes they can access from the safety and comfort of their own home.

The preference for company during exercise in this study was to exercise with one or two people, followed by preferring to exercise alone, and other cancer survivors have indicated similar preferences[45,50]. Based on preferences identified in these South African breast cancer survivors, offering both group-based and individual physical activity programmes may be optimal. Additionally, creating spaces that facilitate physical activity where people may see and

interact with other people such as parks, adequate sidewalks and cycle lanes may also be effective and fulfil the preference for having some company while being physically active.

The most common preferences for receiving physical activity advice in this participant group included receiving it face-to-face from an exercise specialist at a cancer centre, prior to a treatment course. This preference differed from an American breast cancer survivor cohort who preferred to receive information via email or websites, or through a clinic[46]. Early-stage lung cancer survivors wanted to receive advice from a physician before treatment[53]. For a mixed group of cancer survivors, the postal service was the preferred method of receiving advice, specifically from a specialist nurse or physiotherapist[45]. Face-to-face seems to be the preferred method of delivery among cancer survivors overall, with brochures also being a popular option[44,51,52]. The advantage of print materials is that they can reach larger groups of cancer survivors and have been found to increase activity levels in some cancer survivor groups[51,127]. Another important aspect of physical activity advice given to breast cancer survivors is to reiterate that they don't only have to follow a specific programme to increase physical activity levels but teach them ways of incorporating more physical activity into their activities of daily living. This can be done, for instance, by choosing to walk more, and walk faster, standing more frequently at work or at home to break up periods of sitting, playing with children and grandchildren, doing more gardening, and choosing to take the stairs and not the elevator. This will reveal how being more physically active does not need to happen through organised exercise alone but can be easily incorporated into everyday life.

Social inequities are highly prevalent in many sectors in South Africa, including health and physical activity[7,56,58,59], and challenges are still prevalent in terms of access and quality of care[7]. Additionally, the complexity of health problems in different South African populations[84] and the diverse and changing risk and lifestyle factors[60] may interact with physical activity in a different way to how they interact in other countries. This unique interaction creates different barriers and motivators to physical activity in South Africa and could account for some of the differences seen in the preferences of this survivor group. There were, however, many noticeable similarities to cancer survivors from other countries, including other breast cancer survivor groups[9,44-46,50,78]. Most notably walking at a moderate intensity being the favoured exercise type and intensity[9,44-46,49,50,52,53,169], preferring to start a programme immediately after treatment[44,169] and home-based programmes[44,49-52] were similar preferences to other cancer

survivor cohorts. The lack of differences seen may be due in part to data being collected online, which would only have reached online-enabled groups of breast cancer survivors, possibly of similar socioeconomic backgrounds in South Africa. The study may not have been accessible to women living in rural areas, or those of lower socioeconomic status, as they may not have easy access to smartphones or computers which were required to complete the online survey. These women may have had a completely different experience of breast cancer or have experienced additional barriers that could affect their exercise knowledge, levels and preferences. Including all socioeconomic groups within a South African context is important for research going forward.

This speculation thus highlights that these results cannot be generalised to all South African breast cancer survivors and that further research is needed – it is, however, useful to acknowledge there are some similarities to other breast cancer survivors. The similarities were based on the majority of the survivors reporting these preferences, so the results are a good reflection of what this group of South African breast cancer survivors would want in an exercise programme. To encourage breast cancer survivors to achieve recommended physical activity guidelines, tailoring interventions to their preferences and abilities will allow them to participate in exercise they both enjoy and feel comfortable doing, particularly for those who prefer organised and structured exercise. Understanding their preferences is crucial in developing these interventions to increase interest and motivation, and thus remove some of the barriers to being physically active[44,45,112117]. Additionally, having broader public health messages that reveal opportunities for increasing physical activity and decreasing time spent sedentary in everyday life will appeal to those who prefer less organised exercise.

5.8 COMPARING THE GLTPAQ AND IPAQ

Both the Godin leisure-time physical activity questionnaire and the International physical activity questionnaire were used in this study to gather data on physical activity and sedentary behaviour. The different focuses in the questionnaires make it useful to use them in conjunction as it allows for both a more holistic picture of physical activity prevalence, as well as a focus on leisure-time physical activity which is an important category in oncology research[171]. Additionally, the IPAQ asks about physical activity in 'the last seven days', where the GLTPAQ asks about physical activity in a 'typical week'. Due to the context of the Covid-19 lockdown in South Africa, physical activity levels may have differed to typical levels pre-

lockdown. Thus, reporting activity participation from the 'last seven days' rather than a 'typical week' may contribute to skewed data, making it useful to use the two questionnaires together.

The GLTPAQ is used often in cancer and physical activity studies[45,50,139,171,172] and in the current study the data from this questionnaire indicated 56% of the participant group were active. This is corroborated by the data from the IPAQ questionnaire which found 60% of the survivors to be active and meeting guidelines (Figure 8). Although the GLTPAQ is useful for categorising people into basic groups of 'active', 'moderately active' and 'insufficiently active', it does not ask about the specific duration of activity bouts which is useful in calculating weekly physical activity levels for example. Often in physical activity and cancer research, physical activity levels are not the focus and the study, rather it is mainly investigating physical activity preferences or barriers and facilitators to physical activity[44,45,46,112]. As such the use of the Godin questionnaire is sufficient to give a basic idea of the group's physical activity participation. Further, leisure-time physical activity is an important sub-type into behaviour change research in an oncology context[171], supporting the usefulness of this questionnaire in cancer research. However, although the IPAQ is not typically used in cancer research, it provides data on frequency, duration and intensity of activity bouts, so weekly physical activity levels can be calculated and compared to physical activity guidelines. This would be useful in physical activity and cancer research where physical activity prevalence is the main focus. Including the IPAQ (or modified versions) in more physical activity and cancer research could also be useful to identify which categories cancer survivors are most physically active in and see whether this differs to the general population. Additionally, the IPAQ asks questions on sitting time and sedentary behaviour which is useful and necessary to allow researchers to acknowledge how people can both be meeting physical activity guidelines and exceeding recommendations for time spent being sedentary. Future studies investigating levels of physical activity and sedentary behaviour in cancer survivors should consider using the IPAQ for easier comparison to other population groups.

It should be noted that both measures have typically been used in research outside South Africa and were developed elsewhere, making some of the examples of activities at each intensity perhaps unrelatable to South African cancer survivors.

5.9 SUMMARY

Overall a greater proportion of this South African group of breast cancer survivors was meeting physical activity guidelines compared to survivors from other countries, including other breast cancer survivors. The main preference findings of walking and moderate-intensity activity supported findings from other cancer and physical activity research, although some differences were noted in preferences for receiving physical activity advice. The desire to receive advice after diagnosis and before treatment suggest that a breast cancer diagnosis can act as an initiator to behaviour change regarding physical activity levels and highlight the potential of this period creating a 'teachable moment'. The results of this study demonstrate that this group of breast cancer survivors are open and motivated to improve their levels of physical activity through their interest in exercise advice and programmes.

CHAPTER 6

CONCLUSION AND PRACTICAL APPLICATION

The aim of this chapter is to summarise and conclude the findings of the current research project, and based on these, propose recommendations for future research.

6.1 CONCLUSION

This study aimed to deliver an overview of the physical activity and sedentary behaviour levels, and physical activity advice and intervention preferences, of a group of South African breast cancer survivors. With cancer survival rates continuing to increase, particularly for breast cancer survivors who have a high likelihood of longer-term survival, positive lifestyle changes are important. The current study found that, in this group of breast cancer survivors, they are more physically active than many other groups of cancer survivors with the group, on average, meeting the physical activity guidelines. This finding is important, but we still need to consider each individual survivor, as 40% of this group didn't meet the guidelines. Further, despite meeting the guidelines, approximately 65% of the group was still considered overweight or obese, and the group exceeded the recommended sedentary time with high levels of sitting time throughout the week and weekend and time spent in a vehicle. These factors are of concern due to the role these independent risk factors play in increasing the risk of breast cancer and negative breast cancer outcomes. As it is likely that those who are already more active filled in the survey for this study, it is important to spread this public health message because many are still not physically active enough (or at all), and with greater information on the benefits of physical activity, this could change. Education on how increased physical activity and reduced sedentary behaviour can be incorporated into everyday living should be done within the general population and diseased populations. This will help to increase physical activity levels in South Africa as a preventative measure, not just as treatment, against cancer and other non-communicable diseases. It could also form part of an attempt to reduce a small portion of the burden on the healthcare system.

The preferences found in the current study generally concur with preferences observed and reported in other studies on cancer survivors. The majority reporting interest in, and feeling capable of, an exercise programme provides evidence of motivation to be physically active. With over half of the group meeting guidelines but also wanting to receive advice and participate in a programme suggests they may be looking for new and different ways to be

physically active, or feel they are not currently doing it correctly and safely. This opens up potential to initiate a behaviour change that becomes a positive lifestyle change for those who are not active, and to encourage maintenance of a physically active lifestyle for those who are already active. It is important that the information and education given on physical education is linked to dietary interventions, particularly as most of the sample was overweight or obese but also meeting guidelines. The combined effect of diet and exercise-related advice and interventions may be the key to reducing overweight and obesity and should be explored further.

The Godin Leisure-time activity questionnaire was found to be useful in providing a basic image of the frequency of leisure-time physical activity in this group, however needed a modification to include average duration in order to give a more accurate image of physical activity levels and for comparison purposes with physical activity guidelines. The International Physical Activity questionnaire in the current study proved useful for obtaining self-report levels of physical activity, in different categories and at different intensities, for comparison with public guidelines. Internally validating this tool in this specific study would increase its usefulness and validity, particularly because it was developed in a different country and context to South Africa.

In conclusion, this group of breast cancer survivors are, on average, meeting physical activity guidelines, but there is still a need to encourage more holistic positive lifestyle changes, including diet and weight factors. The majority of the participants showed an interest in an exercise programme and felt capable of being physically active which opens the window to initiate lifestyle and behavioural changes and suggests that they would be receptive to, and benefit from, education and interventions in this area. The key is to improve access for all South African breast cancer survivors to information, education, interventions, and other ideas for putting it into practice and improving physical activity levels.

The following practical applications and recommendations for future research are based on the outcomes within this research. As this study is one of the first of its kind in South Africa it opens up many future research opportunities.

6.2 PRACTICAL APPLICATIONS

- These findings provide a good start regarding the physical activity habits of breast cancer survivors in South Africa. What is evident, however, is that while the mean data

suggest adherence to the physical activity guidelines, there were 40% who did not meet the guidelines. Additionally, across the group there were high sitting time and sedentary behaviour levels. There needs to be greater education around the adverse effects of sedentary behaviour and physical inactivity, and how to reduce these levels and break up extended periods of sitting in all areas of life (i.e., transport, work, activities of daily living in the home). More education around increasing physical activity levels not only to meet guidelines but to combat high sedentary time is also necessary.

- There need to be broader public health guidelines put in place promoting physical activity for cancer survivor populations and the general population too. These guidelines and policies can then focus on physical activity as prevention of, and not only treatment for, non-communicable diseases such as cancer. Accompanying these guidelines and policies with community-level programmes may encourage society as a whole to be physically active. Further, when feasible, creating a built environment that creates opportunities for and facilitates safe physical activity participation will be important to further enhance physical activity.
- The preferences for physical activity advice and participation provide a good basis for breast cancer survivor preferences, particularly as they are supported by findings of other studies. These preferences include starting a home-based programme based around moderate-intensity walking, straight after treatment, with one or two other people, and receiving advice face-to-face from an exercise specialist at a cancer centre before treatment. With further research on a larger sample size these findings could be used for the development of physical activity programmes and guidelines tailored to the preferences and abilities of South African breast cancer survivors and enhance the standard of breast cancer care in South Africa.
- The current findings showing that there are high levels of physical activity present in some breast cancer survivors could promote a healthy and physically active lifestyle amongst the wider breast cancer population in South Africa through demonstrating that it is safe and viable for this population.
- Targeted interventions that include physical activity recommendations and behaviour change support are needed to yield the greatest benefit for individual survivors, based on the changes and benefits the survivor wants to see, combined with the lowest risk

of harm. It is crucial that participation in physical activity is feasible, safe, and relevant to the individual in order for benefits to be achieved.

6.3 RECOMMENDATIONS FOR FUTURE RESEARCH

- Although a moderate-intensity, home-based programme will be appropriate for some breast cancer survivors, there is no set weekly dosage for type, intensity, frequency and duration that can be considered evidence-based for all cancer survivors, or even all breast cancer survivors. Thus, further research in this regard is needed.
- Future research should use bigger sample sizes, over a number of years, to gain insight into a greater proportion of the South African breast cancer survivor population and allow specific trends to be identified and analysed. Analysing both pre- and post-diagnosis levels should be included in order to identify physical activity trends and changes before and after a cancer diagnosis, and for comparison purposes.
- Due to the great diversity in South Africa, analysing racial, ethnic and socioeconomic differences in physical activity and sedentary behaviour levels, and preferences, of breast cancer survivors would be beneficial to investigate potential differences.

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APPENDIX A: FINAL ETHICAL CLEARANCE LETTER

Human Ethics subcommittee
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NHREC Registration no. REC-241114-045

27 January 2020
Belinda Campbell
Review Reference: 2019-0292-2084
Email: g14C2072@campus.ru.ac.za

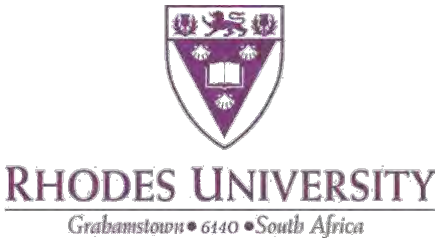
Dear Belinda Campbell
Re: Physical activity levels, and preferences of physical activity interventions, of South African breast cancer survivors.

Principal Investigator: Associate Professor Candice Christie
Collaborators: Miss Belinda Campbell

This letter confirms that the above research proposal has been reviewed and **APPROVED** by the Rhodes University Ethical Standards Committee (RUESC) – Human Ethics (HE) sub-committee.
Approval has been granted for 1 year. An annual progress report will be required in order to renew approval for an additional period. You will receive an email notifying when the annual report is due.
Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on the completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloging number allocated.
Sincerely

Prof Joanna Dames
Chair: Human Ethics sub-committee, RUESC- HE

APPENDIX B: PARTICIPANT INFORMATION LETTER



HUMAN KINETICS & ERGONOMICS

Tel: (046) 603 8471 • Fax: (046) 603 8934 • e-mail: c.christie@ru.ac.za/j.mcdougall@ru.ac.za

Participant information letter

Contact information:
Name: Belinda Campbell
Cell number: 0793336387
Email: bccampbell17@gmail.com

Supervisor Contact information:
Name: Prof. Candice Christie
Cell number: 0835616936
Email: c.christie@ru.ac.za

RUESC HE Ethics Coordinator Contact information:
Name: Mr. Siyanda Manqele
Cell number: 7727
Email: s.manqele@ru.ac.za

Project title: Physical activity levels, and preferences of physical activity interventions of South African breast cancer survivors.

What the study is about: Both a breast cancer diagnosis and subsequent treatments have far-reaching physical and psycho-emotional side effects. Quality of life, as well as elements of self-efficacy are important aspects of an individual's identity which are challenged with the diagnosis of cancer. Leading a physically active lifestyle (through active travel, occupational physical activity, recreational physical activity and activities of daily living) is beneficial to the overall health of individuals and can help in reducing the severity of side effects and improving a person's physical fitness in order to cope better with treatment. Physical activity has been found to yield positive effects throughout the stages of cancer care and there is evidence to suggest a protective effect of regular physical activity throughout one's life for certain cancers. It is important to investigate these factors in a South African context in order to find out the physical activity and sedentary behaviour levels of breast cancer survivors pre and post diagnosis, and their exercise preferences and information needs.

Purpose of study: To determine the levels of physical activity and sedentary behaviour, and the exercise preferences of South African breast cancer survivors.

Procedures: Once you have signed an informed consent form data will be collected from you in the form of questionnaires. The questionnaire consists of 4 sections, 50 questions in total.

Section 1: Anthropometric and demographic data
Section 2: Leisure-time physical activity
Section 3: Type, intensity and frequency of physical activity
Section 4: Exercise and physical activity preferences and information needs

I will email you the link for the online questionnaire – just click on the link and it will take you to the questionnaire and you can follow the prompts to complete and then submit your answers. If you require a hard copy of the questionnaire, please email me.

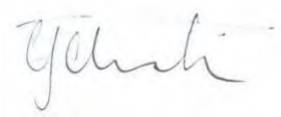
Anonymity and Confidentiality: All your personal information will be kept confidential and your identity as a participant will remain anonymous. Your participation is entirely voluntary and if you wish to withdraw from the study at any stage you may do so without any negative consequences.

Risks: There may be the risk of certain questions included in the questionnaires evoking emotional strain in some way. If you do experience any distress or discomfort, please contact me or a healthcare professional immediately.

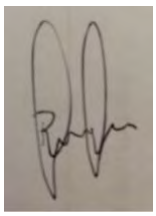
Benefits: As a result of participating in this research and receiving feedback, you will be more educated and informed about the lifestyle and behavioural risk factors involved in the risk of developing breast cancer, as well as how physical activity may play a role not only in the course of the disease but also during your treatment and once you go into remission. Through being more informed about these factors you will be empowered to improve your lifestyle in any aspects you deem necessary.

Feedback: The broad findings of this study will be provided to CANSA to be distributed to all participants. Additionally, findings will also be published in academic journals which are accessible to the public. Furthermore, if you would like to receive individual feedback you are able to contact me directly and I will make this accessible to you.

Regards,



Prof. Candice Christie (Principal Investigator)



Belinda Campbell

APPENDIX C: ETHICAL CLEARANCE LETTER FOR LEAFLET

RHODES UNIVERSITY
Where leaders learn

Faculty of Pharmacy
Artillery Road, Grahamstown, 6139, South Africa
PO Box 94, Grahamstown, 6140, South Africa
t: +27 (0)46 603 8381
f: +27 (0)46 603 7506
e:dean.pharmacy@ru.ac.za

www.ru.ac.za

From:
Associate Professor Roman Tandlich, PhD
Chairperson of the Rhodes University Ethical Standards Committee (RUESC)
Faculty of Pharmacy
Rhodes University
Artillery Road
P.O. Box 94
Makhanda 6140
South Africa
Tel 046-603-8825
Fax 046-63-7506
e-mail: r.tandlich@ru.ac.za.

To whomever it mat concern,

This is to certify that the leaflet for the project to be conducted by Ms. Belinda Campbell and Associate Professor Candice Christie, PhD meets the necessary ethical standards of the research, as judged by the RUESC.

Please do not hesitate to contact me, if you require an further information!

Yours sincerely,

Roman Tandlich, PhD

APPENDIX D: GATEKEEPER PERMISSION LETTER

CANSA
Cancer Association of South Africa
Research • Educate • Support

Toll-Free 0800 22 66 22
www.cansa.org.za

HEAD OFFICE
Bedfordview
+27 11 616 7662 Tel
+27 11 622 3424 Fax
26 Concorde Road West Address
Bedfordview, 2008
PO Box 2121 Postal
Bedfordview, 2007

10 December 2019

Dear Associate Professor Candice Christie,

I, Dr Melissa Wallace, Head of Research at the Cancer Association of South Africa (CANSA) am writing this letter to confirm gatekeeper permission has been provided for you and your collaborators to conduct the research study titled 'Physical activity levels, and preferences of physical activity interventions, of South African breast cancer survivors' (Registration number REC-241114-045) with the approval of CANSA.
I have had the purpose and nature of the study explained to me and have had the opportunity to ask questions about the study. I have on file a copy of the study protocol, informed consent document and provisional ethics approval document for the study. CANSA will assist in promoting the study once final ethics approval has been granted, by posting information about it (which has received approval from the Rhodes University human ethics sub-committee) on our social media platforms (Facebook support groups, Instagram, Twitter), our website and through our service delivery offerings (care homes, care centres, support groups, etc). Interested patients will be invited to contact the research team should they wish to know more about the study or to participate. The informed consent process and data collection will be the responsibility of the researchers.
I understand that all data collected in this study is confidential and anonymous. I also understand that I am free to contact any of the people involved in this research to seek further clarification or information.
Yours sincerely

Dr Melissa Wallace
Head of Research

APPENDIX E: RESEARCH ADVERTISEMENT LEAFLET

BREAST CANCER AND PHYSICAL ACTIVITY

Have you been diagnosed with breast cancer? Are you undergoing breast cancer treatment? Are you in the remission and recovery phase of breast cancer?

If you answered yes to any of these questions, please consider taking part in my Masters research project exploring the physical activity levels and preferences of breast cancer survivors. Your participation could help you to gain a greater understanding of your own physical activity habits and preferences which could inform the type and level of physical activity that will best benefit you.

You will be required to fill out a number of questionnaires that will take approximately 20 minutes to complete. The findings from these questionnaires will inform the development of exercise interventions for South African breast cancer survivors, tailored to their needs and preferences. Through publishing and distributing the findings they will be accessible to the wider community, highlighting how physical activity can be a lifestyle change reducing the risk of breast cancer, and playing a positive role in treatment and recovery for breast cancer survivors.

Inclusion criteria:

- Female breast cancer survivor (includes all phases from diagnosis through to remission)
- Minimum 21 years of age
- South African Nationality

If you are interested in finding out more or participating in this research, please contact me.

Belinda Campbell (Rhodes University Masters student)

Telephone: 0793336387
Email: bccampbell17@gmail.com OR g14c2072@campus.ru.ac.za

This research has been granted ethical approval by the Rhodes University Ethics Board (REC-241114-045)

APPENDIX F: BREAST CANCER AND PHYSICAL ACTIVITY SURVEY

Breast Cancer and Physical Activity

Thank you for agreeing to take part in the study and taking the time to fill out the questionnaire. This research is being conducted to determine the current physical activity and sedentary behaviour levels of breast cancer survivors, and their exercise preferences and information needs. Please be assured that any information you disclose will be kept confidential. Please fill the questionnaire in as fully and accurately as possible; however, if there are any questions you do not want to answer please mark these with 'n/a'.

Physical activity (as defined by the World Health Organisation): "any bodily movement produced by skeletal muscles that requires energy expenditure."
Sedentary behaviour: "any waking behaviour characterised by less than 1.5 metabolic equivalents, while in a sitting, reclining or lying posture."
*Required

➢ Email address *

……..……

➢ Are you willing to complete the questionnaire and take part in the study? *

Mark only one oval.

☐ I consent, begin the study
Skip to question 3
☐ I do not consent and do not want to participate in the study
Skip to section 6 (End of survey)

Demographic and anthropometric information:

1 Age (years):

……..……

2 Sex:

Mark only one oval.

☐ Female
☐ Male
☐ Other:

3 What province are you from?

Mark only one oval.

☐ Eastern Cape
☐ Western Cape
☐ Northern Cape
☐ North West
☐ Free State
☐ KwaZula-Natal
☐ Gauteng
☐ Limpopo
☐ Mpumalanga

4 Time elapsed since diagnosis (months/years):

……..……

5 Stage of cancer at diagnosis:

Mark only one oval.

☐ I
☐ II
☐ III
☐ IV

6 Treatment course (refers to any type of treatment you are undergoing/underwent; both the main treatment and any adjuvant therapies, i.e. chemotherapy and surgery):

7 Stature (cm):

……..……

8 Mass (kg):

……..……

Godin Leisure-Time Exercise Questionnaire	During a typical 7-Day period (a week), how many times on average do you do the following kinds of exercise for more than 15 minutes during your free time (write on each line the appropriate number). Weekly leisure activity score = (9 × Strenuous) + (5 × Moderate) + (3 × Light) EXAMPLE Strenuous = 3 times/wk Moderate = 6 times/wk Light = 14 times/wk Total leisure activity score = (9 × 3) + (5 × 6) + (3 × 14) = 27 + 30 + 42 = 99 Godin Scale Score + Interpretation 24 units or more = Active 14-23 units = Moderately active Less than 14 units = Insufficiently active/Sedentary

9 How many times per week do you participate in STRENUOUS EXERCISE (HEART BEATS RAPIDLY) (e.g. running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long-distance cycling)?

……..……

10 How many times per week do you participate in MODERATE EXERCISE (NOT EXHAUSTING) (e.g. fast walking, baseball, tennis, easy cycling, volleyball, badminton, easy swimming, alpine skiing, popular dancing)?

……..……

11 How many times per week do you participate in MILD/LIGHT EXERCISE (MINIMAL EFFORT) (e.g. yoga, archery, fishing from riverbank, bowling, horse riding, golf, easy walking)?

……..……

12 Weekly leisure activity score = (9 × Strenuous) + (5 × Moderate) + (3 × Light):

……..……

International Physical Activity Questionnaire	FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years) We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport. Think about all the vigorous and moderate activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

13 Do you currently have a job or do any unpaid work outside your home? (IF NO, SKIP TO PART 2: TRANSPORTATION).

Mark only one oval.

☐ Yes
☐ No

14 During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, heavy construction, or climbing up stairs as part of your work? Think about only those physical activities that you did for at least 10 minutes at a time. (IF NO VIGOROUS PHYSICAL ACTIVITY, SKIP TO QUESTION 4).

Mark only one oval.

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7

15 How much time did you usually spend on one of those days doing vigorous physical activities as part of your work (hours/minutes per day)?

……..……

16 Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities

like carrying light loads as part of your work? Please do not include walking. (NO MODERATE PHYSICAL ACTIVITY, SKIP TO QUESTION 6).

Mark only one oval.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

17 How much time did you usually spend on one of those days doing moderate physical activities as part of your work (hours/minutes per day)?

……..……

18 During the last 7 days, on how many days did you walk for at least 10 minutes at a time as part of your work? Please do not count any walking you did to travel to or from work. (IF NO WALKING, SKIP TO PART 2).

Mark only one oval.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

19 How much time did you usually spend on one of those days walking as part of your work (hours/minutes per day)?

……..……

Part 2: TRANSPORTATION PHYSICAL ACTIVITY

These questions are about how you travelled from place to place, including to places like work, stores, movies, and so on.

20 During the last 7 days, on how many days did you travel in a motor vehicle like a train, bus, car, or tram? (NO TRAVELLING IN VEHICLE, SKIP TO QUESTION 10).

Mark only one oval.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

21 How much time did you usually spend on one of those days traveling in a train, bus, car, tram, or other kind of motor vehicle (hours/minutes per day)?

……..……

22 During the last 7 days, on how many days did you cycle for at least 10 minutes at a time to go from place to place? (NO CYCLING, SKIP TO QUESTION 12).

Mark only one oval.

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7

23 How much time did you usually spend on one of those days cycling from place to place (hours/minutes per day)?

……..……

24 During the last 7 days, on how many days did you walk for at least 10 minutes at a time to go from place to place? (IF NO WALKING, SKIP TO PART 3)

Mark only one oval.

☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7

25 How much time did you usually spend on one of those days walking from place to place (hours/minutes per day)?

……..……

Part 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the last 7 days in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

26 Think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do vigorous physical activities like

heavy lifting, chopping wood, shoveling snow, or digging in the garden or yard? (NO VIGOROUS ACTIVITY IN GARDEN, SKIP TO QUESTION 16).

Mark only one oval.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

27 How much time did you usually spend on one of those days doing vigorous physical activities in the garden or yard (hours/minutes per day)?

……..……

28 Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate activities like carrying light loads, sweeping, washing windows, and raking in the garden or yard? (IF NO MODERATE ACTIVITY IN GARDEN, SKIP TO QUESTION 18).

Mark only one oval.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

29 How much time did you usually spend on one of those days doing moderate physical activities in the garden or yard (hours/minutes per day)?

……..……

30 Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate activities like carrying light loads, washing windows, scrubbing floors and sweeping inside your home? (NO MODERATE ACTIVITY INSIDE HOME, SKIP TO PART 4).

Mark only one oval.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

31 How much time did you usually spend on one of those days doing moderate physical activities inside your home (hours/minutes per day)?

……..……

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the last 7 days solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

32 Not counting any walking you have already mentioned, during the last 7 days, on how many days did you walk for at least 10 minutes at a time in your leisure time? (NO WALKING IN LEISURE TIME, SKIP TO QUESTION 22).

Mark only one oval.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

33 How much time did you usually spend on one of those days walking in your leisure time (hours/minutes per day)?

……..……

34 Think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do vigorous physical activities like aerobics, running, fast bicycling, or fast swimming in your leisure time? (NO VIGOROUS ACTIVITY IN LEISURE TIME, SKIP TO QUESTION 24).

Mark only one oval.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

35 How much time did you usually spend on one of those days doing vigorous physical activities in your leisure time (hours/minutes per day)?

……..……

36 Again, think about only those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do moderate physical activities

like bicycling at a regular pace, swimming at a regular pace, and doubles tennis in your leisure time? (NO MODERATE ACTIVITY IN LEISURE TIME, SKIP TO PART 5).

Mark only one oval.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6
- ☐ 7

37 How much time did you usually spend on one of those days doing moderate physical activities in your leisure time (hours/minutes per day)?

……..……

PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

38 During the last 7 days, how much time did you usually spend sitting on a weekday (hours/minutes per day)?

……..……

39 During the last 7 days, how much time did you usually spend sitting on a weekend day (hours/minutes per day)?

……..……

BREAST CANCER SURVIVORS PREFERENCES FOR PHYSICAL ACTIVITY:

40 Would you have liked to receive advice about exercise and physical activity at some point before or after your treatment for breast cancer? (If you respond no to this question you can skip the remaining questions).

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ Maybe

41 Who would you have preferred to receive advice from?

Mark only one oval.

- ☐ Physician
- ☐ Nurse
- ☐ Exercise specialist in cancer centre
- ☐ Exercise specialist in gym
- ☐ Cancer patient/survivor
- ☐ No preference

42 How would you have preferred to receive advice?

Mark only one oval.

- ☐ Face to face
- ☐ Video tapes
- ☐ Brochure/pamphlet

43 Where would you have preferred to receive advice?

Mark only one oval.

- ☐ Cancer centre
- ☐ Gym/community centre
- ☐ At home

44 When would you have preferred to receive advice about exercise and physical activity?

Mark only one oval.

- ☐ Before treatment
- ☐ Immediately after treatment
- ☐ 3-6 months post treatment
- ☐ At least 1 year post treatment

47. Any time before or after treatment, would you have been interested in taking part in an exercise program tailored to breast cancer survivors? (If you respond no to this question you can skip the remaining questions).

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ Maybe

48. When would you like to start an exercise program?

Mark only one oval.

- ☐ Before treatment
- ☐ Immediately after treatment
- ☐ 3-6 months post treatment
- ☐ At least 1 year post treatment
- ☐ No preference

49. What type of exercise would you prefer to do?

Mark only one oval.

- ☐ Walking
- ☐ Swimming
- ☐ No preference

50. Where would you prefer to exercise?

Mark only one oval.

- ☐ At home
- ☐ At a gym
- ☐ Outdoors
- ☐ Cancer centre gym
- ☐ No preference

51. Would you prefer to exercise alone or with other people?

Mark only one oval.

- ☐ Alone
- ☐ Family member
- ☐ 1 or 2 people
- ☐ Large group
- ☐ No preference

52. Would you like your exercise program to consist of low, moderate or high intensity activities?

Mark only one oval.

- ☐ Low
- ☐ Moderate
- ☐ High
- ☐ No preference

53. Do you currently feel capable of engaging in an exercise program?

Mark only one oval.

- ☐ Yes
- ☐ No
- ☐ Maybe

THIS IS THE END OF THE QUESTIONNAIRE, THANK YOU FOR PARTICIPATING.

End of survey

APPENDIX G: CORRELATION MATRIX

	Age	*Stage*	*Time_diag*	*BMI*	*LSI*	*VI*	*MI*	*TPA*	*Advice*	*Participation*	*Capable*
Age	1										
Stage	-0.20259	1									
Time_diag	0.148041	-0.04203	1								
BMI	-0.11481	0.200615	-0.03077	1							
LSI	-0.15331	0.088823	0.098587	0.203543	1						
VI	-0.03886	0.145852	0.247131	0	0.269983	1					
MI	0.175972	0.028705	0.210311	-0.35704	0.010843	0.28049	1				
TPA	0.154339	0.110704	0.262817	-0.13807	0.075145	0.565277	0.811246	1			
Advice	0.134094	-0.23787	-0.18853	0.171211	0.196941	0.216578	-0.05026	0.02065	1		
Participation	0.081314	-0.18877	0.047611	0.050168	0.07652	0.04207	0.113082	0.186253	0.328709	1	
Capable	-0.01221	-0.18773	-0.04768	0.115849	0.320551	0.159143	-0.11841	-0.02218	0.358127	0.717827251	1