School of Psychology
Faculty of Health Sciences

Exploration of Barriers, Motives and Exercise Preferences in Cancer Survivors and a Randomised Controlled Trial to Increase Physical Activity in Colorectal and Endometrial Cancer Survivors at Heightened Cardiovascular Disease Risk

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This thesis is presented for the degree of
Doctor of Philosophy
of
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Declaration

To the best of my knowledge and belief this thesis contains no materials previously published by any other person except where due acknowledgement has been made. This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

The research presented and reported in this thesis was conducted in accordance with the National Health and Medical Research Council National Statement on Ethical Conduct in Human Research (2007) – updated in March 2014. The proposed research studies received human research ethics approval from Curtin University Human Research Ethics Committee (HR30/2016) and St John of God Health Care Human Research Ethics Committee (#756, #937, #1102, #1201).

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Chloe Maxwell-Smith

23 September 2020

Abstract

Background. Cancer survivors are at elevated risk of cardiovascular disease, morbidity, and mortality, due to unhealthy lifestyle factors. Most survivors are insufficiently physically active, more sedentary, and have greater prevalence of overweight or obesity than their non-cancer counterparts. Efforts to promote health behaviours in survivors have typically targeted breast cancer survivors, despite colorectal and endometrial cancers being largely linked to lifestyle-related risk factors and carrying significant risk of cardiovascular disease post-cancer. Moreover, growing evidence supporting tailored interventions indicates that initiatives should be targeted to the psychological factors that affect behavioural change amongst the intervention cohort. Although physical activity interventions have yielded promising results, these initiatives have typically been resource-heavy, and their effects generally diminish once the intervention ceases. The emergence of wearable activity trackers in clinical trials presents a potentially scalable opportunity to promote physical activity uptake and maintenance for cancer survivors.

Objectives. The overarching aim of this project was to explore the barriers, motives, support needs, and factors influencing physical activity in cancer survivors prior to conducting a clinical trial of a wearable activity tracker to promote cancer survivors' physical activity participation and reduce sedentary behaviour. This project consisted of three studies to address this overarching objective. *Study One* explored colorectal cancer survivors' beliefs and barriers towards physical activity participation and to gain specific insights to inform intervention design. *Study Two* broadened findings regarding barriers as well as explored motives, supportive care needs, and exercise preferences of cancer survivors. *Study Three* examined the effectiveness of a wearable activity tracker and action planning intervention in a randomised controlled trial to promote physical activity and reduce sedentary behaviour in colorectal and endometrial cancer survivors at heightened risk of cardiovascular disease.

Methodology. Colorectal cancer survivors ($n = 24$; M age = 69 years) who had comorbidities putting them at heightened risk of cardiovascular disease were recruited for *Study One*. Semi-structured interviews focused on their barriers to physical activity participation. Inductive thematic content analysis was performed on interview transcripts to identify barrier themes. For *Study Two*, colorectal, breast, and endometrial cancer survivors ($n = 183$; M age = 65 years) were invited to complete a mailed health behaviour survey. The survey focused on physical activity, dietary behaviours, preferences, and

attitudes towards health behaviour change. *Study Three* consisted of a 12-week behavioural intervention to promote physical activity for colorectal and endometrial cancer survivors (n = 68; M age = 64 years) who were at elevated risk of cardiovascular disease. Participants were recruited via oncologists' consulting rooms, screened for eligibility, and randomised to the Wearable Activity Technology And Action Planning (WATAAP) intervention (n = 34) or control group (n = 34). The intervention involved using a Fitbit Alta in conjunction with group sessions and resources tethered to the Health Action Process Approach. Participants' accelerometer-measured physical activity, body mass index (BMI), and blood pressure were assessed at baseline and 12 weeks.

Results. Five themes were identified with respect to barriers to physical activity: psychological, environmental, perceptions of physical activity guidelines, lack of practitioner support, and age and energy. Survey results from *Study Two* indicated that survivors had an array of barriers and support needs related to a lack of motivation, knowledge, and support from healthcare practitioners. Other barriers and support needs pertained to psychological obstacles, environmental issues, and social factors. Survivors' motives were primarily concerned with the ability to enjoy life's pleasures. The majority of survivors expressed a preference for unsupervised, self-paced walking outdoors at a moderate intensity. The intervention in *Study Three* resulted in a significant increase of 45 minutes of moderate-to-vigorous physical activity (MVPA) per week in the intervention group, compared to a reduction of 21 minutes of MVPA per week in the control group (F (1, 126) = 5.14, p = .025). This effect was further amplified to a net change of 103 minutes per week between groups, when excluding seven participants due to non-adherence (F (1, 112) = 14.93, p <.001). Preliminary reductions in systolic blood pressure, diastolic blood pressure, and BMI were also identified.

Conclusions. This project contributed to the existing literature on physical activity in cancer survivorship. *Studies One* and *Two* provided insight into survivors' barriers and facilitating factors to health behaviour change after cancer, with a specific focus on the psychological factors affecting physical activity. An important and novel finding was the desire to receive support from oncologists to provide specific advice to initiate health behaviour change. The WATAAP trial, informed by survivors' barriers and support needs identified in *Studies One* and *Two*, was designed to offer a feasible and scalable approach to increasing physical activity in cancer survivors. The WATAAP trial was the first study to assess the effectiveness of smart wearable technology (Fitbit Alta) and action planning in Australian colorectal and endometrial cancer survivors at heightened cardiovascular

risk. Improvements in physical activity show promise for the use of wearable technology and respective web-based applications as components of psychological interventions, and the potential implementation of trackers into out-patient care. The trial supports the use of wearable activity trackers as a key component of feasible and scalable intervention delivery, which may be extended across a broader reach and to other groups at increased risk of cardiovascular disease.

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List of Abbreviations

AIHW	Australian Institute of Health and Welfare
AFVIF	Average Full (collinearity) Variance Inflation Factor
AGCF	Australian Gynaecological Cancer Foundation
APC	Average Path Coefficient
ARIA+	Accessibility/Remoteness Index of Australia
ASA	American Society of Anaesthesiologists
ASCO	American Society of Clinical Oncology
AVIF	Average block Variance Inflation Factor (for model parameters)
BCT	Behavioural Change Technique
BMI	Body Mass Index
CI	Confidence Interval
CONSORT	CONsolidated Standards Of Reporting Trials
CPM	Counts Per Minute
DBP	Diastolic Blood Pressure
DHHS	(United States) Department of Health and Human Services
GLMM	Generalised Linear Mixed Model
HAPA	Health Action Process Approach
HR	Heart Rate
IPAQ-SF	International Physical Activity Questionnaire – Short Form
MET	Metabolic Equivalent of Task
MV10	Moderate-to-Vigorous (physical activity) in bouts ≥10 minutes
MVPA	Moderate-to-Vigorous Physical Activity
NCCN	National Comprehensive Cancer Network
NHMRC	National Health and Medical Research Council
NLBCDR	Non-Linear Bivariate Causality Direction Ratio
PBC	Perceived Behavioural Control
R2CR	R2 Contribution Ratio
RCT	Randomised Controlled Trial
SBP	Systolic Blood Pressure
SCT	Social Cognitive Theory
SD	Standard Deviation
SPIRIT	Standard Protocol Items: Recommendations for Interventional Trials

SPR	Simpson's Paradox Ratio
SSR	Statistical Suppression Ratio
T1	Time 1/Baseline assessment
T2	Time 2/12-week assessment
T3	Time 3/24-week assessment
TPB	Theory of Planned Behaviour
TTM	Transtheoretical Model (of change)
VMU	Vector Magnitude Units
WAT	Wearable Activity Technology
WCRF	World Cancer Research Fund

Trial Abbreviations

ACTION	ACTivity promotION
ACTIVATE	ACTIVity And Technology
BEAT Cancer	Better Exercise Adherence after Treatment for Cancer
ENERGY	Exercise and Nutrition to Enhance Recovery and Good health for You
ENRICH	Exercise and Nutrition Routine Improving Cancer Health
PEACH	Prescribed Exercise After Chemotherapy
PPARCS	Promoting Physical Activity in Regional and Remote Cancer Survivors
PROACTIVE	Promoting Physical Activity during Chemotherapy
REACH	Rural Environments And Community Health
RENEW	Reach out to ENhancE Wellness
SUCCEED	Survivors of Uterine CanCer Empowered by Exercise and healthy Diet
WATAAP	Wearable Activity Technology And Action Planning

Statement of Contribution – Thesis

The candidate, under the supervision of their supervisory team, Dr Sarah Hardcastle, Dr Paul Cohen, and Professor Cameron Platell, undertook the literature review, statistical analyses, interpretation of results, discussion of findings, and conclusions of this research. The thesis was drafted entirely by the PhD candidate, Chloe Maxwell-Smith. Editing was provided by supervisors, Dr Sarah Hardcastle, Dr Paul Cohen, Professor Cameron Platell, and John Curtin Distinguished Professor Nikos Ntoumanis. Chapters were copyedited by Lucy Ridsdale in accordance with the Institute for Professional Editors (IPeD) guidelines for academic editing.

I affirm that the statement of contribution for this thesis is true and correct.

Chloe Maxwell-Smith PhD Candidate	**Dr Sarah Hardcastle** Primary Supervisor 2015-2019
Dr Paul Cohen Supervisor	**Professor Cameron Platell** Supervisor
John Curtin Distinguished Professor Nikos Ntoumanis Primary Supervisor 2020	**Lucy Ridsdale** Academic Editor

Statement of Contribution – Published Chapters

The following statements detail the extent of the intellectual contribution by the PhD candidate, Chloe Maxwell-Smith, and all other co-authors of each peer-reviewed publication.

Maxwell-Smith, C., Zeps, N., Hagger, M. S., Platell, C., & Hardcastle, S. J. (2017). Barriers to physical activity participation in colorectal cancer survivors at high risk of cardiovascular disease. *Psycho-Oncology, 26*(6), 808–814. https://doi.org/10.1002/pon.4234

Location in thesis: **Chapter 4**

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This study was conducted, analysed, and written-up by Chloe Maxwell-Smith, with the support of the co-authors. The study was conceptualised by Dr Sarah Hardcastle, Professor Martin Hagger, Professor Nik Zeps, Professor Cameron Platell, and Chloe Maxwell-Smith. Access to the participant pool was provided by Professor Cameron Platell. Data collection was conducted by Chloe Maxwell-Smith and Dr Sarah Hardcastle, transcribed by Chloe Maxwell-Smith and analysed by Chloe Maxwell-Smith, under the supervision of Dr Sarah Hardcastle. Study findings were written-up by Chloe Maxwell-Smith and edited by Dr Sarah Hardcastle and Professor Martin Hagger. The manuscript was submitted by Chloe Maxwell-Smith and revisions following peer review were made by Chloe Maxwell-Smith, under the supervision of Dr Sarah Hardcastle and Professor Martin Hagger.

I affirm the Statement of Contribution is true and correct.

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Dr Sarah Hardcastle	

Maxwell-Smith, C., Cohen, P. A., Platell, C., Tan, J., Saunders, C., Nightingale, S., Lynch, C., Sardelic, F., McCormick, J., & Hardcastle, S. J. (2020). "To be there for my family" and "Keep my independence": Metropolitan and non-metropolitan cancer survivors' health behaviour motives. *Supportive Care in Cancer, 2020.* https://doi.org/10.1007/s00520-020-05690-9

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This protocol was conceptualised, investigated, and written by Chloe Maxwell-Smith, with the support of the co-authors. The study was conceptualised by Chloe Maxwell-Smith, Dr Sarah Hardcastle, Dr Paul Cohen, and Professor Cameron Platell. Chloe Maxwell-Smith, under the supervision of Dr Sarah Hardcastle and Dr Paul Cohen, reviewed the literature ahead of the trial design. Dr Paul Cohen, Professor Cameron Platell, Dr Patrick Tan, Dr Michael Levitt, Dr Paul Salama, Dr Gregory Makin, Dr Jason Tan, Dr Stuart Salfinger, and Dr Ganendra Raj Ali Kader Mohan assisted in the conceptualisation of recruitment processes and allowed prospective access to the participant pool.

Prospective statistical calculations were performed by Dr Robert Kane, Dr Dana Hince, and Chloe Maxwell-Smith. The manuscript was drafted by Chloe Maxwell-Smith, with editing by Dr Sarah Hardcastle and Dr Paul Cohen. Dr Ruth Jiménez-Castuera translated the manuscript for submission. The manuscript was submitted by Chloe Maxwell-Smith and revisions following peer review were made by Chloe Maxwell-Smith with the support of Dr Sarah Hardcastle, Dr Paul Cohen, Dr Dana Hince, and Dr Ruth Jiménez-Castuera.

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Statement of Contribution – Unpublished Manuscript

The following statements detail the extent of the intellectual contribution by the PhD candidate, Chloe Maxwell-Smith, and all other co-authors of the unpublished manuscript that forms part of this thesis.

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Location in thesis: **Chapter 5**

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Conference Presentation

2018 – Oral presentation:

Wearable Activity Technology And Action-Planning (WATAAP) promoting physical activity in colorectal and gynaecologic cancer survivors: Randomised controlled trial

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Presented at the Annual Conference of the European Health Psychology Society, Galway, Ireland

Presentation abstract is shown in Appendix F.

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Chapter One

1

Introduction

Chapter Overview

This chapter begins with an introduction to the research problem that this thesis aims to address and outlines the thesis statement for this body of work. The overarching objectives of the thesis are described, followed by the specific objectives associated with the three studies presented in this thesis. Finally, an overview of the thesis by chapter is provided.

1.1 Introduction to the Research Problem

Cancer is the second leading cause of death globally, following cardiovascular disease (World Health Organization, 2018). As the effectiveness of cancer treatment and detection technologies improve, the population of cancer survivors continues to rise (Australian Institute of Health and Welfare [AIHW], 2020). Despite having promising rates of survival, many cancer survivors have unhealthy lifestyles (Grimmett et al., 2011; C. R. Leach, Weaver, et al., 2015; Mosher et al., 2009; Mowls et al., 2016; Rock et al., 2012). Most survivors of stages 1 and 2 colorectal and endometrial cancer are overweight and insufficiently physically active (American Society of Clinical Oncology [ASCO], 2019; Fader et al., 2009; Fisher, Beeken, et al., 2016), putting colorectal and endometrial cancer survivors at heightened risk of cardiovascular disease, morbidity, and mortality (C. R. Leach, Weaver, et al., 2015; Ng et al., 2018; Ward et al., 2012; Weaver, Foraker, et al., 2013).

Aerobic physical activity is an established protective behaviour against risk of cardiovascular disease (Kirkham et al., 2016; Ozemek et al., 2018), and has many other physiological (Friedenreich et al., 2009; Kirkham et al., 2016; Meyerhardt et al., 2006; Schmitz & Speck, 2010; Sternfeld et al., 2009; Tian et al., 2016; Warburton & Bredin, 2017) and psychological (Bekhet et al., 2019; Schmitz et al., 2010) benefits for cancer survivorship. The guideline of at least 150 minutes of moderate-to-vigorous intensity physical activity (MVPA) per week has been propounded internationally for cancers survivors following the initial post-surgical rehabilitation (American Cancer Society, 2020; National Comprehensive Cancer Network [NCCN], 2020; Cancer Council, 2019). While most survivors are insufficiently active following the completion of cancer treatment, a “teachable moment” is proposed to follow cancer diagnosis, whereby survivors may be more receptive to making health behaviour change (Bluethmann, Basen-Engquist, et al., 2015; Coa et al., 2015; Demark-Wahnefried et al., 2005).

Interventions seeking to promote physical activity in cancer survivors have often been based on theoretical frameworks that posit the provision of support and target barriers for behavioural change (Gourlan et al., 2016; Ntoumanis, Thørgersen-Ntoumani, et al., 2018; Rhodes et al., 2020; Stacey et al., 2015). As the factors affecting physical activity participation differ according to the motives, barriers, preferences, and needs of the cohort (Buffart et al., 2014; Cormie et al., 2020; Courneya et al., 2007; Ntoumanis, Quested, et al., 2018), investigation into these factors in colorectal and endometrial cancer survivors is necessary to inform the design of a behavioural intervention.

Leading approaches to health behaviour change, including the Health Action Process Approach (HAPA) (Schwarzer, 1992, 1999), share common Behavioural Change Techniques (BCTs) including self-monitoring, action planning, and the provision of support to overcome barriers. These have been effective for initiating physical activity uptake in cancer survivors (Michie, Ashford, et al., 2011; Michie et al., 2013). However, many interventions employing these techniques have been resource-intensive and impractical for scalable implementation into survivorship aftercare (Spark et al., 2013).

Wearable activity trackers present a novel opportunity for resource-efficient delivery of BCTs to promote physical activity in clinical samples (Direito et al., 2014; Fisch et al., 2016; Mercer, Giangregorio, et al., 2016). Coupled with their respective applications, smart trackers have the capacity to facilitate self-monitoring of physical activity, goal setting towards achievements, the provision of feedback on progress towards goals, as well as social support via networking functions (Direito et al., 2014; Mercer, Li, et al., 2016; Stephenson et al., 2017; Zhu et al., 2017). Fitbit trackers in particular have been found to be acceptable for use amongst clinical samples and older adults (Chum et al., 2017; Dean et al., 2018; Gell et al., 2017; Hardcastle, Galliott, et al., 2018; Mercer, Giangregorio, et al., 2016; Rossi et al., 2018). The limited number of studies that have assessed the effectiveness of Fitbits for promoting physical activity in cancer survivors have shown promise when delivered as part of an intervention incorporating targeted BCTs (Cadmus-Bertram et al., 2019; Gell, Grover, et al., 2020; Hartman, Nelson, Myers, et al., 2018). To date, no studies have assessed the effectiveness of a HAPA-based and wearable activity tracker intervention to increase MVPA in endometrial and colorectal cancer survivors.

It is hypothesised that a wearable tracker-based intervention incorporating BCTs that target the factors affecting physical activity uptake will be effective for increasing MVPA in cancer survivors at risk of cardiovascular disease.

1.2 Thesis Objectives

The objective of this thesis was to explore the barriers, motives, and attitudes held by cancer survivors towards physical activity behavioural change, and to implement a Wearable Activity Technology And Action Planning (WATAAP) intervention to promote physical activity in colorectal and endometrial cancer survivors. *Studies One* and *Two* aimed to examine the barriers, motives, and attitudes held by survivors, and the findings informed the design and protocol of *Study Three*, a randomised controlled trial (RCT) testing the WATAAP intervention. The primary objective of the WATAAP intervention was to increase MVPA in colorectal and endometrial cancer survivors at heightened cardiovascular risk. Secondary aims were to assess the effectiveness of the WATAAP intervention across sedentary behaviour and cardiovascular risk factors in this sample.

The secondary objectives of this thesis are outlined below. The literature review in Chapter Three will cover objectives 1-3 and provide a review of the evidence pertaining to *Studies One, Two,* and *Three*. The subsequent chapters will address objectives 4-8.

1. To review the existing literature on the factors facilitating physical activity in cancer survivors, specifically, to provide evidence on motives, barriers, preferences, and support needs ahead of a discussion of behavioural change interventions.
2. To review leading health behavioural change frameworks and interventions to date that have aimed to promote physical activity (often in conjunction with other health behaviours) during cancer survivorship.
3. To review the evidence on contemporary physical activity interventions incorporating wearable activity trackers, and their respective software, alongside BCTs.
4. To undertake a qualitative exploration of the barriers to physical activity in colorectal cancer survivors who are at heightened risk of cardiovascular disease, and to elucidate the specific factors hindering physical activity in the targeted cohort of Australian colorectal cancer survivors who are at cardiovascular risk, ahead of a behavioural intervention.
5. To administer a mixed-methods survey of physical activity behaviour, preferences, attitudes, and factors facilitating physical activity change in order to:

    i) contribute to the limited knowledge base on support needs, motives, and barriers of a broader sample of cancer survivors across geographical classifications, and
    ii) inform the design of a behavioural intervention to promote physical activity in cancer survivors.

6. To present the quantitative components of the mixed-methods survey in order to identify psychological constructs affecting physical activity and the specific exercise preferences of cancer survivors, as well as to inform the design of the behavioural intervention and illuminate any disparities between preferences and physical activity initiatives for survivors.
7. To assess the design and effectiveness of the WATAAP trial for increasing MVPA in colorectal and endometrial cancer survivors, and to consider changes in secondary outcomes of moderate-intensity activity, sedentary behaviour, body mass index (BMI), and blood pressure.
8. To amalgamate the findings from the three studies that constitute this project and synthesise them with the existing knowledge on physical activity promotion in cancer survivors in order to provide a view into the current field of research and directions for future studies.

1.3 Thesis Overview

Chapter one has introduced the thesis topic of physical activity promotion in cancer survivors at risk of cardiovascular disease. The primary objectives of the thesis have been summarised and an overview of the structure of the thesis chapters to follow has been provided.

Chapter two provides the background to colorectal and endometrial cancers, the cancer trajectory, cancer survivorship, and unhealthy lifestyle factors associated with survivorship. An emphasis is placed on the prevalence of physical inactivity and obesity amongst cancer survivors. The chapter also presents a summary of physical activity guidelines, government recommendations, and targeted suggestions for survivorship. A justification for behavioural change initiatives in cancer survivors is established, providing context for the literature review to follow.

Chapter three contains a critical review of the literature to date on factors facilitating physical activity in cancer survivors. Specifically, this includes consideration of the motives, barriers, support needs, and preferences of cancer survivors to engage in physical activity. This chapter also contains a critical review of the psychological interventions to date that aim to promote physical activity in cancer survivors, and outlines leading behavioural change theories in the field. Chapter three provides a review of research into the effectiveness and acceptability of wearable activity trackers and emphasises the lack

of completed wearable activity tracker trials in cancer survivors. This chapter concludes with a summary of the limitations of the existing research and the rationale for this project.

Chapter four is a published manuscript on the results of *Study One* pertaining to colorectal cancer survivors' barriers to engaging in physical activity. Exploration of survivors' barriers is necessary to inform the design and delivery of a behavioural intervention.

Chapters five to seven comprise three manuscripts that present data collected from the quantitative and open-ended aspects of *Study Two*. The survey administered in *Study Two* aimed to address several research questions investigating the factors affecting health behaviours, in addition to a quantitative assessment of the psychological constructs and preferences associated with physical activity. In order to forge clarity across these distinct research questions, and given the rich nature of open-ended responses concerning motives, barriers, and support needs, separate aspects of *Study Two* are presented across three manuscripts.

Chapter five is an unpublished manuscript discussing the barriers and support needs of cancer survivors, as ascertained from open-ended items used in *Study Two*. This paper builds upon barriers identified in *Study One* by drawing links between the barriers reported by survivors and their support needs for making health behaviour changes, in order to inform the design of a behavioural intervention which will aim to overcome these barriers.

Chapter six is a published manuscript that reports cancer survivors' motives to engage in health behaviour changes, based on the responses to open-ended items used in *Study Two*. This paper seeks to identify overarching motives for health behaviour change and discrepancies across demographic factors, to inform the design and framing of a behavioural intervention.

Chapter seven is a published manuscript that discusses the quantitative results of *Study Two.* This chapter places a particular emphasis on the factors affecting participation in physical activity and cancer survivors' physical activity preferences in order to inform the theoretical underpinnings of the behavioural intervention.

Chapter eight is a published protocol manuscript, detailing the WATAAP trial. The chapter incorporates evidence from the literature as well as findings from *Studies One* and *Two* into the rationale for the design of the WATAAP intervention. The study sample, assessment instruments, procedural details, and statistical power are discussed.

Chapter nine is a published manuscript that discusses the results of the WATAAP trial. Results are focused on the primary outcome of MVPA, with consideration given to secondary physical activity and cardiovascular risk outcomes.

Chapter ten concludes the thesis with a comprehensive discussion of the findings of *Studies One, Two,* and *Three*. The overarching implications and contribution of this project are considered in the context of psycho-oncology and health behaviour change. Strengths and limitations of the project are considered, and directions for future research are recommended.

Chapter Two

2

Background

Chapter Overview

This chapter provides a background to cancer survivorship and the typical cancer trajectory for colorectal and endometrial cancer survivors. An emphasis is placed on the established relationships between colorectal and endometrial cancers and unhealthy lifestyle factors. Given the fact that survivors of colorectal and endometrial cancers have often led unhealthy lifestyles prior to their cancer, they remain at risk of cardiovascular disease and other comorbidities. This chapter begins by outlining the risks associated with obesity and physical inactivity for individuals living after cancer, before suggesting greater exploration of the factors affecting physical activity. It concludes by discussing how these might inform effective initiatives that promote physical activity in survivors at risk of cardiovascular disease.

2.1 Cancer

Cancer refers to a collection of diseases whereby the body's cells divide in an abnormal and uncontrollable nature. This surplus of cells results in tumorous growths, which are considered malignant due to the fact that they can invade and damage surrounding tissues, and metastasise (National Cancer Institute, 2015a). Cancer is a leading cause of morbidity and mortality in Australia, with an estimated one in two Australians receiving a cancer diagnosis by the age of 85 (AIHW, 2019). Despite increasing cancer incidence rates, advances in cancer detection and treatment mean that cancer survival rates are also increasing (AIHW, 2020). Across all cancer types, the 5-year survival rate was 69% from 2011–2015 in Australia (AIHW, 2019). However, prevalence and prognosis vary widely across specific cancer types.

2.2 Colorectal Cancer

Colorectal cancer, also known as bowel cancer, refers to malignancies that originate in the colon or rectum. Colorectal cancer is the second most common cancer in Australia across both females and males (AIHW, 2019), with an estimated 16,398 new diagnoses of colorectal cancer in 2019 (Cancer Australia, 2019a).

Several genetic mutations have been established as risk factors for developing colorectal cancer, including MLH1, MSH2, MSH6, PMS2, APC, DPC4, Bmpr1, PTEN, and MYH (Anand et al., 2008). Approximately 5–10% of colorectal cancers result from recognised hereditary conditions, and an additional 20% of colorectal cancers affect individuals with a family history of colorectal cancer (World Cancer Research Fund

[WCRF], 2017). However, it is estimated that 30–50% of colorectal cancers result from lifestyle-related risk factors, including obesity, a high fat diet, and physical inactivity, which are modifiable via health behaviours and lifestyle change (J. Lee et al., 2015; Platz et al., 2000; WCRF, 2017).

2.2.1 Colorectal Cancer Diagnosis and Treatment

The average age of individuals who receive a colorectal cancer diagnosis in Australia is 69 years, with the likelihood of incidence increasing rapidly for those older than 50 (AIHW, 2012a; J. P. Young et al., 2015). Early detection of colorectal cancer is becoming increasingly common due to the National Bowel Cancer Screening Program, which offers free immunochemical faecal occult blood testing to Australian adults from the age of 50 (Lew et al., 2017; Parkin et al., 2018). The purpose of this initiative is to detect precancerous polyps or early-stage colorectal cancer, in order to reduce advanced-stage colorectal cancers and thereby reduce the costs and mortality rates associated with advanced colorectal cancer (Parkin et al., 2018).

The average registry-derived stage of colorectal cancer at diagnosis is 2.4, which indicates that the cancer has grown into the outer layers or through the wall of the colon or rectum, but has not grown into nearby organs, tissues, or lymph nodes (American Cancer Society, 2018). In Australia, the introduction of the screening program means that the registry-derived stage at diagnosis is improving, with almost 40% of diagnoses resulting from the program being stage 1, compared to 12% of symptomatic diagnoses at stage 1 (Ananda et al., 2016). Given that these earlier-stage cancers have not metastasised, the most common treatment involves surgery to remove the cancer and surrounding tissue, and then to anastomose the remaining two ends of the bowel together (Cancer Australia, 2017a). Surgery is often combined with adjuvant chemotherapy, adjuvant or neoadjuvant radiotherapy, or both (National Health and Medical Research Council [NHMRC], 2005).

Chemotherapy is a cytotoxic drug treatment that typically requires several cycles, according to a patient's treatment plan (NHMRC, 2005). Radiotherapy involves a targeted dose of radiation to kill cancer cells and is administered daily in fractions until the required dose is reached (Cancer Australia, 2017b; NHMRC, 2005). Following successful treatment of colorectal cancer and the cessation of active cancer treatments, patients undergo a 5-year follow up. The follow-up period involves an annual computed tomography scan and a colonoscopy at 12 months, and again at 4 years post-treatment, to detect signs of cancer recurrence (Steele et al., 2015). Due to increased awareness and

advancements in technology to aid early detection, 70% of Australians diagnosed with colorectal cancer survive for at least 5 years post-diagnosis (Cancer Australia, 2019a). Survival rates are negatively associated with stage at diagnosis, such that patients diagnosed with stages 1 and 2 colorectal cancer have survival rates of 99% and 89%, respectively (Cancer Australia, 2020a). The cancer survival rate continues to improve after the 5-year follow-up period (Kong et al., 2019).

2.3 Gynaecological Cancer

Gynaecological cancers are malignancies that develop in the female reproductive organs, and include vaginal, cervical, vulval, endometrial, uterine, and ovarian neoplasms (Cancer Australia, 2020b). It is estimated that 6,652 females will be diagnosed with a gynaecological cancer in 2020, making up almost 10% of new female cancer diagnoses (Cancer Australia, 2020b). Women in Australia diagnosed with a gynaecological cancer have a 5-year survival rate of 70% (Cancer Australia, 2020b).

The most common gynaecological cancer is endometrial cancer, which develops in the lining of the uterus. Endometrial cancer constitutes almost half of all gynaecological cancers, with an estimated 3,115 new diagnoses in 2019 (Cancer Australia, 2019b). Endometrial cancer is most common in women aged 65–85 years, with the incidence of endometrial cancer increasing as a result of the typical Western lifestyle and our aging population (Denschlag et al., 2011). Endometrial cancer is attributed largely to environmental factors, with incidence rates up to ten times higher in affluent Western regions, including North America and northern Europe, compared to middle-income or developing regions such as southern Africa and India (Lortet-Tieulent et al., 2018).

Specifically, lifestyle-related risk factors such as insufficient physical activity and obesity increase the likelihood of developing endometrial cancer due to the increased production of oestrogen associated with excess body fat, and the resulting hyperplasia of endometrial tissue (Australian Gynaecological Cancer Foundation [AGCF], 2019; Lortet-Tieulent et al., 2018; WCRF, 2018). Endocrine factors, including prolonged exposure to unopposed endogenous oestrogen or oestrogen replacement therapy, and the use of Tamoxifen appear to increase endometrial cancer risk by two to three times (Brown & Hankinson, 2015; Goodman & Goff, 2009). Women with Lynch syndrome mutations in the mismatch repair genes MLH1, MSH2, MSH6, PMS2 and the EPCAM gene have an elevated lifetime risk of developing endometrial cancer of up to 33%, although lifestyle and anthropometric factors are also considered to play a primary role (AGCF, 2019; Aune

et al., 2015; Cancer Institute, New South Wales, 2020; Fader et al., 2009; Goodman & Goff, 2009; Meyer et al., 2009; Morice et al., 2016; WCRF, n.d.).

2.3.1 Endometrial Cancer Diagnosis and Treatment

The most common symptom of endometrial cancer is abnormal bleeding, which affects approximately 90% of patients (Morice et al., 2016). As individuals with endometrial cancer are usually symptomatic at an early stage, over 85% of endometrial cancers are diagnosed at stages 1 or 2 (Creasman et al., 2006), in accord with the criteria for stage classification established by the International Federation of Gynecology and Obstetrics (AGCF, 2019; Morice et al., 2016). These criteria convey that a diagnosis of early stage endometrial cancer indicates that the tumour is confined to the main body of the uterus (stage 1), is limited to the endometrium (stage 1A), has invaded ≥50% of the myometrium (stage 1B), or has invaded cervical stroma (stage 2) (Goodman & Goff, 2009; Morice et al., 2016). The standard procedures for determining diagnoses are pelvic ultrasonography and endometrial biopsy by Pipelle, endometrial biopsy, or hysteroscopy, dilatation and curettage (Goodman & Goff, 2009; Morice et al., 2016).

Once diagnosed, treatment for most early-stage endometrial cancer entails surgery alone (Creasman et al., 2006), which is often performed laparoscopically (Janda et al., 2010). Adjuvant therapies, including chemotherapy, radiotherapy, and/or hormonal therapy are tailored to the individual based on stage and histology (Creasman et al., 2006; Morice et al., 2016). Follow up for endometrial cancer survivors in Australia involves consultations every 3 to 6 months with the treating gynaecological oncologist, and in some centres, shared care with a gynaecologist or general practitioner, to monitor for cancer recurrence and side effects of adjuvant therapies (AGCF, 2019). The 5-year survival rate for women in Australia who have received a diagnosis of endometrial cancer is 83% (Cancer Australia, 2019b).

2.4 Cancer Survivorship

2.4.1 Cancer Survivorship and the Teachable Moment

The definition of a cancer survivor varies throughout the literature. For the purpose of this thesis, a cancer survivor is defined as any individual who has completed active cancer treatment, and has no signs of remaining cancer (ASCO, 2018). Although individuals who have completed active cancer treatment may be considered survivors indefinitely, this body of research focuses on survivors in the short-term, specifically those

within 5 years of diagnosis. The rationale for studying this cohort was two-fold: firstly, it enabled recruitment of survivors via oncologists, who are well-positioned to encourage behavioural change; secondly, the period following a cancer diagnosis is considered to provide a "teachable moment", whereby survivors are particularly receptive to making behavioural lifestyle change (Demark-Wahnefried et al., 2005).

A review by Demark-Wahnefried et al. (2005) suggests that this juncture presents a transient opportunity for oncologists to intervene by guiding survivors to practise health behaviours, reduce risk factors and improve their overall wellbeing (Coa et al., 2015; Demark-Wahnefried et al., 2005). Research in breast, colorectal, and prostate cancer survivors has supported this notion of heightened receptivity to change, revealing a significant, negative association between time since cancer diagnosis and health behaviours – specifically fruit and vegetable consumption and reduced smoking – such that health behaviours peak a short time following cancer diagnosis (Bluethmann, Basen-Engquist, et al., 2015).

Comparisons between Australian colon cancer survivors, breast cancer survivors, and adults without cancer revealed mixed findings, whereby breast cancer survivors appeared to experience a more significant teachable moment with respect to physical activity, completing more MVPA than individuals in a non-cancer control group (Shi et al., 2017). However, colon cancer survivors completed the same amount of MVPA, but with less light-intensity physical activity and greater sedentary time, than adults without cancer (Shi et al., 2017). The proportion of colorectal cancer survivors who are inactive or insufficiently active increased from 47% pre-diagnosis to 68% 6 months post-diagnosis (Hawkes et al., 2008). Further, a survey from a small sample (n = 24) of breast cancer survivors in Ireland revealed no change in health behaviours at 6 weeks, 6 months, and 1 year following completion of chemotherapy (Broderick, Hussey, et al., 2014). More recent observational findings have revealed that breast cancer survivors are most likely to reduce MVPA and increase sedentary time in the two years following a cancer diagnosis (Shi et al., 2020), warranting elucidation of the factors affecting the teachable moment. It is plausible that the teachable moment may result in an increase in *receptivity* to health behaviour change, but without interventional initiatives following a cancer diagnosis, patients may not capitalise on this moment.

2.4.2 Cancer Survivorship and Cardiovascular Risk

Despite survival rates improving, cancer survivorship entails an array of challenges and survivors remain at greater risk of non-cancer mortality than those without a cancer history (Baade et al., 2006). Survivors of colorectal and gynaecological cancers continue to be at increased cardiovascular risk due to physical inactivity, sedentary behaviour, obesity, poor diet, and other lifestyle factors (Arem & Irwin, 2013; J. Lee et al., 2015; Lynch, 2010; Lynch et al., 2013; Rock et al., 2012; Schüz et al., 2015; Weaver, Foraker, et al., 2013). Gynaecological cancer survivors are more likely to die from cardiovascular disease than cancer recurrence or subsequent primary cancers (Ward et al., 2012), reflecting the prevalence of cardiac disease and risk factors in this cohort. The primary risk factors for survivors are obesity, poor diet, and metabolic syndrome. Endometrial cancer, in particular, has been strongly linked to obesity (Fader et al., 2009), with an estimated 70% of endometrial malignancies being linked to obesity (ASCO, 2019) and obesity rates remaining high into survivorship (Arem & Irwin, 2013). Lifestyle-related risk factors, including physical inactivity, obesity, red-meat consumption, alcohol consumption, and low fruit and vegetable consumption, are estimated to account for almost 40% of colorectal cancer diagnoses (Anand et al., 2008; Erdrich et al., 2015; Islami et al., 2018; Schüz et al., 2015).

Comparisons between cancer survivors and non-cancer cohorts of similar age groups in the United States revealed that cancer survivors are at greater risk of coronary heart failure, chronic obstructive pulmonary disease, and diabetes (Bluethmann et al., 2016). Australian cancer patients and survivors were significantly more likely to have three or more chronic conditions, report a mental health disorder, and experience endocrine, nutritional, metabolic, and cardiovascular disease than the non-cancer Australian population (Ng et al., 2018). Risk of cardiovascular disease is considered to be heightened due to increased prevalence of common risk factors for both cancer and cardiovascular disease in individuals with a current or previous cancer, including smoking, poor nutrition, alcohol consumption, obesity, and insufficient physical activity (Ng et al., 2018; Weaver, Foraker et al., 2013). An Australian population-based survey indicated that cancer survivors have higher levels of alcohol consumption and obesity and are more likely to be current cigarette smokers than a non-cancer population (Eakin et al., 2007). It is estimated that only 5% of cancer survivors meet all three current recommendations for fruit and vegetable consumption, sufficient physical activity, and non-smoking, placing them at heightened cardiovascular risk (C. M. Blanchard et al., 2008; James et al., 2015).

2.5 Physical Activity

2.5.1 Physical Activity Guidelines

Aerobic activity is reliant on the body's capacity to transport oxygen around the body for the generation of energy and has been proven to produce a vast range of physiological and psychological benefits. Evidence supports the value of regular aerobic physical activity and reduced sedentary time for preventing chronic disease (Ozemek et al., 2018; D. J. Ryan et al., 2015) and improving cardiorespiratory fitness, glucose metabolism control, muscle strength, cognitive functioning, and quality of life in older adults (Bouaziz et al., 2017). Aerobic physical activity has been found to reduce body weight (C. E. Matthews et al., 2007), inflammatory markers (S. B. Jones et al., 2013; Tizdast et al., 2016), cardiorespiratory fitness (Lahart et al., 2018), cancer-related fatigue (Tian et al., 2016), cancer recurrence (Friedenreich et al., 2009; Schmitz & Speck, 2010), mortality (Meyerhardt et al., 2006; Sternfeld et al., 2009; Warburton & Bredin, 2017), depression (Bekhet et al., 2019), anxiety (Bekhet et al., 2019), and improve general quality of life (Lahart et al., 2018; Schmitz et al., 2010) in cancer survivors.

In the United States, the NCCN and the American Cancer Society have promoted the physical activity guideline of 150 minutes of MVPA per week for cancer survivors following the initial post-surgical rehabilitation (American Cancer Society, 2020; NCCN, 2020; Rock et al., 2012). Due to the recognised cardiovascular benefits of higher-intensity physical activity, the American Cancer Society (2020) details that 150 minutes of moderate-intensity physical activity per week, 75 minutes of vigorous-intensity physical activity per week, or an equivalent combination of these two, is the minimum level of activity necessary to yield the anthropometric benefits associated with frequent aerobic activity. The recent guidelines for cancer survivors proposed by the American College of Sports Medicine (2019) largely align with the recommendation for 150 minutes of aerobic exercise per week. However, specific doses of 30–60 minutes of aerobic activity three times per week and supplementary resistance exercises have been posited to target specific outcomes of cancer-related fatigue, health-related quality of life, physical and emotional functioning. Activity was previously predicated to yield the optimal benefits in chronic disease risk factors when performed in bouts of at least 10 minutes (Armstrong et al., 2000; Haskell et al., 2007; O'Donovan et al., 2010), however recent guidelines have shifted in focus to reduced sedentary time (United States Department of Health and Human Services [DHHS], 2018). Finally, the guidelines propose that aerobic activity should be

supplemented with muscle-strengthening activities on at least two days per week (Rock et al., 2012).

Although the issue of whether a clear-cut threshold exists has been widely debated (Arem et al., 2015; Robinson et al., 2019; Warburton et al., 2010; Warburton & Bredin, 2016; Warburton & Bredin, 2017), the guidelines provide a specific and defined target. The Australian Government's Department of Health (2014) has adopted these guidelines for Australian adults, and they have now been endorsed by the Cancer Council, for Australian cancer survivors (Cancer Council, 2019).

The Australian Government's recommendations for older adults (≥65 years) are modified such that a greater focus is on moderate- rather than vigorous-intensity physical activity and suggest that inactive older adults build up gradually to this level (Australian Government, Department of Health and Ageing, 2019). Otherwise, the guidelines remain largely the same as those suggested for adults aged 18–64. Similarly, the guidelines for survivors remain largely identical to those for the general population, although the importance of doing something over nothing has been emphasised for survivors (Cancer Council, 2019). A particular recommendation has been made to those in post-treatment rehabilitation to begin exercising as early as possible (Rock et al., 2012; Schmitz et al., 2010). Moreover, the greatest proportion of risk reduction was yielded by the transition from completing no physical activity, to completing a small amount of regular physical activity (Arem et al., 2015). Although this may mean beginning with lighter-intensity activities and less sedentary time, the intensity of physical activity should increase in accordance with the guidelines as the individual progresses further along in the cancer survivorship trajectory (Schmitz et al., 2010).

2.5.2 Physical Activity Intensity

Moderate-intensity activity is described by the American Cancer Society (2020) as requiring an equivalent amount of effort to that of a brisk walk with an elevated heart rate (HR). Whereas vigorous-intensity physical activity involves larger muscle groups, faster breathing, elevated HR, and often sweating. Jogging, running, brisk walking, cycling, swimming, weight training, dancing, and sports such as tennis and basketball often fall into the moderate-to-vigorous intensity category. However, MVPA could also involve activities like digging and heavy labour (American Cancer Society, 2020). Therefore, to assist in the classification of activity intensity, the measurement of MVPA has been linked to the magnitude of elevation in an individual's HR. According to Reed and Pipe (2016),

when performing moderate-intensity physical activity, an individual's HR will be at 64–75% of their maximum HR and when performing vigorous-intensity physical activity, an individual's HR will be at 76–96% of their maximum. The Karvonen Formula (1957) of $HR_{MAX} = 220$ *minus age in years* has been widely adopted to ascertain an individual's maximum HR (Arena et al., 2016; Broderick et al., 2013; Fox & Haskell, 1968; Reed & Pipe, 2016; Scherr et al., 2013). Although further research has been called for to assess the validity of this formula for older adults and clinical cohorts (Reed & Pipe, 2016; She et al., 2015; Tanaka et al., 2001), these estimates are of value to inform individuals when classifying the intensity of their physical activity (Braham et al., 2012; Strath et al., 2000).

2.5.3 Physical Activity and Cancer Survivorship

The majority of cancer survivors are overweight or have obesity, and 82% of survivors do not adhere to the recommendation of five or more bouts of moderate-intensity physical activity, nor to the guideline of 150 minutes of MVPA per week (DHHS, 2018; Grimmett et al., 2011; NCCN, 2020; Rock et al., 2012). Furthermore, almost 20% of long-term cancer survivors fail to complete 10 minutes of moderate-intensity physical activity per week (C. R. Leach, Weaver, et al., 2015).

Following cancer treatment, physical activity in breast (Vagenas et al., 2015) and colorectal (Hawkes et al., 2008) cancer survivors continues to decline, with cancer survivors engaging in less physical activity than those without a cancer history (S. G. Smith & Chagpar, 2010; Z. Wang, McLoone, & Morrison, 2015).

Despite their low physical activity levels, many cancer survivors report being open and willing to participate in interventions that aim to increase physical activity (Blaney et al., 2013; Phillips et al., 2017; L. Smith et al., 2017; Vallance et al., 2013). Moreover, interventions to increase physical activity have been associated with improvements in quality of life, physical function, and mortality (Buffart et al., 2017; Fong et al., 2012; Schmid & Leitzmann, 2014). Specifically, physical activity in survivors has been found to improve cardiovascular fitness and muscle strength, and to contribute to psychological outcomes such as decreased fatigue and depression, and improved physical and mental quality of life, self-esteem, and happiness (Robertson et al., 2019; Rock et al., 2012; Schmitz et al., 2010).

When performed in conjunction with other health behaviours such as fruit and vegetable consumption, regular physical activity has even greater benefits for reducing risk of mortality (Pierce et al., 2008). Conversely, sedentary behaviour is a risk factor for

morbidity, disease recurrence, and mortality (Biswas et al., 2015; Lynch, 2010). Initiatives to increase physical activity and reduce sedentary behaviour have been recommended (Bourke et al., 2014; Buffart et al., 2014; Courneya et al., 2015; Demark-Wahnefried & Jones, 2008; Lynch, 2010; Rock et al., 2012).

It is estimated that 68% of colorectal (Hawkes et al., 2008), 78% of endometrial (Basen-Engquist et al., 2009), and 84% of breast (Boyle et al., 2016; S. G. Smith & Chagpar, 2010) cancer survivors are insufficiently physically active according to the recommended guideline of 150 minutes of MVPA per week (NCCN, 2020). Obesity is the single greatest risk factor for endometrial cancer, and recommendations have been made for physical activity promotion to improve both cancer-related and survivorship outcomes (Moore & Brewer, 2017). Similarly, BMI and physical inactivity have been deemed significant risk factors for colorectal cancer, with weight management via physical activity recommended as a protective factor for mortality (Islami et al., 2018; Shaukat et al., 2017). While lifestyle-related risk factors for cardiovascular disease are prevalent amongst endometrial (ASCO, 2019; Fader et al., 2009; Moore & Brewer, 2017; Ward et al., 2012) and colorectal (Islami et al., 2018; Karahalios et al., 2015; Shaukat et al., 2017) cancer survivors, most physical activity trials to date have recruited breast cancer survivors (Ballard-Barbash et al., 2012; Bluethmann et al., 2017; Bluethmann, Vernon, et al., 2015; Fong et al., 2012; Goode et al., 2015; Löf et al., 2012; Schmitz et al., 2005; Spark et al., 2013; Speck et al., 2010; Spence et al., 2010; Stacey et al., 2015). As cancer survivors, particularly colorectal and endometrial cancer survivors, are considered to be at increased risk of cardiovascular disease due to lifestyle factors, these populations will be a focus of the current thesis.

Chapter Three

3

Literature Review

Chapter Overview

This chapter provides an in-depth review of the literature to date concerning the factors affecting physical activity uptake in cancer survivors. It is acknowledged that a variety of factors facilitate physical activity uptake across different cohorts of cancer survivors. The literature review will focus on current knowledge of survivors' barriers and motives with respect to changing health behaviours – specifically physical activity – in order to provide a background and rationale for *Study One*. The physical activity preferences of survivors are considered, and the disparity between these preferences and programs offered is illuminated. An overview of the current evidence concerning exercise preferences and the nature in which they differ by cohort will inform the rationale for further investigation in *Study Two.*

This chapter also introduces leading theoretical frameworks of health behaviour change, followed by a critical discussion of their applications to promote physical activity in cancer survivor samples. This review of leading theories and their applications will provide support for the psychological constructs that will be assessed in *Study Two* and incorporated into *Study Three*. Support for the use of digital interventions and wearable activity technology (WAT) as a vehicle for BCTs is considered, followed by a review of interventions to date that have utilised Fitbit activity trackers to promote physical activity in cancer survivors. *Chapter Three* concludes with a summary of the current state of the research field and a justification that this project makes a significant contribution to existing knowledge.

3.1 Literature Review of Factors Facilitating Physical Activity in Cancer Survivors

Currently, many cancer survivors fail to engage in physical activity in accordance with the recommended 150 minutes of weekly MVPA (Basen-Engquist et al., 2009; Boyle et al., 2016; DHHS, 2018; Grimmett et al., 2011; Hawkes et al., 2008; C. R. Leach, Weaver, et al., 2015; NCCN, 2020; Rock et al., 2012). This disconnect may be explained, in part, by survivors' sense of disengagement and discouragement with respect to the physical activity guidelines for cancer survivors (Algotar et al., 2018; NCCN, 2020). Motives and intentions were identified as determinants of physical activity for survivors, with intention being strongly associated with survivors' attitudes towards physical activity and perceived behavioural control (PBC) (Stevinson, Tonkin, et al., 2009). Other research suggests that the factors affecting participation in physical activity are unique across

cohorts, warranting an examination of the specific determinants for cancer survivors rather than adoption of a "one size fits all" approach (Badger et al., 2013; Buffart et al., 2014; Cormie et al., 2020; Courneya et al., 2007). To increase uptake, effectiveness, and maintenance of physical activity initiatives, interventions to increase physical activity should be tailored to the unique preferences, motives, and barriers expressed by target cohorts (Cormie et al., 2020; Ntoumanis, Quested, et al., 2018; Stull et al., 2007).

3.1.1 Physical Activity Motives and Barriers in Cancer Survivors

Primary motives for engaging in physical activity identified by breast and prostate cancer survivors include social and networking factors, as well as cancer-specific health-related factors such as avoiding cancer recurrence, and internal motives related to previous exercise history and personal benefits (Patel et al., 2017; Rogers et al., 2010; Wurz et al., 2015). A mixed methods systematic review of factors affecting physical activity in cancer survivors revealed that the perception of control over health, management of stress, and wellbeing were primary facilitators to engage in physical activity (Clifford et al., 2018). Similarly, improvement in health was a motive for physical activity participation in a small sample of older breast cancer survivors in the United Kingdom, along with weight loss and improved body image (Whitehead & Lavelle, 2009). In a sample of 354 endometrial cancer survivors in Canada, the primary motives for engaging in physical activity were weight loss, feeling better about oneself, improving physical and mental health, and flexibility (Karvinen, Courneya, Campbell, et al., 2007). For this sample, primary barriers to physical activity included poor health, lack of time, weather conditions, injury, fatigue, lack of facilities, and lack of motivation (Karvinen, Courneya, Campbell, et al., 2007).

In recent research, endometrial cancer survivors identified a lack of motivation, cost, weather conditions, and injuries as barriers to physical activity (Hardcastle, Glassey, et al., 2017). Conversely, both Canadian breast cancer survivors and a small sample of prostate cancer survivors in New Zealand identified unique barriers associated with cancer-related limitations such as side effects of treatment, bowel issues and post-surgery limitations, and pre-existing health issues, as well as environmental barriers such as lack of time, competing priorities, and costs associated with fitness centres (Patel et al., 2017; Wurz et al., 2015). Echoing "lack of time" as a barrier, American prostate and breast cancer survivors reported psychological and priority-based barriers related to being too busy, lacking willpower, and a dislike of exercise (Ottenbacher et al., 2011). Others reported environmental obstacles, including inclement weather, lack of facilities, and accessibility issues (Brunet et al., 2013; Ottenbacher et al., 2011). Findings were similar across mixed

cancer survivors, who reported health problems, fatigue, pain, weather conditions, a lack of facilities, interest, motivation, and insufficient physical activity advice as barriers (Blaney et al., 2013; Hardcastle, Maxwell-Smith, Kamarova, et al., 2018).

Colorectal cancer survivors perceived disease-specific barriers, including fatigue, feeling unwell, and the symptoms of other comorbidities (Fisher, Wardle, et al., 2016; Lynch et al., 2010), and may also be affected by poor bowel function, discomfort, and other effects of a stoma (Lynch et al., 2010). Other barriers include age, competing commitments for time, alongside personal attribute barriers, including a lack of interest or enjoyment (Fisher, Wardle, et al., 2016; Lynch et al., 2010). While the possible responses for barriers were deduced from an evidence-based list constructed by Lynch et al. (2010), the study by Fisher, Wardle, et al. (2016) sought to ascertain barriers via an open-ended survey method. This may have resulted in greater quality and more valid responses (Bjertnaes et al., 2016; Riiskjær et al., 2012), and this method is warranted, given that existing research has pointed to unique barriers experienced during cancer survivorship (Clifford et al., 2018; Fisher, Wardle, et al., 2016; Lynch et al., 2010).

Most recently, a review by Clifford et al. (2018) indicated the prevalence of treatment-related barriers, including disrupted sleep, pain, and loss of physical function, and lack of time as physical activity barriers. For survivors who have undergone chemotherapy, chemotherapy-induced peripheral neuropathy can result in a sense of numbness and difficulties with proprioception (McCrary et al., 2019). Survivors with peripheral neuropathy may also experience secondary pain, have difficulties with balancing, lose confidence in physical function and mobility, and experience reduced quality of life (McCrary et al., 2019; Tofthagen et al., 2020; Yamamoto et al., 2020). As such, chemotherapy-induced peripheral neuropathy appears to be an additional factor in deterring survivors' participation in physical activity (Clifford et al., 2018).

Given differences across treatment status, duration of treatment, lifestyle prior to cancer, and individual circumstances, it has been suggested that unique cancer experiences result in diverse barriers and motives towards physical activity (Courneya et al., 2007). For example, the compounding of differences between survivors' experiences – including intensity of treatment and potential complications, in addition to demographic and lifestyle variables – may result in disparities in the determinants of physical activity uptake in survivorship (Courneya et al., 2007). As such, examination of the factors affecting physical activity in specific cohorts of cancer survivors could assist in developing more effective initiatives to promote physical activity.

3.1.2 Physical Activity Preferences in Cancer Survivors

In conjunction with the motives and barriers identified, cancer survivors also specify a preference for physical activity that is self-paced, unsupervised and can be completed alone or with a partner (Rogers, Malone, et al., 2009; Rogers, Markwell, et al., 2009; Vallance et al., 2006). Over 80% of cancer survivors report being willing and able to take part in an exercise program (Vallance et al., 2006; Wong et al., 2018). Despite promising outcomes for patients with cancer who participated in supervised interventions (Buffart et al., 2017), survivors expressed a preference for starting a program 1 year or more after completion of active cancer treatment (Blaney et al., 2013; Phillips et al., 2017; Vallance et al., 2013; Wong et al., 2018). McGowan et al. (2013) reported that fewer than 25% of colorectal cancer survivors wanted to exercise at a fitness centre, and most reported a preference for unsupervised exercise (Karvinen, Courneya, Venner, & North, 2007; Rogers, Malone, et al., 2009; Trinh et al., 2012a; Vallance et al., 2006). While some evidence showed that cancer survivors living in rural settings preferred to exercise outdoors or at home, rather than at a fitness facility or cancer centre (Rogers, Markwell, et al., 2009), other research in Canadian rural breast cancer survivors reported a desire for a facility-based, indoor program (Vallance et al., 2013).

Survivors' barriers for participation in the Cancer Council's Life Now supervised exercise program (Cancer Council WA, 2020), were concerned with access to the program, time taken, and cost associated with travel (Hardcastle, Maxwell-Smith, Kamarova, et al., 2018). Structured programs, including the Life Now initiative, operate in metropolitan and inner regional areas (Australian Government, Department of Health, n.d.), limiting the opportunities available to survivors in remote locations. Rural survivors are open to counselling and guidance from an exercise specialist and may be more willing to exercise with their peers (Vallance et al., 2013), compared to metropolitan survivors who report a preference for exercising alone (McGowan et al., 2013; Stevinson, Capstick, et al., 2009; Vallance et al., 2006). Although preferences may vary by geographical classification of remoteness, this has only been directly examined in a small sub-sample of head and neck cancer survivors ($n = 24$) in which no significant differences were identified (Rogers, Malone, et al., 2009). Given that survivors in socially deprived and rural areas have greater lifestyle-related risk factors (Tervonen et al., 2017; Weaver, Geiger, et al., 2013) and are typically underrepresented (Lyford et al., 2018), investigation of disparities in factors affecting physical activity by geographical classification has been recommended (Rogers, Malone, et al., 2009).

In terms of physical activity intensity, cancer survivors report preferring forms of exercise that are of light-to-moderate intensity (Blaney et al., 2013; McGowan et al., 2013). Walking is vastly favoured over other activities, regardless of weather or season (Blaney et al., 2013; Rogers, Markwell, et al., 2009; Wong et al., 2018). A recent review largely concurred with previously reported preferences for a home-based, moderate-intensity intervention that specifically encourages walking alongside exercise counselling delivered by a specialised health practitioner (Wong et al., 2018). Survivors have expressed a desire for mobile technology to facilitate personalised feedback and goal achievement (Robertson et al., 2017). For breast cancer survivors, 80% were interested in receiving an exercise intervention that could be delivered remotely, with 90% reporting that an activity tracker would be a helpful component of such an intervention (Phillips et al., 2017).

Despite the evidence of such preferences, previous programs that have aimed to promote physical activity in cancer survivors have often been facility-based, supervised, or have involved group activities (Pekmezi & Demark-Wahnefried, 2011; Speck et al., 2010). Tailoring the content and structure of interventions to suit particular cohorts of cancer survivors allows for greater self-efficacy, whereby participants feel capable of performing the proposed activity, and is likely to foster sustained practise (Amireault et al., 2013; Nigg et al., 2008).

3.1.3 Support Needs in Cancer Survivors

In accordance with tailoring interventions based on the specific motives, barriers, and preferences of the target group, the support needs of a cohort should also be considered when designing interventions (Hardcastle & Hagger, 2016). The support needs of cancer survivors differ from those of the general population, in that many seek further information on the implications of cancer survivorship and residual effects of cancer, cancer symptoms, or cancer treatment (Hawkes et al., 2015; Kent et al., 2012; Lyu et al., 2020; Playdon et al., 2016; Rogers et al., 2010). Breast, prostate, colorectal, and gynaecological cancer survivors ranging from 4–14 years post-diagnosis revealed unmet needs regarding information on side effects, treatment, health promotion, and sexual functioning. Additionally, over 60% reported unmet interpersonal and emotional support needs, with those less than 10 years post-diagnosis significantly more likely to have interpersonal and emotional needs (Kent et al., 2012). Approximately one third of American cancer survivors at 9 years post-diagnosis have unmet informational support needs about engaging in healthy lifestyle behaviours (Playdon et al., 2016). Survivors specify that they would prefer to receive this informational support either via tailored print materials or from a health professional, with survivors who

report having poor health expressing significantly greater support needs (Playdon et al., 2016). As this exploration of health promotion was limited to survivors' interest in general health behaviours, their specific needs pertaining to exercise, diet, or other health behaviour information cannot be discerned.

Harrison and colleagues reported that cancer survivors, post-treatment, have the greatest number of unmet support needs, compared to any other time during their cancer trajectory (Harrison et al., 2009). The most frequently reported are daily living needs (cooking, shopping, transportation) followed by psychological, informational, and psychosocial needs (Harrison et al., 2009). A systematic review of the supportive care needs of cancer patients in rural and urban locations indicates that rural patients have greater support needs, which are associated with both practical problems, such as transportation and finance, and emotional needs (Butow et al., 2012; Grimison et al., 2012). However, it has previously been suggested that the support needs of Western Australians who had received a cancer diagnosis do not vary significantly by rural classification (White et al., 2011). While the primary support needs of Western Australians were for information regarding the prevention of cancer recurrence and psychological support, survivors in this sample were most frequently diagnosed with breast or prostate cancer and may have been still undergoing treatment (White et al., 2011), which may limit the relevance of their reported needs to cancer survivors who have completed active treatment.

More recently, informational support needs concerning cancer treatment and its side effects were the most common domain of needs in rural cancer survivors (Palmer et al., 2020), indicating that informational needs become particularly prominent in survivorship (Tan et al., 2015). Needs concerning health promotion were identified by 54% of the sample, who were primarily concerned with receiving further information about reducing their risk of cancer recurrence (Palmer et al., 2020; White et al., 2011). Similarly, a review of the supportive care needs of breast cancer survivors revealed that their most prevalent unmet needs pertained to informational and psychological support, with unmet psychological support needs being associated with anxiety and depression in survivors (Fiszer et al., 2014). Survivors desired support with regards to physical care and engaging in healthy lifestyle programs, and had positive attitudes towards receiving such support through an e-program (Jansen et al., 2015). Even several years into survivorship, unmet needs span psychological, social, and physical support (Harrison et al., 2009; Hwang & Park, 2006). Notably, colorectal cancer survivors appeared to have greater informational support needs in later years of survivorship, compared to breast cancer survivors, who

reported a gradual decline in needs (Tan et al., 2015). Due to the fact that survivors have expressed informational and psychosocial care needs (Kent et al., 2012; King et al., 2015; Williams et al., 2018), and that those who are given information respond positively (Calfas et al., 1996; Fisher, Smith, & Wardle, 2016), examination of cancer survivors' support needs should be incorporated into future initiatives to improve health behaviours.

Peer support and contact with health professionals may be ideal channels for the delivery of survivorship-related information. A qualitative synthesis of the supportive care needs of prostate cancer survivors revealed that peer-support and support groups are of value during the follow-up period (King et al., 2015). Moreover, contact with empathetic and experienced specialist cancer nurses, healthcare practitioners, and allied health professionals was of value to survivors and appeared to improve health outcomes. It has been recommended that cancer survivors have greater contact with allied professionals and for them to address unmet emotional support needs regarding treatment-related effects and enduring deficiencies in emotional and informational support. Prostate cancer survivors expressed a need for care packages tailored specifically to their experiences (King et al., 2015). Although these findings demonstrate the presence of patient needs throughout the cancer trajectory, most studies on this topic have focused on survivors' general post-cancer needs (Harrison et al., 2009; Kent et al., 2012; Tzelepis et al., 2018), rather than their specific needs about how to initiate and sustain positive health behaviours post-cancer. Other programs have relied on oncologist-delivered exercise recommendations to promote physical activity (Fisher et al., 2015; L. W. Jones et al., 2004; J.-H. Park et al., 2015), with mixed findings and limitations associated with participants' recall of such recommendations. As such, greater exploration of this subject and initiatives to provide long-term lifestyle support programs for survivors have been recommended (Armes et al., 2009; Hwang & Park, 2006; Kent et al., 2012; King et al., 2015).

Despite the evidence already discussed regarding survivors' support needs, an overarching finding across the literature was the variability of needs across a range of factors, including: cohort (Butow et al., 2012; Fiszer et al., 2014; Harrison et al., 2009; Hwang & Park, 2006; Kent et al., 2012; Williams et al., 2018), geographical classification (Butow et al., 2012), age (Fiszer et al., 2014; Harrison et al., 2009; Kent et al., 2012; Lyu et al., 2020; Williams et al., 2018), education level (Fiszer et al., 2014; Harrison et al., 2009; Hwang & Park, 2006), psychological wellbeing (Butow et al., 2012; Cheng et al., 2016; Fiszer et al., 2014; Harrison et al., 2009; Kent et al., 2012), advancement of cancer (Fiszer et al., 2014; Hwang & Park, 2006), treatment mode (Harrison et al., 2009; Williams et al.,

2018), and longevity of cancer survivorship (Cheng et al., 2016; Fiszer et al., 2014; Harrison et al., 2009; Hwang & Park, 2006). Hence, an investigation of the support needs of specific cohorts of survivors is likely to provide crucial information for the design and protocols of targeted health behaviour initiatives.

3.2 Literature Review of Physical Activity Interventions for Cancer Survivors

A review of controlled trials in cancer survivors provides powerful evidence of the positive effects of physical activity for improving strength, aerobic fitness, quality of life, and reducing fatigue (Speck et al., 2010). As such, it is important to ensure that initiatives designed to increase physical activity in survivors are effective. Commercial lifestyle and weight loss programs that aim to improve physical activity in the general population have been found to have small effects, which have not been durable generally (McEwan et al., 2020) nor specifically in cancer survivor cohorts (Spark et al., 2013). The Curves weight-loss program was offered to a sample of 22 overweight, minority breast cancer survivors in the United States for a 6-month pilot RCT (Greenlee et al., 2013). The program involved receiving a membership for a Curves fitness centre, which employed supervised circuit-based exercise sessions, with the target of exercising 5 days per week along with nutritional information to implement a calorie-restricted diet. The program yielded a statistically significant net body weight loss of 1.5% in the intervention group, compared to a wait-list control group (n = 20) (Greenlee et al., 2013). However, this weight loss was not sustained at the 12-month follow-up assessment (Greenlee et al., 2013).

Another RCT tested an atheoretical health behaviour intervention, Get Fit for the Fight, which targeted body fat, physical function, and quality of life in 28 American breast cancer survivors (Swisher et al., 2015). The 12-week intervention involved completing exercise-physiologist supervised and unsupervised physical activity sessions in accord with the guidelines of 150 minutes of moderate-intensity aerobic activity, completing a physical activity log, and nutrition counselling with a dietician (Swisher et al., 2015). The results revealed significant decreases in percentage of body fat in favour of the intervention group compared to a control group and a significant increase in exercise time over the course of the intervention. However, it must be noted that the physical activity outcome was assessed using a log-style method of self-reporting, which was then converted into a categorical level of activity (Swisher et al., 2015), rather than employing an objective measure of physical activity. Given the intensity of this intervention and the prominence of face-to-face contact

with health professionals, an additional assessment with a longer follow-up period would have been informative regarding the durability of positive effects.

In contrast to atheoretical approaches, there is support for the effectiveness of interventions that are underpinned by psychological theories of behaviour change (Bluethmann et al., 2017; Glanz & Bishop, 2010; Ntoumanis, Thørgersen-Ntoumani, et al., 2018; Rhodes et al., 2020; Short et al., 2011; Stacey et al., 2015; Stull et al., 2007). Evidence supporting tailored interventions based on psychological constructs has also been established from other theoretical perspectives, including consideration of social-cognitive constructs of attitudes towards, and barriers to, engagement in physical activity, which were strongly correlated with adherence (Courneya & Friedenreich, 1997, 1999; Wong et al., 2018). Tailored programs based upon theories that account for motives, barriers, preferences, and psychological determinants of physical activity could lead to increased physical activity and greater adherence to changes (L. W. Jones & Courneya, 2002; Rhodes et al., 2020). A meta-analysis of theory-based RCTs to promote physical activity supported the implementation of interventions based on theoretical frameworks, which result in significant change in physical activity across reviewed theoretical interventions (Gourlan et al., 2016). This has been debated more recently, however, due to a finding of minimal differences between theoretical and atheoretical physical activity interventions (McEwan et al., 2019). Moreover, strict adherence to theoretical principles throughout programs has been recommended to facilitate assessment of their roles in the positive effects of theoretical physical activity interventions for survivors (Bluethmann et al., 2017). Despite the small differences between them, theoretical interventions tend to be more consistently successful, which may be a result of their adherence to clusters of BCTs that are conducive to the application of theoretical approaches (McEwan et al., 2019). Furthermore, employing a theoretical framework of behavioural change facilitates retrospective explanation and understanding of the effective mechanisms or *active ingredients* within the intervention.

3.3 Leading Theoretical Approaches to Health Behaviour Change

Theoretical frameworks for health behaviour change have been applied to explain and promote physical activity in cancer survivorship. Leading theoretical approaches, including Social Cognitive Theory (SCT), the Transtheoretical Model of Change (TTM), the Theory of Planned Behaviour (TPB), the HAPA, and the Taxonomy of BCTs are relevant to this project as they have provided insights into the key psychological constructs that have informed intervention materials and forged behavioural change during cancer

survivorship. Psychological constructs included in SCT, TTM, and TPB have specific relevance to this project as they form the basis for *Study Two.* Discussion of the content and applications of the HAPA and the Taxonomy of BCTs will form the theoretical basis for the design of *Study Three,* the behavioural intervention.

3.3.1 Social Cognitive Theory

Bandura's (1986, 1989) SCT proposes that an individual's behaviour can be explained by their unique cognitive factors that regulate, control, and reinforce goal-oriented behaviours, along with their social environment. Primary determinants of health behaviours include outcome expectations about the behaviour, proximal and distal goals, and both personal and situational barriers to performing the proposed behaviour (Bandura, 1998). Self-efficacy, one's perception of one's capacity to engage in a proposed behaviour, is considered to play a pivotal role in regulating these determinants of health behaviours (Bandura, 1998). A review of the utility of SCT for explaining physical activity across 44 studies revealed that SCT constructs could account for 31% of the variance in physical activity (M. D. Young et al., 2014). Self-efficacy was most consistently associated with physical activity, followed by goals, while outcome expectations were not positively associated with physical activity. Overall, interventions based on SCT have yielded promising results for increasing physical activity (Harrigan et al., 2016; Hatchett et al., 2013; Pinto et al., 2013; Stacey et al., 2015).

3.3.1.1 Applications of Social Cognitive Theory to Promote Physical Activity in Cancer Survivorship

Components of SCT have been frequently identified throughout theory-based interventions to promote physical activity in cancer survivors (Bluethmann et al., 2017; Stacey et al., 2015). Although it is common for programs to adopt aspects of theoretical frameworks, particularly SCT, reviews of these programs have indicated that the greatest benefits are garnered with extensive adherence to the theoretical principles (Bluethmann et al., 2017). The Better Exercise Adherence after Treatment for Cancer (BEAT Cancer) intervention, was a 3-month, intensive, SCT-based intervention for breast cancer survivors in the United States (Rogers et al., 2015). The trial aimed to promote physical activity, aerobic fitness, and improve quality of life via 12 supervised exercise sessions, six group sessions and face-to-face counselling. Sessions focused on fostering a supportive environment for survivors by facilitating goal setting, self-monitoring of behaviour, cognitive reframing to protect against relapse, and stress management to mitigate barriers

(Rogers et al., 2015). Survivors demonstrated significant improvements in physical activity at 3 months compared to the usual-care control group, resulting in a 41-minute between-group difference in accelerometer-derived MVPA (Rogers et al., 2015). Those who received the BEAT Cancer intervention were also more likely to meet physical activity guidelines post-intervention and at the 3-month follow up. Other post-intervention effects include improved fitness and quality of life, which were maintained at 3 months following the cessation of the intervention (Rogers et al., 2015).

A unique component of the BEAT Cancer intervention was the provision of a personal HR monitor to assist with self-monitoring of aerobic activities. Measurement of HR allows for participants to ascertain the intensity of their activity, which is important given the guideline specification of MVPA in order to protect against mortality (Saint-Maurice et al., 2018) and maximise the cardiovascular benefits (Kikuchi et al., 2018; NCCN, 2020). However, further research might consider whether devices alone are sufficient to initiate and sustain behavioural change. The findings of the BEAT Cancer trial show promise for intensive and multi-faceted intervention, but may not be feasible to implement at a larger scale. Therefore, shorter, and more pragmatic approaches to behavioural change could offer a resource-effective solution (Penedo et al., 2020; Post & Flanagan, 2016).

Less-intensive SCT-based counselling interventions have yielded improvements in physical activity. A 12-week email-based intervention for breast cancer survivors incorporated messages and e-counselling which were tailored based on participants' self-efficacy, self-regulation, role identity, and outcome expectancies (Hatchett et al., 2013). The intervention resulted in significant between-group differences in self-reported vigorous-intensity physical activity at 6 weeks and both moderate- and vigorous-intensity physical activity at 12 weeks, when compared to a control group (Hatchett et al., 2013). While these effects demonstrate promise for the less intensive nature of this e-intervention, physical activity outcomes were assessed by days per week that survivors self-reported engaging in moderate- and vigorous-intensity physical activity. This outcome precludes comparison of weekly minutes of physical activity per many other interventions and international physical activity recommendations (American Cancer Society, 2020; Cancer Council, 2019; Australian Government, Department of Health, 2014; NCCN, 2020).

There have been few SCT-based trials that specifically target physical activity in colorectal and gynaecologic cancer survivors. In one of only a few home-based interventions specifically for colorectal cancer survivors in the United States, Pinto et al. (2013) employed weekly telephone counselling and print materials to promote physical

activity. The 12-week intervention materials were based on SCT and TTM constructs and participants also received a pedometer and HR monitoring information to encourage progress towards 150 minutes of weekly MVPA. The intervention produced significant improvements in total minutes of physical activity and caloric expenditure at 3 months and improvements in fitness at 3-, 6-, and 12-month assessments, when compared to the contact control group (Pinto et al., 2013). The primary outcome of physical activity was assessed via self-reported recall, which may have introduced error as well as participant bias into the results (Prince et al., 2008). However, accelerometer-measured estimates of physical activity were used to validate physical activity outcome measures in this study (Pinto et al., 2013). As accelerometry is considered the gold-standard for physical activity measurement (Boyle et al., 2015; Ferrari et al., 2007), validation using accelerometer-derived estimates assists in allaying the potential for error associated with recall. A major strength of this trial is the incorporation of weekly contact for participants in the control group, as well as the intervention group, which involved surveying survivorship symptoms. Between-group differences yielded in this trial support the effectiveness of the intervention components, rather than benefits of contact with research staff.

In an SCT-based intervention to promote physical activity in uterine cancer survivors with overweight and obesity, participants received a 6-month lifestyle intervention aimed to improve BMI, diet, and physical activity (von Gruenigen et al., 2012). The Survivors of Uterine Cancer Empowered by Exercise and Healthy Diet (SUCCEED) intervention adopted SCT principles, targeting self-efficacy and goal setting in order to encourage behavioural change. The intervention was delivered via individual and group counselling sessions over a 6-month period. The face-to-face delivery mode and frequent sessions were countered by equivalent physician contact in the control group, only without counselling components (von Gruenigen et al., 2012). The SUCCEED intervention was successful for producing a significant change in BMI in the intervention group, compared to control group, at both 6- and 12-month assessments (net difference: 1.6kg/m^2 at both time periods) (McCarroll et al., 2014). Significant improvements were yielded across all domains of self-efficacy and in self-reported weekly physical activity minutes between intervention and control groups from baseline to 6 and 12 months (McCarroll et al., 2014). The intensive SUCCEED intervention resulted in durable effects, yielding an increase from 84 weekly minutes at baseline to 301 weekly minutes at 3 months, 249 weekly minutes at 6 months and 216 weekly minutes at 12 months (von Gruenigen et al., 2012), in support of the longer duration and intensive design.

In Australia, mixed cancer survivors and carers were recruited for the Exercise and Nutrition Routine Improving Cancer Health (ENRICH) trial, which involved face-to-face group-based sessions to promote health behaviours (James et al., 2015). The intervention involved the provision of didactic print materials, a pedometer, a resistance exercise band, and six 2-hour group sessions. Intervention materials were linked to SCT-based strategies of goal setting, self-monitoring, self-efficacy, social support, barriers, and facilitators of behaviour change. Results of the ENRICH trial revealed a significant difference in the primary outcome of daily steps across intervention and control groups. Over the 20-week intervention, participants also increased their daily vegetable intake by half a serving and reduced their BMI (James et al., 2015). However, self-reported total physical activity and higher-intensity physical activity did not significantly improve. The focus of this trial on daily steps, rather than higher-intensity physical activities may provide an achievable and accessible option for survivors who are inactive or have poor self-efficacy with respect to physical activity engagement. As current recommendations specify that some activity is better than none (Buffart et al., 2014; O'Donovan et al., 2010), this may be an ideal focus for the initiation of physical activity. However, targeting daily steps may be less effective for garnering cardiovascular benefits that are associated with regular engagement in MVPA (Haskell et al., 2007; O'Donovan et al., 2010). Hence, physical activity at a higher intensity should be encouraged, in accordance with the physical activity guidelines for survivors (Rock et al., 2012).

Another SCT-based intervention, Move More for Life, trialled tailored print and targeted print interventions to promote physical activity in Australian breast cancer survivors, compared to a standard-care control group (Short et al., 2012). The print intervention was delivered via three tailored SCT-based newsletters over 12 weeks, which were based on participants' reported physical activity, demographic, health, and psychosocial factors with tailored goal-setting prompts. The targeted print intervention group received a TPB-based physical activity booklet, which contained exercise recommendations and facilitated planning and barrier management (Vallance, Courneya, Taylor, et al., 2008). The tailored program resulted in improvements in self-reported minutes of MVPA per week, self-reported levels of resistance training per week, and pedometer-measured step count over the course of the intervention (Short et al., 2015). Survivors in the tailored group increased their self-reported weekly MVPA by 24 minutes per week, compared to a 13-minute weekly increase in the targeted TPB-based group and a 64-minute reduction in MVPA in the control group (Short et al., 2015). However, the likelihood of an individual meeting the resistance training guideline was the only

significantly improved outcome, post-intervention. While the SCT-based tailored intervention was beneficial in promoting self-reported physical activity in survivors, SCT-constructs were not reported, which makes it difficult to interpret the most effective components of the program (Stacey et al., 2015). The administration of print materials as part of an intervention offers a cost-effective and feasible option for providing tailored feedback to participants, yet the benefits may not be as significant or as durable as when print materials are incorporated within a multi-modal intervention that also includes more intensive face-to-face or group contact (Schippers et al., 2017; Short et al., 2011; Short et al., 2014; Short et al., 2015; Swartz et al., 2017).

To examine whether telephone counselling could yield the same effects as the gold-standard of face-to-face counselling, Harrigan and colleagues (2016) compared the two counselling modes against a usual-care control group across 6 months in the Lifestyle, Exercise, and Nutrition (LEAN) study. Both telephone and face-to-face counselling adopted an SCT approach and focused on behavioural therapy, physical activity, and caloric intake with the goal of reducing weight in breast cancer survivors. Although those who received the LEAN intervention via face-to-face counselling had a greater weight reduction at 6 months than those who received telephone counselling (6.4% vs. 5.4%, respectively), the difference between the two modes was non-significant. Moreover, both modes yielded significantly greater weight loss than the usual-care control group (2.0%) at 6 months (Harrigan et al., 2016). Not only do these findings support the use of SCT-framed counselling as an effective strategy for promoting health behaviours in cancer survivors, the small non-significant difference in delivery modes produced by the LEAN intervention supports the implementation of feasible, cost-efficient interventions delivered via telephone or electronically.

A meta-analysis of SCT-based studies to promote physical activity and/or healthy diet behaviours in cancer survivors revealed an overall significant intervention effect for those studies targeting physical activity ($n = 12$), with a small-to-medium effect size ($d = 0.33$) (Stacey et al., 2015). Despite this promising result, outcome measures across physical activity trials varied widely and included self-reported physical activity, step count, MET minutes, a one-mile walking test, accelerometer wear, and caloric expenditure (Stacey et al., 2015). Duration of interventions, intensity of interventions, and delivery modes also varied, which may account for variance identified across study findings. Moreover, most of the studies included in Stacey and colleagues' (2015) review did not report on changes in theoretical constructs of SCT, making it difficult to determine the underlying

mechanisms that predict behavioural change. SCT constructs targeted in these studies include knowledge, self-efficacy, outcome expectancies, goals, facilitators, and barriers towards physical activity. These constructs can be mapped onto techniques within the broader taxonomy proposed by Michie and colleagues (Michie, Ashford, et al., 2011; Michie et al., 2013) pertaining to key BCTs such as the provision of information, self-monitoring of behaviour, modelling, use of prompts, goal setting, planning, facilitation of social comparison, and social support (Michie, Ashford, et al., 2011; Michie et al., 2013; Stacey et al., 2015). Since the proposition of the taxonomy, BCTs have been further labelled as content-based or relational, whereby content-based techniques are focused on the intervention materials and relational techniques rely on the interpersonal style of the practitioner in encouraging behaviour change (Hagger & Hardcastle, 2014; Hardcastle, 2016). Relational BCTs play a role in building rapport and bolster the delivery of content-based BCTs (Hardcastle, Fortier, et al., 2017). The majority of SCT interventions were delivered via face-to-face or telephone counselling, which is an ideal delivery mode for implementation of relational BCTs and may enhance the effectiveness of embedded techniques (Dombrowski et al., 2016; Hardcastle, Fortier, et al., 2017; Knittle, 2014). While BCTs have been posited in health behaviour research generally, rather than specifically in oncology, these theoretical links to SCT indicate promise for the effectiveness of SCT-based initiatives in cancer survivorship.

3.3.2 Transtheoretical Model of Change

The TTM is a biopsychosocial framework that attempts to explain the process of intentional behaviour change from the initial stages of adoption to the maintenance phase of the behaviour (Prochaska & DiClemente, 1982, 1983; Prochaska & Marcus, 1994). The TTM proposes the preconditions for change, that positive expectations of behavioural change are held by an individual and that the individual is willing to expend time and effort to change their behaviour. Once these preconditions are met, six stages of change have been proposed within which processes of change can be applied to move from one stage to the next (Prochaska & DiClemente, 1979, 1982; Prochaska & Velicer, 1997).

The model begins with the stage of precontemplation, a non-intentional stage whereby an individual is not considering making any behavioural change within the next 6 months (Prochaska & Velicer, 1997). In the context of health behaviour changes, the individual may be unaware of the risks associated with their unhealthy lifestyle or discouraged by previous failed attempts to change. Once an individual intends to make a behavioural change within the next 6 months, they shift to the contemplation stage of

change. At this stage, an individual is aware of both the benefits and risks of change but has not taken action (Prochaska & Velicer, 1997). Preparation follows, an intentional stage whereby the individual sets plans to take action within the next month to begin behavioural change. These intentional stages of readiness have been closely linked to the construct of *intention* in previous literature (Godin et al., 2004; McMillan & Conner, 2007).

An individual progresses to the action stage, once they have taken specific steps to modify their behaviour and engaged regularly in the behaviour for up to 6 months. Those who continue with their modified behaviour and do not relapse into past habits are recognised as being in the stage of maintenance. This stage is theorised to last between 6 months and 5 years following the initial change, and a longer maintenance period is associated with reduced likelihood of relapse (DHHS, 1990). Some sources refer to a sixth stage of termination, characterised by an individual's high self-efficacy and the absence of temptation to relapse into previous behaviours, that follows successful maintenance of the new behaviour for 5 years (Horiuchi et al., 2013; Prochaska & Velicer, 1997). Progression through these stages is recognised to be cyclical in nature, rather than linear, such that an individual may regress and progress according to their motivational readiness across stages (Ntoumanis, Thørgersen-Ntoumani, et al., 2018; Prochaska et al., 1992).

3.3.2.1 Applications of the Transtheoretical Model to Promote Physical Activity in Cancer Survivorship

A recent meta-analysis of TTM trials revealed significant improvements in physical activity, with these effects moderated by TTM constructs, self-efficacy, and processes of change (Romain et al., 2018). The application of the TTM was supported across cancer patients and survivors, with motivational readiness predicting physical activity adherence (Husebø et al., 2013). However, findings from other studies suggest that categorising behavioural change into distinct stages rather than a continuous process could hinder the model's applicability and measurability across samples (Bridle et al., 2005; Hutchison et al., 2009; Marshall & Biddle, 2001).

Regarding cancer survivor cohorts, the vast majority of TTM-based initiatives to promote physical activity have recruited breast cancer survivors. Most recently, a review of theory-based interventions to promote physical activity in breast cancer survivors supported the role of TTM-based interventions as a framework for "stage-matching" survivors based on their readiness for change (Bluethmann et al., 2017). Furthermore, profiling by these stages was often considered as a means of tailoring interventions and implemented in

conjunction with BCTs such as goal setting, social support, monitoring, and the provision of feedback (Bluethmann et al., 2017).

A 24-week TTM-based intervention was delivered via 21 sessions to promote physical activity and quality of life in American breast cancer survivors (Basen-Engquist et al., 2006). Survivors were randomised via an adaptive process to increase equality between the intervention ($n = 35$) and the usual-care control group ($n = 25$). Ninety-minute group sessions focused on assessing stage of change and print materials were provided, tailored to participants' stage of readiness. After 6 months, the intervention group performed significantly better on a 6-minute walking test than the usual-care control group and had improved general health scores and motivational readiness (Basen-Engquist et al., 2006). However, significant between-group changes were not produced for moderate- or vigorous-intensity physical activity outcomes. As this intervention constituted over 30 hours of face-to-face contact with the research team, positive effects are likely to be bolstered by the intensity and frequency of sessions, which may not be sustained in the long-term. A long-term follow-up assessment would have provided valuable insight on the maintenance of change following the cessation of intervention contact. Another TTM-based supervised exercise intervention for breast cancer survivors, however, provided support for the role of self-efficacy and progression through the behavioural processes of change in physical activity adherence at the 6-month follow-up assessment after a 12-month program (Loprinzi et al., 2012).

The tailoring of intervention delivery in accordance with TTM-based stage of readiness for change has been supported in other contexts. TTM-based health behaviour interventions targeting motivational readiness for physical activity and diet change were found to be feasible and acceptable to Korean breast cancer survivors (Kim et al., 2011) and yielded promising findings across moderate-intensity physical activity and nutritional outcomes (M. K. Lee, Yun, et al., 2014). The TTM-based intervention targeted progression through stages of change and provided support for the delivery of intervention content via print materials and telephone counselling for eliciting readiness for health behavioural change (Kim et al., 2011). The 12-week tailored intervention yielded significantly greater improvements in motivational readiness for physical activity, healthy diet, emotional functioning, fatigue, and depression outcomes, compared to a control group of breast cancer survivors (Kim et al., 2011).

The TTM has been successfully applied to a web-based program, whereby breast cancer survivors randomised to the intervention group ($n = 29$) received action planning,

feedback and educational materials, including the physical activity and nutritional guidelines for cancer survivors (M. K. Lee, Yun, et al., 2014). The intervention was linked to stages of change, processes of change, decisional balance, and self-efficacy constructs. Compared to an education-only control group (n = 28), a higher proportion of participants in the intervention group were performing moderate-intensity physical activity and consuming five servings of fruits and vegetables per day according to self-reported exercise and diet logs. Those in the intervention group also had improved quality of life outcomes and greater motivational readiness at 12 weeks (M. K. Lee, Yun, et al., 2014), showing promise for the effectiveness of low-cost delivery modes. Although moderate-intensity physical activity measures more closely align with the physical activity guidelines for garnering cardiovascular benefits (DHHS, 2018; O'Donovan et al., 2010), objective measurement of physical activity via accelerometry is recommended over self-report instruments (Broderick, Ryan, et al., 2014; Prince et al., 2008).

3.3.3 The Theory of Planned Behaviour

The TPB was proposed by Ajzen (1991) to explain and predict the determinants of behaviour. According to the TPB, health behaviours are a function of intention to perform the proposed behaviour (Ajzen, 1991). Ajzen (1991) theorises that intentions capture motivational factors that influence behaviours and the amount of effort an individual is willing to expend to engage in this behaviour. Attitudes, subjective norms, and PBC over a behaviour determine the behavioural intention (Ajzen, 1991). Attitudes are considered as one's evaluations of a behaviour, and are proposed to be affective or instrumental in nature (Ajzen, 1991; Rhodes & Courneya, 2003). Both instrumental and affective attitudes contribute independently to behavioural intention (Ajzen, 2011). Affective attitudes are experiential, and are often based on the pleasure associated with a behaviour, whilst instrumental attitudes pertain to the usefulness or perceived importance of engaging in a behaviour (Ajzen, 2011). Subjective norms pertain to the perceived approval of the behaviour from others, and PBC is the individual's belief about their opportunities and execution of a behaviour (Ajzen, 1991; Rhodes & Courneya, 2003).

3.3.3.1 Applications of the Theory of Planned Behaviour to Promote Physical Activity in Cancer Survivorship

These components of the TPB have been applied to explain and predict a broad range of health behaviours, including alcohol consumption (Cooke et al., 2016), smoking cessation (De Wilde et al., 2017), and intention to eat a healthy diet (Close et al., 2018),

along with physical activity change during interventions for older adults (Stolte et al., 2017), and physical activity in individuals with disabilities (T. Kirk & Haegele, 2018), children (Santina et al., 2017), adults in the United Kingdom (Bird et al., 2018) and Canadian colorectal, breast and prostate cancer survivors (Forbes et al., 2014). TPB interventions to promote physical activity aim to facilitate positive attitudes, subjective norms, or PBC, via strategies targeting behavioural, normative or control beliefs. Of note, the role of social support has been posited as a replacement for subjective norms, due to its utility as a predictor of physical activity intention, independently of other TPB variables (Courneya et al., 2000). Therefore, interventions adopting a TPB-based perspective to promote physical activity may do well to incorporate group support components or an accountability network (Courneya et al., 2000).

Other techniques targeting TPB-based constructs, including scheduled exercise, accountability prompts, informational support, and positive reinforcement were utilised to increase aerobic fitness in Irish cancer survivors following chemotherapy (Broderick et al., 2013). The 8-week Prescribed Exercise After Chemotherapy (PEACH) intervention resulted in significantly greater self-reported physical activity post-intervention and at the 3-month follow-up assessment compared to the control group. The accelerometer-derived MVPA measure did not yield any significant differences post-intervention or at follow up. Notably, intervention and control groups differed significantly at baseline, such that survivors randomised to the intervention group had greater time since treatment and were more likely to have had radiotherapy (Broderick et al., 2013). As evidence has indicated that greater intensity of treatment, further advancement of cancer, and a shorter time period since completion of cancer treatment are likely to result in poorer uptake of physical activity (Buffart et al., 2014; Kampshoff et al., 2014), the possible effects of systematic bias should be acknowledged.

3.3.4 Theory of Planned Behaviour and Intention

Intention to perform physical activity has been identified as a primary determinant of physical activity in several studies (Close et al., 2018; Doherty et al., 2018; T. Kirk & Haegele, 2018; Santina et al., 2017; Stolte et al., 2017). Although interventions targeting physical activity via the TPB have often been effective for changing physical activity *intentions* (T. L. Webb & Sheeran, 2006), they do not always produce a proportionate increase in physical activity *behaviour* (Hagger & Chatzisarantis, 2005; Rhodes & Quinlan, 2018; T. L. Webb & Sheeran, 2006). In the most recent meta-analysis of TPB constructs for explaining health behaviours, intention accounted for 23% of the variance

in physical activity (McEachan et al., 2011). Despite the significance of intention as a predictor, 77% of variance remains unaccounted for. This unexplained variance has been dubbed the *intention–behaviour gap* (Rhodes & Quinlan, 2018; Sniehotta, Scholz, & Schwarzer, 2005), and has resulted in the proposition of implementation intentions as part of the TPB. Furthermore, the addition of the psychological constructs of physical activity self-efficacy, physical activity planning, and past physical activity behaviours in conjunction with the TPB components have resulted in an amended model that accounts for 54% of the variance in physical activity behaviour in colorectal cancer survivors during chemotherapy (Bao et al., 2020). Given the utility of planning alongside intention to account for variance in physical activity behaviours, interventions that adopt the TPB as a framework or incorporate planning as components of physical activity interventions have been recommended (McEachan et al., 2011; Steinmetz et al., 2016).

The Activity Promotion (ACTION) trial involved a 12-week TPB-based intervention, in which print materials, a step pedometer, or a combination of the two were employed to promote physical activity in Canadian breast cancer survivors (Vallance et al., 2007). The components of the ACTION intervention aimed to elicit physical activity change via the TPB constructs: intention, attitudes, subjective norms, PBC, planning, behavioural, normative, and control beliefs (Vallance, Courneya, Plotnikoff, & Mackey, 2008). The intervention was linked to the TPB via print materials focusing on belief change, planning and implementation intentions. Findings revealed that planning and intention partly mediated physical activity change at 12 weeks in groups that were provided with a TPB-based intervention, supporting the importance of implementation intention in behavioural change. Those who received the ACTION intervention also reported greater instrumental attitudes, compared to the standard-recommendation control group. Self-reported MVPA increased by 89 minutes per week for the pedometer-based group, and 87 minutes per week for the pedometer and TPB-based print materials group (Vallance, Courneya, Plotnikoff, & Mackey, 2008). At the 6-month follow-up assessment, MVPA had decreased by 36 minutes per week, but it still remained 56 minutes greater than at baseline in those who received a pedometer and TPB materials (baseline: 119 minutes per week, 12-week assessment: 211 minutes per week, 24-week assessment: 175 minutes per week) (Vallance, Courneya, Plotnikoff, Dinu, & Mackey, 2008). Regarding the guideline of 150 minutes of weekly MVPA, 49% of survivors who completed the trial were meeting the guidelines at 6 months, compared to 39% pre-trial (Vallance et al., 2010).

Although these findings are promising for the utility of pedometers in conjunction with TPB-based print materials, these effects did not significantly differ from the change in physical activity for participants who received only a pedometer or only print materials, both of which also produced improvements in self-reported MVPA (Vallance et al., 2007). Moreover, the follow-up Promoting Physical Activity during Chemotherapy (PROACTIVE) trial, which utilised TPB-based intervention materials and a step pedometer to promote physical activity in breast cancer patients receiving chemotherapy, did not yield significant improvements in physical activity compared to a standard public health recommendation (Vallance et al., 2016). Objective measurement of physical activity outcomes may have further clarified the differences across intervention conditions in both ACTION and PROACTIVE trials. These trials were valuable for discerning the applicability of TPB constructs for informing a physical activity behavioural intervention for breast cancer survivors. However, the survivors recruited to these studies may represent a particularly motivated sample. Additionally, the recruitment of patients receiving chemotherapy may yield more unfavourable outcomes, compared to recruitment of survivors who have completed active cancer treatment. Researchers may consider screening tools to target a particularly unmotivated and underserved sample, such as a brief assessment of readiness to change or physical activity level prior to recruitment. This would also assist to ascertain whether the utility of TPB constructs extends to other psychographic profiles, in addition to motivated individuals (Hardcastle, Hancox, et al., 2015).

3.3.5 Health Action Process Approach

The HAPA is a social-cognitive model that incorporates intentions and planning components to explain health behaviours. Pioneered by Schwarzer (1992, 1999), the HAPA builds upon H. Heckhausen's (1991) proposition of motivational and volitional phases of action, as well as components of SCT. The HAPA asserts that health behaviours can be explained by an individual's intentions, self-efficacy, and outcome expectancies with the addition of self-regulatory processes. These self-regulatory processes include maintenance and coping self-efficacy, as well as the effects of barriers and support resources (Schwarzer, 1999; 2014). These constructs come into play during the motivational phase of action, whereby an individual has formed intentions but has not yet formed plans or taken any specific action towards the desired behaviour (Schwarzer, 1999). Intentions are proposed to arise from outcome expectancies, self-efficacy to perform a behaviour, and risk perception. It is hypothesised that self-efficacy and outcome

expectancies are the most primary determinants of intention, and the perception of risks associated with a given behaviour is a secondary determinant (Schwarzer, 2014).

Once an individual begins to form plans with respect to their desired behaviour, they transition to the volitional stage of action. Planning is a particularly important component of the HAPA model, as where many other theories (SCT, TTM, TPB) are focused on increasing one's motivation to act, the HAPA proposes that it is self-regulatory planning processes that bridge the intention–behaviour gap (Sniehotta, Scholz, & Schwarzer, 2005; Sutton, 2008). Initial plans are likely to be action plans for the desired behaviour, and entail a mental simulation of what, when, where, and how actions will be performed. Action plans are "postdecisional, preactional cognitions" (Schwarzer, 2014, para. 5) that are largely affected by the perceived self-efficacy of the individual, whereby perceived self-efficacy and the past experience of the individual must be sufficient to carry out the proposed plans (Schwarzer, 1999). In conjunction with action planning, the later addition of coping planning to the HAPA model (Sniehotta, Schwarzer, Scholz, & Schüz, 2005) acknowledges the importance of anticipating and accounting for potential obstacles or competing priorities that may hinder uptake of the desired behaviour (Godinho et al., 2014; Schwarzer, 2014). Coping planning has been identified as an effective safeguard for overcoming barriers when implemented along with action planning for the promotion of physical activity, compared to action planning alone (Sniehotta et al., 2006). Action planning and coping planning partially mediated the relationship between intention and behaviour in a meta-analysis of studies targeting physical activity (Carraro & Gaudreau, 2013), supporting their role in bridging the intention–behaviour gap (Carraro & Gaudreau, 2013; Sniehotta, Scholz, & Schwarzer, 2005).

According to the HAPA, once action towards the desired behaviour has been initiated, action control and maintenance self-efficacy are the primary determinants of an individual's ability to persevere once competing priorities and barriers arise. Action control pertains to the cognitions that initiate and regulate action, including self-monitoring of one's progress (Schwarzer, 2016). Maintenance self-efficacy refers to the individual's perceived confidence in their ability to self-regulate in the face of barriers, while persisting with their efforts to fulfil their intentions (Schwarzer, 2014). Self-regulation is particularly important during this volitional stage of action, as barriers, situational factors, and support resources may begin to affect behavioural outcomes (Schwarzer, 2014). Depending on the prevalence of situational barriers, as well as an individual's perceived maintenance self-efficacy, one may be tempted into an unhealthy behaviour as a result of barriers to action plans. Other situational factors, such as social

support from a network or group, reinforce action control and therefore bolster engagement with health behaviours (Schwarzer, 2014). The cyclical nature of the action phase through cognitive, behavioural, and situational dimensions continues until the individual either achieves successful behavioural change or disengages from the desired outcome (Schwarzer, 2014). In parallel with the HAPA, the proposition of implementation intentions also focuses on the translation of intentions into behaviour.

3.3.5.1 Implementation Intentions in Physical Activity

Where intentions are focused on a specific outcome, implementation intentions employ an *if–then* strategy by relating an intention to a cue (Gollwitzer, 1999). The addition of this conditional component coincides with the motivational and volitional phases of action, whereby intentions are formed in the motivational phase and subsequent planning and steps towards action occur in the volitional phase (J. Heckhausen & H. Heckhausen, 2018). A health behaviour intervention by Y. Zhang and Cooke (2012) supported the critical role of the volitional stage of action in bringing about behavioural change. An emphasis on implementation intentions has yielded positive results when incorporated into intervention packages to promote physical activity. Formation of walking plans and implementation intentions in sedentary women significantly improved step count, self-efficacy, and PBC, compared to a control group (Arbour & Martin Ginis, 2009). Another trial by Prestwich and colleagues (2012) assessed the efficacy of implementation intention planning, in conjunction with a partner-based intervention, targeting weight loss and physical activity over 6 months. Results indicated that collaborative implementation intention bolstered accountability and was effective for reducing weight and increasing physical activity in participants (Prestwich et al., 2012). Findings from a longitudinal study in older adults indicate that intention to perform physical activity was mediated by planning, such that planning may bridge the intention–behaviour gap, in accordance with the HAPA (Gellert et al., 2012; Sniehotta, Scholz, & Schwarzer, 2005; Sutton, 2008). In another study by Conner et al. (2010), young adults completed questionnaires based on TPB constructs of intention and action planning and self-reported physical activity. Planning was found to partially mediate the intention–behaviour relationship, with the strength of the intention moderating this mediation effect (Conner et al., 2010). Those who planned their physical activity also completed a greater level of physical activity. A regression of TPB constructs onto predicted physical activity behaviours revealed that 61% of the variance in future exercise behaviour was accounted

for by intention, planning, past physical activity behaviour, and an *intention x planning* interaction (Conner et al., 2010).

In older adults with obesity, an intervention focusing on generating implementation intentions during three face-to-face group sessions yielded a significant within-group improvement in pedometer-measured daily steps at 2 months (Bélanger-Gravel, Godin, Bilodeau, & Poirier, 2013). Moreover, daily steps in the intervention group continued to increase between the 2- and 6-month follow-up assessments, supporting the sustained impact of forming implementation intentions even after the cessation of the intervention (Bélanger-Gravel, Godin, Bilodeau, & Poirier, 2013). Despite these promising findings regarding the utility of planning and intention for increasing physical activity, other research has indicated that physical activity implementation intentions differ by age group and intentions may be weaker in older adults (Alley et al., 2018). Furthermore, measuring physical activity using self-reported methods or step counts may be subject to bias (Prince et al., 2008), result in overestimation (Prince et al., 2008), and limit congruence with the promotion of MVPA per the guidelines for survivors (Rock et al., 2012).

The efficacy of these planning-based techniques may be attested by their prevalence across psychological theories widely implemented in health behavioural change, including the TPB and the HAPA model (Hagger & Luszczynska, 2014). For example, the use of implementation intentions to promote physical activity in conjunction with barrier management – a technique that is pertinent to the HAPA – was found to increase behavioural change (Bélanger-Gravel, Godin, & Amireault, 2013). Implementation intention has a significant impact on physical activity behaviour (Bélanger-Gravel, Godin, & Amireault, 2013), which may be further augmented by the incorporation of barrier management and action planning as a part of physical activity interventions (Bélanger-Gravel, Godin, & Amireault, 2013; Hagger & Luszczynska, 2014). Targeting these constructs may also be conducive to tailoring interventions, such that specific plans are tailored to individual barriers and goals (van Stralen et al., 2011). Although a recent review of the mediators of physical activity behaviour change highlighted heterogeneous results regarding the role of intention (Rhodes et al., 2020), forging intentions to perform physical activity and physical activity action planning are largely considered to be effective BCTs as components of the HAPA and more broadly across the taxonomy of BCTs (Bélanger-Gravel, Godin, & Amireault, 2013; Gollwitzer, 1999; Hagger & Luszczynska, 2014; Michie et al., 2009; Michie et al., 2013).

3.3.5.2 Applications of the Health Action Process Approach to Promote Physical Activity in Cancer Survivorship

A meta-analysis of studies that assessed HAPA constructs and physical activity outcomes revealed significant associations in support of the HAPA model, across all HAPA constructs except for risk perception (Gholami et al., 2014). A more recent meta-analysis of HAPA applications in health behaviour contexts yielded small-to-medium effects across HAPA constructs, and supported the finding that the role of risk perception may be minor for explaining physical activity behaviour (C.-Q. Zhang et al., 2019).

Interventions that have adopted the HAPA model as a theoretical framework to promote physical activity have shown promise in clinical trials (Gaston & Prapavessis, 2014; Platter et al., 2016; Ungar, Sieverding, et al., 2016). An intervention incorporating the HAPA constructs of action planning and coping planning were found to significantly increase accelerometer-measured MVPA bouts in pregnant Canadian women, compared to a control group (Gaston & Prapavessis, 2014). However, this intervention was HAPA-inspired rather than cohesively HAPA-based, in that it largely focused on the planning components of the HAPA framework. As such, the results of this intervention cannot be considered as support for other pre-intentional HAPA constructs.

A brief HAPA-based intervention was delivered to acute cardiac ward patients, with the objective of increasing uptake of weekly physical activity (Platter et al., 2016). Patients randomised to the intervention group attended a 1-hour group session on physical activity information, action and coping planning and group discussion with a trained nurse. At 2 months, those in the intervention group increased their total physical activity by 80 minutes per week, compared to 3 minutes in the control group. At 6 months a 50-minute per week increase in physical activity remained in the intervention group, compared to baseline (Platter et al., 2016). Although the results of this study support the combination of HAPA-based intervention components along with informational initiatives in a group setting, the magnitude of physical activity change must be interpreted with caution as physical activity was self-reported and based on total physical activity, rather than MVPA (Platter et al., 2016). An intervention and outcome measure specifically targeting MVPA is recommended, based on current guidelines, which stipulate that physical activity at a moderate-to-vigorous intensity is optimal (World Health Organization, 2020).

The HAPA supports the tailoring of interventions based on facilitators of physical activity to promote behavioural change in clinical samples (Schwarzer et al., 2011). Inactive cancer (primarily breast, colorectal and prostate cancer) patients in Germany also

benefitted from a HAPA-based intervention to promote physical activity (Ungar, Sieverding, et al., 2016). The 4-week intervention targeted HAPA self-regulatory principles with a particular focus on barrier management, in conjunction with social support delivered via a role model for each participant. The intervention was delivered through a 1-hour counselling session followed by three weekly phone calls. The exercise intervention group was significantly more likely to meet the physical activity guidelines compared to a stress management control group (50% vs. 39%) and at the 10-week follow-up assessment (64% vs. 15%), according to self-report assessments (Ungar, Sieverding, et al., 2016). The exercise intervention group also benefited from stress management components of the intervention, according to a self-reported distress thermometer (Ungar, Sieverding, et al., 2016), which may be associated with the psychosocial aspects of overcoming barriers or creating coping plans for obstacles, per the HAPA model. Positive outcome expectancies predicted physical activity behaviour at the 10-week follow-up assessment (Ungar et al., 2019). While outcome expectancies were largely positive across patients who received both the physical activity and stress-management interventions, those who expressed interest in participating in exercise programs were likely to have greater outcome expectancies towards physical activity (Ungar et al., 2019). Counselling sessions, group environments and supplementary phone calls all foster psychosocial support, a resource posited to facilitate action and maintenance according to the HAPA (Schwarzer, 2014; Schwarzer, 2016). Assessment of behavioural change maintenance at a longer follow-up period would be of value for illuminating the role of psychosocial support in long-term change.

3.3.6 Taxonomy of Behavioural Change Techniques

Many recent interventions promoting physical activity have opted to employ a selection of BCTs rather than strictly adhering to a single behavioural change theory, paving the way for a scoping taxonomy of techniques. This selection of techniques has advantages and disadvantages. One of the drawbacks of designs that do not strictly map to a theoretically driven approach is that evaluation of the efficacy of intervention components and integration of those components can only be evaluated to a limited extent. Despite this limitation, recent efforts have been made to enforce a hierarchical structure within the taxonomy of BCTs to facilitate the quantification and measurement of techniques (Cane et al., 2015; Michie et al., 2015). As health behavioural change frameworks have great homogeneity and often share common psychological constructs (Rhodes et al., 2020), targeting specific constructs via BCTs may be beneficial for

understanding the contribution of individual constructs and their role in larger frameworks. Moreover, this approach is of value for allowing "cherry-picking" of BCTs in a bottom-up manner, such that interventions can be optimally tailored for the targeted behavioural outcomes (Cane et al., 2015).

A taxonomy of 93 techniques for eliciting behavioural change has been established by Michie and colleagues (Abraham & Michie, 2008; Michie et al., 2009; Michie et al., 2013), with these techniques being extensively applied as components of initiatives to promote physical activity (French et al., 2014; Hankonen et al., 2015; Michie et al., 2009; Michie, Ashford, et al., 2011; Olander et al., 2013; Samdal et al., 2017). The taxonomy of techniques was developed by Michie and colleagues in conjunction with the broader Behavioural Change Wheel (Michie, van Stralen, & West, 2011). The wheel incorporates the target cohort and behaviour, as well as contextual factors, as variables that determine the recommended intervention approach. The central behavioural system of the wheel is referred to as the COM-B system, denoting the three conditions – capability, opportunity, and motivation – that determine behaviour (Michie, van Stralen, & West, 2011). According to this framework, BCTs are observable and replicable strategies that should be selected and implemented in accordance with the behavioural dimensions that the intervention aims to target (Michie, Abraham, et al., 2011; Ntoumanis, Thørgersen-Ntoumani, et al., 2018). Moreover, given that behaviours are hypothesised to result from a combination of these factors, initiatives should incorporate techniques that target perceived capability, opportunity and motivation for behavioural change in line with the needs of a specific cohort (Hardcastle & Hagger, 2016; Howlett et al., 2019; Michie, van Stralen, & West, 2011; Ntoumanis, Quested, et al., 2018).

3.3.6.1 Applications of Behavioural Change Techniques to Promote Physical Activity in Cancer Survivorship

The BCT taxonomy allows for researchers to select evidence-based techniques for behavioural change that are best suited to their chosen theoretical framework. A meta-regression of BCTs by Michie et al. (2009) revealed that, of 26 BCTs, self-monitoring explained the most variance in physical activity and healthy eating outcomes. That is, self-monitoring is the single most effective of BCTs implemented to promote these health behaviours. When employed in conjunction with another self-regulatory technique, such as intention formation, goal setting, provision of feedback, or review of goals, interventions were even more effective for improving health behaviours (Michie et al., 2009). Interventions that do not definitively adhere to a single theoretical approach, but

incorporate a range of BCTs such as action planning, self-monitoring, goal setting, providing feedback, and facilitating social comparison and support, have been effective for increasing physical activity in cancer survivors (Bennett et al., 2007; Kanera et al., 2017; Michie et al., 2013; Valle et al., 2013). Programs that utilised BCT-based packages, including self-monitoring and goal setting over a 12-week intervention yielded promising effects for promoting physical activity in breast cancer survivors, according to a qualitative synthesis of trials (Short et al., 2013). The synthesis was limited by a lack of quantitative analyses of effects and a small sample (n = 10) of studies included.

A more recent review on effective BCTs for physical activity and healthy eating in adults with overweight and obesity supported the effectiveness of self-monitoring and goal setting for both short- and long-term behavioural change (Samdal et al., 2017). Other predictors of long-term health behaviour change include formation of outcome goals, provision of feedback on progress, and the use of self-monitoring devices such as pedometers (Maher et al., 2015; Ntoumanis, Thørgersen-Ntoumani, et al. 2018; Samdal et al., 2017). Given their promise for sustained behavioural change, BCTs should be primary constituents of physical activity programs for cancer survivors, older adults, and those at heightened cardiovascular risk for whom the effects of previous programs are generally poorly maintained (Goode et al., 2015, Grimmett et al., 2019; Marcus et al., 2006; Müller-Riemenschneider et al., 2008; Short et al., 2013; Spark et al., 2013).

3.3.7 Motivational Interviewing and Counselling

Motivational interviewing refers to directive, client-centred counselling with the purpose of allaying ambivalence and strengthening commitment and motivation for behavioural change (Rollnick & Miller, 1995). Motivational interviewing has been conceptualised in four processes: engaging, focusing, evoking, and planning (W. R. Miller & Rollnick, 2013). Engagement between client and practitioner is essential for building rapport and a supportive environment. A goal is then identified, which requires focusing and evoking change in order to make progress towards this goal (B. Miller & Moyers, 2012). Planning is then considered an ongoing process, whereby options about how to proceed are considered, negotiated, and implemented (B. Miller & Moyers, 2012). Motivational interviewing began as a counselling style, borne out of clinical practice, and has since developed into a complex intervention constituted of BCTs (Hardcastle, Fortier, et al., 2017). However, motivational interviewing is not currently based on a psychological theory of behaviour change, rather these processes have arisen from empirical observations of behavioural change processes in clinical practice contexts (Rollnick & Miller, 1995).

3.3.7.1 Applications of Motivational Interviewing to Promote Physical Activity in Cancer Survivorship

Motivational interviewing and other relational and counselling techniques have been implemented across a range of interventions to promote health behaviours, including smoking cessation (Wakefield et al., 2004), consumption of a healthy diet (Campbell et al., 2009; Hardcastle & Hagger, 2011), reduction of the risk of cardiovascular disease (Hardcastle et al., 2013), and physical activity promotion in disadvantaged groups (Hardcastle et al., 2012), and cancer survivors (Bennett et al., 2007; Spencer & Wheeler, 2016; Stacey et al., 2015).

Motivational interviewing techniques have also been successful as components of physical activity programs to increase steps counts in breast cancer survivors (Swenson et al., 2010), total physical activity in breast cancer survivors (Spector et al., 2014) and as a part of an SCT intervention to improve fruit and vegetable intake, physical activity and overall wellbeing in breast cancer survivors in the United States (Djuric et al., 2011). A 6-month intervention by Lahart and colleagues (2016) employed motivational interviewing principles via a face-to-face consultation, along with three support phone calls and print materials to promote physical activity in 80 breast cancer survivors in the United Kingdom. Intervention materials were focused on encouraging survivors to meet the physical activity guideline of at least 150 minutes of moderate-intensity physical activity per week, and was supplemented with a physical activity information pack. Vigorous-intensity physical activity was found to increase significantly by 264 MET minutes per week for the intervention group, compared to survivors in a usual-care control group. Total physical activity increased significantly in the intervention group by 530 MET minutes at 6 months. A small improvement was yielded for the secondary outcome of BMI, indicating promise for the follow-on effects of weight loss as a result of physical activity uptake (Lahart et al., 2016). Although these results are promising and indicate the efficacy of motivational interviewing and counselling techniques for eliciting long-term change, the measurement of change in MET minutes in these interventions may hinder the comparison of these findings to the effects of others. Other limitations include the measurement of physical activity using self-report methods (Prince et al., 2008), rather than an objective primary measure, and the lack of blinding in research staff who performed assessments, which may have introduced experimenter bias (Lahart et al., 2016).

3.3.7.2 Applications of Hybrid Behavioural Change Approaches to Promote Physical Activity in Cancer Survivorship

Other counselling approaches that have been informed by a hybrid of theoretical frameworks have been effective for producing long-term health behavioural change. It should be noted that, while the programs discussed below have had varying levels of success in eliciting behaviour change, a major limitation is their lack of fidelity to a single theoretical framework, hindering evaluation of its applicability (Bluethmann et al., 2017). In the Fresh Start RCT, Demark-Wahnefried et al. (2007) aimed to improve health behaviours in breast and prostate cancer survivors in North America. The Fresh Start intervention consisted of tailored print materials based on SCT constructs of barriers and goal attainment and the TTM construct of stage of readiness to change (Demark-Wahnefried et al., 2007). Participants were provided with didactic modules on the targeted behaviours of physical activity, fruit and vegetable consumption, and restriction of fat intake, and encouraged to achieve the goal of 150 minutes of weekly physical activity over the course of the 10-month intervention. A control group was provided with a workbook package containing health behaviour education materials. The intervention group (n = 271) significantly increased their physical activity by 59 weekly minutes post-intervention, compared to an increase of 39 weekly minutes in the control group (n = 272), and had significantly greater diet quality, lower fat intake and reduced BMI compared to the control group post-intervention (Demark-Wahnefried et al., 2007). Effects on diet quality and fat intake were maintained at 24 months, but physical activity and BMI improvements were not sustained (Christy et al., 2011; Mosher et al., 2013). The primary outcome of this trial was number of health behaviours practised at a "goal-level", which limits the transferability of findings to initiatives that are aiming exclusively to improve physical activity. Assessments were primarily conducted via self-reported telephone interviews, but were validated via clinical assessments in a subsample of participants (Demark-Wahnefried et al., 2007). A stronger focus on meeting the guideline of 150 minutes of weekly MVPA specifically, rather than 150 minutes of total weekly physical activity, would be beneficial and better reflect current recommendations (NCCN, 2020; O'Donovan et al., 2010). Further investigation of strategies to deliver a tailored intervention to survivors in a cost-effective manner has been recommended (Demark-Wahnefried et al., 2007).

The Reach out to Enhance Wellness (RENEW) trial sought to investigate the effectiveness of an SCT- and TTM-based physical activity and diet intervention on functional outcomes in older, breast, colorectal, and prostate cancer survivors with

overweight and obesity in the United States, Canada, and the United Kingdom (*n* = 641) (Demark-Wahnefried et al., 2012; Morey et al., 2009). The intervention involved 15 telephone counselling sessions over the 12-month intervention, self-monitoring via a pedometer and daily log, tailored workbooks, and print materials. Tailoring of intervention materials allows the program to target participants' stage of readiness to change and individual goals. Counselling sessions focused on monitoring progress, providing reinforcement, overcoming barriers, and enhancing social support. BCTs targeting constructs of both SCT and the TTM were selected to target the specific sample, mode of delivery, and outcome of interest. Physical function, the primary outcome, was ameliorated for the intervention group who self-reported a significantly lower level of decline than the control group at 12 months (Morey et al., 2009). For secondary outcomes, results revealed improved self-reported duration of endurance physical activity, lower BMI, and improved diet quality as a result of the RENEW intervention. These effects were maintained at the 2-year follow-up assessment (Demark-Wahnefried et al., 2012). Notably, survivors recruited to the RENEW trial averaged almost 9 years post-diagnosis. While these outcomes were secondary to physical function, the findings provide support for the long-term effects of intervention designs that are tailored to the psychosocial profile of cancer survivors (Hardcastle & Hagger, 2016). Recent examination of the effectiveness of the RENEW intervention by geographical classification indicated that rural survivors had poorer health outcomes at baseline and may have benefitted from a more intensive approach (Gray et al., 2019). This trial was successful in eliciting behavioural change in long-term survivors, supporting the implementation of behavioural change programs beyond the window of the teachable moment, and providing a template for the tailoring of these programs for disadvantaged cohorts (Bluethmann, Basen-Engquist, et al., 2015; Demark-Wahnefried et al., 2005; Gray et al., 2019).

Other telephone-delivered interventions such as the Can Change program promoted physical activity, nutrition, weight management, and smoking cessation via a 6-month health coaching intervention for Australian colorectal cancer survivors (Hawkes et al., 2009, 2013). Eleven coaching sessions were based on acceptance and commitment therapy, which capitalises on commitment and behavioural change strategies to generate flexibility and diminish psychological obstacles to action (Hawkes et al., 2009; Hayes et al., 2006). In this intervention, participants also received a pedometer to encourage monitoring of physical activity, an intervention handbook, and motivational print materials (Hawkes et al., 2009, 2013). Weekly MVPA increased by 26 minutes from baseline to 6 months in the intervention group (*n* = 205), compared to 15 minutes in the

usual-care control group ($n = 205$). At the 12-month follow up, the effects of the intervention were sustained, resulting in a statistically significant between-group effect (Hawkes et al., 2013). Survivors who received the Can Change intervention were also significantly more likely to be meeting the Australian physical activity guideline of 150 minutes of weekly MVPA (16%), compared to the control group (9%). Moreover, the intervention resulted in significant improvements in BMI at both 6 months (-.5kg/m^2) and 12 months (-.9kg/m^2), suggesting promising results for the sustained effects of the intervention on anthropometric risk factors (Hawkes et al., 2013). The success of the Can Change trial on a large sample of colorectal cancer survivors indicates the potential for remote delivery of feasible yet effective interventions to promote sustained behavioural change. However, measures of physical activity were self-reported, which may have resulted in inflated effects. Additionally, the Can Change trial targeted health behaviours generally, rather than specifically physical activity. As such, significant improvements in anthropometric measures such as BMI may have resulted from change in diet, better weight management, decreased alcohol consumption, or general lifestyle change. As the benefits of engaging in these health behaviours are likely to have significant overlap, further examination of the direct effects of physical activity promotion and resulting behavioural change would be valuable (Hawkes et al., 2013).

Breast cancer survivors in the United States reduced their body weight by 6.0% after receiving a 12-month group-based behavioural intervention supplemented with telephone counselling and tailored print materials (Rock et al., 2015). The Exercise and Nutrition to Enhance Recovery and Good Health for You (ENERGY) RCT targeted weight loss via group sessions, and tailored telephone support and print materials. The intervention was based on SCT principles of reinforcement of self-efficacy via goal setting and targeting barriers, alongside the use of motivational interviewing techniques during counselling interactions (Rock et al., 2013). The less-intensive intervention group received fewer weight management resources, weight maintenance guidelines, educational support, and received a monthly update telephone call. Self-reported MVPA was significantly greater in the ENERGY intervention group ($n = 348$) at 6 months and 12 months, compared to the lower-intensity group ($n = 349$). Although those in the intervention group maintained 3.7% body weight loss at the 24-month follow-up assessment, effects on MVPA were not sustained (Rock et al., 2015). As the less intensive group demonstrated improvements in physical activity at 24 months comparable to those of the primary intervention group, investigating a potential Hawthorne effect may be useful, as well as exploring the role of the lower-intensity intervention for informing feasible, remote approaches to long-term change.

The incorporation of telephone counselling was also utilised in the Stepping Stone trial in the United States. The Stepping Stone trial sought to assess the feasibility of a pilot dietary and physical activity intervention that employed a combination of TPB and SCT-based strategies in black breast cancer survivors with overweight and obesity ($n = 22$) (Sheppard et al., 2016). The 12-week, multi-modal intervention involved educational materials, group sessions, and motivational phone calls. The intervention was tailored based on participants' behavioural intention, per the TPB, but targeted SCT-based constructs, including self-efficacy and role modelling, and built upon planning for physical activity barriers (Sheppard et al., 2016). Acceptability and adherence to this intervention was high, and the intervention was successful in improving MET minutes of activity, VO_{2MAX}, and dietary outcomes (Sheppard et al., 2016). The intervention group increased their self-reported moderate- and vigorous-intensity physical activity at 12 weeks by 84 minutes and 58 minutes, respectively. However, when compared to a control group, who received an educational booklet, net changes were reduced to an increase of 1.7 minutes and 29 minutes of weekly moderate- and vigorous-intensity physical activity, respectively (Sheppard et al., 2016). Findings show promise for the implementation of similar modes of delivery, whereby face-to-face contact helps to initiate uptake of physical activity and engagement with the program, and contact then tapers off into less intensive delivery modes such as telephone calls, to feasibly sustain behavioural maintenance. Further, larger-scale initiatives should aim to ascertain the effective components of such interventions where a range of BCTs from several approaches have been utilised. Based on the evidence reviewed thus far, facilitation of content-based BCTs such as goal-setting activities and didactic information on physical activity benefits may be optimised via the delivery of relational techniques, including the provision of a supportive environment and affirmations regarding progress (Hardcastle, Fortier, et al., 2017).

3.4 Digital Interventions to Promote Physical Activity

The recent emergence of digital interventions has revealed that initiatives to promote physical activity may be delivered remotely as a feasible option for long-term support (Groen et al., 2018; Michie et al., 2017). Digital interventions involve the delivery of materials via websites, computer programs, email, telephone, smartphone applications, text messaging, or digital monitoring devices. A review of programs delivered across a range of digital modalities revealed reductions in cardiovascular disease-related events, hospitalisations, and all-cause mortality when targeted to health behaviours including physical activity, weight loss, and medication adherence (Widmer et al., 2015). Internet-

based health behaviour interventions have been successful for eliciting improvements in physical activity, but have yielded a small effect size ($d = 0.11$) (Davies et al., 2012). Another meta-analysis of mobile phone-based interventions to improve physical activity supported their utility for promoting physical activity, but authors noted that as smartphone-based interventions were in their infancy at the time of review, the effectiveness of smart-mobile interventions may not be represented by the outcomes of all mobile-based initiatives (Fanning et al., 2012). In a more recent review by Stockwell et al. (2019), digital interventions that combine clusters of at least three BCTs are optimal for producing significant improvements in physical activity and sedentary behaviour in older adults. Improvements in systolic blood pressure (SBP) and physical functioning were also associated with digital interventions for older adults (Stockwell et al., 2019), however greater evidence is needed to support their use for long-term change.

3.4.1 Digital Interventions to Promote Physical Activity in Cancer Survivorship

Efforts to broaden the reach of interventions promoting health behaviours in cancer survivors have shown that the implementation of intervention materials via telephone and online delivery presents a feasible and low-cost approach (Kopp et al., 2017). A recent review of distance-based physical activity programs for cancer survivors noted that the incorporation of technology may facilitate more diverse and broad-reaching opportunities for delivery (Groen et al., 2018). The review of 29 distance-based RCTs suggested a small effect of programs for promoting physical activity in survivors, yielding a mean improvement of 49 minutes of weekly MVPA for survivors across interventions. While this improvement translates to a small clinically meaningful effect, limitations of studies included a heavy reliance on self-report measures and the recruitment of homogeneous (Caucasian and young) samples of survivors (Groen et al., 2018).

The empirical findings identified by Groen et al. (2018) aligned with another systematic review and meta-analysis of digitally-based physical activity interventions for cancer survivors, which reported a mean increase of 41 minutes per week of MVPA across interventions (Roberts et al., 2017). Most interventions in this review were website-based, with only two employing smartphone applications. Similarly, a review of technology-based lifestyle interventions in younger samples of cancer survivors revealed that most digital interventions to date have been website-based, with those targeting physical activity often involving pedometer wear (Kopp et al., 2017). Programs were deemed effective in promoting increased physical activity, improved body competition, flexibility,

and fitness and were considered feasible and acceptable given their streamlined use of resources and high retention rates (Kopp et al., 2017).

A 6-week online patient education workshop with a focus on fostering group support was trialled to promote health behaviours in 352 cancer survivors (O'Carroll Bantum et al., 2014). The e-intervention consisted of modules of didactic materials tailored to health behaviours in cancer survivors. The website also involved a group discussion centre, goal-setting materials, and support from cancer survivors acting as mentors (O'Carroll Bantum et al., 2014). The intervention resulted in significant improvements in sleep quality and weekly strenuous aerobic physical activity at 6 months compared to a wait-list control group (O'Carroll Bantum et al., 2014). However, changes were not observed across other outcomes, including moderate-intensity physical activity, light-intensity physical activity, quality of life, and fruit and vegetable consumption. It must be noted that recruitment of survivors for this study was primarily conducted online via social networking sites, which may have captured a study sample with greater technological literacy than other recruitment methods. The sample consisted of 87% Caucasian, 82% female and 47% breast cancer survivors (O'Carroll Bantum et al., 2014), which may limit the external validity of findings for application amongst males and survivors of other ethnicities. Outcomes were self-reported and therefore subject to recall bias, socially desirable responses, or inaccurate estimations regarding duration and intensity of physical activity (Prince et al., 2008).

Another Facebook-based trial, Fitnet, aimed to promote physical activity in young adult cancer survivors (Valle et al., 2013). The 12-week intervention utilised the SCT construct of social support via the Facebook platform and the provision of pedometers to facilitate self-monitoring, a supportive environment, and bolstering of self-efficacy and confidence to overcome physical activity barriers. Results were compared to a control group who were also added to a Facebook group and received a pedometer, but were not directed by interactions and activities within the Facebook platform. Although the intervention significantly improved light-intensity physical activity in participants, changes in MVPA and total physical activity were non-significant (Valle et al., 2013). Regarding changes in psychological constructs, results revealed that the Fitnet intervention was no more effective than the self-help control group for improving SCT constructs of self-efficacy, social support, and self-monitoring. As both arms of this trial yielded similar benefits across self-monitoring and some social support measures (Valle et al., 2015), further investigation of the positive effects of groups in an e-environment in

conjunction with self-monitoring tools, rather than the intervention ingredients themselves, may be important.

Smartphone applications have been considered to be superior to websites for the delivery of interventions (Roberts et al., 2017). As the use of smartphone applications as a part of health behavioural interventions has been found to yield significant improvements in the general population (J. Zhao et al., 2016), programs may be improved via the use of these applications to facilitate the delivery of intervention content for cancer survivors. Firstly, the use of smartphone applications presents greater opportunities and ease to access intervention materials in daily life, measure progress, and thereby increase engagement (J. Zhao et al., 2016). Secondly, the functionality of smartphone applications enables users to be prompted via notifications. This allows for BCTs, such as the provision of real-time feedback and support, to be built into applications. In this way, feedback can be provided when an individual reaches a certain goal, at a particular time of the day, or at some other milestone linked to intervention delivery. The success of application-driven interventions in the general population (Helbostad et al., 2017; J. Matthews et al., 2016; J. Zhao et al., 2016) may be attributed to the evidence-based BCTs that are incorporated into their content and delivery. According to a review by Roberts et al. (2017) the most common BCTs incorporated into digital interventions are self-monitoring, goal setting and feedback. Other studies of BCTs incorporated into smartphone applications revealed social support (Yang et al., 2015), the provision of instructions, setting tasks, and self-monitoring (Direito et al., 2014) to be the most prevalent. Reviews have supported the prevalence of self-monitoring as the most frequently identified BCT used in smartphone applications targeting health behaviour (J. Matthews et al., 2016; J. Zhao et al., 2016), with self-monitoring also the most persuasive feature of smartphone applications targeting physical activity change (J. Matthews et al., 2016). Incorporation of self-monitoring as a behavioural change strategy varies across applications, with some requiring manual records of behaviour, while others use automatic tracking of measures such as steps, “active minutes” (time spent performing MVPA in bouts of at least 10 minutes [Fitbit, n.d.-a]), sedentary minutes, intensity of activity, and distance travelled, ascertained via wearable devices (J. Matthews et al., 2016).

3.4.2 Physical Activity Promotion Using Wearable Activity Technology

WAT, including trackers and their respective smartphone applications, provide a practical and novel means of implementing BCTs such as self-monitoring, feedback, goal setting, and social support (Lyons et al., 2014; Lyons & Swartz, 2017; Mercer, Li, et al.,

2016; Zhu et al., 2017). Not only do wearable trackers such as Fitbit trackers provide real-time prompts and feedback during wear, users can also set long-term activity goals and monitor progress and accomplishments towards these goals (Mercer, Li, et al., 2016). Rewards for achieving set goals, despite being virtual, are appealing and encouraging to users as they foster a sense of progression and attainment throughout behavioural milestones (J. Matthews et al., 2016). The provision of real-time feedback, user-friendly design, and personalised elements were also considered to increase the effectiveness of digital tools (J. Zhao et al, 2016). In particular, personalisation of feedback based on the goals of the user has been recognised as a powerful component of the monitoring and feedback loop which is the basis of many physical activity tracking applications (J. Matthews et al., 2016). WAT has been recommended for measuring physical activity and, when used in conjunction with associated applications, provides benefits beyond those yielded from pedometer wear (Case et al., 2015; J. B. Wang et al., 2016).

Wearable activity trackers, in conjunction with their smartphone applications, have led to a small-to-moderate increase in minutes of daily physical activity and a moderate increase in daily step count, according to a meta-analysis of wearable tracker-based interventions in adult populations (Gal et al., 2018). The use of wearable trackers has also been effective for promoting physical activity in a sample of mid-older aged adults (Lyons et al., 2017). An Australian trial of activity trackers revealed that women and younger individuals were more likely to use a tracker, with the step count feature and accuracy of the tracker being important characteristics (Alley et al., 2015). However, the importance of the accuracy of activity measures for specific user groups has been questioned, given that engagement may be largely attributed to the behavioural change and networking aspects of WAT, rather than accuracy per se (Shin et al., 2019; Walker et al., 2016). Moreover, Walker et al. (2016) recommended the use of trackers to boost awareness and interest in monitoring activity, rather than for their accuracy in calculating activity outcomes. Others have supported the incorporation of trackers as a component of a motivational package (Direito et al., 2017; Stephenson et al., 2017), with a view that wearable trackers may facilitate greater awareness and be useful in clinical settings (Diaz et al., 2015; Fisch et al., 2016; Ilhan & Henkel, 2018; Mercer, Giangregorio, et al., 2016).

3.4.2.1 Wearable Activity Technology in Clinical Samples

A common context of studies of WAT in the literature to date has been medical settings or patient samples (Coughlin & Stewart, 2016; Diaz et al., 2015). In Shin and colleagues' (2019) review of 463 wearable tracker studies, 23% were in a medical or

treatment context. Although these studies have frequently focused on individuals in rehabilitation or increasing mobility in certain cohorts (Appelboom et al., 2015; D. J. Cook et al., 2013; Roe et al., 2016; Treacy et al., 2017), offering wearable trackers to patients with chronic disease and comorbidities may allow health professionals to better capitalise on the teachable moment (Demark-Wahnefried et al., 2005; Phillips et al., 2019).

For older adults with chronic disease, the use of wearable trackers was found to be both acceptable and insightful (Hardcastle, Galliott, et al., 2018; Mercer, Giangregorio, et al., 2016). Participants trialled various trackers and reported that a simple pedometer was the least acceptable to use and the Fitbit Zip was the most acceptable (Mercer, Giangregorio, et al., 2016). Older adults in particular listed the physical appearance, comfort level, and ease of using the tracker as factors that affected their perceived acceptability rating (Mercer, Giangregorio, et al., 2016). The most commonly reported deterrent of tracker use was difficulty in setting it up, given that most do not come with a hard copy instruction manual. Older adults suggested that the incorporation of wearable trackers in the health sector and endorsed by health professionals, would support patient uptake of tracker use (Mercer, Giangregorio, et al., 2016). Thus far, promising preliminary effects of wearable trackers have been identified across cohorts with a range of chronic conditions, including chronic obstructive pulmonary disease (De Sousa Sena et al., 2015), hypertension (Mercer, Giangregorio, et al., 2016), hyperlipidaemia (Mercer, Giangregorio, et al., 2016), diabetes (Mercer, Giangregorio, et al., 2016), major depressive disorder (Chum et al., 2017), overweight and obesity (Dean et al., 2018), and advanced cancer (Shinde et al., 2017).

3.4.2.2 Wearable Activity Technology in Cancer Survivors

The use of WAT has been recommended as a part of oncological initiatives to improve management of cancer and improve stages of aftercare and recovery (Fisch et al., 2016; Gresham et al., 2018). To date, the trial of WAT in oncological settings has largely been amongst breast cancer survivors. Involvement in remote exercise counselling and participation in a physical activity intervention was attractive to breast cancer survivors following completion of cancer treatment (Phillips et al., 2017; Vallance et al., 2013). Ninety per cent of survivors welcomed the proposition of wearable trackers as a component in a physical activity intervention, with many expressing a desire for tailored feedback and tracking of other wellbeing outcomes, including fatigue (Phillips et al., 2017). Survivors believe that prompts to reduce sedentary behaviour delivered via a wrist-worn vibrating tracker would be a helpful tool (Lloyd et al., 2016).

It should be noted that simple and user-friendly trackers have been recommended, given that those who experience issues with setting up or using their tracker are at risk of disengagement with the device altogether (Pope et al., 2018; Rosenberg et al., 2016). Throughout a 10-week pilot trial using Polar M400 watches in middle-aged breast cancer survivors, participants required extensive user training and reported finding the device difficult to use, which may have contributed to non-adherence (Pope et al., 2018). Other breast cancer survivors reported tracker use as insightful for monitoring activity in accord with the guideline of 150 minutes of weekly MVPA, but felt despondent when their Polar A360 tracker did not capture perceived high-intensity activities (Kokts-Porietis et al., 2019). Although it appears that only a minority of survivors experienced difficulties with operating their wearable trackers or associated applications, these difficulties may result in disinterest and an unwillingness to engage with technology (Nguyen et al., 2017).

Breast cancer survivors who wore a Jawbone UP wrist-worn activity tracker while already participating in a supervised exercise program reported that the tracker increased their awareness of sedentary behaviour, and but they did not find the generic daily step goal encouraging (H. S. Wu et al., 2019). Participants expressed an unmet desire for more personalised feedback that could be garnered by receiving a report on their tracked activity and encouragement from a physiotherapist (H. S. Wu et al., 2019). However, these data were provided by a small sample (n = 10) of breast cancer survivors from the Netherlands, who were young compared to the average cancer survivor (range: 33–64 years) (H. S. Wu et al., 2019). Older and inactive survivors may have different experiences with wearable technology.

In a more personalised design, 45 breast cancer survivors were randomised to either a light-to-moderate intensity or moderate-to-vigorous intensity 12-week intervention in which they were required to wear a Polar A360 activity tracker and monitor their HR as an indicator of intensity (McNeil et al., 2019). Participants were also provided with a self-monitoring diary, goal-setting activities, and sessions with an exercise physiologist. Results revealed that the light-to-moderate intensity intervention was significantly more achievable, and this group engaged in significantly more MVPA and significantly less sedentary behaviour compared to the control group at 12 weeks (McNeil et al., 2019). Lower-intensity and higher-intensity groups improved weekly MVPA by 42 minutes and 24 minutes, respectively. While improvements from initial physical activity and cardiopulmonary fitness remained at 24 weeks, these improvements became non-significant following cessation of coaching and prompts after 12 weeks (McNeil et al., 2019). Diminished benefits following

the cessation of the intervention may indicate that tracker wear alone may be insufficient for sustained behavioural change, but could be supplemented by "boosters" to support maintenance (Müller-Riemenschneider et al., 2008).

For 83 inactive breast cancer survivors, the 12-week Activity And Technology (ACTIVATE) trial involved wearing a Garmin Vivofit tracker in conjunction with behavioural feedback, goal-setting activities and telephone coaching sessions (Lynch et al., 2019). The intervention incorporated a range of BCTs targeting behavioural change, rather than adopting a particular theoretical model. Post-intervention accelerometer wear revealed significant between-group findings in weekly MVPA of 69 minutes and a significant reduction in bouts of sedentary behaviour favouring the intervention group (Lynch et al., 2019). At the 24-week follow-up assessment (12 weeks post-intervention), small improvements were sustained with respect to diminished fatigue for survivors in the intervention group, compared to their baseline levels, supporting the effectiveness of a wearable tracker-based intervention package for maintaining improvements in secondary outcomes (Vallance et al. 2020). The convenience sampling style of recruitment to the ACTIVATE trial may have resulted in enrolment of a more motivated sample, potentially limiting the external validity of study findings. Amelioration of this limitation by screening according to inactivity or comorbidities could assist in recruiting a needs-based sample, but may hinder recruitment of an adequately powered sample size (Mendoza-Vasconez et al., 2016). The ACTIVATE intervention design and results supported the proposition that interventions using WAT are optimal when implemented in conjunction with other BCTs and support tools (Lynch et al., 2018; Lynch et al., 2019; Vallance et al., 2020).

3.4.3 Fitbit Activity Trackers

Fitbit activity trackers are light, silicone, waist-worn and wrist-worn devices that provide users with a step count, distance walked, caloric expenditure, and a measure of "active minutes". Active minutes are calculated using an estimation of MET minutes, and are accumulated after an individual has been active for a minimum of 10 minutes at or above 3 METs, reflecting physical activity guidelines that encourage bouts of activity of at least 10 minutes in duration (Centers for Disease Control and Prevention, 2020; Rock et al., 2012). Used in conjunction with the respective Fitbit smartphone application, the Fitbit is a tool for self-monitoring daily and long-term activity, and prompts goal setting, provides feedback, and encourages social support between users. Social aspects of the Fitbit network allow for individuals to engage in supportive social comparison, social interaction, and social prompts, aligning with BCTs (Michie et al., 2013).

3.4.4 Validity of Fitbit Activity Trackers

The accuracy of Fitbit trackers for ascertaining physical activity measures has been investigated by comparing them to other trackers and accelerometer-derived estimates. In one prospective study, the accuracy of the waist-worn Fitbit Zip and Fitbit One devices for measuring step count was supported, when compared to smartphone applications, accelerometer-estimates, and other wearable devices (Case et al., 2015; Tully et al., 2014). When compared to ActiGraph accelerometer estimates, the clip-on Fitbit One model was found to be in agreement for measuring steps and overall activity, but overestimated MVPA in prostate cancer patients (van Blarigan et al., 2017). Results of a review by Evenson et al. (2015) also supported the validity of the step count function of the Fitbit, whilst revealing limitations in the validity of Fitbit devices for estimating caloric expenditure (Evenson et al., 2015; Price et al., 2017). Although there have been few studies investigating the accuracy of Fitbit devices for measuring distance travelled (Evenson et al., 2015), it has been noted that small discrepancies in step count may be compounded in calculations that use these data, such as distance travelled and caloric expenditure (Case et al., 2015). In a qualitative acceptability study with cancer survivors, several participants reported the most demonstrable inaccuracy with wrist-worn Fitbits as being able to accumulate steps by shaking their arm (Hardcastle, Galliott, et al., 2018). Despite this issue, excellent agreement between waist-worn Fitbit models and ActiGraph accelerometer estimates of activity have been established in community-dwelling, older adults (S. S. Paul et al., 2015), while another study revealed agreement between Fitbit models and ActiGraph accelerometer estimates of MVPA over 7 days (Brewer et al., 2017). Fitbit models performed most accurately of all WATs and pedometers, in accord with research-grade accelerometers (Ferguson et al., 2015). The wrist-worn Fitbit Flex and ActiGraph accelerometer estimates of activity were also largely in agreement in free-living adults (Kooiman et al., 2015) and cardiac patients (Alharbi et al., 2016), however it should be noted that the Fitbit Flex was more accurate in free-living settings than in laboratory testing (Sushames et al., 2016). While some research has indicated that the Fitbit Flex tended to overestimate daily steps (Alharbi et al., 2016; Chu et al., 2017; Dominick et al., 2016), other studies identified an underestimation compared to observation and accelerometer estimates (Sushames et al., 2016).

Examination of the validity of the wrist-worn Fitbit Charge model indicated good agreement with accelerometer-derived estimates of MVPA, but not steps (Hargens et al., 2017). A review of the accuracy of Fitbit models, including the wrist-worn Fitbit Alta

showed acceptable accuracy for step counts when participants were walking or jogging, but cautioned that overestimation of steps was most common during free-living contexts (Freehan et al., 2018). The Fitbit Alta model yielded an excellent correlation to accelerometer-derived estimates for running in a sample of six athletes (Stamm & Hartanto, 2018) and correlated with, but overestimated, steps compared to accelerometer-derived step estimates in eight patients with chronic obstructive pulmonary disease (Blondeel et al., 2018). Findings on validity must be interpreted with caution given the very small sample sizes in the limited studies to date. Most of the studies thus far concerning the accuracy of the Fitbit Alta and Alta HR have been in sleep research (J. D. Cook et al., 2019; Kubala et al., 2020, Liu et al., 2019; Moreno-Pino et al., 2019), rather than physical activity estimates.

3.4.5 Acceptability of Fitbit Activity Trackers

Despite scarce evidence to date on the effectiveness of Fitbits to increase physical activity amongst cancer survivors, the literature available on the acceptability of Fitbit use amongst survivors is promising. The Fitbit Zip, a waist-worn, clip-on tracker was found to be acceptable amongst prostate cancer patients (Rosenberg et al., 2016). Patients found the tracker comfortable and easy to use, and were keen to continue wear following the 3-week acceptability trial. Some reported technological barriers, especially with setting up the device and sought assistance from family members (Rosenberg et al., 2016). As only 56% of the sample in this study owned a smartphone, but 96% owned a computer, Rosenberg and colleagues (2016) recommended that future initiatives to focus on devices that did not rely on smartphone ownership or high technological literacy and could be set up and synchronised via either method. After completing a pilot intervention involving Fitbit One wear with supporting phone calls and text messages, breast cancer survivors reported the WAT-based intervention and remote contact components to be convenient (Gell, Tursi, et al., 2020). Survivors valued the ability to monitor the intensity of their activity using the tracker to ensure participation in MVPA (Gell, Tursi, et al., 2020).

Wrist-worn Fitbit trackers have been found to be feasible and acceptable for wear amongst endometrial cancer survivors (Rossi et al., 2018) and non-metropolitan cancer survivors (Hardcastle, Galliott, et al., 2018). A pilot study testing a wrist-worn Fitbit Flex and Facebook intervention in young adult cancer survivors yielded promising findings regarding the acceptability of the device (Miropolsky et al., 2020), with Mendoza et al. (2017) recommending a fully powered RCT to examine the effectiveness of WAT for increasing physical activity. While younger survivors enjoyed the social components of the Fitbit

software and application (Miropolsky et al., 2020), others were more interested in personal and tailored feedback than social comparison (Phillips et al., 2017). Moreover, interviews with current Fitbit users indicated that those interested in social comparison are more likely to already be motivated to change and receptive to challenges (Chung & Danis, 2016).

When compared to other WATs, the Fitbit was valued by breast cancer survivors for the provision of real-time feedback, which was supplemented by encouraging emails, another feature of the Fitbit software system (Nguyen et al., 2017). Social networking components of the Fitbit system seemed to be attractive, with some survivors suggesting that peer support via these social networks may supplement tracker use (Nguyen et al., 2017). Survivors preferred models with screens and greater functionality, compared to those without screens (Nguyen et al., 2017). Non-metropolitan survivors reported that the Fitbit Alta in particular was an ideal size, had an easily visible screen, and was easy to use alongside the supplementary Fitbit application (Hardcastle, Galliott, et al., 2018). This coincided with positive feedback about the Fitbit Alta from endometrial cancer survivors following a 30-day trial (Rossi et al., 2018).

3.4.6 Fitbit-Based Interventions for Cancer Survivors

To date, clinical trials of Fitbit devices as a part of behavioural interventions in cancer survivors have been early-phase feasibility studies with small samples.

3.4.6.1 Waist-Worn Fitbit Interventions for Cancer Survivors

Most of the published trials to date have incorporated the Fitbit One (i.e., Dreher et al., 2019; Gell et al., 2017; Hartman, Nelson, Myers, et al., 2018; Kenfield et al., 2019; Le et al., 2017; Yurkiewicz et al., 2018), a clip on, pedometer-style triaxial accelerometer device. The Fitbit One measures steps, calories burned, distance travelled, stairs climbed, and sleep activity. Pilot studies in 19 survivors of childhood cancer (age 15–35) (Le et al., 2017) and 33 young adult cancer patients (age 15–28) (Yurkiewicz et al., 2018) have indicated that the Fitbit One was acceptable (Le et al., 2017), and that patients particularly enjoyed the technological aspect of the tracker-based intervention (Yurkiewicz et al., 2018). After 6 months of Fitbit One wear, survivors' accelerometer-assessed MVPA increased non-significantly by 36 minutes per week (Le et al., 2017), whilst 79% of patients in the pilot study by Yurkiewicz et al. (2018) self-reported increased physical activity. The findings of studies by Le et al. (2017) and Yurkiewicz et al. (2018) must be interpreted with caution, given that the acceptability of digital health interventions is greater in younger cohorts of cancer survivors (A. B. Sanders et al., 2019). Other middle-

aged breast cancer patients undergoing chemotherapy had poor adherence to Fitbit-based initiatives (Dreher et al., 2019; Nyrop et al., 2018), which may further support survivors' preferences for the implementation of programs following the completion of cancer treatment (Blaney et al., 2013; Vallance et al., 2013; Wong et al., 2018).

A group of 24 mixed cancer survivors participated in a 4-week tracker-based intervention which involved wearing a Fitbit One with a focus on self-monitoring, tailored text messages, and telephone-delivered health coaching sessions to promote daily steps and MVPA (Gell et al., 2017). Despite a lack of a significant increase in physical activity over the short duration of the intervention, survivors reported satisfaction with the technological delivery of the intervention and were most satisfied with the Fitbit and coaching session components (Gell et al., 2017). At 8 weeks, participants had maintained increased MVPA levels, compared to the Fitbit-only control group, indicating that Fitbit-wear in conjunction with coaching and prompt components may be optimal (Gell, Grover, et al., 2020). In a larger scale 12-week RCT involving 42 breast cancer survivors, the Fitbit One clip-on tracker was used in an intervention to promote MVPA (Hartman, Nelson, & Weiner, 2018). Participants wore the Fibit One daily and self-reported tracker and application use. Adherence to Fibit wear throughout the trial was high (88% of days), with the intervention group increasing the accelerometer-measured MVPA by 101 minutes per week over 12 weeks (Hartman, Nelson, Myers, et al., 2018; Hartman, Nelson, & Weiner, 2018). However, as Fitbit adherence was boosted by frequent prompts throughout the study, the high adherence rate may not be representative of adherence to Fitbit wear once intervention prompts and monitoring have ceased (Hartman, Nelson, & Weiner, 2018). An extended follow-up assessment measuring physical activity outcomes and Fitbit adherence following the cessation of all other intervention materials would further inform Fitbit engagement findings.

In one of few studies in survivors of cancers other than breast cancer, the Prostate 8 RCT recruited prostate cancer survivors at risk of unhealthy lifestyle behaviours, to assess the feasibility and effectiveness of a 12-week pilot program promoting lifestyle change (Kenfield et al., 2019). Survivors in the lifestyle intervention (n = 37) were encouraged to engage in healthy dietary behaviours, physical activity, and smoking cessation via the delivery of a multi-modal intervention package (Kenfield et al., 2019). The WAT-based Prostate 8 intervention involved receiving a Fitbit One tracker, TPB-based text messages, and log-in access to the intervention website which contained personalised tracking, feedback, and didactic tools. The primary objective of this pilot design was to assess the

feasibility of the Prostate 8 intervention. Participants who received the intervention highly rated the use of trackers, text messages, and personalised feedback, and deemed the intervention acceptable, although some failed to notice website resources (Kenfield et al., 2019). However, health behaviour outcomes from the pilot study indicated that the intervention was effective across dietary, rather than activity outcomes (Kenfield et al., 2019). While the single physical activity outcome did not change between groups over the 12-week trial, this may be attributed to the conflation of vigorous activity and brisk walking as a single physical activity outcome. Examination of separate physical activity outcomes across intensity levels may elucidate if changes were greater for some intensities, but not others, especially given the focus of the Fitbit system on walking and daily steps (Bassett et al., 2017). Although the findings of Fitbit One trials provide insight on the general utility of WAT to self-monitor physical activity, use of wrist-worn tracker models may be more appropriate to encourage daily wear and frequent monitoring (Hardcastle, Galliott, et al., 2018; Nguyen et al., 2017).

3.4.6.2 Wrist-Worn Fitbit Interventions in Cancer Survivorship

The 12-week Smart Pace trial involved the wrist-worn Fitbit Flex, daily TPB-based text messages, and educational print materials to increase physical activity and quality of life, and assess the feasibility of a larger-scale trial in colorectal cancer survivors (H. Chan et al., 2018). A net change of 13 minutes of weekly MVPA was captured between the intervention and print materials-only control arm (van Blarigan et al., 2019). Engagement data revealed that the Fitbit was utilised and considered to be acceptable by the intervention group, but engagement with text messages decreased over the course of the trial (van Blarigan et al., 2019). Although the Fitbit Flex model has shown promise for the effective use of WAT generally as an interventional tool (Mendoza et al., 2017), the Flex does not have a screen, which limits the feedback and information available to users without referring to the application or Fitbit Dashboard website. Since the accessibility and size of the Fitbit screen has been mentioned by survivors as a factor affecting the usability of devices (Hardcastle, Galliott, et al., 2018; Nguyen et al., 2017), other Fitbit models may be more effective.

A 6-month weight-loss program in the United States involving the Fitbit Charge device, along with an SCT-based and informational intervention, resulted in significant weight loss and increased tracking of steps and physical activity across a sub-sample of breast cancer survivors at 3 months (Ferrante et al., 2017). The Charge model incorporates a small screen that allows for tracking towards daily goals, but more detailed feedback and

logging of activities must be completed using the application or website (Fitbit, n.d.-b). Despite promising preliminary findings for the intervention, weight loss occurred in both the intervention and tracker-only control groups and did not significantly differ when the full sample was assessed at the end of the 6-month intervention (Ferrante et al., 2018). This may indicate that wearing a Fitbit tracker alone, or a tracker in conjunction with a lower-intensity intervention, is sufficient for weight loss and health behaviour change.

Most recently, a review of wearable tracker studies in breast, colorectal, and prostate cancer survivors revealed that of the eight RCTs found during the literature search, five were in breast cancer survivors (Coughlin et al., 2020). An additional study in breast and colorectal cancer survivors (Cadmus-Bertram et al., 2019) assessed an intervention package including a Fitbit Charge HR or Charge 2, an informational and goal-setting session, and Fitbit connections with a support partner (Cadmus-Bertram et al., 2019). After 12 weeks, accelerometer-based assessments revealed a significant 69-minute increase in weekly MVPA from baseline, compared to the 20-minute increase in the educational control group, along with a significant improvement in daily steps. Despite recruiting a small sample of colorectal cancer survivors, this sample consisted of 90% breast cancer survivors (Cadmus-Bertram et al., 2019), illustrating the predominance of breast cancer survivor samples in this field.

3.5 Summary and Rationale

There are several components of this literature review to summarise in order to articulate the rationale for this project. Firstly, the vast literature base on health behaviour interventions for cancer survivors indicates that intervention designs that incorporate theoretical underpinnings are most effective for bringing about behavioural change. There is significant overlap in the leading theories that seek to explain behavioural change. The majority of the leading behavioural change frameworks that have guided health behaviour change interventions have acknowledged the role of the factors facilitating health behaviour change, according to cancer survivors, including barriers, motives, preferences, and support needs. However, there are little existing data on the factors influencing health behaviours in colorectal and endometrial cancer survivors. As these cancer types are associated with unhealthy lifestyle behaviours, investigation of the barriers to health behaviour change will be valuable to inform future behavioural change initiatives for these specific groups of survivors. Given the role of psychological constructs, including self-efficacy, positive attitudes, and perceived control over behavioural outcomes, the

development of a behavioural intervention that is designed to target the psychological profile, preferences, and needs of survivors is important.

Of leading health behaviour frameworks discussed in this review, the HAPA model shows promise for tethering planning stages with the contribution of external supports and overcoming of barriers to bridge the intention–behaviour gap. The taxonomy of BCTs constitutes an array of evidence-based strategies to foster behavioural change. The current review on health behaviour literature, specifically regarding the promotion of physical activity in cancer survivors, indicates that self-monitoring, action planning, goal setting, the provision of feedback, and instructional information have yielded promising results in previous physical activity interventions. However, interventions are often short in duration, and resource-intensive – and therefore not scalable.

Wearable activity trackers present a feasible and effective vehicle for delivering evidence-based BCTs (e.g., self-monitoring, the provision of feedback, goal setting, and social comparison) to survivors to foster sustained behavioural change. The Fitbit has been considered acceptable in early phase clinical trials, with limited but promising findings regarding its effectiveness for promoting physical activity as a part of a feasible behavioural intervention. The WATAAP trial addresses a gap in the literature since it is the first study to incorporate Fitbit devices along with HAPA-based action planning materials to promote MVPA in colorectal and endometrial cancer survivors at heightened cardiovascular risk. No studies of Fitbit-based physical activity interventions to date have recruited colorectal and endometrial survivors. As smart wearable trackers are optimised for the feasible delivery of BCTs, they present a novel opportunity for intervention that surpasses the utility of pedometers or manual behaviour logs, and incorporate the promising constructs of the HAPA model. This trial offers insight to a pragmatic and scalable opportunity to incorporate WAT as a part of routine outpatient care, and as a broader, distance-based intervention tool to reach underrepresented samples.

Chapter Four

4

Barriers to Physical Activity Participation

Chapter Overview

This chapter was published in *Psycho-Oncology*. It describes *Study One*, which explored the barriers that colorectal cancer survivors perceive towards physical activity. Overarching themes including psychological obstacles, poor knowledge of physical activity recommendations, and a lack of practitioner support, are described with illustrative quotes. The discussion considers barriers that are related to practitioner support and medical surveillance, whereby survivors believe medication or medical attention may replace the need for physical activity. This publication concludes by suggesting that the support of medical staff and health practitioners, in addition to education about the physical activity guidelines, may be necessary for physical activity to be promoted successfully.

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PAPER

Barriers to physical activity participation in colorectal cancer survivors at high risk of cardiovascular disease

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Abstract

Background. Lifestyle-related factors, including inadequate physical activity, may contribute to increased risk of developing cardiovascular disease in colorectal cancer survivors. Identification of the barriers to physical activity is important for forming an evidence base of factors to target in future physical activity programs aimed at improving cardiovascular health in this population.

Methodology. Colorectal cancer survivors ($n = 24$) from St John of God Subiaco Hospital, in Western Australia, participated in semi-structured interviews about their current physical activity behaviours and perceived barriers to physical activity.

Results. Inductive thematic content analysis of interviews revealed five overarching themes relating to barriers to physical activity: psychological barriers, environmental barriers, knowledge of guidelines, lack of practitioner support, and age and energy barriers.

Conclusions. Novel findings revealed participants' dependence on practitioner support, including a reliance on practitioners to recommend lifestyle change. Survivors also revealed that regular check-ups to monitor cardiovascular risk replaced the need for healthy lifestyle change. With survivors holding the advice of clinicians in high regard, an opportunity exists for clinicians to facilitate lifestyle change. Healthcare professionals such as nurses can implement motivational strategies and provide additional health information during follow-up visits, to ensure long-term adherence. Individuals who reported psychological, motivational, and environmental barriers may benefit from interventions to improve self-regulation, planning, and problem-solving skills.

4.1 Introduction

Colorectal cancer is the second most common type of cancer among Australians (Cancer Council, 2014), and the third most common type of cancer worldwide (B. W. Stewart & Wild, 2014). There were 1.4 million new instances of colorectal cancer reported globally in 2012 (Steward & Wild, 2014). Although survival rates are increasing, many cancer survivors suffer from additional comorbidities that put them at risk of developing cardiovascular disease (Weaver, Foraker, et al., 2013). Lifestyle factors such as insufficient physical activity, low fruit and vegetable intake, smoking, and alcohol consumption make individuals susceptible to both cancer and cardiovascular disease (Huxley et al., 2009; Katzmarzyk et al., 2009; Stampfer et al., 2000). As a result, insufficiently active colorectal cancer survivors who fail to make healthy lifestyle changes post-treatment are likely to have a substantially higher risk of developing cardiovascular disease. Furthermore, only 53% of colorectal cancer survivors meet the physical activity guidelines (150 minutes of MVPA per week) pre-diagnosis, and 32% meet these guidelines post-diagnosis (Lynch et al., 2007). More recent data reveals only 20–25% of colorectal cancer survivors currently meet the physical activity guidelines (Fisher, Smith, & Wardle, 2016) and that as little as 16% may be performing sufficient MVPA in 10-minute bouts as recommended in previous physical activity guidelines (Lynch, Boyle, et al., 2016; O'Donovan et al., 2010).

Previous research has identified a range of physical activity barriers for cancer survivors such as a lack of time or motivation (Beehler et al., 2014; Blaney et al., 2013; Courneya et al., 2005; Ottenbacher et al., 2011), and cancer-specific barriers concerning benefits and safety (Blaney et al., 2013; Fisher, Wardle, et al., 2016; L. W. Jones & Courneya, 2002). Breast cancer survivors (n = 23) identified barriers to physical activity including competing priorities, procrastination, fatigue, and a lack of interest, discipline, and time (Rogers et al., 2007).

In addition, a lack of motivation appears to be a prominent barrier to physical activity participation in cancer survivors (Hardcastle, Maxwell-Smith, et al., 2017). Survivors previously reported being too busy, having no willpower, or had a lack of interest in engaging in physical activity (Arroyave et al., 2008; Beehler et al., 2014; Blaney et al., 2013; Courneya et al., 2005; Hardcastle, Maxwell-Smith, et al., 2017; Lynch et al., 2010; Ottenbacher et al., 2011). Participants' attitudes toward change may also be an important factor, and cancer survivors have been shown to harbour beliefs that any changes in their health behaviour would come too late in their life to make a difference to their health (Beehler et al., 2014). Other influential barriers are beliefs about social and environmental

factors such as bad weather, responsibilities at home, and lack of an exercise partner (Arroyave et al., 2008). Lack of access to facilities such as sports grounds or gyms has also been identified as a prominent barrier to physical activity participation (Beehler et al., 2014). Unsurprisingly, health concerns have emerged as a barrier to increased activity in cancer survivors (Beehler et al., 2014; Blaney et al., 2013; Courneya et al., 2005; Ventura et al., 2013). Health concerns in colorectal cancer survivors have included fatigue, feeling unwell, and difficulties with diarrhoea or incontinence (Anderson, Steele, & Coyle, 2013; Fisher, Wardle, et al., 2016; Hardcastle, Maxwell-Smith, et al., 2017; Lynch et al., 2010).

There is some evidence to suggest that physical activity barriers differ according to cancer type. Ottenbacher et al. (2011) compared the barriers reported by breast (n = 259) and prostate (n = 193) cancer survivors, finding significant differences between the types of barriers reported by cancer type. Despite common barriers between cohorts such as "too busy" and "lack of willpower", breast cancer survivors reported greater barriers than prostate, with prostate cancer survivors focusing on practical barriers (i.e., access to gym), and breast cancer survivors being more concerned with their image (i.e., feeling self-conscious) (Ottenbacher et al., 2011). This discrepancy of barriers between cancer types illustrates the need for research concerning the unique barriers that apply to specific cancer types. Furthermore, a review of 82 physical activity trials for cancer survivors revealed that 83% of trials recruited only breast cancer survivors (Speck et al., 2010), demonstrating a need for further research with colorectal cancer survivors.

To our knowledge only a handful of studies have explored barriers to physical activity in colorectal cancer survivors in Australia (Hardcastle, Maxwell-Smith, et al., 2017; Lynch et al., 2010), Canada (Courneya et al., 2005), and the UK (Fisher, Wardle, et al., 2016). Most recently, Fisher, Wardle, et al. (2016) found that survivors' barriers resulted from their cancer or other age and health-related morbidities. Hardcastle, Maxwell-Smith, et al. (2017) identified motivational barriers and uncertainty about whether health behaviour changes were worth it.

Several theories have gained credibility to explain physical activity behaviour change, including TPB (Ajzen, 1991), Self-Determination Theory (R. M. Ryan & Deci, 2000), and Self-Efficacy Theory (Bandura, 1977). The current study is not aligned to any particular theoretical framework because it is inductive in nature. However, given previous research findings and the aforementioned theories, we expect that low self-efficacy, motivation, and behavioural control may be theoretical components of emerging barriers.

The aim of the present study was to explore colorectal cancer survivors' experiences and barriers to physical activity amongst those with comorbidities, as a precursor to developing effective patient-centred interventions. It was expected that results would corroborate with previous findings of environmental (Beehler et al., 2014), psychological (Courneya et al., 2005), and physical/health-related barriers (Lynch et al., 2010), but also broaden and deepen existing knowledge by providing new insights into patients' beliefs and barriers, and practitioner encouragement to meet them. The recruitment of colorectal cancer survivors for this study is justified by the role of lifestyle-related risk factors in this group, and the recruitment of survivors of a single cancer type is appropriate for the in-depth exploration of barriers within a small sample (K. D. Miller et al., 2019). The study adopted a qualitative inductive approach, which is appropriate when studying phenomena about which little is known, and when there is a need for in-depth, rich data. It was expected that pertinent themes would emerge from our analysis of colorectal cancer survivors' barriers to physical activity.

4.2 Methodology

4.2.1 Participants and Recruitment

Participants were considered eligible for recruitment if they had completed active treatment for colorectal cancer in the past 2 years and had existing morbidities that increased their risk of cardiovascular disease. Participants' cardiovascular risk was indexed by an American Society of Anaesthesiologists (ASA) score between 2 and 3, indicating that their comorbidities such as hypertension, hypercholesterolemia, hyperlipidaemia, and BMI >30 put them at elevated risk of cardiovascular disease. The ASA score is globally recognised as an indicator of physical health status of patients prior to undergoing surgery (Owens et al., 1978). Individuals with an ASA score of 1 are considered healthy and not at cardiovascular risk, whereas those with an ASA score exceeding 3 were excluded as a result of being at severe or life-threatening risk.

Colorectal cancer consultants at St John of God Subiaco Hospital (n = 4) sent letters inviting eligible patients to participate (n = 126). Participants were required to phone or email their consultant to confirm their consent to participate. Participants were then contacted by telephone by the researcher to arrange a time and location for the interview. Interviews were conducted at the participants' homes or another suitable location, as chosen by the participant. The St John of God Human Research Ethics Committee approved this research prior to data collection (#756; Appendix G, Section G.1). Participants gave written

informed consent prior to interviews (Appendix G, Section G.2) and consented to being audio-recorded.

4.2.2 Procedure

Semi-structured interviews were conducted to explore current physical activity levels, and motives and barriers to increasing physical activity levels. Three interviewers collected the data. Interviewers were experienced and received relevant training prior to conducting the semi-structured interviews. Two interviewers had extensive experience in interviewing for qualitative research, and the third interviewer was a PhD candidate who received training prior to interviewing. During the interviews, participants were asked about their current perceived health and subsequently, whether they had been advised to be physically active by hospital or allied healthcare professionals. Participants were also asked about their current physical activity behaviour and their attitudes, motives, and barriers towards physical activity participation. Fidelity of responses across interviewers was achieved with close adherence to interview guide and a moderation process during interview training. The interview guide can be found in Appendix G, Section G.3.

4.2.2.1 Inductive Thematic Content Analysis

Interviews were audio-recorded and transcribed verbatim before undergoing inductive thematic content analysis (Braun & Clarke, 2006). An independent expert reviewed the interviews to ensure consistency across interviewers and pseudonyms were assigned to transcripts. The analysis began with the process of immersion in which transcripts were read carefully several times to establish meanings and experiences. Codes were assigned to salient text segments across the entire data set, before codes were combined to define overarching themes. Themes were drawn with a focus on participants' barriers around physical activity and health changes. This inductive approach of analysis can be contrasted with a deductive approach, where text segments would be organised on the basis of predetermined themes. Although researchers were trained to act as objective observers, researchers' prior knowledge of established theory and research in the field is a probable and acknowledged influence on the development of subsequent themes (Braun & Clarke, 2006). The themes were reviewed to eliminate overlap in content, before being named.

4.3 Results

From the 126 eligible individuals, 19% (n = 24; 13 female, 11 male)[1] participated in the study. The majority of participants (65%) were in the lower annual household income categories. These income categories are approximately equivalent or below the average annual household income in Australia of A$50,128 (US$36,118) (Australian Bureau of Statistics, 2015). Response bias analyses revealed no significant differences in age (t (124) = 1.53, p = .294) and gender distribution (χ^2 (1) = 1.63, p = .202) of those who participated (n = 24) compared to those who declined participation (n = 102). There was, however, a significant difference between participants and non-participants across ASA score, such that those with an ASA score of 3 were more likely to participate and those with an ASA score of 2 were more likely to decline (χ^2 (1) = 5.15, p = .023). Participant characteristics are summarised in Table 4.1.

Inductive thematic content analysis of the interview data revealed five themes of barriers towards physical activity:

1. Psychological barriers with sub-themes *not the sporty type*, *too much effort/lack of willpower* and *competing priorities/lack of time*.
2. Environmental barriers with sub-themes *weather* and *lack of social support*.
3. Perceptions concerning physical activity guidelines with sub-themes *insufficient knowledge of guidelines*, *guidelines not applicable* and *doing sufficient physical activity*.
4. Lack of practitioner support with sub-themes *medical surveillance* and *insufficient physical activity advice from medical professionals*.
5. Age and energy.

Each of these themes will be discussed in the next sections.[2]

[1] Female and male refer to participants' self-reported gender throughout this thesis.

[2] In accordance with Sandelowski (2001), the words "few", "commonly", and "many" will represent indeterminate quantities where "few" implies approximately 20% or less, "commonly" implies approximately 50%, and "many" implies approximately 75% or more.

Table 4.1
Self-Reported Demographic Characteristics for Interviewed Colorectal Cancer Survivors

Characteristic	
	Mean (SD)
Age (years)	
Mean	69.38 (4.19)
Range	63–77
	n (%)
Marital Status	
Married/living together	16 (66.7%)
Divorced	4 (16.7%)
Not married	
Widowed	
Highest Completed Education	
Primary	2 (8.3%)
Secondary/high school	10 (41.7%)
Post-school vocational	6 (25.0%)
University	2 (8.3%)
Annual Household Income[a]	
<A$30,000	6 (25.0%)
A$30,000–$52,000	7 (29.2%)
A$52,000–$104,000	3 (12.5%)
A$104,000–$156,000	3 (12.5%)
A$156,000–$208,000	
A$208,000–$260,000	1 (4.2%)

Note. *n* = 24. Four participants did not report their marital status, highest completed education, and annual household income. [a]A$1 = approximately US$0.70.

4.3.1 Psychological Barriers

Barriers pertaining to a psychological origin were common, with sub-themes of *not the sporty type*, *too much effort/lack of willpower*, and *competing priorities/lack of time*.

4.3.1.1 Not the Sporty Type

Many patients attributed their inactivity to not being the type of person who likes or is good at sport. For example, "I've never played a sport, it's just not my interest at all. It's just not me, [I'm] not set up that way" (Pauline, aged 68). Participants seemed to view physical activity as being synonymous with sport. Stuart argued: "I've never spent my life exercising. … I get more enjoyment from keeping my mind going than I would do exercising" (aged 68). Paul referred to the particular personality of those who exercise regularly, stating, "They were of that mindset. … You always get a proportion of people who will exercise. … It's a little bit hard getting me into a routine" (Paul, aged 65). For Paul, the ability to be physically active is associated with particular personality traits. Some participants appeared to feel discouraged when comparing themselves to a more disciplined ideal: "There are some people a lot fitter than you are … that show you up type [of] thing. … You feel like a failure and that sort of puts you off" (Lynda, aged 63).

4.3.1.2 Too Much Effort/Lack of Willpower

Poor motivation to participate in physical activity was characterised by a lack of effort and discipline. The effort to be physically active was identified by Elaine (aged 66), "You've got to get motivated to get up. … It feels like too much effort". Elaine also reiterated the need for support through weight loss and exercise programs, "I need the reminders or the instigation to go. … I can't do it on my own, I just don't have the motivation" (aged 66). Stuart also attributed his physical inactivity to a lack of self-discipline: "I suppose it's in your make up whether you actually can discipline yourself to exercise" (Stuart, aged 68). For Pauline (aged 68), "It's just making that effort. … It's not in me at the moment". Participants commonly alluded to poor self-discipline and a lack of motivation: "I wish I was one of these strong willpowered persons, but no, I'm not" (Patricia, aged 76). David (aged 64) implied he was lacking discipline: "Some people are lazy like me and can't be bothered".

4.3.1.3 Competing Priorities/Lack of Time

For David, lack of time due to work was his primary barrier to physical activity, "While I'm working it's hard. … It's very hard to … get the exercise and the time to do the exercise. Because I'm working, you just don't get the time" (David, aged 64). Richard

identified barriers around prioritising his time; "[My wife and I would] go for a half an hour walk at night-time. But then I started building this house and things seemed to change. Plus, we have our grandkids at least one night every week" (Richard, aged 66). Participants attributed their lack of physical activity to other demands on their time that took precedence, such as work, family, or social commitments.

4.3.2 Environmental Factors

Participants identified barriers within their social or physical environment that prevented them from being physically active. Sub-themes within this dimension include *weather* and *social support.*

4.3.2.1 Weather

Many participants reported that hot weather conditions prevented them from exercising outdoors. Stuart reported: "I don't do it in this weather. … It's too hot. … It's not an excuse; it's the reason I don't do it" (Stuart, aged 68) and for Lynda, "I know it's an excuse, but it's just the heat just kills me. … Once it starts cooling down more, then I can do a bit more exercise" (Lynda, aged 63). Wendy also viewed heat as a barrier, "I can't walk in the hot weather. I walk around shopping centres, but through the day they get so hot from body heat" (Wendy, aged 68). Similarly, Pauline stated, "You don't feel inclined to go out because it's just not nice walking in the heat" (Pauline, aged 68).

4.3.2.2 Social Support

Paul mentioned being more physically active when exercising socially, "You would get to meet all these new people each day through the exercise" (Paul, aged 65). Patricia made a similar case, "I have started walking three or four times a week with a friend. … This other friend who is a neighbour said could we do it and we both feel good about it" (Patricia, aged 76). In few cases, a group atmosphere was deemed intimidating, "I'm quite shy so sort of going to a group … unless you're sort of with someone, sometimes it can be quite daunting" (Lynda, aged 63).

4.3.3 Perceptions and Knowledge Concerning Physical Activity

This theme included the following sub-themes: *Insufficient knowledge of guidelines, guidelines not applicable,* and *doing sufficient physical activity*. Many participants were either unaware of the recommended government guidelines, overestimated the amount of physical activity they did each day, or felt that the guidelines did not apply to them.

4.3.3.1 Insufficient Knowledge of Guidelines

When asked about the government guidelines, participants were commonly unaware that such guidelines existed, "I don't know what you mean" (Jenny, aged 72). Others were unsure, "Well they say about 15 minutes a day, don't they?" (Annie, aged 69). Patricia was unaware of the guidelines but engaged in regular walking: "I have started walking about three or four times a week with a friend, but we're both the same age, so we don't go too far or too fast" (aged 76). Barry was unaware of whether he was meeting the guidelines: "I don't know how far it is but maybe I could try and go a bit further" (aged 73). David overestimated the guidelines, "I have a sort of rough idea that you should be walking for probably an hour a day or two" (aged 64).

4.3.3.2 Guidelines Not Applicable or Beneficial

Participants commonly stated that the physical activity guidelines were not applicable to them, "I probably don't technically do enough exercise, but I'd say that I'm not in the bracket that needs to do exercise" (Mike, aged 65). As a cattle farmer, Mike argued that he already had many duties to complete on the farm. Mike justified his physical activity via social comparison, stating that he was "active compared to most people" (aged 65).

Pauline had knowledge of physical activity guidelines but did not see any positive outcomes from participating in physical activity: "I don't think I'll be any healthier for doing it, quite honestly" (aged 68). Concerning the physical activity guidelines, Barbara said: "But this is for younger people, I think" (aged 76).

4.3.3.3 Doing Sufficient Physical Activity

Many participants felt that they were sufficiently active. Annie said: "I do about a kilometre a day. … I'm doing enough as far as I'm concerned" (aged 69). Carol felt that she was sufficiently active as a result from conducting her daily tasks: "As far exercise goes … walking, well nearly running, I walk so fast normally. But that's like shopping centres, to appointments, to the car" (aged 68). Richard believed the accumulation of activity within his daily routine exceeded the guideline requirements, "I think I'm doing more than the equivalent [of the guidelines]. You see this set of stairs? … That's nearly 36 steps that I run up and down or walk up and down every day" (aged 66). Participants appeared to be misinformed about the guidelines or held inaccurate beliefs that they were sufficiently physically active.

4.3.4 Lack of Medical Practitioner Support

This theme encompassed two sub-themes: *medical surveillance* and *insufficient physical activity advice from medical professionals*.

4.3.4.1 Medical Surveillance

Participants commonly believed that medical surveillance was sufficient to guard against future health problems. With regard to reduced hypertension as a benefit of increased physical activity, Stuart responded, "Well the medication I take is for blood pressure" (aged 68). While discussing physical activity he added, "I just don't feel the need to do it terribly much, that's all" (Stuart, aged 68). Mike's doctor also recommended medication rather than diet change for his health problems, "He said, 'I'll put you on Lipitor because that's much easier than changing your diet'" (Mike, aged 65). Pauline made a similar point: "[My GP] is aware that I don't have regular exercise. … She doesn't get on my back about it" (Pauline, aged 68). Pauline continued: "I saw my cardiologist last week; he's happy with me. … I'm quite happy with the way my health is going".

4.3.4.2 Insufficient Physical Activity Advice From Medical Professionals

Many participants reported receiving little advice concerning physical activity from medical professionals. When asked what their consultant recommended to improve their health, Mary said, "Someone said, 'Just walk, it does your bowel good if you're walking'" (Mary, aged 65). However, when asked whether healthcare professionals recommended a duration, intensity or frequency for walking, Mary responded, "Ah, no". Kathleen reported receiving no information regarding physical activity but felt that "it was imperative that you had it, because you just didn't know what you were capable of doing" (Kathleen, aged 73).

4.3.5 Age and Energy

Participants commonly attributed inactivity to their age and low energy levels. "As you get older you have a lack of energy anyway, so it's very difficult to know what's due to the cancer, or it's just getting older and you don't have that energy level anymore" (David, aged 64). Carol stated, "I'm so sick of being sick and I'm so tired of being tired. I want to have some energy, I want to have some life about me" (Carol, aged 68). Mike was concerned about reduced muscular strength resulting from his age: "The energy levels are alright, it's just that I'm weak. … That's just what you get when you get old" (Mike, aged 65).

4.4 Discussion

The purpose of this study was to identify barriers to physical activity among colorectal cancer survivors with comorbidities. The five primary themes identified encompassed psychosocial, health and environmental influences on physical activity participation among colorectal cancer survivors. Participants commonly reported motivational and psychological barriers to physical activity participation, and this is consistent with previous research throughout the cancer survivor literature (Arroyave et al., 2008; Beehler et al., 2014; Blaney et al., 2013; Courneya et al., 2005; Hardcastle, Maxwell-Smith, et al., 2017; Lynch et al., 2010; Ottenbacher et al., 2011).

Most participants were unaware of the physical activity guidelines and some felt that the guidelines did not apply to them due to their age or health. Participants reported being active, but further exploration revealed that their activity levels were insufficient to gain health benefits. While lack of knowledge of physical activity guidelines alone may not necessarily be a barrier to performing sufficient physical activity, this issue was often reported in conjunction with barriers concerning the applicability of these guidelines to survivors and scepticism about their benefits. Previous research suggests that colorectal cancer survivors experience confusion about health guidelines, and are uncertain of the benefits (Anderson, Steele, & Coyle, 2013; Hardcastle, Maxwell-Smith, et al., 2017). Similar results were reported by Lynch et al. (2010), with colorectal cancer survivors overestimating their physical activity levels, when only a third met the guidelines. Future educational initiatives to promote physical activity in cancer survivors might consider a focus on the benefits and applicability of the physical activity guidelines, in order to ameliorate these misconceptions.

Given the tendency for overestimation of activity, and the reported lack of practitioner support, assistance from the oncology team is crucial for facilitating health behaviours in this cohort. For example, research has demonstrated that colorectal cancer survivors who recalled receiving advice about physical activity were significantly more likely to engage in sufficient levels of physical activity up to 3 years post-treatment, than those who did not recall receiving advice (Fisher et al., 2015). Indeed, it would appear that oncologists hold an influential position for offering guidance on health behaviour change (Bellizzi et al., 2005; Hardcastle & Cohen, 2017). Despite survivors' reliance on practitioners to facilitate change, clinicians in Scotland ($n = 323$) report patient sensitivity and lacking time and skills as barriers to health behaviour recommendations (Anderson, Caswell, et al., 2013). Furthermore, only 31% of colorectal cancer patients in England ($n = 15{,}254$)

recall receiving health advice from their practitioner (Fisher et al., 2015), and less than half of clinicians report attempting to offer advice (L. W. Jones et al., 2005). Other clinicians report a lack of knowledge concerning the physical activity guidelines (Hardcastle, Kane, et al., 2018), indicating that educational approaches to address barriers held by oncologists in delivering such recommendations may also be of value.

The theme of medical surveillance is novel and has not been reported in previous research. Participants expressed beliefs that their regular check-ups and monitoring of risk factors were sufficient to protect their health. This reinforces the need for oncologists to encourage health behaviour change in routine follow-up visits with patients. Another solution could involve oncologists referring patients for specialist advice from a behavioural change expert or nurse. Intentions for further research on exercise referral services have also been suggested (Fisher, Smith, & Wardle, 2016). This could become a routine part of post-cancer care, if found to be successful.

The theme concerning environmental barriers to physical activity replicates previous findings (Arroyave et al., 2008; Beehler et al., 2014; A. Jones & Paxton, 2015; Lynch et al., 2010). Most recently, Y. P. Wu and colleagues (2015) found burdens relating to finances, family issues, and access to exercise facilities were barriers to health behaviour change. The present study also found that competing priorities for time and hot weather were barriers to physical activity participation. These barriers align with research in survivors of various cancer types (Hardcastle, Glassey, et al., 2017; Karvinen, Courneya, Campbell, et al., 2007; Ottenbacher et al., 2011; Patel et al., 2017; Wurz et al., 2015), suggesting that some factors that facilitate physical activity may be generalised across cancer survivor cohorts.

Finally, many participants reported lacking in energy as a result of their age. Previous research has also identified cancer-related fatigue as a major barrier to physical activity participation (Blaney et al., 2013). Moreover, qualitative research by Lynch et al. (2010) identified fatigue preventing physical activity amongst the strongest barriers post-diagnosis for colorectal cancer patients.

4.4.1 Clinical Implications

The current study has provided further rationale for the involvement of oncology practitioners in the promotion of physical activity. Given patients' lack of knowledge concerning physical activity guidelines or the importance of regular physical activity to reduce risk of cardiovascular disease, oncologists could play a valuable role in the

promotion of physical activity during routine follow-up care. Utilising activity trackers such as Fitbits for self-monitoring physical activity may assist patients in gaining an accurate understanding of their activity level. Given the findings in relation to a lack of willpower, time, energy, and social support, and inclement weather, these individuals are likely to benefit most from interventions aimed at promoting planning, self-regulation, problem-solving, and life skills (Hardcastle, Tye, et al., 2015). It would also be worthwhile for interventions to address perceptions such as "not the sporty type" and outline the differences between sport, exercise, and physical activity.

4.4.2 Strengths and Limitations

This study offers detailed and insightful data on physical activity in colorectal cancer survivors. It makes a unique contribution to current knowledge by providing an in-depth analysis of the barriers to physical activity participation among colorectal cancer survivors at elevated risk of cardiovascular disease. The inductive approach reveals novel themes such as patients' beliefs about medical surveillance and attitudes relating to physical activity guidelines. The use of the ASA score criteria enabled recruitment of colorectal cancer survivors with existing comorbidities who are at higher cardiovascular risk. Such samples are often underrepresented in this field, given that unhealthier individuals tend to be less interested, have less knowledge, and are less willing to participate in physical activity research (Chinn et al., 2006).

Although interview questions were designed to be free from bias, we acknowledge the possible role of interview questions in directing the interview topic or impacting responses. Participant recruitment from a single private hospital may not adequately represent the population of colorectal cancer survivors in Australia. Further, examination of respondents revealed a response bias across their ASA score, where a higher proportion of participants had an ASA score of 3, compared to an ASA score of 2. The implication of a response bias towards a higher cardiovascular risk sample, although not anticipated, allows this study to hone in on a group that is typically harder to reach.

4.4.3 Conclusion

The current study has provided rich, in-depth insight into the barriers to physical activity participation in colorectal cancer survivors at elevated risk of cardiovascular disease. The themes included psychological, environmental, social, and health-related barriers. Implications of the study indicate the valuable role of oncologists to prescribe or recommend physical activity during routine follow-up care. Findings from this study

suggest that future interventions should provide clear and specific information on physical activity guidelines, include a patient-centred rationale for physical activity behaviour change, and work to reduce motivational barriers to physical activity.

Chapter Five

5

Barriers and Support Needs for Physical Activity and Dietary Change

Chapter Overview

This chapter is an unpublished manuscript that seeks to expand upon the previous chapter by exploring barriers and support needs to engaging in physical activity and healthy diet behaviour change in a broader sample of cancer survivors. Respondents in this component of *Study Two* are colorectal, endometrial, and breast cancer survivors across geographical classifications. Social, professional, and informational themes are discussed in order to clarify current gaps in health promotion for survivors. This chapter further consolidates an understanding of cancer survivors' barriers to physical activity identified in *Study One* and may inform supportive and educational components in a health behaviour intervention.

MANUSCRIPT – CANCER SURVIVORS' BARRIERS AND SUPPORT NEEDS FOR ENGAGING IN PHYSICAL ACTIVITY AND DIETARY BEHAVIOUR CHANGE

Maxwell-Smith, C., Cohen, P. A., Tan, J., Platell, C., Makin, G., Saunders, C., Nightingale, S., Lynch, C., Sardelic, F., McCormick, J., & Hardcastle, S. J. (2020). Cancer survivors' barriers and support needs for engaging in physical activity and dietary behaviour change. Manuscript prepared for publication.

Abstract

Background. Cancer survivors are at risk of comorbidities, with those in regional and remote areas being particularly susceptible. Survivors identify unique barriers and support needs to adopt health behaviours, and these factors have previously received little attention for survivors outside of metropolitan areas.

Methodology. Survivors (n = 183) of colorectal, breast, and endometrial cancer were from metropolitan (n = 103) and non-metropolitan (n = 80) areas in Australia. Respondents completed open-ended survey items by describing their barriers and support needs for making physical activity and dietary changes. Responses underwent inductive thematic content analysis.

Results. Survivors' barriers were primarily concerned with motivational and social factors. Support needs corresponded with barriers, encompassing accountability, information from health professionals, and a supportive social environment. Non-metropolitan survivors expressed logistical barriers and desired allied health professionals' support.

Conclusions. Novel insights have revealed the importance of social influences in supporting behavioural change. As a lack of motivation was a primary barrier across health behaviours and locations, programs may focus on strengthening commitment for change and harnessing the value of local support networks.

5.1 Introduction

Despite increased survival rates, many cancer survivors remain at high risk of morbidity due to unhealthy lifestyle choices (Rock et al., 2012). The majority of cancer survivors are overweight or obese, consume insufficient fruits and vegetables, and are insufficiently active, per the guideline of 150 minutes of weekly MVPA (Mowls et al., 2016; Rock et al., 2012).

Poor motivation and willpower, limited knowledge of health recommendations, and the high cost of healthy foods are primary dietary barriers for colorectal and breast cancer survivors (Hardcastle, Maxwell-Smith, et al., 2017; M. K. Lee et al., 2019; Ventura et al., 2013). Survivors' main barriers to physical activity are psychological factors pertaining to their psychographic profile, motivation, self-efficacy, and priorities; practical barriers, including lack of equipment; insufficient knowledge about recommendations and benefits; inadequate practitioner support; and medical issues, including cancer- and treatment-related barriers (Clifford et al., 2018; Fisher, Wardle, et al., 2016; Maxwell-Smith et al., 2017; Olson et al., 2014; Ottenbacher et al., 2011; Sun et al., 2020).

Investigation of support needs amongst survivors has focused primarily on the cancer experience and recovery (Ahern et al., 2016; Butow et al., 2012; Harrison et al., 2009; Palmer et al., 2020) and fatigue (Schmidt et al., 2018), rather than health behaviours. However, survivors have revealed informational support needs (Clifford et al., 2018; Kent et al., 2012; Lyu et al., 2020; Palmer et al., 2020), scepticism of physical activity (Hardcastle, Galliott, et al., 2019), and dietary guidelines (Hardcastle, Maxwell-Smith, et al., 2017; Koutoukidis et al., 2017), as well as a desire for accountability and advice from health practitioners (Hardcastle, Galliott, et al., 2019; Koutoukidis et al., 2017; Kwok et al., 2015). While there are disparities in the treatment, trajectory, and journey of survivors of different cancer types, the above common needs have been established across cancer types (Butow et al., 2012; Harrison et al., 2009; Palmer et al., 2020). Moreover, given that research in this field largely consists of breast cancer samples (Butow et al., 2012), efforts to incorporate survivors of other cancer types are important. Specifically, recruitment of endometrial and colorectal cancer types, alongside breast cancer survivors, is of value for targeting cancer types that are closely linked with lifestyle-related risk factors and therefore may be most central to initiatives to promote health behaviours (ASCO, 2019; Erdrich et al., 2015; Islami et al., 2018; Schüz et al., 2015).

Compared to metropolitan survivors, those in rural locations are more likely to be physically inactive, have greater numbers of comorbidities, have greater obesity, and experience financial difficulties and practical obstacles throughout their cancer experience (Tervonen et al., 2017; Weaver, Geiger, et al., 2013). Rural survivors report specific environmental, social, and psychological barriers to health behaviours, including inconvenience and effort involved (Halverson et al., 2013; Fazzino et al., 2016), lack of facilities, weather, financial and travel difficulties (Frensham et al., 2018; Massarweh et al., 2014), fatigue (Olson et al., 2014), and insufficient knowledge of physical activity guidelines (Hardcastle, Galliott, et al., 2019). Those in rural or remote areas are likely to experience greater support needs than their metropolitan counterparts (Adams et al., 2017; Ahern et al., 2016; Martinez-Donate et al., 2013; Olson et al., 2014; Palmer et al., 2020), which may extend to health behaviour change support needs.

There is little research exploring the barriers and support needs for health behaviours experienced in heterogeneous geographical classifications. The present study will address this gap by exploring the barriers and support needs of cancer survivors across metropolitan and non-metropolitan geographical classifications to inform the design of effective health behaviour interventions.

5.2 Methodology

5.2.1 Participants

Endometrial, colorectal, and breast cancer survivors who had completed cancer treatment including surgery, adjuvant chemotherapy, and/or radiotherapy within the 5 years prior, were in remission and without recurrence, were eligible for inclusion. Survivors were identified via medical records at participating sites: St John of God Subiaco and Murdoch Hospitals, Women Centre in West Leederville, Hollywood Private Hospital, Western Australia and Tamara Private Hospital in Tamworth, New South Wales, Cancer Specialists, Victoria, and breast cancer nurses in South Australia and Western Australia.

Participants were classified into metropolitan and non-metropolitan groups (C. L. Paul et al., 2013; Tervonen et al., 2017), according to their Accessibility/Remoteness Index of Australia (ARIA+) classification, based on road distance (km) to service centres (AIHW, 2004). ARIA+ classifications are determined by index scores per 1km area, which constitute major cities, inner regional, outer regional, remote, and very remote regions. Residential postcodes were input into the ARIA online tool to discern participants' classifications (Psycho-Oncology Co-Operative Research Group, 2018).

5.2.2 Instruments

Participants completed a survey asking them to describe the main barriers that inhibit physical activity and dietary change, including the reasons underpinning the barriers. Items were: "Please list the main barriers for you to make physical activity changes and your reasons for these barriers" and "please list the main barriers for you to make health diet changes and your reasons for these barriers". Participants were also asked to describe the forms of support that would be most helpful for making physical activity and healthy diet changes. This item read: "Please list forms of support that would be most helpful for making physical activity and healthy diet changes and your reasons". Approximately half a page of lined space followed each item. Barriers and support needs were explored via an inductive approach as previously recommended, and informed by previous inductive survey items (Fisher, Wardle, et al., 2016). Barriers to physical activity and diet were considered separately, as previous studies in clinical populations indicate discrepancies between diet and activity obstacles (Cho & Park, 2017; Ventura et al., 2013), whereas support needs appear to be more generalised (Harrison et al., 2009). These open-ended items formed part of a larger mixed-methods survey administered for *Study Two*, which sought to investigate the factors affecting health behaviours in cancer survivors.

5.2.3 Procedure

This study was approved by the St John of God Human Research Ethics Committee and Curtin University Human Research Ethics Committee (#937, #1102, #1201; HR30/2016; Appendix H, Section H.1) and adheres to the tenets of the Declaration of Helsinki (World Medical Association, 2018). Eligible English-speaking cancer survivors were identified from oncologists' medical records and offered a survey and return envelope during a follow-up appointment, or were posted an information sheet (Appendix H, Section H.2) and survey (Appendix H, Section H.3), and return envelope after expressing interest in the WATAAP (Maxwell-Smith et al., 2018) or physical activity in regional and remote cancer survivors (PPARCS) trials (Hardcastle, Hince, et al., 2019). Participants gave written informed consent with an opportunity to ask any questions before completing the survey. Data were collected between April 2016 and November 2019.

5.2.3.1 Inductive Thematic Content Analysis

Inductive thematic content analysis began with immersion into the data (Braun & Clarke, 2006), which were deidentified and input into an Excel spreadsheet for manageability. Data were crudely segmented by tagging and colour-coding to represent

broad categories of responses. Coding of data resulted in the formation of tentative themes. Re-immersion was performed to draw deeper meaning and hand-drawn schematics assisted in the classification and refinement of themes. A theme is constituted by an emergence of shared meaning linked to a central underlying idea throughout the data (Braun & Clarke, 2020). Per the updated guidelines on thematic analysis by Braun and Clarke (2020), themes arise as a result of these recurring and shared meaning between responses, rather than quantification of their prevalence. Sub-themes were then classified, and themes were refined to remove overlap, then finalised (Braun & Clarke, 2006). CMS and SJH independently reviewed themes and sub-themes and any conflicts in interpretation were resolved by reverting to the raw responses and ensuring fidelity to them (D. K. C. Chan et al., 2014), consistent with the guidelines for credibility in qualitative analyses (Alhojailan, 2012; Braun & Clarke, 2006). A final review ensured representativeness of the nature of responses, per the *define and refine* principle (Braun & Clarke, 2006). Openness to the interpretation of responses throughout the analysis was prioritised, however it is acknowledged that previous experience and research may result in presuppositions regarding the findings. The extensive use of direct quotes provides a credible and transparent interpretation of results (Kvale & Brinkmann, 2009).

5.3 Results

Of those invited to participate, 86% (n = 183) returned a survey. Participants were mostly female (n = 124, 68%), a mean of 65 years of age (*standard deviation [SD]* = 9.90) and 2.39 years (SD = 1.49) post-cancer treatment. Participants were classified in major cities (n = 103, 56%), inner regional (n = 28, 15%), outer regional (n = 49, 27%), remote (n = 2, 1%), and very remote (n = 1, 1%) areas, which were collated into metropolitan (n = 103, 56%) and non-metropolitan locations (n = 80, 44%), per previous research (Tervonen et al., 2017).

Demographic data for all surveyed survivors and by geographical classification are reported in Table 5.1.

Table 5.1
Sample Demographics for All Surveyed Survivors and by Geographical Classification

	Overall (*n* = 183)	**Metropolitan** (*n* = 103)	**Non-Metropolitan** (*n* = 80)
	Mean (SD)	*Mean* (SD)	*Mean* (SD)
Age	65.05 (9.90)	65.98 (8.48)	63.86 (11.41)
Years since diagnosis	3.04 (1.54)	3.83 (1.13)	2.45 (1.54)
Years since treatment completion	2.39 (1.49)	3.23 (1.24)	1.82 (1.38)
	n (%)	*n* (%)	*n* (%)
Gender			
Female	124 (67.8%)	59 (57.3%)	65 (81.3%)
Male	59 (32.2%)	44 (42.7%)	15 (18.8%)
Cancer Type			
Breast	58 (31.7%)	0	58 (72.5%)
Colorectal	89 (48.6%)	67 (65.0%)	22 (27.5%)
Endometrial	35 (19.1%)	35 (34.0%)	0
Treatments administered[a]			
Surgery	117 (100%)	49 (100%)	68 (100%)
Chemotherapy	63 (53.8%)	24 (49.0%)	39 (57.4%)
Radiotherapy	49 (41.9%)	10 (20.4%)	39 (57.4%)
Hormone therapy	25 (21.4%)	0	25 (36.8%)
Brachytherapy	3 (2.6%)	2 (4.1%)	1 (1.5%)
Immunotherapy	2 (1.7%)	0	2 (2.9%)
State			
Western Australia	117 (63.9%)	103 (100%)	14 (17.5%)
New South Wales	46 (25.1%)	0	46 (57.5%)
Victoria	18 (9.8%)	0	18 (22.5%)
South Australia	2 (1.1%)	0	2 (2.5%)
Lifestyle			
Non-smoker	169 (92.3%)	97 (94.2%)	72 (90.0%)
Smoker	14 (7.7%)	6 (5.8%)	8 (10.0%)
Alcoholic drinks per day			
0	58 (31.7%)	27 (26.2%)	31 (38.8%)
1–2	99 (54.1%)	61 (59.2%)	38 (47.5%)
3–4	16 (8.7%)	13 (12.6%)	3 (3.8%)
5+	3 (1.6%)	2 (1.9%)	1 (1.3%)
Missing	7 (3.8%)	0	7 (8.8%)

	Overall (*n* = 183)	**Metropolitan** (*n* = 103)	**Non-Metropolitan** (*n* = 80)
	n (%)	*n* (%)	*n* (%)
Marital Status[a]			
Married/in a relationship	89 (76.1%)	38 (77.6%)	51 (75.0%)
Single	10 (8.5%)	5 (10.2%)	5 (7.4%)
Divorced/separated	11 (9.4%)	5 (10.2%)	6 (8.8%)
Widowed	7 (6.0%)	1 (2.0%)	6 (8.8%)
Education[a]			
University degree	44 (37.6%)	24 (49.0%)	20 (29.4%)
Post-school qualification	36 (30.8%)	13 (26.5%)	23 (33.8%)
High school	34 (29.1%)	12 (24.5%)	22 (32.4%)
Other qualification	2 (1.7%)	0	2 (2.9%)
No qualification	1 (0.9%)	0	1 (1.5%)
Ethnicity[b]			
Caucasian	113 (99.1%)	48 (98%)	65 (100%)
Indian	1 (0.9%)	1 (2.0%)	0
Income[b] (AUD)[c]			
<$30,000	20 (17.5%)	4 (8.2%)	16 (24.6%)
$30,001-$52,000	29 (25.4%)	12 (24.5%)	17 (26.2%)
$52,001-$104,000	33 (28.9%)	15 (30.6%)	18 (27.7%)
$104,001-$156,000	18 (15.8%)	10 (20.4%)	8 (12.3%)
$156,001-$208,000	10 (8.8%)	4 (8.2%)	6 (9.2%)
>$208,000	4 (3.5%)	4 (8.2%)	0

Note. [a]data available for 117 participants; [b]data available for 114 participants; [c]average annual household income before taxes.

5.3.1 Physical Activity Barriers

Three major themes were identified with respect to physical activity barriers; *lacking motivation, environmental,* and *medical/health barriers.* Sub-themes of *competing priorities*, *psychographic profile*, and *inertia* characterised the lacking motivation theme. Environmental barriers formed *social* and *physical environment* sub-themes. Medical barriers were reported across *cancer-related barriers* and *comorbidities & pain* sub-themes. Demographic information for illustrative quotes is denoted by M/F (male/female), C/E/B (colorectal/endometrial/breast cancer), MET/NMET (metropolitan/non-metropolitan), and age. Additional quotes with respect to physical activity barriers are reported in Table 5.2.

5.3.1.1 Lacking Motivation

Psychological barriers pertaining to "a lack of motivation" (M, C, MET, 66) spanned across sub-themes of *competing priorities, psychographic profile,* and *inertia*. One breast cancer survivor stated "[the] main barrier for me is motivation when you go through such a lot in your life. I tend to give up" (F, B, NMET, 71), while other metropolitan survivors mentioned "willingness" (F, C, MET, 54), "mindset" (M, C, MET, 73), and "my own state of mind" (F, C, MET, 63).

Competing Priorities

For some, a lack of motivation was linked to uninterest in physical activity, "I have more interesting things to do" (F, E, MET, 65), and these participants reported specific interests, "[I] prefer sit down hobbies – knitting, reading, puzzles" (F, B, NMET, 70), or competing priorities: "my meditations … are much more important to me" (F, B, NMET, 72).

Work commitments were frequently mentioned as competing priorities, "[I] just keep working, it's a way of life" (M, C, MET, 82), with non-metropolitan survivors mentioning manual work: "being a farmer I do a lot of hours driving tractors" (M, C, NMET, 74) and "farm work is exercise-rich" (M, C, NMET, 72). Non-metropolitan survivors also reported competing priorities alongside limited time: "you know you should be exercising and giving yourself time to do it but work, social, and enjoyment commitments always seem to come first" (F, B, NMET, 79). Some acknowledged these barriers as excuses, "[I'm] always using the excuse 'haven't got time'" (C, F, NMET, 36), and "I have other tasks to perform and tend to use this as an excuse for my not exercising" (B, F, NMET, 63).

Psychographic Profile

Some survivors linked their lack of motivation to psychographic factors: "I am not motivated naturally to exercise although I'm aware of the benefits" (F, C, MET, 78), lack of enjoyment: "I have never exercised for pleasure. I only 'exercise' when I work" (M, C, NMET, 81), or low confidence: "doubt in myself!" (F, B, NMET, 47). Others made a link between perceived competence and a dislike for physical activity, "[I] don't like sport or exercise … [I'm] clumsy and uncoordinated in sport" (F, B, NMET, 74) and "[I] hate water – can't swim" (F, B, NMET, 67).

Inertia

"Laziness" (F, E, MET, 68) and "inertia" (F, E, MET, 64) were also mentioned as barriers to physical activity, especially in metropolitan survivors. One stated, "lazy, lazy, lazy" (M, C, MET, 59), while others mentioned tiredness in conjunction with motivation, "[I'm] quite tired some days as I work 36 hours a week and I don't feel motivated" (F, B, NMET, 63) and "making the first move is always hard" (F, C, MET, 68).

5.3.1.2 Environmental Barriers

Barriers were reported across sub-themes of *social* and *physical environment*. Social environmental barriers were often related to a lack of family support, whereas physical environmental barriers were logistical in nature and pertained to weather and cost.

Social Environment

Primarily female survivors reported "lack of family support" (F, C, MET, 56), with some referring to their spouse as a barrier to physical activity participation: "[my] husband doesn't like me to go out walking on my own" (F, B, NMET, 67), "getting caught up with what my husband wants to do" (F, B, NMET, 79), and "partner support" (M, C, MET, 71). Others referred to broader familial obstacles: "weekends busy with family" (F, C, NMET, 65) and "juggling the kids" (F, B, NMET, 40). A "lack of social circles" (F, B, NMET, 60) was also mentioned.

Physical Environment

Physical and logistical barriers, including inclement weather and the cost of participating in a facility-based program were primarily reported by non-metropolitan survivors: "weather – either too hot, cold or wet!" (M, C, NMET, 88) and "if the weather is inclement (e.g., raining, very windy, stormy) this makes it difficult to go for a walk. …

Even driving to the gym can be dangerous" (F, B, NMET, 62). The cost of facilities was acknowledged exclusively by non-metropolitan participants: "finances stop me from going to exercise classes" (F, C, NMET, 62) and "too expensive at $15 a class" (F, B, NMET, 70). Distance was mentioned a few times by non-metropolitan survivors, "no gym – [it's an] 80km round trip" (F, B, NMET, 67).

5.3.1.3 Medical and Health Barriers

Cancer-related barriers including the effects of treatment emerged as a sub-theme of medical barriers. Other health-related barriers formed the sub-theme of *comorbidities & pain.*

Cancer-Related Barriers

For some survivors, the medical and health barriers they reported pertained to post-treatment complications. Colorectal survivors reported, "the cancer has resulted in my body being restricted in heavy lifting and demanding aerobic exercises … [as well as] secondary illnesses following on from the original cancer, which have interrupted my attempts to maintain/improve fitness" (M, C, MET, 63). Another stated "The cancer journey itself, including pain from radiation therapy, nausea from chemo, constraints of managing ileostomy and subsequent hernia" (M, C, NMET, 72). Treatment-related barriers were reported, "I have neuropathy in my fingers and toes. Sometimes my balance is affected" (F, B, NMET, 75).

Comorbidities & Pain

Chronic morbidities inhibited physical activity engagement: "[I'm] incapable due to chronic back pain, arthritis, osteoporosis" (F, B, NMET, 70), "heart disease: cardiomyopathy, atrial fibrillation, heart failure" (F, B, NMET, 61), "Parkinson's" (F, C, MET, 74), and "rheumatoid arthritis" (F, E, NMET, 59). Others mentioned pain, including arthralgia: "aching bones/joints" (F, C, MET, 74) and "chronic back pain" (F, C, MET, 61).

Table 5.2
Main Themes and Sub-Themes and Illustrative Quotes for Surveyed Survivors' Physical Activity Barriers

Theme/Sub-Theme	Illustrative Quotes
Lack of Motivation	
Competing Priorities	"interests that keep me busy" (M, C, NMET, 88), "I am currently organising a ukulele festival" (F, B, NMET, 68), "I have a hectic workload and often feel very tired at the end of the day" (F, B, NMET, 62), "work, work, and more work!" (M, C, MET, 68), "work five days a week" (F, C, NMET, 65), "work – no routine. Due to constant changes in routine, have to always be available for many jobs and people" (F, B, NMET, 61), "there is always work to do" (F, B, NMET, 57), "I am working harder than ever" (F, B, NMET, 76), "overwhelming work life, always tired, hard to prioritise" (F, B, NMET, 62), "dedicated time, limited opportunity, other demands" (M, C, MET, 68), "time pressure" (M, C, MET, 64), "availability" (M, C, MET, 68)
Personality	"a lot of the 'she'll be right' attitude" (F, B, NMET, 71), "personal commitment" (F, C, MET, 69), "stubbornness" (M, C, MET, 68), "can't enjoy sport" (F, B, NMET, 78), "I don't like getting hot and sweaty" (F, C, MET, 69), "I do not enjoy activity for its own sake" (M, C, MET, 70), "if I'm honest I don't really like exercise" (F, E, MET, 67), "I don't naturally like to exercise" (F, B, NMET, 46)
Inertia	"apathy" (M, C, MET, 72), "mental drive to push oneself" (F, B, NMET, 68), "willpower – I just need to do it" (F, B, NMET, 67), "lack of energy and motivation" (F, E, MET, 59), "laziness, lack of willpower" (F, B, NMET, 59), "laziness/tiredness" (M, B, NMET, 71)
Environmental Barriers	
Social Environment	"doing it alone" (F, E, MET, 59), "social shyness" (F, E, MET, 64), "family requirements" (M, C, MET, 70), "no babysitter" (F, E, MET, 39), "not having company to exercise with" (F, C, MET, 73)
Physical Environment	"cold weather is the main issue. I prefer physical activity outdoors (cycling/walking)" (F, B, NMET, 63), "couldn't get out of bed earlier to beat the heat" (F, E, MET, 63), "I find that during summer it is harder to exercise, especially walking" (F, E, MET, 67), "I do not like walking in real bad weather" (M, C, NMET, 63), "cold weather/wet weather" (F, C, NMET, 44), "cost of memberships and sticking to them" (F, B, NMET, 36), "selecting activities that do not cost" (F, B, NMET, 68), "cost of living" (F, B, NMET, 60), "financial" (M, C, NMET, 67), "distance from gym" (M, C, NMET, 79), "remoteness from exercise facilities" (M, C, NMET, 72)

Theme/Sub-Theme	Illustrative Quotes
Medical/Health Barriers	
Cancer-Related	"Constant lower back pain from my bowel surgery" (M, C, MET, 53), "after chemo, being easily out of breath. I still suffer the after-effects of chemo: pins and needles, numb in my feet and hands" (M, C, MET, 45), "peripheral neuropathy – difficulty walking and using hands" (F, E, MET, 69) "fatigue from radiotherapy" (F, E, MET, 61), "neuropathy" (F, E, MET, 61), "reconstructive surgery" (F, B, NMET, 67), "joint pain from Tamoxifen" (F, B, NMET, 51)
Comorbidities & Pain	"injury/pain" (M, C, MET, 73), "aches & pains" (M, C, MET, 73), "pain causing damage to my body" (M, C, MET, 58), "hip pain" (F, E, MET, 62), "back and knee pain" (F, B, NMET, 63), "wonky knees" (F, B, NMET, 74), "joint discomfort" (F, C, MET, 69)

5.3.2 Dietary Barriers

Participants' barriers towards making dietary changes fell into *logistical*, *psychological*, *social environment*, and *medical* themes. *Accessibility* and *cost* were frequent logistical barriers, while *lacking motivation* was a common sub-theme of psychological barriers. Social environmental barriers often focused on family obstacles in hindering dietary changes, and medical issues were reported as deterrents. Additional quotes concerning survivors' dietary barriers are reported in Table 5.3.

5.3.2.1 Logistical Barriers

Sub-themes of *accessibility*, *cost* and *confusion about diet* emerged within the theme of logistical barriers to dietary changes. Access to healthy foods and the high costs of them deterred survivors. Confusion about diet was often linked to conflicting information and recommendations.

Accessibility

Although the sub-theme of accessibility was mentioned by a few metropolitan survivors, i.e., "access to healthier, cost-effective food options" (F, C, MET, 54), it was more prominent in the non-metropolitan cohort: "living in the country it is harder to get nice fresh veg[etables]" (M, C, NMET, 74). However, the non-metropolitan group was polarised with respect to these factors, with others stating: "we grow most [of our] vegetables and fruit … and cook most dishes ourselves" (M, C, NMET, 74), "[I've] always grown my own veggies [vegetables] and poultry meat" (F, B, NMET, 76) and "meat is butchered on farm and hens provide eggs" (M, C, NMET, 72).

Cost

Cost was mentioned across survivors: "cost of healthy foods" (F, E, MET, 67), and appeared to overlap with convenience, "eating healthy and clean is hard work on yourself and your wallet. You pay the price on eating healthy" (F, C, NMET, 36). Others also referred to the effort and time involved in meal preparation, "having time to cook and prepare healthy meals" (M, C, MET, 45) and "fatigue from food preparation, fatigue from planning" (F, E, MET, 61).

Confusion About Diet

Confusion about what constitutes a healthy diet and lack of dietary knowledge were reported, "not fully knowing what is healthy/unable to attain healthy food" (M, C, MET, 58), "lack of knowledge on food choices" (F, B, NMET, 63), and "I need to figure out what I can and can't eat" (M, C, MET, 58). Some non-metropolitan survivors referred to conflicting dietary information: "There seems to be so [much] conflictive information out there. Who do I believe?!" (F, C, NMET, 50) and "I'm confused by all the conflicting dietary advice, especially about fats" (F, B, NMET, 68).

5.3.2.2 Psychological Barriers

Psychological barriers to dietary change included sub-themes of *emotional eating* and *lacking motivation*. A few survivors also alluded to self-efficacy and weaknesses.

Emotional Eating

Females often commented on pleasure: "I enjoy sweet-tasting food. I always have [to] include [a] sweet treat" (F, B, NMET, 63), and emotional eating, "eating for comfort and to provide highlights in my day" (F, E, MET, 64) and "I eat poorly. [I] snack when tired and pushed. That is a fairly constant place for me to be– emotional eater/chocolate, sweet snacks" (F, B, NMET, 60). Others mentioned excessive eating as a reward: "Reward or treat-eating – [It's] too easy to give yourself a treat without really earning or committing to the exercise … [I] need to manage portion sizes" (M, C, NMET, 60).

Lacking Motivation

One breast cancer survivor described "bad ingrained eating habits which are hard to reign in. Lack [of] discipline. It is easier sometimes to take the unhealthy option as its usually in a packet" (F, B, NMET, 63). Participants described a "lack of interest/motivation" (M, B, NMET, 71) and "not motivated to cook" (F, B, NMET, 61),

often in conjunction with laziness: “lazy with food preparation; [I] don’t like cooking” (F, E, MET, 63). Colorectal cancer survivors referred to “discipline” (M, C, MET, 52), “mindset” (F, C, NMET, 57), and being “rebellious” (F, E, MET, 59). A few non-metropolitan survivors alluded to self-efficacy “No matter how hard I try, I keep failing” (F, B, NMET, 66), “sugar is my downfall” (F, B, NMET, 66) and “addiction” to sweets (F, B, NMET, 67), or skills for healthy eating: “I can’t cook” (F, B, NMET, 55) and “difficulty preparing food” (F, C, NMET, 57).

5.3.2.3 Social Environment

Social and family-related barriers were common, with several survivors commenting on the difficulty of having “a family of fussy eaters” (F, B, NMET, 52), while males worried about “disrupting my wife’s menus!” (M, C, MET, 73) and “don’t want to be a burden on my family” (M, C, MET, 75). Survivors were influenced by their partner’s preferences: “my husband can say ‘let’s have something for tea’ like a toasted sandwich or fish and chips and I fall into line” (F, B, NMET, 79), “my husband does [the] cooking” (F, E, MET, 64), and “choice of food is not independent – somewhat dependent on partner’s choices” (M, C, MET, 68). Barriers concerned with cooking for the family were particularly common in breast cancer survivors, “having to cook for husband who doesn’t eat a big variety. I get sick of cooking two different meals” (F, B, NMET, 67). Broader social environments were also mentioned, including “events with family/friends and kids” (F, B, NMET, 46), “eating out” (F, E, MET, 59), and “social pressures” (M, C, MET, 73).

5.3.2.4 Medical Barriers

Finally, the theme of dietary barriers related to medical issues emerged. Cancer or treatment-related barriers to eating a healthy diet were identified, especially amongst colorectal survivors: “I have limited diet choices after cancer treatment” (M, C, MET, 58), “my bowel problem … my bowel ends up ruling everything at all times” (F, C, NMET, 62) and “changes to certain foods [I can eat] after bowel surgery” (M, C, MET, 53). Survivors reported limitations: “being limited to what can be eaten” (F, E, MET, 59) and “limited variation of foods I can tolerate” (F, B, NMET, 55).

Table 5.3
Main Themes and Sub-Themes and Illustrative Quotes for Surveyed Survivors' Dietary Barriers

Theme/Sub-Theme	Illustrative Quotes
Logistical Barriers	
Accessibility	"lack of organic foods sold locally" (F, C, NMET, 44), "cost and lack of variety plus remoteness, everything is transported from frozen. Fruit and veg[etables] are old. Bread frozen and thawed out, re-bagged and then sold as fresh" (F, B, NMET, 60)
Cost	"prices" (F, C, NMET, 50), "organic food is so expensive" (F, E, MET, 65), "maybe time to prepare" (F, C, MET, 68), "time to prepare a proper diet" (M, C, MET, 58), "no time to cook each evening as [I'm] prepar[ing] … for [the] next workday" (F, B, NMET, 60), "lack of organisation" (F, E, MET, 59), "lengthy preparation, shopping and storing – limited shelf life" (F, B, NMET, 70)
Confusion About Diet	"confusion as to what is healthy – 'superfood' hype not helpful" (F, E, MET, 62), "lack of awareness of food content" (M, C, MET, 68), "there are so many different opinions on what is healthy" (F, B, NMET, 71), "too many different opinions on what is good for us and what is bad for us (e.g., dairy, meat, eggs)" (F, B, NMET, 67)
Psychological Barriers	
Emotional Eating	"[I] like to make cakes and sweets. I find this relaxing and enjoyable" (F, E, MET, 67), "I enjoy good food and go out a lot to eat" (F, C, MET, 69), "emotional snacking" (F, B, NMET, 36), "I may need to control my portion sizes" (M, C, NMET, 81), "I like to reward myself with food. I always enjoy my food" (F, B, NMET, 70)
Lack of Motivation	"motivation" (F, E, MET, 64), "mindset, staying motivated" (F, E, MET, 61), "habit" (F, E, MET, 66), "willpower" (F, C, NMET, 44), "change can be hard" (M, C, MET, 60)
Social Environment	"Constant lower back pain from my bowel surgery" (M, C, MET, 53), "after chemo, being easily out of breath. I still suffer the after-effects of chemo: pins and needles, numb in my feet and hands" (M, C, MET, 45), "peripheral neuropathy – difficulty walking and using hands" (F, E, MET, 69) "fatigue from radiotherapy" (F, E, MET, 61), "neuropathy" (F, E, MET, 61), "reconstructive surgery" (F, B, NMET, 67), "joint pain from Tamoxifen" (F, B, NMET, 51)
Medical Barriers	"bowel blockage risk" (M, C, NMET, 57), "food is unimportant to me. Sinus problems mean lack of taste" (M, C, MET, 68), "energy levels" (F, E, MET, 62), "not feeling well" (F, E, MET, 69), "with ataxia you can get really tired. I sometimes make easier choices" (F, B, NMET, 79)

5.3.3 Support Needs

Participants' support needs for making physical activity and dietary changes fell into *practitioner & informational support, accountability & monitoring,* and *social environment* support needs. A desire for practitioner support overlapped with informational needs as survivors referred to programs developed by specialists. Survivors desired accountability and monitoring, and a supportive social environment with sub-themes of partner and group support. Additional quotes with respect to survivors' support needs are reported in Table 5.4.

5.3.3.1 Practitioner & Informational Support

Sub-themes of *practitioner support* and *informational support* arose, however there was some overlap between these sub-themes. Survivors referred to support from a range of practitioners and allied health professionals. Informational support was reported in conjunction with specialists, particularly the desire for a program to follow.

Practitioner Support

Practitioner support needs were expressed primarily by colorectal and breast cancer survivors regarding a range of health professionals, including, "doctors" (F, C, MET, 41), "GP" (F, B, NMET, 55), "cancer nurse" (F, B, NMET, 67), "dietician" (F, C, NMET, 36) "personal trainer" (F, B, NMET, 40), "health coach" (F, B, NMET, 74), "physiotherapist and nutritionist" (M, C, NMET, 72), and "life coach" (F, B, NMET, 73). The desire for support from practitioners appeared to pertain to allied health professionals in non-metropolitan survivors.

Some desired the support of a health professional in conjunction with the informational support of a plan: "need to consult a nutritionist to work out [a] proper diet based around [the] limited food I can eat" (M, C, MET, 58) and "exercise physiologist to structure [the] best program and follow through at gym for fixed period (e.g., 3 months)" (M, C, NMET, 60). Survivors often considered their doctor to be a primary support source who could subsequently recommend allied health professionals: "your own GP. They can put you on the right path as to contact information … Your GP also has your health info if you have other health issues and can advise on diet" (F, B, NMET, 55). Others indicated a perceived overlap between health professional and informational needs: "dedicated health 'help desk' line in specialist recovery from cancer departments" (M, C, NMET, 72).

Informational Support

Informational needs appeared to be related to confusion about recommended health behaviours. Survivors across locations expressed a desire for "knowing what is healthy and what is not. … [There are] too many studies with conflicting outcomes" (M, C, MET, 58) and "more information about the benefits and reduction in cancer recurrence risk" (F, B, NMET, 46). Some desired a diet plan: "packaged dietary program that would deliver healthy choices and controlled portion size" (M, C, NMET, 60), while others referred to research on diet-related benefits: "articulated positive outcomes in credible literature" (M, C, MET, 68).

Further information concerning the outcomes of physical activity engagement was desired: "information on whatever a small change in physical activity can do" (F, C, NMET, 54), and "a structural program of what to do" (F, C, MET, 53). For some, the rationale for lifestyle change was missing alongside clear guidance concerning health behaviour change priorities: "understanding why the change is necessary and what the changes can do for you, from professionals, [and] help with prioritising what changes are needed first. Sometimes it's too much to have to change everything, when small changes have big impacts" (M, C, MET, 61).

5.3.3.2 Accountability & Monitoring

While survivors across location desired accountability and monitoring, "goal setting and tracking" (M, C, MET, 61), this was most common in non-metropolitan respondents: "check from someone to keep me accountable and motivated" (F, B, NMET, 68), and "regular checks by someone else. This may possibly keep me focused" (M, C, NMET, 63). Another desired "motivational goal setting for support, encouragement, and monitoring" (M, C, NMET, 60). Monitoring weight was mentioned in conjunction with accountability, "sometimes others accompanying me, measuring my success e.g., weight loss" (F, B, NMET, 54), "weigh-in" (F, E, MET, 72) and "motivation to lose weight i.e., give a person a month to lose weight then weigh in and keep going back to get down to goal weight" (F, E, MET, 63).

Some desired a mentor: "An occasional conversation with an interested mentor would assist more than anything" (F, B, NMET, 68), "positive reinforcement, encouragement without competition" (F, C, MET, 63), and "having a coach to offer support and encouragement" (F, B, NMET, 62). Participants also mentioned self-monitoring and feedback: "a daily measure of my exercise achievement– to keep me on track" (F, B,

NMET, 65) as well as "being monitored/accountability/reward" (F, E, MET, 61) and "feedback from progress" (F, E, MET, 59). Two survivors mentioned wearable trackers and two others described mobile applications, "where I can see all my efforts and compare to others" (M, C, MET, 45) and "an app to keep [me] on target" (F, B, NMET, 63).

5.3.3.3 Social Environment

Within social environmental support needs, sub-themes of *partner support* and *group support* emerged. Across sub-themes, participants desired the company of others who have a similar mindset or like-minded company.

Partner Support

Participants desired support: "partner support, family support, peer support" (M, C, MET, 65) and "my partner's support without pressure" (F, E, MET, 65). Others mentioned practical involvement: "my wife to be on the same plan. I would be more inclined to keep following the plan" (M, C, NMET, 63), and "a partner with similar goals – easier to stay focused and avoid temptations" (F, B, NMET, 60). A couple of participants mentioned "family encouragement" (F, E, MET, 39) and "support from friends" (F, B, MET, 73).

Group support

"Group support for cancer survivors" (F, E, MET, 67) was considered to be of value for metropolitan survivors, along with "surround[ing] myself with like-minded people" (M, C, MET, 52) and "encouragement in programmes…which give info about helpful strategies and show that others are dealing with the same issues" (F, E, MET, 59). Others referred to more active "group discussions" (F, C, MET, 68) and "small group activity classes" (F, E, MET, 64).

Table 5.4
Main Themes and Sub-Themes and Illustrative Quotes for Surveyed Survivors' Support Needs

Theme/Sub-Theme	Illustrative Quotes
Practitioner & Informational Support	
Practitioner Support	"health checks (doctor's advice)" (M, C, MET, 65), "medical practitioners" (F, B, NMET, 50), "physiotherapist" (F, E, MET, 77), "physio appointments for rehab" (F, B, NMET, 54), "diabetes nutritionist" (F, B, NMET, 78), "encouragement from health professionals" (M, C, MET, 68), "counselling for attitudes to food" (F, B, NMET, 63), "personal trainer – assists with exercise and ensuring that at least some activity is happening, no matter what age/fitness level" (F, C, NMET, 36), "exercise physiologist" (M, C, MET, 71)
Informational Support	
Dietary	"more (official) information on what foods I should eat (other than obtained from the web)" (M, C, MET, 73) "suitable cookbook that helps me produce tasty meals without any unnecessary or complicated expenditure of effort" (M, C, MET, 71), "education on types of foods, what has higher protein, fats, carbs, etc. How to read labels, what does my body need" (F, B, NMET, 58), "a more comprehensive cookbook would be helpful" (M, C, NMET, 72), "a booklet on meal portions and how to cut down. Easy recipes would be good too" (F, B, NMET, 57), "a dietician to create a one-month menu for me" (F, B, NMET, 68)
Physical Activity	"advising on physical activities and food intake" (F, B, NMET, 74), "core exercise for bones" (F, B, NMET, 70), "amount of exercise needed to take part in" (F, C, NMET, 53), "latest research" (F, E, MET, 64), "full knowledge of my body and what it requires" (F, B, NMET, 70), "learn more on diet, meditation and exercise" (F, C, NMET, 44)
Accountability & Monitoring	"being accountable. Having someone to check in with" (F, B, NMET, 47), "motivator, follow up to make sure I did what I planned" (F, B, NMET, 58), "evidence of progress according to plan" (F, E, MET, 77) "tracking my progress would help" (F, B, NMET, 66), "locking it into my weekly routine, membership with accountability" (F, B, NMET, 36), "coaching" (M, C, MET, 73), "someone to check up on me to make me complete tasks" (F, B, NMET, 71), "someone to be accountable to … to keep me going" (F, C, NMET, 50)
Social Support	
Partner Support	"a partner with [a] like-mind" (F, C, MET, 74), "my partner, accepting food changes and giving me time out to exercise" (F, B, NMET, 50)
Group Support	"a post-cancer group" (F, B, NMET, 60), "ability to network with those that are in the same situation" (F, E, MET, 58) "company of others" (F, C, MET, 69), "group challenges" (F, E, MET, 61), "actual exercise classes – more inclined to be active if [I] joined a group because would feel more obligated" (F, B, NMET, 59)

5.4 Discussion

In this study, cancer survivors identified psychological, informational, and practical barriers and support needs for engaging in healthy lifestyle behaviours, with minor disparities by geographical classification. Survivors' barriers across health behaviours and geographic classification related to poor motivation and social influences, primarily spousal support. Support needs were related to health professionals, advice, accountability, and monitoring of health behaviours. Non-metropolitan survivors more frequently reported barriers around competing priorities and work, and accessibility to both healthy foods and physical activity facilities. The support needs of survivors were similar across location. However, the desire for group support in metropolitan, but not in non-metropolitan, survivors may be attributed to the community-based trust and peer support experienced in rural communities, which may encourage physical activity, health-promoting behaviours, and support mental health (Gunn et al., 2020). One important consideration is that survivors in smaller, rural communities may be reluctant to divulge personal information and have privacy concerns in support group sessions with other community members (Gunn et al., 2020).

Non-metropolitan survivors reported support needs for allied health professionals (dieticians, exercise physiologists, coaches) more frequently than doctors' support, compared to metropolitan survivors who expressed equal needs for their doctors' and health professionals' support. This disparity has not been recognised previously, however research in rural survivors indicates insufficient social and health professional support (Adams et al., 2017; Olson et al., 2014), reduced access to health professionals (Gunn et al., 2020), and a potential for health coaching (Ristevsk et al., 2020). Tailoring to the needs of non-metropolitan survivors by fostering a health coaching relationship in remote communities has been recommended for future programs (Ristevsk et al., 2020). Regional and remote survivors in the current study reported their physical environment, cost, and accessibility to facilities as barriers, especially concerning physical activity. This sparsity of facilities may also apply to limited access to health professionals in remote locations. An implication of these findings is that e-delivery of didactic information and professional support may offer a broad-reaching and feasible means to address this need.

The unmet need of support from health practitioners appears to be linked to barriers associated with requiring a physician's approval to engage in lifestyle change. This need coincides with previous evidence supporting survivors' desire and trust in oncologists to advise on health behaviours (Hardcastle, Galliot, et al., 2019; L. Smith et al., 2017). The

endorsement of correct practise of health behaviours by physicians is critical given that survivors turn to less credible sources in the absence of their practitioner's advice (L. Smith et al., 2017). Furthermore, the conjunction of informational and medical support needs indicates that adherence to lifestyle recommendations would be bolstered if doctors and allied healthcare practitioners evidenced approval and encouragement of health behaviours (Hardcastle & Cohen, 2017; Maxwell-Smith et al., 2017).

The emergence of spousal influence as both a barrier and a support need is a novel finding. Few studies have assessed the effectiveness of health behaviour interventions involving partners of cancer survivors, although a program targeting survivors and their carers resulted in significant improvements in MVPA and BMI (Stacey et al., 2017). This study found that physical activity and dietary efforts were thwarted by a lack of support from immediate social networks, and points to the potential drawbacks of intervening with only the survivor and not their household. Similar findings have been identified with patients at risk of cardiovascular disease in primary care (Hardcastle & Hagger, 2011). The tendency for survivors to report lack of family support and caregiving roles as barriers has been previously acknowledged (Clifford et al., 2018), and the cultural significance of such barriers was suggested. Future initiatives should incorporate spouses to overcome barriers, bolster social support, and foster behavioural maintenance.

A desire for accountability and monitoring across survivors has been recognised previously in both non-metropolitan (Frensham et al., 2018; Hardcastle, Galliott, et al., 2019) and metropolitan (Hardcastle, Glassey, et al., 2017; Koutoukidis et al., 2017) survivors. External accountability needs coincide with motivational barriers, which were reported across physical activity and healthy eating. A lack of motivation, discipline, and willpower were previously recognised as barriers to physical activity change (Olson et al., 2014), diet behaviours (Hardcastle, Maxwell-Smith, et al., 2017), and adherence to a weight loss intervention (Fazzino et al., 2016) in urban and rural survivors. In the current study, accountability was mentioned in conjunction with the use of technology as a support tool, pointing to the possibility of digital programs to deliver BCTs (Roberts et al., 2017). Although the use of external accountability as an extrinsically driven motive may assist in the facilitation of health behaviour change, the effect will likely be short-lived (Deci & Ryan, 1985). Interventions must find a balance whereby externally driven motives encourage the uptake of health behavioural change and intrinsically driven motives – that have a personal appeal to survivors – facilitate the maintenance of health behaviours

following the cessation of external support (Amireault et al., 2013; Hardcastle, Galliott, et al., 2019).

Interventions incorporating mentorship could facilitate the delivery of didactic components to address informational needs. In the current study, survivors across locations reported confusion about guidelines, being discouraged by conflicting advice, and not recognising a rationale for health behaviour change. Moreover, cancer-related and treatment-related barriers were common, despite evidence to suggest that some could be overcome by participating in health behaviours (Dennett et al., 2019; Sheehan et al., 2020). Although poor knowledge of health recommendations has been previously established (Clifford et al., 2018; Hardcastle, Maxwell-Smith, Hagger, et al., 2018; Maxwell-Smith et al. 2017), informational support needs expressed in the current study suggest a potential for interventions to fulfil this need with educational components. One recommendation may be the use of targeted print materials, recipe books, or lifestyle plans to meet the informational support needs of survivors. Enhancement of positive outcome expectancies of health behaviour participation could be promoted by including didactic information on the benefits to be garnered, including the amelioration of cancer-related obstacles. For survivors who are aware of the guidelines, but fail to achieve them, provision of a rationale for health behaviour participation that appeals to the autonomous motives of survivors could foster long-term change (Deci & Ryan, 1985; Hardcastle, Galliott, et al., 2019), and could be sustained remotely (Smith-Turchyn et al., 2020).

5.4.1 Study Limitations

This study was limited to primarily private hospital patients. An inductive approach facilitated novel insights into the prevalence of spousal dependency, informational, and professional needs, yet deductive survey items provide value for quantifying responses. While this exploratory approach is useful for gaining insight into whether disparities exist by geographical classification of survivors, a quantitative design may be warranted to assess the magnitude and statistical significance of such disparities. Future research should investigate barriers and support needs for behavioural maintenance, in addition to initiation, given poor adherence (Amireault et al., 2013; Spark et al., 2013).

5.4.2 Clinical Implications

Programs could overcome barriers and fulfil unmet needs by fostering autonomous motives and incorporating family members' participation, didactic information, and

practitioner support. Disparities within competing priorities and practitioner support needs by geographical location may necessitate tailored interventions.

5.4.3 Conclusion

Barriers including a lack of motivation, social influences, and poor knowledge appear to map onto survivors' needs for accountability, and social, informational, and practitioner support. Survivors in metropolitan locations often referred to motivational and health-related barriers. Non-metropolitan survivors expressed logistical barriers associated with accessibility to facilities and desired support from health professionals. Interventions should target survivors' households and involve allied health professionals to deliver didactic information on health benefits.

Chapter Six

6

Cancer Survivors' Health Behaviour Motives

Chapter Overview

This chapter has been published in *Supportive Care in Cancer*. It presents an exploration of cancer survivors' motives to engage in physical activity and healthy dietary behaviour change. Respondents were colorectal, endometrial, and breast cancer survivors in metropolitan and non-metropolitan locations. The primary motives identified by survivors pertained to life's pleasures, longevity, and independence. The contribution of this chapter is relevant to framing programs in concordance with survivors' motives to engage in change, which may not be primarily concerned with physiological improvements.

PUBLICATION – "TO BE THERE FOR MY FAMILY" AND "KEEP MY INDEPENDENCE": METROPOLITAN AND NON-METROPOLITAN CANCER SURVIVORS' HEALTH BEHAVIOUR MOTIVES

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ORIGINAL ARTICLE

Check for updates

"To be there for my family" and "Keep my independence": Metropolitan and Non-Metropolitan Cancer Survivors' Health Behaviour Motives

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Abstract

Purpose. Cancer survivors are at elevated risk of comorbidities and mortality, and those living outside of metropolitan areas are particularly susceptible given poorer socioeconomic, health, and support resources. As engagement in health behaviours is affected by participants' autonomous motives, investigation of the motives of cancer survivors in metropolitan and non-metropolitan areas could elucidate the values and reasons for practising health behaviours, allowing programs to be tailored to these motives.

Methodology. Metropolitan (n = 103) and non-metropolitan (n = 80) Australian cancer survivors completed a survey item by describing their motives for physical activity and healthy dietary change. Inductive thematic content analysis of responses was performed to establish themes across health behaviour motives.

Results. Analyses revealed four themes: *to be able to…*, *longevity*, *psychological health* and *appearance.* Survivors primarily referred to being able to enjoy family, leisure activities, travel, and staying independent, with these motives often linked to longevity. Motives were similar across locations, however those in non-metropolitan locations reported continuation of work and pain relief more frequently. Female survivors more often reported weight loss as a health behaviour motive.

Conclusions. A predominant motive for health behaviour change in cancer survivors across geographical classification was the ability to enjoy family and engage in leisure and work activities. Programs aiming to promote health behaviours in cancer survivors might consider framing interventions accordingly by emphasising the potential outcomes of longevity and maintaining independence.

6.1 Introduction

As cancer survival rates continue to increase (AIHW, 2019), supportive care for cancer survivors has become a priority. Survivors continue to lead unhealthy lifestyles typified by higher physical inactivity, sedentary behaviour, and obesity, than their non-cancer counterparts (Bluethmann, Basen-Engquist, et al., 2015; Ward et al., 2012). There are also geographical inequalities in health amongst cancer survivors (Tervonen et al., 2017; Weaver, Geiger, et al., 2013), with poorer survival rates for those living in non-metropolitan areas compared to those living in major cities (Tervonen et al., 2017). Non-metropolitan cancer survivors are at increased risk of unhealthy behaviours, inadequate support, and comorbid conditions (Gunn et al., 2020; Weaver, Geiger, et al., 2013).

Interventions to promote health behaviours in cancer survivors have shown promising results when tethered to the theoretical constructs underpinning implementation of health behaviours (Campbell et al., 2009; Glanz & Bishop, 2010; Ntoumanis, Thørgersen-Ntoumani, et al., 2018). According to several leading behavioural change frameworks including SCT (Bandura, 1989; Ntoumanis, Thørgersen-Ntoumani, et al., 2018), TPB (Ajzen, 1991, 2015) and Self-Determination Theory (Deci & Ryan, 1985; Ntoumanis et al., 2020), motives to engage in health behaviours play a significant role in behavioural change (Cadmus et al., 2009; Pinto & Ciccolo, 2011). Autonomous motives, in which individuals personally value or enjoy a behaviour, are the most dominant predictor of physical activity outcome expectancies in adult cancer survivors (Wilson et al., 2006).

While autonomous motives specifically involving family were identified as reinforcers for nutritional and lifestyle change in female survivors (St George et al., 2020), specific tailoring of dietary change initiatives to personal motives has been further supported in other survivor samples (Bours et al., 2015). Moreover, colorectal cancer survivors report the prevention of cancer recurrence as their primary motive for dietary change, indicating the presence of the teachable moment to tap motives and encourage lifestyle change during survivorship (Bours et al., 2015).

Such motives may include networking, social support, physiological benefits, and psychological motives related to personal fulfillment, which have been previously identified as facilitating physical activity in survivors (Frensham et al., 2018; Wurz et al., 2015). Further supporting the value of motivation in health behaviour change, a lack of motivation was a primary reason for non-participation in an exercise program for cancer survivors and an exercise barrier for colorectal cancer survivors (Hardcastle, Maxwell-

Smith, Kamarova, et al., 2018; Maxwell-Smith et al., 2017). Based on the prevalent role of motivation in determining health behaviours, efforts to support motivation and thereby encourage the uptake of health behaviours have been recommended (Bours et al., 2015; Hardcastle, Hancox, et al., 2015).

Few studies have investigated the motives of non-metropolitan cancer survivors for engaging in health behaviours. However, compared to their urban counterparts, survivors in non-metropolitan areas report unique influences (Frensham et al., 2018; Hardcastle, Galliott, et al., 2019) and barriers towards health behaviour participation (Fazzino et al., 2016), including environmental, psychological, and social factors. Informational barriers to physical activity are also present, as survivors have insufficient knowledge of the physical activity guidelines (Hardcastle, Galliott, et al., 2019; Olson et al., 2014). Compared to metropolitan survivors, survivors at increasing remoteness tend to be of greater disadvantage (Tervonen et al., 2017). However, even regional survivors experience poorer survival rates and greater survivorship burden than metropolitan survivors (AIHW, 2019; Tervonen et al., 2017). As such, programs tailored to the unique facilitators of health behaviour uptake in non-metropolitan survivors have been recommended (Vallance et al., 2013).

Despite the importance of motivational factors in the initiation of health behaviours (Pinto & Ciccolo, 2011), there is a dearth of research that explores the health behaviour change motives of cancer survivors across geographical classification. Examination of these motives could inform the design of interventions and facilitate tailoring by elucidating the values and reasons for adopting health behaviours. Intervention content could be tailored to appeal to the motives of survivors, to increase the uptake to and effectiveness of programs (Campbell et al., 2009; Horne et al., 2012). The objective of the current study was to inductively explore the motives of metropolitan and non-metropolitan cancer survivors to engage in physical activity and consume a healthy diet.

6.2 Methodology

6.2.1 Participants

The eligible participant pool for *Study Two* has been previously described in Section 5.2.1.

6.2.2 Instruments

Participants completed the open-ended item: "Please list your main motives for physical activity and health diet changes and your reasons for these motives", which was part of a larger mixed-methods survey assessing the factors affecting physical activity change. Half a page of lined paper followed this item and respondents were able to list several motives. This approach was employed in accord with previous use of an open-ended item to explore benefits of exercise in survivors (Fisher, Wardle, et al., 2016), but adjusted to suit this study's scope and focus on personal motives.

6.2.3 Procedure

The procedure for *Study Two* and process of inductive thematic content analysis have been previously described in Section 5.2.3 and Section 5.2.3.1, respectively.

6.3 Results

6.3.1 Descriptive Statistics

Eighty-six per cent (n = 183) of survivors invited to participate returned a survey. Participants were colorectal (n=89, 49%), breast (n=58, 32%), and endometrial (n=35, 19%) cancer survivors and were classified into metropolitan (n = 103, 56%) and non-metropolitan locations (n = 80, 44%), based on their ARIA+ classification and per previous research (Tervonen et al., 2017). Demographic data for all survivors surveyed in *Study Two* and sub-groups by geographical classification have been previously reported in Table 5.1. Survivors reported a mean of 2.60 (SD = .75) motives per survey.

6.3.2 Health Behaviour Motives

Analysis of survivors' motives to make physical activity and dietary changes identified four themes: *to be able to…, longevity, psychological health,* and *appearance*. *To be able to* motives fell into sub-themes of *enjoy family and set a good example* and *enjoy travel, leisure and independence*. Sub-themes of *longevity* included *general health* and *disease prevention*. Although distinct themes have been identified, it must be noted that longevity and physical function factors were commonly paired with *to be able to…* motives. The use of illustrative quotes has assisted in depicting typical or especially informative responses. However, themes are a result of shared meanings throughout the data pool (Braun & Clarke, 2020) and are not encompassed within a single quote. Demographic information for illustrative quotes is denoted by M/F (male/female), C/E/B (colorectal/endometrial/breast

cancer), MET/NMET (metropolitan/non-metropolitan), and age. Additional illustrative quotes are presented in Table 6.1.

6.3.2.1 To Be Able To…

This theme related primarily to independent living and mobility in order to extend time with, or take care of, family and pursue personal interests.

Enjoy Family and Set a Good Example

Being able to enjoy and take care of the family was a common motive for engaging in positive health behaviours: "I would like to be around for a while to come as I love my family" (F, B, NMET, 63) and "want to feel strong and myself again, for family's sake" (F, B, NMET, 50). Some mentioned grandchildren, positing that enjoyment of grandchildren would be enriched by having better health ("enjoy being a grandparent" [M, C, MET, 79]; and "I want to be as fit and healthy as possible to enjoy minding my two grand-daughters fairly often" [F, B, NMET, 67]). Survivors referred to their family's dependence as a motive, "people dependent on me" (F, E, MET, 73), and "family – important for me to be around" (M, C, NMET, 60).

Others referred to a desire to be a healthy role model for their children, "to be a role model for my daughters!" (F, B, NMET, 47), and, "have a 16-year old son and would like to ensure he continues to develop healthy eating habits" (F, B, NMET, 55). One cancer survivor alluded to a broader contribution, "I feel I have a lot to contribute to both society and my family. I want to be around for as long as possible to do so" (F, E, MET, 67). A few male survivors mentioned their friends, "socialising with friends" (M, C, MET, 75), and "maintain[ing] a social lifestyle" (M, C, MET, 65), which may be linked to an emerging trend of enjoyment of life's pleasures.

Enjoy Travel, Leisure & Independence

The theme of *to be able to…* extended to a desire to maintain leisure activities and independence, indicating the belief that health behaviours sustain the ability to enjoy pleasures: "to have more options for leisure activities" (F, MET, 65) and "enjoying the outdoors" (F, E, MET, 59). A few non-metropolitan survivors referred to sports and work, which may be more physically demanding in non-metropolitan samples: "to continue to carry out my workload and sporting activities" (M, C, NMET, 77), and "energetically pursue activities I enjoy such as skiing and swimming, as well as actively engage in farm work" (M, C, NMET, 72). The desire to travel was often expressed with references to

mobility and enjoying family: "want to keep active for longer, be able to travel" (F, E, MET, 70), and "I want to be able to travel … to visit children and grandchildren interstate and overseas, and to enjoy exploration – cultural and physical" (M, C, NMET, 72).

Others expressed motives concerned with maintaining independence and physiological capabilities: "keep my independence" (F, E, MET, 73) and "maintain agility with older age, pride in physical ability, and self-reliance" (M, C, MET, 59), and "maintaining mobility and muscle strength as getting older, maintaining ability to live independently and manage daily activities" (F, B, NMET, 73).

Both metropolitan and non-metropolitan survivors referred to mobility: "to be physically able to perform normal daily tasks, keep mobile" (M, C, MET, 63). A few were motivated by improving strength ("to be physically strong" F, C, MET, 73) or regaining lost strength ("I loved the strength I had and want it again" (F, B, NMET, 51).

6.3.2.2 Longevity

Respondents were concerned with both the duration ("extending lifespan" [M, C, MET, 64], and "to live as long as possible, until I am in my late nineties" [F, B, NMET, 35]), and quality ("looking after my body to have a longer, healthy life" [F, E, MET, 39]) of their life. Survivors referred to longevity concerning *general health* and *disease prevention*.

General Health

Wellbeing motives were common, with survivors often reporting "general health and wellbeing" (M, C, NMET, 61) and "to stay healthy … nothing else" (F, E, MET, 65) as their motives. Others referred to physical and mental wellbeing separately, indicating the view that health behaviours would be of benefit to both domains: "health and wellbeing, I believe being physical and having a healthy diet benefits my body and mind" (F, B, NMET, 59) and "keep my body and mind as healthy as possible" (M, C, NMET, 58).

Disease Prevention

A couple of respondents alluded to disease prevention as coming "hand-in-hand" with longevity: "so that the cancer will not return; to live a long and healthy life" (F, C, MET, 73), while others referred to "avoiding disease" (M, C, NMET, 73). Some specifically referred to lifestyle change and its importance following a cancer diagnosis: "be cancer free – it basically says it all. Exercise and a healthy diet play a big part in this" (F, C,

NMET, 36), and "cancer – [it's] not a death sentence but it was a warning to change lifestyle" (F, B, NMET, 60).

A common motive was the prevention or management of a range of comorbidities including, from a diabetic, "reduc[ing] sugar" (M, C, MET, 70), "slowing onset of dementia" (F, C, MET, 69), "prevent[ing] me having a heart attack or stroke" (F, C, MET, 69), "supporting my joints – rheumatoid arthritis" (F, B, NMET, 58), "for the ataxia" (F, B, NMET, 79), and "[to counteract] my tendency to develop osteoporosis" (F, B, NMET, 78). Non-metropolitan survivors also referred to reducing pain, "ward[ing] off aches and pains from surgery and medication" (F, B, NMET, 46), and made specific references to physical activity for alleviating their pain: "I have developed mild joint pain. I noticed it [isn't] as severe when I keep active" (F, B, NMET, 55).

6.3.2.3 Psychological Health

A couple of respondents referred to the psychological benefits of both physical activity and healthy dietary behaviours, indicating their perception of the benefits yielded by both: "I like to feel good and not have carbohydrate highs. I like to be able to think clearly; wrong foods make my thinking gluggy. Moderate exercise gives me personal thinking space and raises my self-esteem – endorphin induced" (F, B, NMET, 68) and "both make me feel great" (F, B, NMET, 59). In a similar vein, another respondent reported being motivated by improved mental health as a result of physical activity, "feeling good after a walk/run helps with [my] mental headspace" (F, C, NMET, 36), while others commented on their "quality of life" (F, B, NMET, 58).

Stress relief motivated some metropolitan survivors, "dealing with work stress" (F, E, MET, 59), and "cycling reduces my stress. I find if I do not cycle, I feel it [stress] build up … which was [the] major factor I believed caused my cancer" (M, C, MET, 45). Experiencing a boost in affect was also depicted as a motivating factor, with one survivor reporting a "sense of achievement" (M, C, MET, 68), and another stating, "some control over my sense of wellbeing and to improve my confidence" (F, B, NMET, 62).

Energy and sleep quality were considered, often together: "increased energy levels, better sleep" (M, C, MET, 81). Others referred to improved energy levels in conjunction with wellbeing, "hav[ing] lots of energy, keep[ing] positive, and enjoy[ing] life" (F, B, NMET, 40), and "feeling well and having energy" (F, B, NMET, 66).

6.3.2.4 Appearance & Weight

A theme of physical appearance arose, with survivors describing "looking better" as a health behaviour motive. Survivors stated that they were generally motivated to "look and feel better" (M, C, MET, 60), while others mentioned their size: "not getting too big" (M, C, MET, 65). Physical appearance motives were most frequently reported by females and often referred specifically to clothing: "fit[ting] into normal range clothing" (F, E, MET, 61), and "fitting into clothes better" (F, B, NMET, 78). While a couple referred to prevention of weight gain ("prevent[ing] weight gain" [M, C, MET, 70], "weight control" [F, C, MET, 81]), most reported a desire to lose weight: "losing weight and being able to wear the clothes that fit me again would be great" (F, B, NMET, 66) and "weight loss" (M, C, MET, 66).

Table 6.1
Survivors' Illustrative Quotes of Motives for Health Behaviour Change by Theme and Sub-Theme

Theme/Sub-Theme	Illustrative Quotes
To be able to…	
enjoy family and set a good example	"to be there for my family" (F, E, MET, 62), "be here for my kids" (F, B, NMET, 46), "I want to live longer, enjoying family, friends and the countryside" (M, C, NMET, 72), "family – two gorgeous grandsons. I want to be around to see them grow into adults. A wonderful husband who wants to join me in a new healthy lifestyle" (F, B, NMET, 55), "desire to set an example to family and friends" (M, C, MET, 68), "setting a good example for my daughter" (F, E, MET, 39), "engaging with friends and family" (M, C, MET, 65)
enjoy travel, leisure and independence	"to walk my dogs because they love it and so do I" (F, B, NMET, 66), "continue playing social competition tennis" (F, B, NMET, 59), "work longer" (F, B, NMET, 50), "to improve cardiac health … to be able to lead class camps/walks, maintain active lifestyle, camping, hiking" (F, B, NMET, 73), "travel and explore new places" (F, B, NMET, 55), "remaining able to travel on holidays" (M, C, MET, 73), "belief that exercise is essential for flexibility and safety against falls" (F, E, MET, 77), "to keep moving" (F, E, MET, 59), "being able to move and get physical with ease" (F, C, MET, 63), "keeping active" (M, C, MET, 65), "stamina" (M, C, MET, 68), "muscle tone" (F, C, MET, 55), "to feel stronger in myself" (F, B, NMET, 62)

Theme/Sub-Theme	Illustrative Quotes
Longevity	"I like living" (F, E, MET, 52), "saving my life" (M, C, MET, 65)
General health	"to remain as healthy as possible for as long as possible" (M, C, MET, 79), "healthy wellness" (F, C, MET, 74), "I just want to be as healthy as I possibly can" (F, B, NMET, 59), "well-living physically and mentally" (F, C, MET, 69)
Disease prevention	"from reading many articles and books, physical activity and a healthy diet should assist in longevity with fewer diseases" (F, B, NMET, 68), "to remain healthy, reduce my risk of recurrence, reduce my risk of another type of cancer" (F, E, MET, 58), "keep cancer away" (F, E, MET, 63), "stay cancer-free" (F, B, NMET, 40), "hopefully resist a recurrence of my cancer" (F, B, NMET, 67), "I have heard that exercise is extra important if one has cancer" (F, B, NMET, 78), "delay progress of cancer, ultimately cure myself" (F, C, NMET, 44), do not want to have cancer again – or any debilitating disease" (F, B, NMET, 70), "heart health" (M, C, MET, 72), "to reduce pain and strengthen bones" (F, B, NMET, 70), "less aches and pains" (M, C, MET, 66)
Psychological health	"improved mental and emotional wellbeing" (F, E, MET, 64), "feel better" (M, B, NMET, 57), "caring for myself" (F, E, MET, 61), "conquer depression" (F, B, NMET, 61), "happiness, enjoyment of life" (F, C, MET, 74), "relaxes body and mind" (F, E, MET, 69), "more mentally alert" (F, B, NMET, 78), "I do believe you are what you eat and exercise is very important along with a good amount of sleep" (M, C, NMET, 74), "to feel more energetic" (F, C, NMET, 61), "improved physical health and increased energy" (F, E, NMET, 64), "vitality" (F, E, MET, 64)
Appearance	"appearance" (F, C, MET, 41), "looking healthy" (M, C, MET, 73), "looking better in clothes" (F, E, MET, 72), "body image and general appearance. I like to look good" (F, E, MET, 67), "I am way overweight and get exhausted easily. Uncomfortable in my clothes" (F, B, NMET, 50), "weight control, physical appearance" (F, E, MET, 81), "to lose the weight I've gained over the past year and to fit into a wardrobe of clothing I am tired of looking at" (F, C, MET, 78), "clothing, hooray it fits again" (M, C, MET, 70)

6.4 Discussion

This survey sought to provide novel insights into the motives of cancer survivors residing in metropolitan and non-metropolitan areas to implement physical activity and healthy dietary change. The predominant theme identified was *to be able to…* and was depicted by survivors' motives to maintain their roles and capabilities, which was prevalent across sub-themes of *enjoying family*, *leisure*, *travel*, *independence*, and *functional mobility*. Participants were also motivated by *longevity*, *general health*, *disease prevention*, and to a lesser extent, *psychological health*, followed by *appearance*.

A novel finding of the current study is the theme of being able to fulfil caregiving roles within the family and engage in pleasurable leisure pursuits as a primary motive to implementing health behaviour change. The value of *to be able to…* was frequently linked to caregiving within the family and the pursuit of leisure and travel, a finding which is novel in the cancer survivor literature. This theme has been documented previously in a study exploring dimensions associated with exercise maintenance, whereby participants reported being able to continue family and recreational activities as a motive to continue exercising 2 years after the conclusion of a cardiac rehabilitation program (Hardcastle, McNamara, & Tritton, 2015). While the ability to care for family was a common motive for female survivors, other research has identified caregiving roles as a barrier to lifestyle change (Mochari-Greenberger & Mosca, 2012). If caregiving can be framed as a motive to engage in health behaviour, rather than a competing priority, this autonomous source of motivation may support sustained health behaviour change (Deci & Ryan, 1985; Ntoumanis et al., 2020; Samdal et al., 2017).

Given the prominence of the *to be able to…* theme, future interventions may consider reframing lifestyle programs around promoting independence and the ability to enjoy family and active leisure, in order to improve uptake (Horne et al., 2012). A focus on such benefits to be garnered or maintained by survivors may promote the attractiveness of programs and improve recruitment in otherwise unmotivated samples (Hardcastle, Hancox, et al., 2015).

Non-metropolitan cancer survivors in the current study appear to be motivated to engage in health behaviours in order to continue working and to alleviate arthralgia and other physical pain, which could be attributed to the remote population often living and working on farms or maintaining larger properties. Therefore, physical activity programs targeted at rural survivors may do well to emphasise the role of physical activity participation to maintain functional health and mobility (Ziegler & Schwanen, 2011). Overall, there appeared to be few differences in motives across geographical classification, although this should be further investigated via rigorous, experimental designs. Despite the results of the current study indicating that motives are largely consistent in survivors across geographical classification, recent studies indicate that factors affecting physical activity in survivors, including survivors' knowledge of guidelines and practical issues of facilities and travel, vary by location (Hardcastle, Galliott, et al., 2019; Vallance et al., 2013). Future research may further investigate whether differences in motives exist by remoteness, and whether these can be explained by disparities in knowledge or in unique facilitators and barriers to health behaviour change (Bours et al., 2015; Tervonen et al., 2017).

The motive of remaining able to engage in pleasures is notable given that cancer survivors have previously reported a tension between a desire for longevity by adopting a healthy lifestyle versus enjoying living and the intended continuation of current lifestyle behaviours (Hardcastle, Maxwell-Smith, et al., 2017; Milosevic et al., 2020). Previous work found that some survivors were sceptical of the benefits of changing their lifestyle in older age (Hardcastle, Maxwell-Smith, et al., 2017), which may be a contributing factor in poor uptake to programs (Hardcastle, Maxwell-Smith, Kamarova, et al., 2018). An emphasis on increased quality of life and the capacity to enjoy life's pleasures as outcomes of health behaviour uptake may assist in fostering participation in behavioural programs (Rhodes & Kates, 2015).

Notably, survivors tended to report motives that were non-specific to diet or physical activity (i.e., longevity, feeling better, general health, being a role model for family, and losing weight) or specifically related to physical activity (i.e., mobility, fitness, and bodily pain-related motives). Almost no motives were specifically related to diet. This may indicate a lack of interest from survivors in implementing dietary change (Hardcastle, Maxwell-Smith, et al., 2017), which seems to also reflect the lack of research on the mediators of dietary change, compared to physical activity, in survivors. As motives were often related to lifestyle generally, survivors may be more attracted to programs that emphasise healthy lifestyle change, rather than focus solely on dietary outcomes.

The identification of appearance-related motives in this study is consistent with survivors previously reporting body image as a motive following engagement in health behaviours (Frensham et al., 2018). As appearance-related motives have been linked to negative outcomes, an alternative focus on health-related benefits of exercise and nutrition initiatives has been recommended (Vartanian et al., 2012). Further, gender may be associated with the experience of appearance-related motives, as this theme was more dominant in female survivors. This outcome is supported by existing literature that posits the dominance of body image and appearance-related motives in females (Martinez et al., 2014).

6.4.1 Limitations

A main limitation of this study is the likelihood of participation bias, as those who are most in need of making lifestyle changes may have been less likely to participate. Due to the varied specialties of participating oncologists, survivors' cancer types were inconsistent across locations. Larger studies may overcome this limitation by recruiting from state-wide cancer registries. A small proportion of this study's non-metropolitan sample resided in remote and very remote locations, which may limit the relevance of the

current findings for survivors in these areas. A quantitative approach with a larger sample is necessary for rigorous comparisons by location, while recruitment of remote survivors is an important endeavour for future research (Gunn et al., 2020). While efforts to identify discrepancies by geographical classification were conservative in this study, quantitative research may build upon this by assessing the statistical significance of any differences in the prevalence or nature of reported motives.

6.4.2 Conclusion

The current study sought to ascertain the motives of metropolitan and non-metropolitan cancer survivors to adopt physical activity and healthy dietary behaviours. Preliminary considerations of geographical classification indicate that functional health motives and the ability to keep working may be more relevant to non-metropolitan cohorts. Survivors were motivated by the ability to care for their family and engage in personal interests. Health behavioural change in this at-risk (Bluethmann, Basen-Engquist, et al., 2015) and growing (AIHW, 2019) population may be achieved by targeting cancer survivors' autonomous motives, by emphasising the value of lifestyle change for achieving longevity, maintaining capabilities, and enjoying life's pleasures.

Chapter Seven

7

Psychological Correlates of Physical Activity and Exercise Preferences

Chapter Overview

This chapter is a manuscript that has been published in *Psycho-Oncology*. The chapter presents the psychological correlates and preferences of cancer survivors with respect to physical activity. Respondents were colorectal, endometrial, and breast cancer survivors in metropolitan and non-metropolitan locations. This publication makes several contributions to the overall objectives of this thesis by assessing psychological constructs that may be associated with physical activity uptake. Exercise preferences of survivors are assessed, and considered in the context of the survivors' geographical classification. Results are discussed with respect to their value for informing the design of a behavioural intervention to promote physical activity.

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Psychological correlates of physical activity and exercise preferences in metropolitan and nonmetropolitan cancer survivors

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Abstract

Objective. Interventions to increase physical activity in cancer survivors have often adopted a "one size fits all" approach, and may benefit from being tailored to psychological constructs associated with behaviour. The study objective was to investigate the exercise preferences and psychological constructs related to physical activity among cancer survivors.

Methodology. Post-treatment colorectal, endometrial, and breast cancer survivors (n = 183) living in metropolitan and non-metropolitan areas completed survey measures of physical activity, preferences, attitudes, self-efficacy, PBC, and intention toward physical activity.

Results. A structural equation model with adequate fit and quality indices revealed that instrumental attitude and self-efficacy were related to physical activity intention. Intention was related to behaviour and mediated the relationship between self-efficacy and behaviour. Preferred exercise intensity was related to self-efficacy, PBC, attitudes, and intention, while preferred exercise company was related to self-efficacy and PBC. Participants preferred moderate-intensity physical activity (71%), specifically self-paced (52%) walking (65%) in an outdoor environment (58%).

Conclusions. Since instrumental attitude and self-efficacy were associated with physical activity, incorporating persuasive communications that target attitudes in physical activity interventions may promote physical activity participation. As cancer survivors who prefer light-intensity exercise and exercising with others report lower self-efficacy and PBC, interventions targeting confidence and successful experience in this group may also be warranted.

7.1 Introduction

Colorectal, breast, and endometrial cancers are amongst the most frequently diagnosed cancer types in Australia (AIHW, 2020), and have been linked to heightened morbidity (C. R. Leach, Weaver, et al., 2015; Weaver, Foraker, et al., 2013). Despite promising survival rates, survivors remain at risk of cardiovascular disease due to insufficient physical activity, obesity, and an unhealthy diet (Weaver, Foraker, et al., 2013). Efforts to promote physical activity in cancer survivors appear to be most effective when they adopt techniques derived from theories of behaviour (Buffart et al., 2014), and specifically theory-based constructs that have shown promise for predicting physical activity (Stacey et al., 2015).

Several theories seek to explain the predictors of health behaviour including the TPB (Ajzen, 1991), SCT (Bandura, 1989), and TTM (Prochaska & DiClemente, 1983). The TPB stipulates that attitudes towards a given target behaviour, social norms, and PBC predict an individual's intention to engage in behaviour (Ajzen, 1991). The TPB has shown promise for predicting physical activity in rural breast cancer survivors (Vallance et al., 2012). Furthermore, research has shown that affective attitudes, notably enjoyment and positive anticipated affect, and PBC, consistently predict physical activity intention and behaviour (Focht, 2013; McEachan et al., 2011; Ungar, Wiskemann, & Sieverding, 2016).

According to SCT, behaviour is determined by social cognitive factors that regulate and reinforce goal-oriented behaviours over time. Self-efficacy is a core construct of SCT and reflects individuals' subjective evaluation of their ability to perform a behaviour (Bandura, 1989). Self-efficacy is a key determinant of behaviour within the theory and has similar content to PBC within the TPB (Ajzen, 1991), indicating overlap between these theoretical approaches. Perceived competence, a proxy for self-efficacy, has been shown to predict physical activity in Australian cancer survivors (Milne et al., 2008) and interventions targeting change in self-efficacy have been effective for promoting physical activity in cancer survivors (Stacey et al., 2015). Finally, the TTM proposes that motivational readiness predicts behaviour (Prochaska & DiClemente, 1983), and is closely aligned with behavioural intention from the TPB (McMillan & Conner, 2007).

Taken together, constructs from SCT, TPB, and TTM have consistently predicted physical activity in chronic illness contexts including cancer (McEachan et al., 2011; Stacey et al., 2015; Ungar, Wiskemann, & Sieverding, 2016; Vallance et al., 2012).

Numerous researchers have recognised substantive redundancy in constructs across social cognition theories applied to health behavior, suggesting that constructs from many social cognition theories can be synthesised into core determinants (Conner & Norman, 2015; McMillan & Conner, 2007). Recognising this overlap, researchers have adopted integrated approaches to identifying correlates of physical activity, which have informed interventions targeting these core constructs to promote physical activity in cancer survivors (Rock et al., 2015; Sheppard et al., 2016).

Self-efficacy and affective attitudes towards exercise have been identified as correlates of physical activity (Stacey et al., 2015; Ungar, Wiskemann, & Sieverding, 2016). Further, practising preferred exercise type has been linked to improved physical activity attitudes, PBC, and intention in breast cancer survivors (Courneya et al., 2008). As exercise that is in accord with an individual's preferences is likely to yield greater enjoyment, perceived control, motivation, and positive instrumental and affective attitudes, it follows that preferences may be a correlate of physical activity behaviour that is mediated by behavioural intention. However, preferences other than exercise type and their relationship with theoretical constructs have received little attention (Rhodes & Kates, 2015).

There is also limited research examining whether physical activity correlates are consistent across cancer survivors living in non-metropolitan and metropolitan areas in Australia, with previous research limited to a handful of studies with small samples (Frensham et al., 2014; Hardcastle, Maxwell-Smith, Kamarova, et al., 2018; Smith-Turchyn et al, 2020). Such comparisons are important given a third of Australians reside in non-metropolitan regions (Tervonen et al., 2017), and non-metropolitan survivors experience unique physical activity barriers (Frensham et al., 2014; Hardcastle, Maxwell-Smith, Kamarova, et al., 2018). Cancer survivors living in regional and remote areas have worse health outcomes and greater survivorship-related burden than their metropolitan counterparts (C. L. Paul et al., 2013; Tervonen et al., 2017). Given that psychosocial factors and needs appear to differ by region (Smith-Turchyn et al., 2020; Vallance et al., 2013), ascertaining whether exercise preferences and resulting attitudes and confidence differ by geographical classification may inform the design and potential tailoring of future interventions (Smith-Turchyn et al., 2020).

This study aimed to identify relations between a core set of social cognition factors derived from multiple theories, exercise preferences, and physical activity participation in Australian cancer survivors across non-metropolitan and metropolitan areas. Exercise

preferences are hypothesised to correlate with attitudes, PBC, and self-efficacy, which are in turn hypothesised to be associated with greater intention, as measured by motivational readiness. Intention is hypothesised to be associated with physical activity.

7.2 Methodology

7.2.1 Participants

The eligible participant pool for *Study Two* has been previously described in Section 5.2.1.

7.2.2 Procedure

The recruitment procedure for *Study Two* has been previously described in Section 5.2.3.

7.2.3 Psychological and Demographic Predictors

7.2.3.1 Demographic Variables

Participants self-reported their demographic characteristics, including age, gender, cancer type, time since treatment completion, and smoking and alcohol consumption levels. Smoking and alcohol consumption items were adapted from those administered in the National Health Interview Survey (2015).

7.2.3.2 Exercise Preferences

Preferred exercise company, type, location, intensity, and structure were assessed, which were adapted from previous research by Courneya and Hellsten (1998) concerning preferences and personality constructs. For example, participants indicated their preferred exercise intensity by selecting either *low*, *moderate*, or *high*, indicating light-, moderate-, and vigorous-intensity physical activity.

7.2.3.3 Psychological Constructs

Items assessing PBC and self-efficacy were adapted from previous research (Manstead & van Eekelen, 1998) and measured on 6-point scales (1 = *no control* and 6 = *complete control*). Three items (e.g., "Whether or not I am physically active is entirely up to me") were averaged to produce the PBC score. The single item: "I am confident that I would be able to be physically active" assessed self-efficacy. Intention was measured on a single item tapping motivational readiness ("How ready are you to implement physical activity changes?"), which has been used as a measure of intention in previous research (Courneya et al., 2008; McMillan & Conner, 2007). Responses were provided on a 10-

point scale (1 = *not ready at all* and 10 = *extremely ready*) (K. A. Blanchard et al., 2003). Attitudes were measured on three items in responses to the common stem ("For me, being physically active at a moderate intensity in the next two weeks is…"). Responses were provided on 6-point semantic differential scales. Instrumental attitudes were measured using the *extremely important*-to-*unimportant* bipolar adjectives and affective attitudes using the *extremely enjoyable*-to-*unenjoyable* and *extremely pleasant*-to-*unpleasant* bipolar adjectives.

7.2.4 Outcome Measures

7.2.4.1 Physical Activity

Physical activity was measured using the 7-item International Physical Activity Questionnaire, Short-Form (IPAQ-SF) (Craig et al., 2003). Participants self-reported amount and intensity of walking, and moderate- and vigorous-intensity physical activity performed per week, with scores converted to METs using standardised formulae. Total physical activity is the weighted sum of the scores for each intensity. The IPAQ is reliable (Craig et al., 2003) and valid (Tran et al., 2013) for an older adult population against pedometers and 7-day activity logs.

7.2.5 Data Analysis

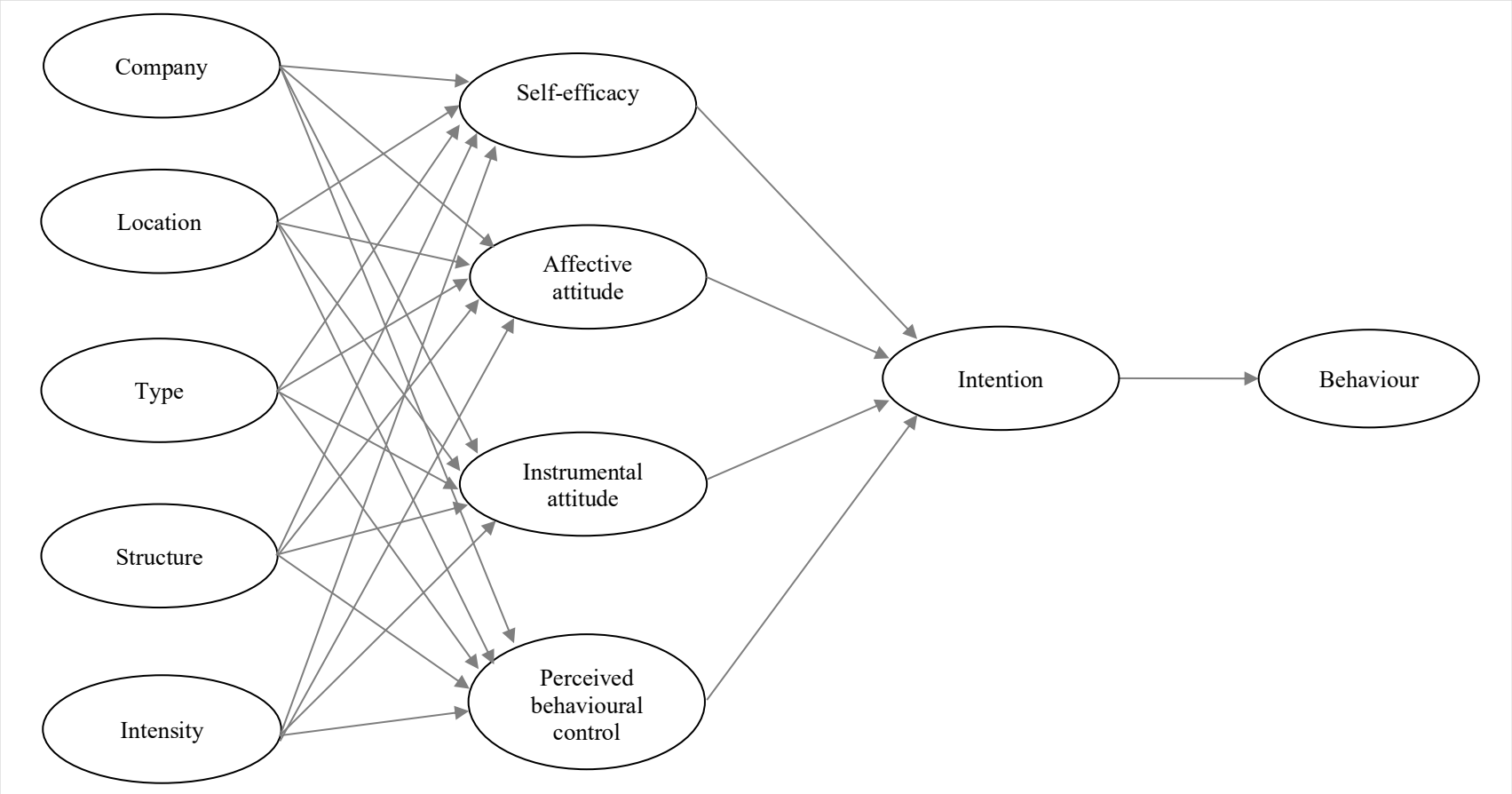
Hypothesised relations among the integrated model constructs, shown in Figure 7.1, were tested with variance-based structural equation modelling using the WARP v.7.0 analysis package (Kock, 2020). Model parameters and standard errors were computed using the "Stable3" estimation method. Model constructs were represented by single-item latent variables, which enabled the modelling of measurement error. Construct validity of the single-item latent variables was established using the normalised factor pattern loadings which should approach or exceed .700. Predictions of the proposed model were estimated by specifying hypothesised relations among the latent variables and testing the fit of the model with the data. Effects of the binary exercise preference variables on model constructs were also included. Binary demographic variables were included as covariates. There were few instances of missing data with missing data ranging from 0.55% to 7.55%. Missing data were imputed using hierarchical linear regression. This is a common imputation method used in conjunction with variance-based structural equation modelling, which has been shown in simulation studies to produce estimates closely aligned with data sets with no missing data (Kock, 2020).

Adequacy of the proposed model was established using an overall goodness-of-fit index, with values of .100, .250, and .360 corresponding to small, medium, and large effect sizes. Further information on the quality of the model was provided by the average path coefficient (APC) and average R^2 coefficients, both of which should be statistically significant. In addition, an overall goodness-of-fit index is provided by the average block variance inflation factor for model parameters (AVIF) and the average full collinearity variance inflation factor (AFVIF), which should be equal to or lower than 3.3 for well-fitting models. Four further indices were used to evaluate model quality: the Simpson's paradox ratio (SPR), R^2 contribution ratio (R^2CR), the statistical suppression ratio (SSR), and the non-linear bivariate causality direction ratio (NLBCDR). The SPR should exceed .700 and ideally approach 1.000, the R^2CR and SSR should exceed 0.900 and 0.700, respectively, and the NLBCDR should exceed .700 for high quality models (Kock, 2020).

Model effects were estimated using standardised path coefficients with confidence intervals and test statistics. Effect sizes were estimated using an equivalent of Cohen's *f*-square coefficient, with values of .02, .15, and .35 representing small, medium, and large effect sizes, respectively. The sample size of 183 survivors was considered sufficient for a variance-based analysis, as recommended by Savalei's (2019) approach for small samples of ~200. These recommendations indicate that a sample >100 can achieve conventional levels of power, with recognised benefits of employing single-item indicators of variables and data sets with minimal instances of missing data to reduce measurement error typically associated with small samples (Wolf et al., 2013).

The presence of differences in effects for participants living in non-metropolitan locations relative to participants in metropolitan locations was tested using multi-sample analyses. The model was re-estimated separately in each group, comparing parameter estimates in these models using the Satterthwaite method with two-tailed significance tests (Kock, 2020).

Figure 7.1
Proposed Model Illustrating Effects Among Constructs



Note. Effects of control variables (gender, age, alcohol consumption) omitted for clarity.

7.3 Results

Participants (n = 183) were mostly female (n = 124, 68%), averaged 65 years old (SD = 9.90), and 2.39 years post-treatment completion (SD = 1.49). Survivors were recruited from sites in Western Australia (n = 117, 64%), New South Wales (n = 46, 25%), Victoria (n = 18, 10%), and South Australia (n = 2, 1%), and classified as metropolitan (n = 103, 56%) and non-metropolitan (n = 80, 44%). Full demographic characteristics of all survivors surveyed in *Study Two* have been previously reported in Table 5.1.

Intention differed by age (r = -.268, p <.001), recruitment method (r = .154, p = .043), and cancer type (F (2, 174) = 6.53, p = .002, η^2 = .070), such that younger patients, breast cancer patients, and patients recruited via their expression of interest in research participation reported greater intentions concerning physical activity change. Age was associated with instrumental attitude (r = -.171, p = .024), such that younger survivors perceived physical activity to be more important. Survivors recruited via an expression of interest in research participation reported greater MET minutes of weekly physical activity (r = .170, p = .026).

Descriptive statistics of measures by location are reported in Table 7.1. Non-metropolitan participants' scores on intention, self-efficacy, and instrumental attitudes were significantly higher than those in metropolitan areas, and physical activity was also higher with a difference that approached conventional levels of statistical significance. Internal consistency of the PBC (α = .65) and affective attitude (α = .95) scales were acceptable.

Participants' physical activity preferences are reported in Table 7.2. Most participants preferred unsupervised/self-paced exercise (52%), specifically walking (65%), alone (44%), outdoors (58%) at a moderate intensity (71%). Exercise intensity preferences differed across participants' age, such that those with a preference for high-intensity activity were younger (F (2, 179) = 5.62, p = .004, η^2 = .059).

Factor loadings for the single-item latent variables approached or exceeded the recommended 0.700 cut-off values in all cases (factor loading range = .643 to .971). Correlations among the majority of constructs were small-to-medium in size (r range = .235 to .638), with the exception of the relationship between PBC and behaviour which was not statistically significant (r = .138, p = .063).

Table 7.1
Physical Activity and Psychological Constructs Across All Surveyed Survivors and by Geographical Location

	All participants (*n* = 183) *Mean* (SD)	**Metropolitan** (*n* = 103) *Mean* (SD)	**Non-Metropolitan** (*n* = 80) *Mean* (SD)	***p***
Total activity METs/week	2022.81 (2352.63)	1714.31 (1917.03)	2467.92 (2823.17)	.054
PBC Scale	3.93 (0.70)	3.90 (0.76)	3.97 (0.63)	.534
Intention	6.73 (2.26)	6.13 (2.33)	7.50 (1.91)	**<.001**
Self-efficacy	3.77 (0.86)	3.64 (0.88)	3.92 (0.81)	**.028**
Affective attitude	3.39 (0.99)	3.29 (0.98)	3.51 (1.00)	.140
Instrumental attitude	3.63 (0.97)	3.49 (1.06)	3.80 (0.82)	**.033**

Note. Physical activity data were collected using the International Physical Activity Questionnaire – Short Form. PBC scale scored 0 (*no control*) to 5 (*complete control*). Intention scored on readiness for change 10-point scale from 1–10. Self-efficacy scored 0 (*no confidence*) to 5 (*completely confident*). Affective attitudes were scored 0 (*extremely unenjoyable*) to 5 (*extremely enjoyable*). Instrumental attitudes were scored 0 (*extremely unimportant*) to 5 (*extremely important*). *p* is significant using the alpha-level <.05.

Table 7.2
Exercise Preferences Across All Surveyed Survivors and by Geographical Location

	All participants (n = 183) N (%)	**Metropolitan** (n = 103) N (%)	**Non-Metropolitan** (n = 80) N (%)	p^a
Exercise company				
Alone	80 (43.7%)	44 (42.7%)	36 (45.0%)	.563
With a partner	53 (29.0%)	34 (33.0%)	19 (23.8%)	
With a few people	32 (17.5%)	17 (16.5%)	15 (18.8%)	
In a group	14 (7.7%)	6 (5.8%)	8 (10.0%)	
Missing	4 (2.2%)	2 (1.9%)	2 (2.5%)	
Exercise location				
Outdoors	106 (57.9%)	61 (59.2%)	45 (56.3%)	.811
At home	41 (22.4%)	23 (22.3%)	18 (22.5%)	
Fitness centre	32 (17.5%)	17 (16.5%)	15 (18.8%)	
Missing	4 (2.2%)	2 (1.9%)	2 (2.5%)	
Exercise type				
Walking	118 (64.5%)	66 (64.1%)	52 (65.0%)	.902
Cycling	18 (9.8%)	12 (11.7%)	6 (7.5%)	
Weight training	12 (6.6%)	6 (5.8%)	6 (7.5%)	
Aerobics	11 (6.0%)	4 (3.9%)	7 (8.8%)	
Swimming	6 (3.3%)	6 (5.8%)	0	
Jogging	5 (2.7%)	3 (2.9%)	2 (2.5%)	
Missing	13 (7.1%)	6 (5.8%)	7 (8.8%)	

	All participants (n = 183) N (%)	**Metropolitan** (n = 103) N (%)	**Non-Metropolitan** (n = 80) N (%)	p^a
Exercise intensity				
Moderate	130 (71.0%)	71 (68.9%)	59 (73.8%)	.881
Low	45 (24.6%)	27 (26.2%)	18 (22.5%)	
High	7 (3.8%)	5 (4.9%)	2 (2.5%)	
Missing	1 (0.5%)	0	1 (1.3%)	
Exercise structure				
Unsupervised/self-paced	95 (51.9%)	52 (50.5%)	43 (53.8%)	.536
Supervised/instructed	27 (14.8%)	14 (13.6%)	13 (16.3%)	
Recreational	23 (12.6%)	17 (16.5%)	6 (7.5%)	
Spontaneous/flexible	16 (8.7%)	8 (7.8%)	8 (10.0%)	
Scheduled	9 (4.9%)	5 (4.9%)	4 (5.0%)	
Competitive	4 (2.2%)	2 (1.9%)	2 (2.5%)	
Missing	9 (4.9%)	5 (4.9%)	4 (5.0%)	

Note. Items derived from model by Courneya and Hellsten (1998). [a]*p*-values for chi-square difference tests.

7.3.1 Structural Equation Models

The proposed model exhibited adequate fit and quality indices (APC = .117, p <.027; average R^2 = .231, p <.231; AVIF = 1.232; AFVIF = 1.584; goodness-of-fit = .481; SPR = .815; R^2CR = .960; SSR = .889; NLBCDR = .778). Standardised parameter estimates, standard errors, and effect sizes for all direct and indirect effects are summarised in Table 7.3.

7.3.1.1 Direct Effects

Intention (β = .234, p <.001), but not PBC (β = .074, p = .155), significantly predicted behaviour. Self-efficacy (β = .371, p <.001) and instrumental attitude (β = .151, p = .018) significantly predicted intention, with non-significant effects for PBC (β = .078, p = .142) and affective attitudes (β = .061, p = .201). Preferring to exercise with others significantly predicted PBC (β = -.187, p = .005) and self-efficacy (β = -.171, p = .009), and preference of higher exercise intensity significantly predicted intention (β = .130, p = .036), PBC (β = .303, p <.001), self-efficacy (β = .405, p <.001), and instrumental (β = .356, p <.001) and affective (β = .209, p = .002) attitudes, but not behaviour. The effect fell only marginally short of significance (β = .095, p = .097). Overall, the model accounted for significant variance in physical activity (R^2 = .155) and intention (R^2 = .488).

7.3.1.2 Indirect and Total Effects

There was a significant indirect effect of self-efficacy on behaviour mediated by intention (β = .087, p = .046), but no effects for PBC, and instrumental and affective attitudes (βs <.035, ps >.248). The sum of indirect effects of intensity preference on behaviour through all the variables fell short of statistical significance by a trivial margin (β = .109, p <.066). Together with the non-significant direct effect, this resulted in a significant total effect for intensity preference on behaviour (β = .204, p = .002). Multi-sample analyses indicated no significant differences in model effects across participants living in non-metropolitan and metropolitan areas. Full results of the multi-sample analyses are presented in Table 7.4.

Table 7.3
Standardised Parameter Estimates for Direct and Indirect Effects for the Structural Equation Model

Effect	β	*p*	*SE*	ES	Effect	β	*p*	*SE*	ES
Direct effects									
Int.→Beh.	.234	**<.001**	.071	.064	Type→PBC	-.015	.421	.074	.001
PBC→Beh.	.074	.155	.073	.015	Struc.→PBC	.032	.330	.073	.003
Gender→Beh.	-.149	**.020**	.072	.022	Intens.→PBC	.303	**<.001**	.070	.084
Age.→Beh.	.089	.110	.073	.009	Gender→SE	.014	.425	.074	.000
Alc.→Beh.	.151	**.018**	.072	.026	Age→SE	-.084	.126	.073	.010
Com.→Beh.	.093	.100	.073	.006	Alc.→SE	-.053	.237	.073	.002
Loc.→Beh.	-.007	.465	.074	.000	Com.→SE	-.171	**.009**	.071	.026
Type→Beh.	.067	.179	.073	.009	Loc.→SE	-.079	.139	.073	.004
Struc.→Beh.	.03	.344	.073	.001	Type→SE	-.116	.055	.072	.027
Intens.→Beh.	.095	.097	.073	.023	Struc.→SE	.003	.485	.074	.000
PBC→Int.	.078	.142	.073	.031	Intens.→SE	.405	**<.001**	.068	.159
SE→Int.	.371	**<.001**	.069	.220	Gender→Iatt.	.077	.147	.073	.007
Iatt.→Int.	.151	**.018**	.072	.079	Age→Iatt.	-.156	**.015**	.072	.031
Aatt.→Int.	.061	.201	.073	.026	Alc.→Iatt.	.139	**.027**	.072	.015
Gender→Int.	.080	.138	.073	.010	Com.→Iatt.	.058	.213	.073	.005
Age.→Int.	-.202	**.002**	.071	.056	Loc.→Iatt.	.080	.138	.073	.005
Alc.→Int.	-.079	.138	.073	.006	Type→Iatt.	.165	**.011**	.072	.038
Com.→Int.	-.082	.132	.073	.008	Struc.→Iatt.	.097	.091	.072	.018
Loc.→Int.	-.044	.273	.073	.005	Intens.→Iatt.	.356	**<.001**	.069	.145
Type→Int.	-.010	.444	.074	.002	Gender→Aatt.	.137	**.029**	.072	.026
Struc.→Int.	.056	.224	.073	.009	Age→Aatt.	-.173	**.008**	.071	.037
Intens.→Int.	.130	**.036**	.072	.049	Alc.→Aatt.	.110	.064	.072	.012

Effect	β	*p*	*SE*	ES	Effect	β	*p*	*SE*	ES
Gender→PBC	.066	.184	.073	.001	Com.→Aatt.	.111	.063	.072	.018
Age→PBC	.198	**.003**	.071	.031	Loc.→Aatt.	-.018	.405	.074	.001
Alc.→PBC	-.182	**.006**	.071	.032	Type→Aatt.	-.109	.067	.072	.013
Com.→PBC	-.187	**.005**	.071	.029	Struc.→Aatt.	.025	.365	.074	.002
Loc.→PBC	-.039	.298	.073	.001	Intens.→Aatt.	.209	**.002**	.071	.050
Indirect effects[a]									
PBC→Int.→Beh.	.018	.363	.052	.004	Iatt.→Int.→Beh.	.035	.248	.052	.011
SE→Int.→Beh.	.087	**.046**	.051	.021	Aatt.→Int.→Beh.	.014	.391	.052	.003
Sum of indirect effects[a]									
Gender→Beh.	.031	.338	.073	.004	Loc.→Beh.	-.018	.402	.074	<.001
Age.→Beh.	-.044	.273	.073	.004	Type→Beh.	-.010	.448	.074	.001
Alc.→Beh.	-.033	.324	.073	.006	Struc.→Beh.	.020	.393	.074	.001
Com.→Beh.	-.048	.258	.073	.003	Intens.→Beh.	.109	.066	.072	.026
Total effects[b]									
PBC→Beh.	.092	.102	.073	.018	Loc.→Beh.	-.025	.368	.074	.001
Gender→Beh.	-.118	.051	.072	.017	Type→Beh.	.058	.216	.073	.008
Age→Beh.	.045	.269	.073	.005	Struc.→Beh.	.050	.249	.073	.002
Alc.→Beh.	.118	.052	.072	.020	Intens.→Beh.	.204	**.002**	.071	.049
Com.→Beh.	.046	.267	.073	.003					

Note. [a]Sum of indirect effects of past behaviour on behaviour through all model constructs; [b]Total effect comprising sums of all indirect effects through model constructs plus the direct effect; β = Standardised parameter estimate; *SE* = Standard error of parameter estimate; ES = Effect size; Int. = Intention; Beh. = Behaviour; PBC = Perceived behavioural control; Iatt. = instrumental attitude; Aatt. = affective attitude; Alc. = Alcohol consumption; Com. = Preferred company when exercising (with company vs. alone); Loc. = Preferred exercise location (outdoors/home vs. facility); Type = Preferred exercise type (walking vs. non-walking); Struc. = Preferred exercise structure (supervised vs. unsupervised); Intens. = Preferred exercise intensity (low vs. moderate/high).

Table 7.4
Mean Differences and Test Statistics in Parameter Estimates Across Metropolitan and Non-Metropolitan Communities from Multi-Sample Structural Equation Modelling

Effect	β	*p*	*SE*	ES	Effect	β	*p*	*SE*	ES
Int.→Beh.	.064	0.466	.642	.138	Type→PBC	.021	0.143	.886	.148
PBC→Beh.	.097	0.672	.501	.144	Struc→PBC	.060	0.411	.681	.147
Gender→Beh.	.008	0.057	.954	.143	Intens.→PBC	.065	0.471	.638	.138
Age.→Beh.	.053	0.367	.714	.144	Gender→SE	.174	1.198	.231	.145
Alc.→Beh.	.048	0.338	.736	.142	Age→SE	.204	1.415	.157	.144
Com.→Beh.	.023	0.161	.872	.142	Alc.→SE	.160	1.105	.269	.145
Loc.→Beh.	.119	0.811	.417	.146	Com.→SE	.063	0.447	.655	.140
Type→Beh.	.084	0.584	.559	.144	Loc.→SE	.048	0.332	.740	.145
Struc→Beh.	.195	1.348	.178	.145	Type→SE	.160	1.099	.272	.146
Intens.→Beh.	.132	0.902	.367	.146	Struc→SE	.126	0.86	.390	.146
PBC→Int.	.137	0.965	.335	.142	Intens.→SE	.046	0.342	.732	.134
SE→Int.	.195	1.446	.148	.135	Gender→Iatt.	.224	1.558	.119	.144
Iatt.→Int.	.065	0.446	.656	.145	Age→Iatt.	.233	1.661	.097	.140
Aatt→Int.	.001	0.010	.992	.143	Alc.→Iatt.	.289	2.006	.045	.144
Gender→Int.	.068	0.458	.647	.148	Com.→Iatt.	.005	0.033	.974	.143
Age.→Int.	.081	0.574	.566	.140	Loc.→Iatt.	.091	0.621	.534	.147
Alc.→Int.	.151	1.060	.289	.143	Type→Iatt.	.185	1.312	.190	.141
Com.→Int.	.200	1.039	.165	.144	Struc→Iatt.	.012	0.084	.933	.145
Loc.→Int.	.307	2.132	.033	.144	Intens.→Iatt.	.069	0.524	.600	.132

Effect	**β**	***p***	***SE***	**ES**	**Effect**	**β**	***p***	***SE***	**ES**
Type→Int.	.173	1.191	.234	.145	Gender→Aatt.	.306	2.161	.031	.142
Struc→Int.	.030	0.206	.837	.147	Age→Aatt.	.309	2.178	.029	.142
Intens.→Int.	.164	1.126	.260	.146	Alc.→Aatt.	.361	2.528	.011	.143
Gender→PBC	.118	0.806	.421	.147	Com.→Aatt.	.225	1.552	.121	.145
Age→PBC	.002	0.014	.989	.140	Loc.→Aatt.	.159	1.093	.274	.146
Alc.→PBC	.043	0.305	.761	.142	Type→Aatt.	.179	1.229	.219	.146
Com.→PBC	.067	0.467	.640	.143	Struc→Aatt.	.014	0.095	.924	.148
Loc.→PBC	.101	0.690	.490	.147	Intens.→Aatt.	.057	0.407	.684	.139

Note. Difference tests and 95% confidence intervals determined using the Satterthwaite method. β diff. = Absolute difference in standardised parameter estimate; *t* = *t*-test of difference in parameter estimates; *SE* = Standard error of the difference standardised parameter estimate; Int. = Intention; Beh. = Behaviour; PBC = Perceived behavioural control; Alc. = Alcohol consumption; Com. = Preferred company when exercising (with company vs. alone); Loc. = Preferred exercise location (outdoors/home vs. facility); Type = Preferred exercise type (walking vs. non-walking); Struc. = Preferred exercise structure (supervised vs. unsupervised); Intens. = Preferred exercise intensity (low vs. moderate/high).

7.4 Discussion

This study revealed novel findings supporting an association between exercise intensity preference with self-efficacy, affective and instrumental attitudes, PBC, and intention, and a total effect between intensity preference and behaviour. Self-efficacy and instrumental attitude were significantly associated with intention, and in turn, intention significantly correlated with behaviour. The model fit did not significantly differ by geographical classification.

The significant associations between exercise intensity preference and physical activity intention and behaviour are important findings, suggesting that survivors who prefer lighter-intensity exercise report lower levels of confidence and motivation. These survivors may be less likely to engage in MVPA. Accordingly, proposed physical activity interventions for survivors should aim to increase activity by bolstering self-efficacy and intention, especially for disengaged and unmotivated individuals (Hardcastle, Hancox, et al., 2015). Identification of preferences for light-intensity physical activity may be a useful screening tool to identify survivors who could benefit from counselling interventions targeting perceived importance of and confidence in physical activity engagement, or a matched lower-intensity intervention that focuses on participation in light-to-moderate intensity physical activity. Further, preference for exercising with others was associated with lower self-efficacy and PBC, indicating the importance of promoting successful physical activity experiences by a gradual approach to increasing exercise intensity. Such support may necessitate counselling and motivational interviewing interventions which aim to foster self-determined motivation for behaviour change self-efficacy (Kosteli et al., 2016; Pudkasam et al., 2018).

Participants favoured moderate-intensity physical activity, specifically walking, that is self-paced, outdoors and alone or with a partner. Exercise preferences did not differ by geographical classification. While the current findings regarding the preference for moderate-intensity activities and walking are consistent with previous research (Rogers, Markwell, et al., 2009; Vallance et al., 2013), they differ to those of a Canadian study in which rural breast cancer survivors preferred supervised, indoor exercise (Vallance et al., 2013). Many existing programs are facility-based, supervised, and often involve group activities (Buffart et al., 2014; Hardcastle, Maxwell-Smith, Kamarova, et al., 2018). Uptake to and effectiveness of future interventions may be improved if they better match the exercise preferences of survivors for moderate-intensity walking programs. Based on

indications that preferences may vary across cohorts, future research to explore changes in exercise preferences across age and survivorship phase could be worthwhile.

The association between instrumental attitude and intention among cancer survivors is a novel finding. Previous research supports affective, rather than instrumental, attitudes as the predominant correlate of physical activity intention (Ungar, Wiskemann, & Sieverding, 2016) and behaviour (Rhodes & Kates, 2015). A possible interpretation is that instrumental attitude may be more critical to the uptake of physical activity, consistent with current findings, while affective attitude may be more relevant to behavioural maintenance (Ungar, Wiskemann, & Sieverding, 2016). This seems to be consistent with existing research. A previous study (Trinh et al., 2012b) found that instrumental attitude, but not affective attitude, predicted physical activity intention in cancer survivors, while other research supports relations between perceived importance and affective response and physical activity participation (Courneya et al., 2008; Hardcastle, Maxwell-Smith, Kamarova, et al., 2018; Rhodes & Kates, 2015).

Future research might consider the consistency of preferences and correlates among Australian metropolitan and non-metropolitan survivors when designing and testing physical activity interventions. Although differences by geographical classification were not identified in the current study, previous evidence has indicated particular needs and barriers to physical activity in remote survivors (Smith-Turchyn et al., 2020; Tervonen et al., 2017; Vallance et al., 2013). As non-metropolitan survivors are disadvantaged, and have greater comorbidities and support needs than their urban counterparts (Tervonen et al., 2017), tailoring interventions to suit rural survivors may involve similar intervention materials, exercise type, structure, and setting, but with more contact or supportive components (Smith-Turchyn et al., 2020).

7.4.1 Study Limitations

The cross-sectional design of the current study precludes the inference of causal effects among model constructs. The proposed direction of effects is therefore inferred from theory alone, not the data. Further, normative or self-perception measures were not examined, which should be considered in future studies.

7.4.2 Clinical Implications

As instrumental attitude and self-efficacy appear to be closely related to physical activity behaviour, future interventions should promote the importance of physical activity

and foster confidence to engage in physical activity. Exercise preferences for unsupervised, moderate-intensity activities such as walking, and psychological constructs did not vary by location. Exercise intensity and company preferences were associated with psychological constructs, such that survivors who prefer to exercise with others and at a light intensity may benefit from specific initiatives to strengthen intentions and confidence.

7.4.3 Conclusion

Current findings revealed that instrumental attitudes and self-efficacy correlated with physical activity intention, and intentions were closely linked to behaviour. Preferred exercise intensity and company also correlated with psychological constructs underpinning physical activity. Preferences and correlates did not vary by geographical classification, although those who preferred lighter-intensity activities may have less confidence and intentions for physical activity engagement. Interventions that target improved self-confidence and affective attitudes, and are tailored according to preferred exercise intensity, may be a useful approach to improve uptake and adherence to physical activity programs in cancer survivors.

Chapter Eight

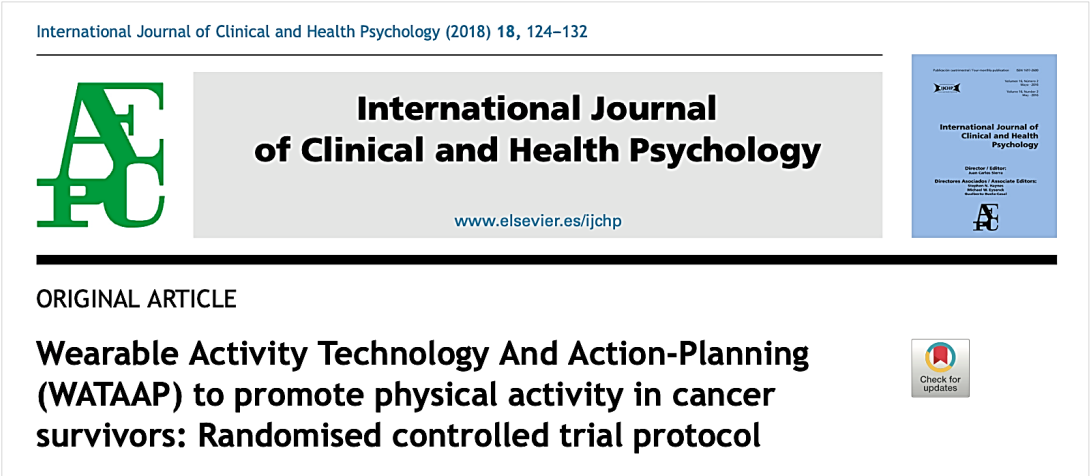
8

Wearable Activity Technology And Action Planning (WATAAP) – Trial Protocol

Chapter Overview

This chapter presents a protocol manuscript for *Study Three,* which has been published in the *International Journal of Clinical and Health Psychology*. The protocol proposed a HAPA-based wearable activity tracker intervention for colorectal and endometrial cancer survivors. The protocol of this trial was informed by the key findings of *Studies One* and *Two*[3] regarding psychological constructs, factors facilitating, preferences, and barriers to physical activity in survivors. This publication demonstrates consideration of the theoretical basis of the HAPA for the intervention and the utility of wearable devices as a vehicle for intervention delivery.

PUBLICATION – WEARABLE ACTIVITY TECHNOLOGY AND ACTION PLANNING TO PROMOTE PHYSICAL ACTIVITY IN CANCER SURVIVORS: RANDOMISED CONTROLLED TRIAL PROTOCOL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ORIGINAL ARTICLE

Wearable Activity Technology And Action-Planning (WATAAP) to promote physical activity in cancer survivors: Randomised controlled trial protocol

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Maxwell-Smith, C., Cohen, P. A., Platell, C., Tan, P., Levitt, M., Salama, P., Makin, G. B., Tan, J., Salfinger, S., Kader Ali Mohan, G. R., Kane, R. T., Hince, D., Jiménez-Castuera, R., & Hardcastle, S. J. (2018). Wearable Activity Technology And Action-Planning (WATAAP) to promote physical activity in cancer survivors: Randomised controlled trial protocol. *International Journal of Clinical and Health Psychology, 18*(2), 124–132. https://doi.org/10.1016/j.ijchp.2018.03.003

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[3] Findings of these studies informed the design of Study Three. However, due to publication delays, manuscripts presenting the findings of Study Two were published after those of Study Three.

Abstract

Objective. Colorectal and endometrial cancer survivors are at elevated cardiovascular risk due to comorbidities and sedentary behaviour, warranting a feasible intervention to increase physical activity. The HAPA is a promising theoretical framework for health behaviour change, and wearable physical activity trackers offer a novel means of self-monitoring physical activity for cancer survivors.

Methodology. Sixty-eight survivors of colorectal and endometrial cancer will be randomised into a 12-week intervention or control group. Participants in the intervention group will receive: a Fitbit Alta to monitor physical activity, HAPA-based group sessions, a HAPA-based booklet, and support phone-call. Participants in the control group will only receive the HAPA-based booklet. Accelerometer-derived physical activity, blood pressure, BMI, and HAPA constructs will be assessed at baseline, 12 weeks (post-intervention), and 24 weeks (follow up).

Results. Data analysis will use the *group x time* interaction from a generalised linear mixed model (GLMM) analysis.

Conclusions. Physical activity interventions that are acceptable and have robust theoretical underpinnings show promise for improving the health of cancer survivors.

8.1 Introduction

Cancer survivors are at increased risk of secondary cancers, cardiovascular disease, and other comorbidities compared to those without a cancer history (Rock et al., 2012). Despite cancer survival rates improving, survivors of colorectal and endometrial cancers continue to be at cardiovascular risk due to their physical inactivity. Up to 70% of endometrial cancer survivors are obese (von Gruenigen et al., 2008), and these survivors are twice as likely to die from not meeting the government's physical activity guidelines of 150 minutes of moderate-intensity physical activity per week (Fisher, Smith, & Wardle, 2016). Fifty-eight percent of colorectal cancer survivors are overweight or obese, and 83% are insufficiently active (Grimmett et al., 2011), putting survivors at cardiovascular disease risk. Given that these two cancer types have a high survival rate, and a significant proportion of these individuals have comorbidities resulting in increased cardiovascular disease risk (Loprinzi & Lee, 2014), interventions to increase physical activity in these patients are important. Clinicians may be optimally positioned to capitalise on the teachable moment (Demark-Wahnefried et al., 2005) or post-traumatic growth (Ochoa et al., 2017) created by the cancer diagnosis, and play a central role in guiding survivors towards positive health behaviours that improve physical wellbeing.

Interventions that incorporate BCTs, including goal setting, counselling, and feedback to increase physical activity and improve quality of life in survivors, have yielded promising findings (Bennett et al., 2007; Torre-Luque et al., 2016). Based on the effectiveness of these interventions and our recent qualitative work (Hardcastle, Maxwell-Smith et al., 2017; Hardcastle, Glassey, et al., 2017; Maxwell-Smith et al., 2017), addressing support needs and facilitating self-monitoring strategies for survivors are important components of successful interventions (Hardcastle, Hancox, et al., 2015).

8.1.1 Wearable Trackers

WAT holds great potential as a self-monitoring tool to increase physical activity in survivors. Wearable trackers and associated software applications use many of the techniques employed in physical activity interventions (i.e., self-monitoring, feedback, and goal setting) (Lyons et al., 2014). Thus, WAT presents a feasible opportunity for widespread physical activity promotion (J. P. Sanders et al., 2016).

Previous physical activity interventions for cancer survivors have used pedometers as self-monitoring tools (Bennett et al., 2007). Smart wearable trackers are hypothesised to be more effective than pedometers for increasing physical activity because they provide

real-time feedback and prompts. Smart WAT also links to smartphone applications where users can monitor behaviour and create a network to promote accountability and facilitate peer-support amongst other users.

The Fitbit has demonstrated effectiveness for increasing physical activity in overweight and obese adults (J. B. Wang, Cadmus-Bertram, et al., 2015). The first Fitbit trial in cancer survivors has recently been published, however the Fitbit and Facebook intervention targeted adolescent cancer survivors (Mendoza et al., 2017). To date, no completed study has assessed the effectiveness of the Fitbit to increase physical activity in adult survivors.

8.1.2 Health Action Process Approach

Physical activity interventions that are based on theoretical underpinnings have been more successful for improving health-related outcomes than atheoretical ones (Bennett et al., 2007; Parschau et al., 2014). The HAPA attempts to overcome the intention–behaviour gap by proposing two phases that are required for behaviour change: motivation and volition (Schwarzer & Luszczynska, 2008). Motivational processes involve initial recognition of risk perception and positive outcome expectances associated with behavioural change. The individual must form an intention to change and graduate to volitional processes by acting on this intention. This requires planning and self-efficacy for the proposed behaviour and self-regulation to monitor and maintain the behavioural change (Schwarzer & Luszczynska, 2008). A recent intervention by Ungar, Sieverding, and colleagues (2016) found survivors who received HAPA-based counselling to enhance self-regulation were significantly more active than a control group.

Given the promise of the HAPA model and the importance of self-regulation for successful behaviour change, physical activity interventions for survivors that involve monitoring and motivational tools are warranted. The use of a Fitbit as a motivational device to increase physical activity in cancer survivors is yet to be explored and is a novel aspect of the study.

8.1.3 Aims

This study aims to determine whether a pragmatic intervention package using WAT, coupled with action planning, goal setting, and coping planning is effective for increasing physical activity and reducing sedentary behaviour in endometrial and colorectal cancer survivors at elevated cardiovascular disease risk. A secondary aim is to assess the acceptability of this intervention for being incorporated into routine aftercare for survivors.

8.2 Methodology

8.2.1 Design

The two-arm RCT tests the efficacy of a self-monitoring intervention relative to an information-only control group. Participants will complete data collection at baseline (T1), after the 12-week intervention (T2), and at the 24-week follow-up assessment (T3). Ethical approval was obtained from the St John of God Hospital Human Research Ethics Committee (#1102; Appendix I, Section I.1) and reciprocal approval from Hollywood Private Hospital. The reporting of the study will adhere to the Consolidated Standards of Reporting Trials (CONSORT) and Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines for RCTs (Begg et al., 1996; A.-W. Chan et al., 2013). The proposed WATAAP study flow chart is presented in Figure 8.1.

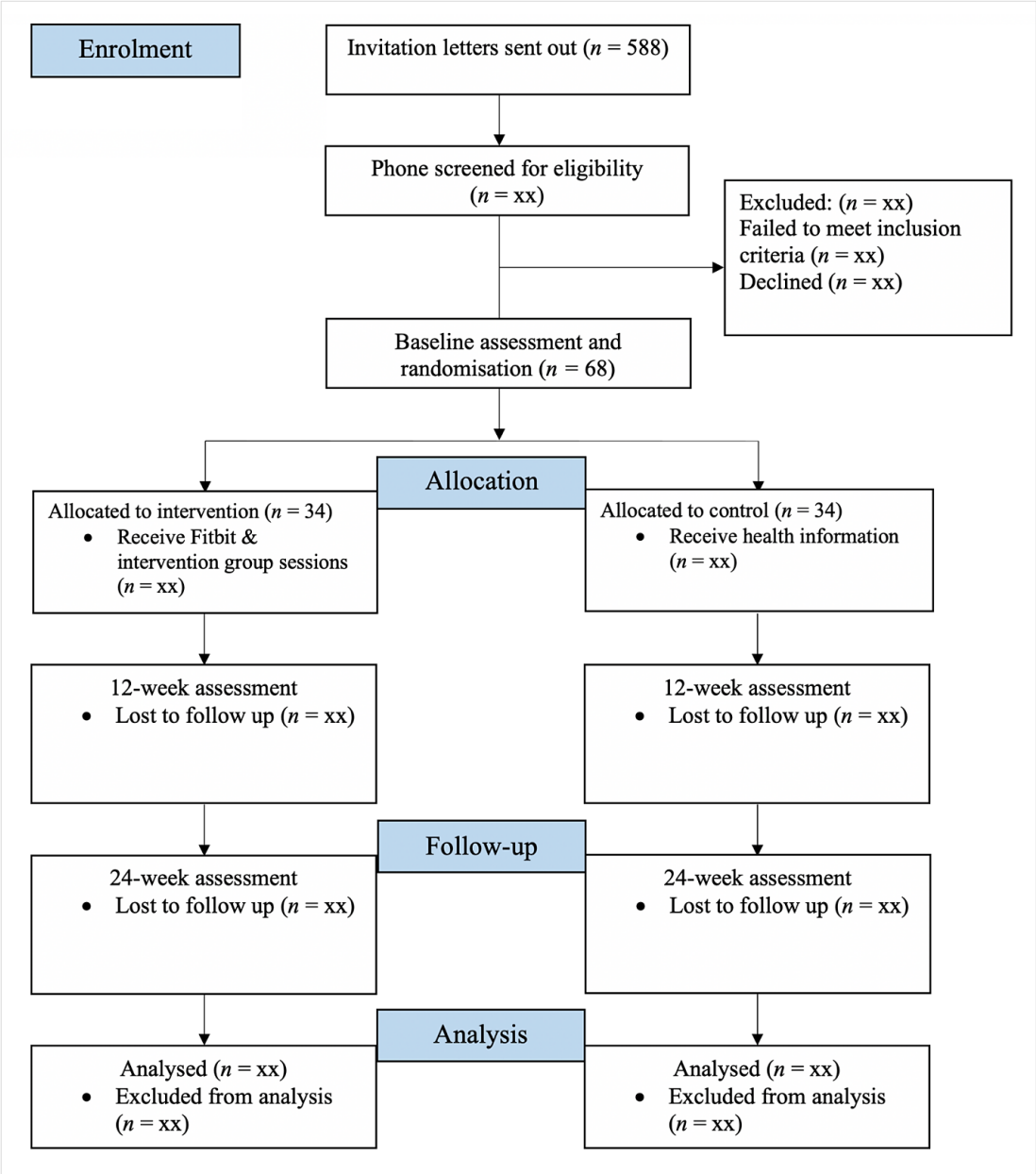
8.2.2 Participants

8.2.2.1 Selection Criteria

Participants will be stage 1 and 2 colorectal and endometrial cancer survivors aged 18–80, who have finished active treatment (surgery, chemotherapy, and/or radiotherapy) in the previous 5 years, and are completing less than 150 minutes of MVPA per week (Rock et al., 2012). Participants must have comorbidities resulting in increased risk of cardiovascular disease identified through hospital records (i.e., they must be on blood pressure medication or have blood pressure >150/90mmHg, BMI >28, hypercholesterolemia >5.2mmol/L), or an ASA score of 2 or 3, in the absence of medical records[4]. Participants who are in remission at the time of recruitment, English-reading and speaking, living in the Perth metropolitan area, and have no surgery planned for the 6 months following recruitment will be eligible to participate.

[4] Some oncologists use ASA scores as a primary indication of cardiovascular risk. Other oncologists collect data on blood pressure, cholesterol, and body mass index.

Figure 8.1
Flow Diagram of Proposed WATAAP Trial Design



Exclusion criteria apply to those who

1. are meeting the physical activity guidelines (Rock et al., 2012);
2. have a current diagnosis of a severe psychiatric illness or cardiac abnormalities (those with minor psychiatric diagnoses will be eligible if they are willing and able to participate in the intervention);
3. have severe physical disabilities including arthritis;
4. have ASA scores of 1 or 4;
5. are already enrolled in a physical activity program/trial;

6. have been diagnosed with uterine carcinosarcoma (also known as malignant mixed Mullerian tumour) or uterine serous carcinoma as these cancer types are associated with a poor prognosis.

Individuals with an ASA score of 2 or 3 will be eligible for recruitment. An ASA score from 1–4 is assigned to patients upon admission to hospital for a surgical procedure. A low ASA score indicates minimal cardiovascular risk, and a higher ASA score suggests comorbidities that may threaten a patient's life. Participants with ASA scores of 2 or 3 have comorbidities putting them at risk of cardiovascular disease. The ASA score is globally recognised as an indicator of the physical health status of patients prior to undergoing surgery (Owens et al., 1978).

8.2.2.2 Recruitment

Participants will be recruited using purposive sampling methods, involving screening the hospital records of participating oncologists (n = 8) to collate a pool of eligible survivors. The participating oncologists are based at St John of God Subiaco and Murdoch Hospitals, Hollywood Private Hospital, and the Women Centre in West Leederville, Western Australia. Eligible individuals (n = 588) will be mailed an invitation letter (Appendix I, Section I.2) and information sheet (Appendix I, Section I.3) from their treating oncologist.

8.2.3 Randomisation

An independent statistician will generate the randomisation sequence using STATA v14 with a 1:1 allocation using blocks of 4. Following their baseline assessment, participants will be allocated to either intervention or control groups by the statistician using the next consecutive randomisation code. Participants will be randomly sorted into blocks, with random assignment to group within each block. Upon randomisation, participants will be evenly split between treatment (n = 34) and control groups (n = 34). Assessors (post-baseline), clinicians, and data analysts will be blinded to group allocation.

8.2.4 Statistical Power and Sample Size

For each GLMM, the 2-way *group x time* interaction embodies the treatment effect. According to G*Power, for the primary outcome (MVPA), 28 participants in each of the two groups provides sufficient power for an 80% chance of detecting a small-to-moderate (f = .17) *group x time* interaction at an alpha level of .05. A meta-analysis of physical activity interventions in cancer survivors reported a weighted mean effect size of 0.38 (95

CI: 0.22–0.54) for the difference between groups on physical activity outcomes (Speck et al., 2010). A similar effect size (i.e., 0.4) is anticipated as a result of the WATAAP intervention. Recruitment of 68 participants ensures that if 20% are lost to follow up, the intervention will still be adequately powered at 80% to detect a meaningful change. A dropout rate of 20% is a conservative estimation, given previous dropout rates of ~10% in similar intervention designs for survivors (Bennett et al., 2007; Short et al., 2012).

8.2.5 Instruments

8.2.5.1 Primary Outcomes

The primary outcome will be minutes of MVPA ascertained using the ActiGraph Link GT9X (ActiGraph, LLC, Pensacola, FL, USA). Participants will wear the accelerometer on their right hip for all waking hours across 7 consecutive days. Individual days of wear time must exceed 10 hours to be considered valid for analysis. Non-wear periods defined as intervals of at least 60 consecutive minutes of zero counts per minute (CPM) will be excluded from analyses. Activity counts will be categorised as: sedentary (<100cpm), light intensity (100–1951cpm), moderate intensity (1952–5724cpm), and vigorous intensity (>5725cpm), using data recorded in 60-second epochs (Lynch, Boyle, et al., 2016).

8.2.5.2 Secondary Outcomes

Sedentary Behaviour

Sedentary behaviour will be defined by accelerometer activity counts of <100cpm, for 20 consecutive minutes or more, which corresponds to clinical changes in cardio-metabolic biomarkers (Lynch, Boyle, et al., 2016). The accelerometer log (Appendix I, Section I.4) completed by participants will assist in differentiating sedentary time from non-wear time.[5]

8.2.5.3 Covariates

Several demographic characteristics and comorbidities have been identified as covariates in cancer survivors, based on similar research (Loprinzi & Lee, 2014). Therefore, this information will be obtained at T1, including marital status, household income, and educational attainment (Appendix I, Section I.6).

[5]Additional secondary outcomes in the published version of this chapter included self-reported physical activity, quality of life, and HAPA constructs. However, examination of the effects of the WATAAP intervention on these secondary outcomes falls outside the scope of this thesis. Therefore, the description of these measures has been omitted from this chapter for clarity and is shown in Appendix I, Section I.5.

Blood pressure will be measured using an Omron IC-10 Upper Arm Blood Pressure Monitor (HEM 7070-E), which has been validated for use by the British Hypertension Society (2017). BMI will be calculated by measuring height at T1 and weight at each assessment.

8.2.5.4 Process Evaluation

Intervention acceptability will be assessed at T3, where participants will be invited to provide feedback concerning the effective and ineffective components, and the practicality of the intervention via interviews. Fitbit use will be monitored weekly using the Fitbit software, to assist with the assessment of intervention adherence.

8.2.6 Procedure

Participants will contact a member of the trial team to express their interest in participating in the study. Those who express interest will undergo phone screening to assess eligibility, before organising their baseline assessment appointment.

Assessments will be conducted in a clinic room at St John of God Subiaco Hospital, Perth, Western Australia. The baseline assessments will be performed by a member of the trial team (CMS), prior to randomisation. Subsequent assessments will be performed by a trial co-ordinator who is blinded to group allocation and not involved in the administration of the intervention. Group sessions will be held in a meeting room at St John of God Subiaco Hospital and led by team investigators (CMS and SJH). Text messages and phone calls will act as reminders for participants to attend group sessions. Attendance at group sessions will be monitored as a measure of intervention adherence.

The baseline assessment will begin with participants reading the information sheet (Appendix I, Section I.3) before providing consent to participate (Appendix I, Section I.7). Participants will be required to complete a questionnaire assessing demography, physical activity, quality of life, exercise attitudes, and cardiovascular risk. Height (only at T1), weight, and blood pressure will then be recorded by the assessor. At the end of their assessment, participants will be provided with an ActiGraph Link GT9X accelerometer (ActiGraph, LLC, Pensacola, FL, USA) to record their activity for the subsequent week, an accelerometer log for recording accelerometer wear, and a HAPA-based trial booklet. The assessor will inform the participant of the accelerometer wear instructions and provide a prepaid postage satchel to the participant to return their accelerometer. The assessment procedure will be repeated at T2 and T3. The intervention will cease prior to the T2 assessment and the treatment group will be required to return their Fitbit at T3.

8.2.6.1 Intervention

The intervention includes three components:

1. a Fitbit Alta;
2. two group sessions;
3. one telephone-delivered feedback and support session.

All participants will receive a HAPA-based printed booklet on physical activity guidelines, home-based exercises, benefits of regular physical activity, physical activity logs, confidence building, barrier solving, coping planning, action planning, and goal-setting activities.

Intervention Arm

1. **WAT tracker:** Participants are provided with a Fitbit Alta activity tracker, which they will sign-out at their first group sessions, and be encouraged to wear for the duration of the trial. This is a slim, wrist-worn device that displays steps, distance, "active minutes" (MVPA in bouts of at least 10 minutes), and caloric expenditure. The Fitbit was chosen because previous work demonstrates its usefulness and acceptance amongst cancer survivors (Nguyen et al., 2017) and older adults (>70; McMahon et al., 2016). The Fitbit Alta also alerts users to sedentary behaviour and progress towards activity goals. Data from the device can be uploaded to the Fitbit application via Bluetooth. At the first group session, participants will be assisted to install the smartphone/tablet/computer application, and to pair their device with the application. A member of the trial team will send friend requests to each participant so that engagement with the application and activity can be monitored weekly.
2. **Group sessions**: Sessions lasting for approximately 2-hours will be delivered at weeks 1 and 4, with approximately 10–12 participants in each session. Group sessions will correspond with components of the HAPA-model.

    a) Session one (week 1) will focus on introducing participants to the Fitbit Alta and giving instructions on how to use the device as a self-monitoring tool. The first part of the session will be largely didactic covering risks of inactivity (corresponding to the risk perceptions construct in HAPA), the benefits of physical activity (targeting positive outcome expectancies of the HAPA), detailed physical activity guidelines (steps and MVPA), and enhancing confidence and importance to participate in physical activity at the recommended

level (targeting action self-efficacy and intention). In keeping with this approach, personalised physical activity feedback will be provided to each participant based on their T1 accelerometer data. During this session, participants will be encouraged to complete action planning activities within the WATAAP trial booklet (illustrative excerpt shown in Appendix I, Section I.8), which corresponds to HAPA action planning as a strategy to aid the translation of intentions to behaviour. Participants will also have an opportunity to engage in goal-setting exercises from the WATAAP booklet for the following 3 weeks. Behaviour change specialist SJH and CMS will assist participants with action planning, goal-setting, and self-monitoring activities.

b) Session two (week 4) will be focused on support needs, problem solving, and coping planning. The session will use the WATAAP booklet to prompt physical activity planning and coping planning (corresponding to HAPA coping planning) for the following 4 weeks, as well as targeting maintenance self-efficacy. Specifically, participants will be asked to consider situations or obstacles to implementing their physical activity plans, and form *if–then* plans. The final part of the session will involve demonstrations of strength-training exercises that could be performed at home, using household items. Participants will be given the opportunity to practise strength-based exercises during the session to check their technique and foster perceptions of confidence. This session will also allow for troubleshooting of problems that participants encounter regarding Fitbit use.

3. **Telephone-delivered feedback and support session**: A trial team member will telephone each participant during week 8 of the trial for approximately 20 minutes. The purpose of the call will be to discuss progress to date, with a focus on self-regulation, maintenance self-efficacy and coping planning, based on the principles of the HAPA and the relational techniques of motivational interviewing (Hardcastle, Fortier, et al., 2017). Coping planning to overcome barriers will also be discussed. The interview guide is shown in Appendix I, Section I.9.

Control Arm

Participants in the control group will receive the WATAAP trial booklet (illustrative excerpt shown in Appendix I, Section I.8) containing physical activity guidelines and motivational tools. However, the control group will not receive group sessions, a Fitbit Alta or a telephone-delivered support session. Participants will receive feedback on their

physical activity levels and be offered the opportunity to trial the Fitbit Alta for 6 weeks following trial completion (post-T3).

8.3 Results

8.3.1 Statistical Analyses

Primary and secondary outcome variables will be analysed via a series of GLMMs employing appropriate distributions and link functions for each outcome measure. All GLMMs will include the fixed effects of group (intervention vs. control), time (T1, T2, and T3), and the 2-way *group x time* interaction. A random effect of *participant* will be included to account for the correlation within people, inherent in a longitudinal design.

Cancer type, gender, age, socio-economic status, BMI, and blood pressure will be included as covariates within the model. Compared to the traditional statistical procedures for analysing behavioural change, the GLMM is less sensitive to participant attrition because it does not rely on participants providing data at every assessment point. The GLMM maximum likelihood procedure is a full information estimation procedure that uses all data present at each assessment time-point. Missing data will be investigated for patterns in terms of observed study variables. Multiple imputation will be considered if data are arguably missing at random and less than 20% of the data are missing. Twenty-five data sets will be imputed based on all relevant observed variables, including the interaction term and outcome measure of interest for each specific analysis. Sensitivity analyses will be conducted to consider the effect of potential missing not-at-random mechanisms on parameter estimates from imputed datasets (Sterne et al., 2009). Qualitative data from post-trial interviews will be analysed using inductive thematic content analysis to identify common themes concerning active ingredients, barriers to behaviour change, and intervention acceptability (Braun & Clarke, 2006).

8.4 Discussion

The trial will examine the effectiveness and acceptability of an intervention that combines WAT (the Fitbit Alta) with self-regulation techniques (action planning, goal setting, and coping planning) to increase physical activity and reduce sedentary behaviour in colorectal and endometrial cancer survivors. This protocol describes the first intervention to employ the Fitbit Alta to promote physical activity in adult survivors, contributing to the growing research on the effectiveness of home-based, brief interventions to promote physical activity.

There is growing evidence to suggest that physical activity reduces the risk of cardiovascular disease and cancer recurrence (Hamer & Warner, 2017). However, few survivors are meeting the minimum physical activity guidelines (Rock et al., 2012). Feasible physical activity interventions that meet the preferences and support needs of cancer survivors, and can be integrated into routine practice contexts, are needed (Hardcastle & Cohen, 2017).

Previous research supports the exercise preferences of cancer survivors for home-based, unsupervised, self-paced, moderate-intensity physical activity, that involves primarily walking (Hardcastle, Maxwell-Smith, Kamarova, et al., 2018, Hardcastle & Cohen, 2017; Maxwell-Smith et al., 2017), and the desire for monitoring and accountability (Bennett et al., 2007; Hardcastle, Maxwell-Smith, Kamarova, et al., 2018). Since self-monitoring (Hardcastle, Hancox, et al., 2015) has been identified as an effective strategy for increasing physical activity, WAT may serve as a valuable tool for measuring activity in a practical and motivational way. Further, home-based interventions offer advantages that may mitigate access and transport issues, and are less expensive than supervised, facility-based programs that require participants to attend classes or maintain a health club membership (Hardcastle, Glassey, et al., 2017). Examination of intervention acceptability will indicate whether such programs can be implemented for improving physical activity of cancer survivors as a part of follow-up care. If this home-based and low-intensity design is found to be effective, other health outcomes such as fatigue may be targeted in similar digital interventions for survivors (Brandenbarg et al., 2018).

Between 12 weeks (T2) and 24 weeks (T3), intervention participants will keep the activity tracker but receive no formal support. Therefore, changes in physical activity between T2 and T3 in the intervention group will provide some insight concerning whether ongoing behavioural support is necessary in combination with WAT to sustain increases in MVPA and reductions in sedentary behaviour. Interventions that are able to demonstrate sustained increases in physical activity are needed.

8.4.1 Conclusion

The WATAAP trial is pragmatic and primarily concerned with evaluating whether a low-intensity intervention package (WAT combined with limited behavioural support) is effective for increasing MVPA and reducing sedentary behaviour in survivors compared to usual care. If found to be effective, this would suggest the integration of such low-cost

interventions into clinical practice contexts with the support of oncology clinicians, nurses, allied professionals, or charitable organisations.

Chapter Nine

9

Wearable Activity Technology And Action Planning (WATAAP) – Randomised Trial

Chapter Overview

This chapter, published in *Psycho-Oncology*, presents the primary findings of *Study Three.* An introduction to the WATAAP trial is provided and the findings of the trial are discussed. The primary outcome of MVPA is considered, ahead of secondary outcomes of physical activity and cardiovascular risk. The results of the WATAAP trial are discussed in relation to the effectiveness of wearable tracker-based interventions with a suggestion to examine long-term effects. This chapter provides a significant and novel contribution to the existing knowledge on smart WAT as a component of behavioural interventions in colorectal and endometrial cancer survivors.

PUBLICATION – A RANDOMISED CONTROLLED TRIAL OF WEARABLE ACTIVITY TECHNOLOGY AND ACTION PLANNING (WATAAP) TO PROMOTE PHYSICAL ACTIVITY IN COLORECTAL AND ENDOMETRIAL CANCER SURVIVORS

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A randomized controlled trial of WATAAP to promote physical activity in colorectal and endometrial cancer survivors

Maxwell-Smith, C., Hince, D., Cohen, P. A., Bulsara, M. K., Boyle, T., Platell, C., Tan, P., Levitt, M., Salama, P., Tan, J., Salfinger, S., Makin, G. B., Mohan, G. R. K. A., Jiménez-Castuera, R., & Hardcastle, S. J. (2019). A randomized trial of WATAAP to promote physical activity in colorectal and endometrial cancer survivors. *Psycho-Oncology, 28*(7), 1420–1429. https://doi.org/10.1002/pon.5090

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Abstract

Objective. The objective of this study was to ascertain whether wearable technology, coupled with action planning and goal setting was effective in increasing physical activity in colorectal and endometrial cancer survivors at cardiovascular risk.

Methodology. Sixty-eight survivors who had cardiovascular risk factors and were insufficiently active were randomised to intervention and control arms. Participants in the intervention arm were given a wearable tracker for 12 weeks, two group sessions, and a support phone-call. Participants in the control arm received print materials describing physical activity guidelines. Assessments at baseline and 12 weeks measured triaxial and uniaxial estimates of MVPA, sedentary behaviour, blood pressure, and BMI.

Results. A net increase of 66 minutes in MVPA per week favouring the intervention group was identified at 12 weeks. *Group x time* interactions were significant for minutes of MVPA (F (1, 126) = 5.14, p = .025). For those with diastolic hypertension there was a significant *group x time* interaction (F (1, 66) = 4.89, p = .031), with a net reduction of 9.65mmHg between groups.

Conclusions. Significant improvements in MVPA were observed following the intervention. The results display promise for the use of pragmatic, low-intensity interventions using WAT.

9.1 Introduction

Physical activity reduces the risk of cardiovascular disease (J. Stewart et al., 2017), cancer, and cancer-related death (Hamer & Warner, 2017). In survivors of cancer, physical activity may reduce the risk of recurrence (Hamer & Warner, 2017). Sedentary behaviour is an independent risk factor for cancer occurrence and mortality (Kerr et al., 2017). However, few cancer survivors meet the current guidelines of >150 minutes of MVPA per week (Rock et al., 2012) and many are sedentary (Lynch, Boyle, et al., 2016).

Although survival rates are increasing, many colorectal and endometrial cancer survivors have comorbidities and lifestyle-related risk factors for cardiovascular disease (Weaver, Foraker, et al., 2013), including insufficient physical activity, sedentary behaviour, poor diet, and obesity (Hamer & Warner, 2017; Ward et al., 2012; Weaver, Foraker, et al., 2013). Over 58% and 63% of colorectal and endometrial survivors respectively are overweight or obese (C. R. Leach, Weaver, et al., 2015). Further, ~50% and ~70% of colorectal and endometrial survivors respectively are insufficiently active (Hammer et al., 2014; Lynch, van Roekel, & Vallance, 2016) putting these survivors at cardiovascular risk. In a retrospective cohort study of more than 30,000 endometrial cancer patients, cardiovascular disease was the leading cause of death (Ward et al., 2012).

Many physical activity interventions in cancer survivors are facility-based, supervised, or group-based (Buffart et al., 2014; Covington et al., 2019; Hardcastle, Maxwell-Smith, Kamarova, et al., 2018; H. J. Leach et al., 2019; Speck et al., 2010), despite survivors identifying barriers around cost, accessibility, and intimidation (Hardcastle, Glassey, et al., 2017; Maxwell-Smith et al., 2017). Many survivors express a preference for unsupervised, self-paced, light-to-moderate intensity physical activity, specifically walking (Blaney et al., 2013; Hardcastle & Cohen, 2017). Home-based interventions may mitigate barriers to exercise, complement exercise preferences and facilitate exercise adherence (Hardcastle & Cohen, 2017; Hardcastle & Hagger, 2016). There is a gap in knowledge concerning the effectiveness of less intensive home-based interventions that may be more cost-effective and scalable.

Wearable trackers hold potential as a low-cost and continuous self-monitoring tool, with their associated applications offering several evidence-based BCTs, including goal setting, feedback, self-monitoring, and social support (Lyons et al., 2014; Michie et al., 2013). As such, WAT could represent a cost-effective and scalable intervention. However, several evidence-based BCTs are not integrated into trackers or their respective smartphone applications, including action planning, coping planning, commitment, and

instruction on performance of the behaviour (Lyons et al., 2014). Due to these omissions and other barriers, including dwindling motivation, WAT alone might be insufficient to produce long-term physical activity engagement (Simblett et al., 2018). The present trial included two group sessions to include these BCTs that are largely omitted from WAT and their respective smartphone applications. Reviews of trials incorporating WAT support the effectiveness of trackers for increasing physical activity (Ridgers et al., 2016) and reducing sedentary behaviour (Stephenson et al., 2017).

There is evidence to support the effectiveness of WAT for increasing physical activity amongst adults with chronic disease (M. A. Kirk et al., 2019), post-menopausal women (Cadmus-Bertram et al., 2015), and breast cancer survivors (Hartman, Nelson, Myers, et al., 2018; Pope et al., 2018). Research on smart wearable trackers in survivors has thus far been limited to predominantly breast cancer survivors and has not involved group sessions as a component of the intervention. The current trial is novel because it includes group sessions and relational support (Hardcastle, Fortier, et al., 2017), and the inclusion of BCTs (e.g., action planning) that are absent from wearable trackers and their respective smartphone applications. To the author's knowledge, the WATAAP trial is the first to combine a smart wearable activity tracker with group sessions, in a pragmatic, low-intensity intervention to improve physical activity and reduce sedentary behaviour in colorectal and endometrial cancer survivors.

The primary aim of the WATAAP trial was to ascertain whether wearable technology, in conjunction with action planning, goal setting and coping planning, was effective in increasing MVPA in colorectal and endometrial cancer survivors at cardiovascular risk. A secondary aim was to assess the effectiveness of the intervention for reducing sedentary time, blood pressure, and BMI.

9.2 Methodology

The trial was a two-arm, multicentre RCT, conducted in Perth, Western Australia. The study was approved by the St John of God Human Research Ethics Committee (#1102; Appendix I, Section I.1), and registered (ANZCTR2617000131358). Written informed consent (Appendix I, Section I.7) was obtained from participants prior to enrolment.

9.2.1 Participants

Participants included stage 1 and 2 colorectal and endometrial cancer survivors who had completed active cancer treatment within the 5 years prior to recruitment and were

deemed to be insufficiently physically active and at elevated risk of cardiovascular disease. The full eligibility criteria have been previously published (Maxwell-Smith et al., 2018).

9.2.2 Recruitment

Eligible cancer survivors were identified from colorectal (n = 4) and gynaecologic (n = 4) oncologists' medical records and were mailed an invitation letter (Appendix I, Section I.2) and participant information sheet (Appendix I, Section I.3). Individuals who expressed interest were screened by telephone from July 2017 to ensure eligibility prior to recruitment, with assessments occurring in August 2017 and December 2017.

9.2.3 Randomisation

Following baseline assessments, an independent statistician who was blinded to the assessments and intervention, randomised participants to intervention or control arms using consecutive randomisation codes (STATA v14) with a 1:1 allocation in blocks of 4.

9.2.4 Design

9.2.4.1 Intervention Arm

The 12-week intervention consisted of three components, which have previously been described (Maxwell-Smith et al., 2018):

1. The Fitbit Alta is cost-effective, slim, and has demonstrated acceptability for use by cancer survivors (Hardcastle, Galliott, et al., 2018). The wrist-worn tracker records daily steps, MVPA accrued in bouts of ≥10 minutes (MV10), distance, and provides automated prompts encouraging participants to accumulate ≥250 steps per hour. Participants received and set up their Fitbit Alta during group session 1 using their phone, tablet, or computer. Fitbit engagement data were collected daily via the Fitbit dashboard following participants' acceptance of a friend request with a study investigator.
2. Participants attended a 2-hour group session (~11 per group) facilitated by behaviour change specialist SJH and CMS in weeks 1 and 4. Session 1 involved Fitbit set-up and presentation on physical activity messaging, goal setting, confidence building, action planning, coping planning, and self-monitoring of active and sedentary behaviour. Emphasis was given to reducing bouts of sedentary behaviour and responding to the automatic prompts to take steps, in addition to encouraging planned bouts of MVPA. Participants were assisted to complete action planning and goal-setting activities. Session 2 focused on reviewing goals, forming *if–then* plans and coping strategies to overcome barriers, based on previous research (Hardcastle,

Glassey, et al., 2017; Maxwell-Smith et al., 2017). Home-based strength exercises were demonstrated with an opportunity for practise. Participants were encouraged to log strength training manually on the Fitbit application.

3. Participants received a 20-minute phone call from CMS or SJH during week 8 to discuss progress, assessment of physical activity in relation to the guidelines, amendment of goals, and coping planning strategies. The interview guide is shown in Appendix I, Section I.9.

9.2.4.2 Control Arm

This group received the trial booklet (also given to the intervention group), which included print materials containing physical activity guidelines and recommendations, but were not specifically encouraged to increase their physical activity. The booklet also included examples of aerobic training that could be completed at home, and worksheets to self-monitor and self-regulate physical activity engagement (illustrative excerpt shown in Appendix I, Section I.8).

9.2.5 Assessments

Data collection was performed during 30-minute assessments at baseline (T1), and 12 weeks (T2). Assessments post-randomisation were conducted at St John of God Subiaco Hospital by hospital staff blinded to group allocation, who measured height (only at T1), weight, and blood pressure. Participants were given an ActiGraph Link GT9X accelerometer (ActiGraph, LLC, Pensacola, FL, USA), waistband, wear log (Appendix I, Section I.4), and postage materials. Participants were instructed to wear the accelerometer on the day following their assessment and to continue to wear it for seven consecutive days, before posting the accelerometer back to the research team.

9.2.6 Outcome Measures

9.2.6.1 Physical Activity

Minutes per week of MVPA were ascertained from the ActiGraph Link GT9X accelerometer (ActiGraph, LLC, Pensacola, FL, USA). Participants wore the accelerometer on their right hip for all waking hours across seven consecutive days at each assessment time point. Wear time had to exceed ten hours per day and contain no excessive counts (>20,000) to be considered valid, with non-wear time defined as at least 60 consecutive minutes of zero counts (C. E. Matthews et al., 2008). Data were processed

using 60-second epochs. Daily accelerometer logs were completed by participants to allow for cross-checking of data.

Two thresholds were applied to the data to define physical activity.

1. Sasaki cut-points were the primary outcome measure since they utilise triaxial data based on three planes of movement (vertical, antero-posterior and medio-lateral) (Sasaki et al., 2011). The Sasaki equation has been validated (Sasaki et al., 2011) and demonstrated better accuracy and precision in assessing MVPA among free-living older adults (Aguilar-Farias et al., 2019). Sasaki vector magnitude unit (VMU) cut-points were: sedentary (<674vmu), moderate (2690–6165vmu), vigorous (6167+vmu), and MVPA (2690+vmu). Bouts of sedentary time for a minimum of 20 consecutive minutes were analysed due to corresponding clinical changes in cardio-metabolic biomarkers (Lynch, Boyle, et al., 2016).
2. Freedson cut-points (Freedson et al., 1998) rely on uniaxial data (vertical plane) and are the most commonly reported in the field, therefore allowing comparison of WATAAP findings to other studies (Peddle-McIntyre et al., 2018). Freedson cut-points were: sedentary (<100cpm), moderate (1952–5724cpm), vigorous (5725+cpm), and MVPA (1952+cpm). Sedentary behaviour was also considered in 20-minute bouts (<100cpm).

9.2.6.2 Cardiovascular Risk

Blood pressure and BMI indicated modifiable cardiovascular risk. Blood pressure was measured twice and averaged using an Omron IC-10 Upper-Arm Monitor (HEM 7070-E) before being recorded in millimetres of mercury (mmHg). BMI was calculated using participants' weight at each assessment and height measured at T1.

9.2.7 Sample Size

Sample size calculations were aimed at detecting a small-to-moderate effect (f = .17) when comparing treatment and control groups on our primary outcome of MVPA, as identified in similar designs (Speck et al., 2010). Fifty-six participants were required (28 per group) for a *group x time* interaction on the primary outcome of MVPA, with 80% power and an alpha level of 0.05. Recruitment of an additional 20% allowed for attrition.

9.2.8 Statistical Methods

All analyses were performed using SPSS Statistics v24 (SPSS Inc., Chicago, IL, USA). Demographic characteristics at baseline are reported for intervention and control arms (Table 9.1). Since MV10 included a large proportion of true zero minutes/week values, models produced a poor fit. MV10 was therefore dichotomised into insufficiently active (<150 minutes/week) vs. sufficiently active (≥150 minutes/week).[6] Other continuous outcomes were inspected graphically to determine appropriate distributions for the GLMMs. Residual and deviance distributions were visually inspected to ensure they were consistent with the assumption of normality for continuous outcomes. The specific GLMM used to analyse each measure is listed in Table 9.2. The *estimated means* from the models are reported for continuous measures as these are the best representation of central tendency of the data given the distributions of the outcome variables (Table 9.3). *Observed means*, based on the usual assumption of normality, are reported in Table 9.4 for the purpose of comparison with other studies.

All models included the fixed effects group (intervention, control), time (T1, T2), and *group x time* interaction, with a random intercept for *participant*. All models were subsequently adjusted for minutes of accelerometer wear, age, gender, and cancer type, but these factors did not alter the results (data not shown).

A sensitivity analysis was performed only for participants who had specific cardiovascular risk factors at baseline (Table 9.5). A second sensitivity analysis excluded seven participants who did not adhere to the intervention or control group (Table 9.6).

9.3 Results

Figure 9.1 displays the flow of randomised participants to intervention (n = 34) and control (n = 34) groups. Non-response bias analyses revealed no significant differences across age, ASA score, BMI, cancer grade, gender, surgeon, hospital site, cancer type, or adjuvant therapies between responders and non-responders to the invitation letter. Responders had a shorter follow-up time since diagnosis (2.2 vs. 2.9 years) compared to non-responders (t (276) = 3.22, p <.05).

Demographic characteristics were similar across groups at baseline, except that the intervention arm contained more endometrial survivors (Table 9.1). Sixty-four

[6] Outcomes are presented in units per week, per previous recommendations to facilitate comparisons across studies (Friedenreich et al., 2019).

participants (94%) completed the 12-week assessment. Intervention adherence was excellent, with 94% attendance across group sessions. Eighty-eight percent (n = 29) of participants in the intervention group accepted the Fitbit friend request. Fitbit engagement was high with 86% (SD = 29) of valid wear-days over the 12 weeks (n = 28). Three participants did not appear to engage with their Fitbit beyond week 4, and one experienced syncing errors. Mean daily steps across each intervention week are reported in Figure 9.2, with steps ranging from 8,233 per day in week 2 to 10,318 per day in week 12 (M = 9217, SD = 705). Despite all participants reporting as insufficiently active during phone screening, eight participants (12%) completed ≥150 minutes per week of MV10 at baseline, according to uniaxial estimates. These participants have been included for the purposes of the intention-to-treat analyses.

Table 9.1
Baseline Characteristics of WATAAP Trial Participants

	Overall (n = 68)	**Intervention** (n = 34)	**Control** (n = 34)	***p***
	Mean (SD)	*Mean* (SD)	*Mean* (SD)	
Age	64.07 (7.94)	65.26 (7.41)	62.88 (8.37)	.218
Body Mass Index	28.26 (4.95)	28.86 (4.93)	27.66 (4.96)	.322
	n (%)	*n* (%)	*n* (%)	
Gender				.069
Female	34 (50.0%)	21 (61.8%)	13 (38.2%)	
Male	34 (50.0%)	13 (38.2%)	21 (61.8%)	
Marital status				.359
Married/In a relationship	52 (76.4%)	25 (73.5%)	27 (79.4%)	
Divorced/Separated	9 (13.2%)	6 (17.6%)	3 (8.8%)	
Single	6 (8.8%)	2 (5.9%)	4 (11.8%)	
Widowed	1 (1.5%)	1 (2.9%)	0	
Education				.670
University degree	33 (48.5%)	17 (50.0%)	16 (47.1%)	
Post-school training	17 (25.0%)	9 (26.5%)	8 (23.5%)	
High school	18 (26.5%)	8 (23.5%)	10 (29.4%)	
Ethnicity				1.000
Caucasian	66 (97.1%)	33 (97.1%)	33 (97.1%)	
Indian	2 (2.9%)	1 (2.9%)	1 (2.9%)	
Household income (AUD)				.339
≤$30,000	7 (10.3%)	5 (14.7%)	2 (5.9%)	
$30,001–$52,000	18 (26.5%)	11 (32.4%)	7 (20.6%)	

	Overall (*n* = 68)	**Intervention** (*n* = 34)	**Control** (*n* = 34)	***p***
$52,001–$104,000	20 (29.4%)	7 (20.6%)	13 (38.2%)	
$104,001–$156,000	13 (19.1%)	6 (17.6%)	7 (20.6%)	
≥$156,000	9 (13.3%)	4 (11.7%)	5 (14.7%)	
Missing	1 (1.5%)	1 (2.9%)	0	
Smoking status				.562
Non-smoker	55 (80.9%)	26 (76.5%)	29 (85.3%)	
Ex-smoker	11 (16.2%)	7 (20.6%)	4 (11.8%)	
Current smoker	2 (2.9%)	1 (2.9%)	1 (2.9%)	

	Overall (*n* = 68)	**Intervention** (*n* = 34)	**Control** (*n* = 34)	***p***
Comorbidities				.950
Overweight	25 (36.8%)	12 (35.3%)	13 (38.2%)	
Obese	24 (35.3%)	14 (41.2%)	10 (29.4%)	
Hypertensive	26 (38.2%)	11 (32.4%)	15 (44.1%)	
Hypercholesterolemic	15 (22.1%)	8 (23.5%)	7 (20.6%)	
Diabetic	9 (13.2%)	3 (8.8%)	6 (17.6%)	
Insufficiently active	60 (88.2%)	32 (94.1%)	28 (82.4%)	
Cancer type				**.042**
Colorectal	53 (77.9%)	23 (67.6%)	30 (88.2%)	
Endometrial	15 (22.1%)	11 (32.4%)	4 (11.8%)	
Treatment				.760
Surgery only	35 (51.5%)	16 (47.1%)	19 (55.9%)	
Surgery with chemotherapy	17 (25.0%)	11 (32.4%)	6 (17.6%)	
Surgery with radiotherapy	2 (2.9%)	2 (5.9%)	0	
Surgery with chemotherapy and radiotherapy	14 (20.6%)	5 (14.7%)	9 (26.5%)	

Note. *cancer type differed between groups, $p < .05$. Hypertensive: ≥140/90mmHg or taking antihypertensive medication. Hypercholesterolemic: total cholesterol >5.2mmol/L or taking antihypercholesterolemic medication. Insufficiently active: completing <150 minutes/week of MVPA in bouts of ≥10 minutes.

Figure 9.1
Consort Flow Diagram of the WATAAP trial

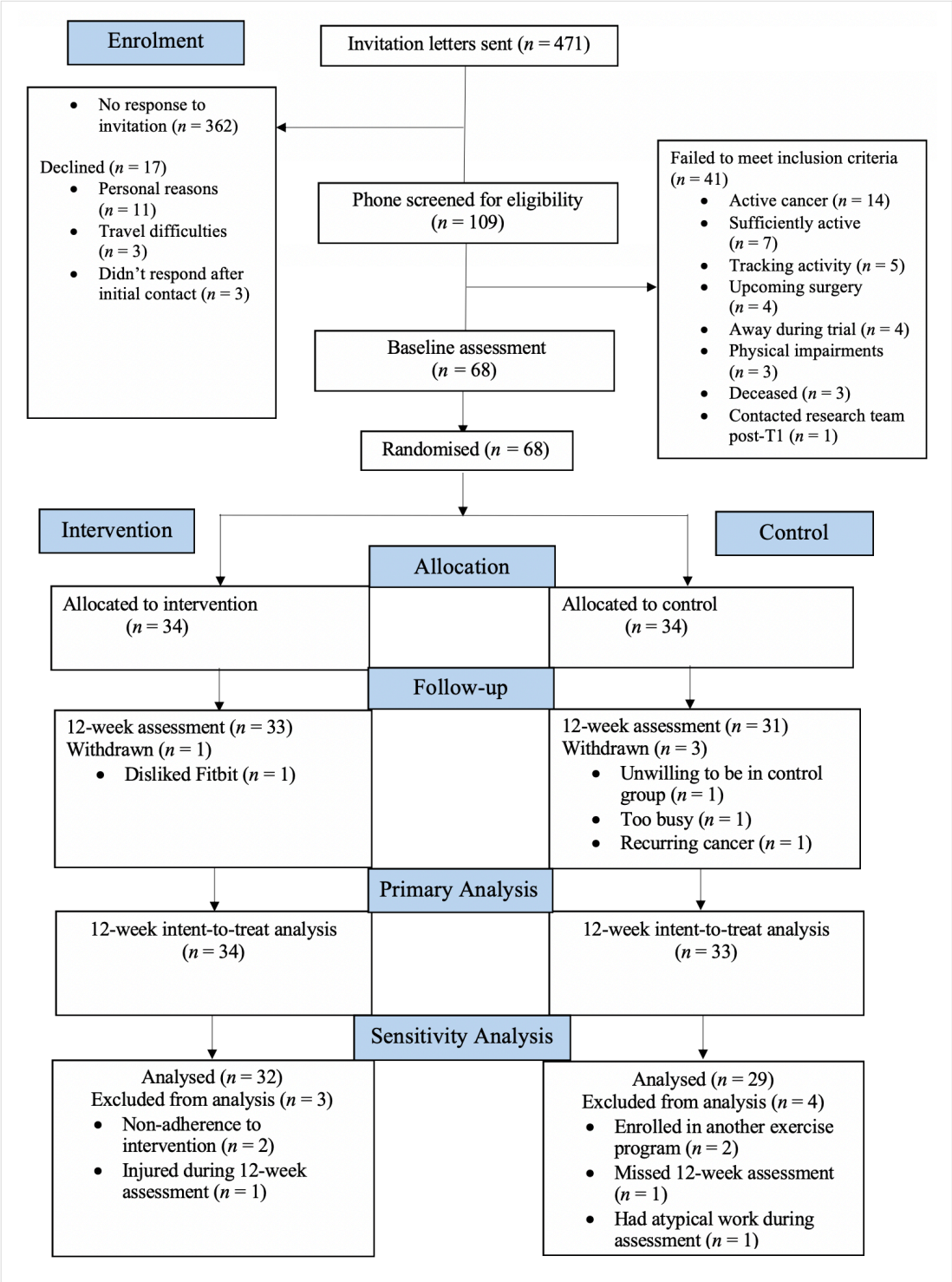

Figure 9.2
Fitbit Recorded Daily Step Count Averaged Across Participants for Each Week of the WATAAP Intervention

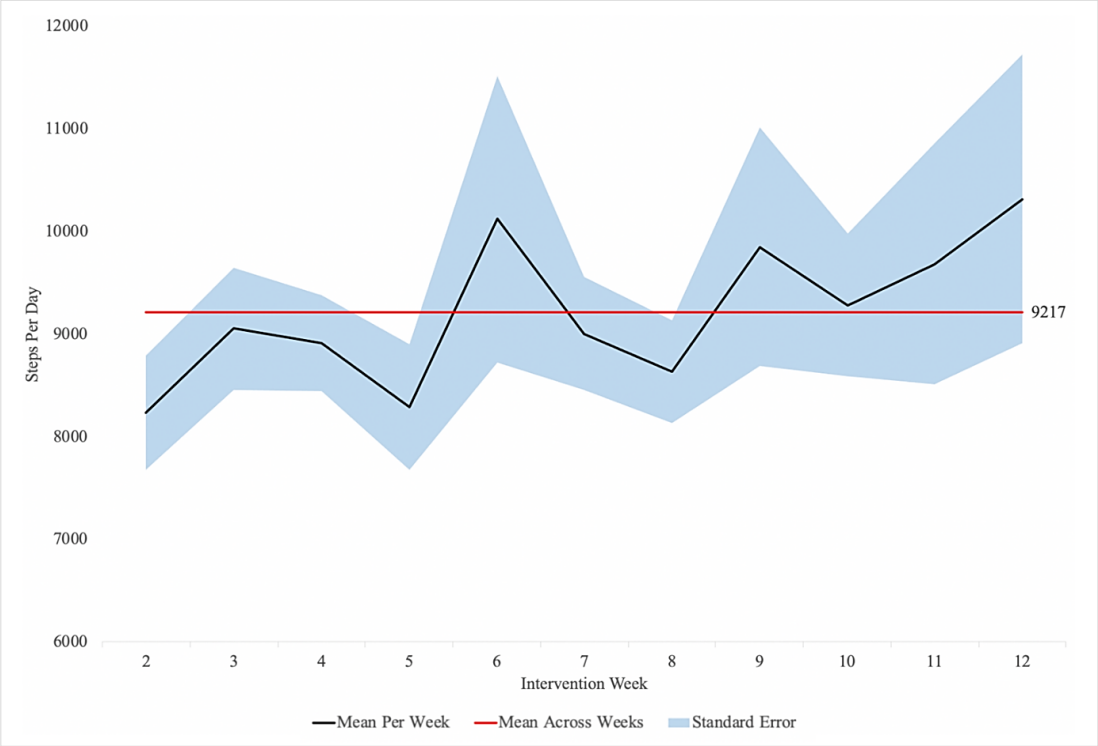

Table 9.2
Distribution Families, Link Functions, and Outcomes Reported Using Generalised Linear Mixed Models

	Distribution Family	Link Function	Outcome Measure Reported
Activity Measures			
MVPA	Gamma	Natural log	Estimated margins (mins/week)
Moderate	Gamma	Natural log	Estimated margins (mins/week)
Sedentary (hrs/week)	Normal	Identity	Estimated margins (hrs/week)
Sedentary in bouts of ≥20 min (hrs/week)	Normal	Identity	Estimated margins (hrs/week)
MVPA in bouts of ≥10 min	Binomial	Logit	N and % of participants sufficiently active (≥150 mins/week)
Cardiovascular Risk Factors			
Systolic blood pressure	Normal	Identity	Estimated margins (mmHg)
Diastolic blood pressure	Normal	Identity	Estimated margins (mmHg)
Body mass index	Normal	Identity	Estimated margins (kg/m^2)

9.3.1 Intention-to-Treat Analyses

9.3.1.1 Activity Measures

The intervention group demonstrated significant increases in MVPA (net change: 66 minutes per week; F (1, 126) = 5.14, p = .025) compared with the control group using triaxial estimates but not uniaxial estimates (MVPA net change: 36 minutes per week, F (1, 127) = 2.29, p = .133; moderate net change: 40 minutes per week, F (1, 127) = 3.13, p = .079. Uniaxial estimates are consistently lower than triaxial estimates (Table 9.3). The *group x time* interaction for the dichotomised MV10 was non-significant (F (1, 126) = .00, p = .989). However, the observed mean increases in MV10 were higher in the intervention group vs. the control group on both triaxial (29 vs. 8 minutes per week) and uniaxial measures (31 vs. 7 minutes per week) of MVPA accumulated in bouts of at least 10 minutes. Sedentary time decreased significantly from T1 to T2 by 2.94 and 2.61 hours per week for the intervention and control group respectively (F (1, 126) = 10.04, p <.01). Sedentary behaviour in ≥20-minute bouts decreased for both groups (F (1, 127) = 13.61, p <.001). *Group x time* interactions were non-significant (F (1, 127) = .09, p = .767; Table 9.3).

9.3.1.2 Cardiovascular Risk Outcomes

SBP (F (1, 128) = 17.36, p <.001), diastolic blood pressure (DBP) (F (1, 128) = 4.43, p <.05), and BMI (F (1, 128) = 35.31, p <.01) improved significantly over time across both groups. *Group x time* interactions for these three outcomes were non-significant (Table 9.3), however, the reduction in SBP and DBP for the intervention group was more than twice that of the control group (-14 vs. -6mmHg, respectively for SBP and -5 vs. -1mmHg for DBP). For participants with hypertension (DBP) at baseline (n = 36), there was a significant *group x time* interaction (F (1, 66) = 4.89, p =.031) with a net reduction of 9.65mmHg in the intervention group. Reductions in SBP, according to hypertensive risk (n = 47 ≥140/90mmHg) were not significantly different between the intervention and control groups respectively (-17 vs. -9mmHg) (Table 9.5).

9.3.2 Sensitivity Analyses

Exclusion of seven participants due to non-adherence (Table 9.6) resulted in significant interactions on MVPA for triaxial (F (1, 112) = 14.93, p <.001) and uniaxial (F (1, 113) = 8.96, p =.003) estimates with net increases of 103 and 64 minutes respectively, in favour of the intervention. MV10 yielded a significant *group x time* interaction on uniaxial

estimates (F (1, 113) = 4.30, p =.040), with six participants becoming sufficiently active in the intervention group, compared to two in the control group at T2.

Table 9.3
Estimated Means for Physical Activity and Cardiovascular Risk Outcomes

	Baseline		12 Weeks		Change		Group x time	
	Intervention *Mean* (CIs)	**Control** *Mean* (CIs)	**Intervention** *Mean* (CIs)	**Control** *Mean* (CIs)	**Intervention** *Change* (CIs)	**Control** *Change* (CIs)	***F***	***p***
	All Participants (*n* = 67)						*df* (1,126)	
Triaxial estimates								
MVPA (mins/week)	267 (207, 344)	261 (202, 337)	312 (242, 402)	240 (185, 311)	+45 (2, 88)	-21 (-59, 17)	5.14	**.025**
Moderate activity (mins/week)	254 (198, 325)	247 (192, 317)	295 (230, 379)	217 (168, 280)	+41 (0, 83)	-29 (-65, 7)	6.77	**.010**
Sedentary time (hrs/week)	72 (68, 75)	72 (68, 75)	69 (66, 72)	69 (65, 72)	-3 (-5, -1)	-3 (-5, 0)	.04	.851
MV10 (completing ≥150 mins/week)	*n* = 6 (18%)	*n* = 5 (15%)	*n* = 9 (27%)	*n* = 7 (21%)	*n* = +3	*n* = +2	.00	.989
	All Participants (*n* = 67)						*df* (1,127)	
Uniaxial estimates								
MVPA (mins/week)	170 (128, 225)	158 (119, 211)	186 (140, 247)	138 (103, 185)	+16 (-21, 53)	-20 (-52, 12)	2.29	.133
Moderate activity (mins/week)	164 (125, 216)	152 (115, 201)	178 (135, 235)	127 (96, 168)	+14 (-21, 50)	-25 (-56, 5)	3.13	.079
Sedentary time (hrs/week)	64 (60, 67)	64 (60, 67)	61 (57, 64)	60 (57, 64)	-3 (-5, 0)	-4 (-6, -1)	.13	.717
Sedentary ≥20-min bouts (hrs/week)	27 (23, 31)	28 (24, 32)	23 (19, 27)	24 (20, 28)	-4 (-7, -1)	-4 (-8, -1)	.09	.767
MV10 (completing ≥150 mins/week)	*n* = 2 (6%)	*n* = 5 (15%)	*n* = 8 (24%)	*n* = 6 (18%)	*n* = +6	*n* = +1	1.66	.199

	Baseline		12 Weeks		Change		Group x time	
	Intervention *Mean* (CIs)	**Control** *Mean* (CIs)	**Intervention** *Mean* (CIs)	**Control** *Mean* (CIs)	**Intervention** *Change* (CIs)	**Control** *Change* (CIs)	***F***	***p***
	All Participants (*n* = 68)						*df* (1,128)	
Cardiovascular risk								
Body mass index (kg/m2)	28.86 (27.17, 30.54)	27.66 (25.98, 29.34)	28.41 (26.73, 30.10)	27.19 (25.51, 28.87)	-.44 (-.65, -.23)	-.47 (-.69, -.25)	.04	.848
Systolic blood pressure (mmHg)	145.15 (138.96, 151.33)	139.82 (133.64, 146.01)	131.34 (125.08, 137.60)	133.63 (127.21, 140.05)	-13.80 (-20.44, -7.17)	-6.19 (-12.98, .60)	2.52	.115
Diastolic blood pressure (mmHg)	88.00 (83.99, 92.01)	84.15 (80.14, 88.15)	82.60 (78.55, 86.66)	82.96 (78.80, 87.12)	-5.40 (-9.73, -1.07)	-1.19 (-5.62, 3.24)	1.81	.181

Note. Means are predicted from the models accounting for clustering between participants. *n* (%) are reported for binary logistic regression analyses on MV10. MVPA: Moderate-to-Vigorous Physical Activity. MV10: Moderate-to-Vigorous activity completed in ≥10-minute bouts.

Table 9.4
Observed Means for Physical Activity per Week Across Intervention and Control Groups in the WATAAP Trial

	Baseline		12 Weeks		Change	
	Intervention *Mean* (SD)	**Control** *Mean* (SD)	**Intervention** *Mean* (SD)	**Control** *Mean* (SD)	**Intervention** *Change*	**Control** *Change*
	All Participants (n = 67)					
Triaxial estimates						
MVPA (mins/week)	296 (127)	313 (177)	364 (188)	311 (232)	+68	-2
Moderate activity (mins/week)	281 (123)	293 (161)	343 (177)	274 (205)	+62	-19
Sedentary time (hrs/week)	72 (10)	72 (11)	69 (9)	69 (11)	-3	-2
MV10 (completing ≥150 mins/week)	76 (70)	78 (96)	105 (113)	86 (118)	+29	+8
Uniaxial estimates						
MVPA (mins/week)	190 (97)	194 (124)	229 (147)	205 (208)	+38	+12
Moderate activity (mins/week)	182 (91)	183 (111)	215 (134)	184 (194)	+33	+1
Sedentary time (hrs/week)	64 (10)	64 (11)	61 (9)	60 (10)	-3	-4
Sedentary ≥20-min bouts (hrs/week)	27 (12)	28 (13)	23 (10)	24 (11)	-3	-5
MV10 (completing ≥150 mins/week)	59 (65)	62 (84)	90 (110)	69 (105)	+31	+7
Cardiovascular risk						
Body mass index (kg/m2)	28.86 (4.93)	27.66 (4.96)	28.66 (4.85)	27.11 (5.10)	-.20	-.55
Systolic blood pressure (mmHg)	145.15 (18.83)	139.82 (21.57)	131.64 (16.14)	134.35 (15.21)	-13.51	-5.47
Diastolic blood pressure (mmHg)	88.00 (12.90)	84.15 (9.52)	82.58 (13.78)	83.23 (10.56)	-5.42	-.92

Note. CI: Confidence Interval, MVPA: Moderate-to-Vigorous Physical Activity, MV10: Moderate-to-Vigorous Physical Activity completed in ≥10-minute bouts.

Table 9.5
Sensitivity Analysis of Cardiovascular Risk Factors Including Only a Needs-Based Sample Across Intervention and Control Groups in the WATAAP Trial

	Baseline		12 Weeks		Change		Group x time	
	Intervention *Mean* (CIs)	**Control** *Mean* (CIs)	**Intervention** *Mean* (CIs)	**Control** *Mean* (CIs)	**Intervention** *Change* (CIs)	**Control** *Change* (CIs)	***F* (df)**	***p***
Cardiovascular risk								
Body mass index ≥25 (kg/m2) *n* = 50	30.92 (29.44, 32.40)	29.87 (28.33, 31.42)	30.47 (28.99, 31.95)	29.38 (27.84, 30.93)	-.45 (-.70, -.20)	-.49 (-.77, -.21)	.05 (1,93)	.828
Body mass index ≥30 (kg/m2) *n* = 26	33.29 (31.77, 34.81)	33.35 (31.58, 35.12)	32.94 (31.42, 34.46)	32.84 (31.07, 34.62)	-.35 (-.68, -.01)	-.51 (-.91, -.10)	.37 (1,47)	.544
Systolic blood pressure ≥140 (mmHg) *n* = 47	153.17 (146.17, 160.18)	146.67 (139.81, 153.53)	136.44 (129.43, 143.44)	137.54 (130.40, 144.68)	-16.74 (-25.18, -8.30)	-9.13 (-17.63, -.63)	1.60 (1, 88)	.210
Diastolic blood pressure ≥90 (mmHg) *n* = 36	96.00 (90.97, 101.03)	88.41 (83.09, 93.73)	86.23 (81.07, 91.38)	88.29 (82.82, 93.76)	-9.77 (-15.76, -3.79)	-.12 (-6.46, 6.22)	4.89 (1, 66)	**.031**

Note. Means are predicted from the models taking into account clustering between participants. Outcome cut-offs for needs-based analyses are derived from established recommendations (Australian Government, Department of Health, 2009; National Heart Foundation Australia, 2016; Stone et al., 2014).

Table 9.6
Sensitivity Analysis of Physical Activity per Week Across Intervention and Control Groups in the WATAAP Trial when Excluding Seven Participants due to Non-Adherence

	Baseline		**12 Weeks**		**Change**		**Group x time**	
	Intervention *Mean* (CIs)	**Control** *Mean* (CIs)	**Intervention** *Mean* (CIs)	**Control** *Mean* (CIs)	**Intervention** *Change* (CIs)	**Control** *Change* (CIs)	***F***	***p***
	All Participants (*n* = 61)						*df* (1,112)	
Triaxial estimates								
MVPA (mins/week)	265 (202, 348)	254 (192, 337)	325 (247, 427)	211 (159, 281)	+60 (17, 103)	-43 (7, 79)	14.93	**<.001**
Moderate activity (mins/week)	251 (193, 327)	239 (182, 314)	306 (235, 399)	194 (147, 256)	+55 (14, 96)	-45 (-78, -11)	16.02	**<.001**
Sedentary time (hrs/week)	71 (67, 75)	72 (68, 76)	68 (64, 72)	69 (65, 73)	-3 (-6, 0)	-3 (-6, 0)	.01	.946
MV10 (completing ≥150 mins/week)	*n* = 5 (16%)	*n* = 5 (17%)	*n* = 8 (26%)	*n* = 4 (13%)	*n* = +3	*n* = -1	.63	.429
	All Participants (*n* = 61)						*df* (1,113)	
Uniaxial estimates								
MVPA (mins/week)	165 (123, 221)	151 (111, 205)	188 (140, 254)	111 (81, 151)	+24 (-13, 60)	-40 (-70, -10)	8.96	**.003**
Moderate activity (mins/week)	159 (120, 211)	145 (108, 194)	180 (135, 239)	103 (77, 139)	+21 (-13, 56)	-41 (-70, -13)	9.76	**.002**
Sedentary time (hrs/week)	63 (59, 67)	64.26 (61, 68)	60.19 (57, 64)	60 (56, 64)	-3 (-5, 0)	-4 (-7, -1)	.41	.521
Sedentary ≥20-min bouts (hrs/week)	26 (22, 30)	29 (25, 33)	22 (18, 26)	24 (19, 28)	-4 (-7, -1)	-5 (-9, -2)	.32	.572
MV10 (completing ≥150 mins/week)	*n* = 1 (3%)	*n* = 5 (17%)	*n* = 7 (23%)	*n* = 3 (10%)	*n* = +6	*n* = -2	4.30	**.040**

Note. Means are predicted from the models taking into account clustering between participants. *n* and % are reported for binary logistic regression analyses on MV10.

9.4 Discussion

The WATAAP trial is one of the first to utilise a smart wearable activity tracker in combination with action planning and goal setting to increase physical activity in cancer survivors. Intention-to-treat analyses revealed a significant between-group net difference of 66 minutes per week of MVPA favouring the intervention group (45-minute increase at 12 weeks). Sedentary behaviour reduced significantly by ~3 hours per week for both groups. This reduction remained when examining bouts of ≥20 minutes, suggesting that wearing an accelerometer in itself may prompt less sedentary behaviour. Given that replacing one hour of sedentary time per day with an equal amount of activity is associated with reduced all-cause mortality in older adults completing little activity (C. E. Matthews et al., 2015), further investigation of strategies for reducing sedentary behaviour is warranted.

For those classified as hypertensive for DBP, there was a significant reduction in the intervention group of 9.77mmHg compared to the control group, and a trend towards a significant reduction in SBP. These findings are substantial given the effects of previous physical activity interventions on blood pressure (Diaz & Shimbo, 2013). However, these results are consistent with a review on walking interventions on blood pressure control that reported mean changes ranging from -5.2 to -11mmHg for SBP and -3.8 to -7.7mmHg for DBP (L.-L. Lee et al., 2010). The substantial reduction in blood pressure may be explained in part by this study's selection of older participants with existing cardiovascular risk factors.

Previous physical activity interventions for survivors have typically demonstrated small effect sizes (Goode et al., 2015; Groen et al., 2018). The WATAAP trial yielded promising findings when compared to similar designs with net changes of 24 minutes per week (James et al., 2015) and 33 minutes per week (J.-H. Park et al., 2015) of self-reported MVPA. A similar low-intensity intervention produced an increase of 18 minutes per week of MVPA following a Fitbit intervention for overweight and obese adults (J. B. Wang, Cadmus-Bertram, et al., 2015). Further, a 10-week wearable device and social media-based intervention yielded an increase of 25 minutes of MVPA per week in breast cancer survivors (Pope et al., 2018). The substantial increase of 45 minutes per week of MVPA observed following the WATAAP intervention is almost double that of most previous studies (Goode et al., 2015; Groen et al., 2018; Pope et al., 2018; J. B. Wang, Cadmus-Bertram, et al., 2015), and may be attributed to the evidence-based BCTs that are now incorporated into smart WAT, including self-monitoring, goal setting, and behavioural feedback. A recent higher-intensity Fitbit intervention with breast cancer survivors supports this finding, demonstrating a 103-minute net improvement in weekly MVPA (Hartman, Nelson, Myers, et al., 2018).

Most recently, the ACTIVATE trial adopted a similar design and intervention package of a Garmin Vivofit tracker, counselling, goal setting and feedback for inactive breast cancer survivors (Lynch et al., 2019). Despite being slightly more intensive than the WATAAP design, a similar between-groups difference of 69 minutes of weekly MVPA was produced at 12 weeks. The ACTIVATE trial also produced small but promising findings on secondary outcomes including diminished fatigue and sedentary behaviour (Lynch et al., 2019; Vallance et al., 2020), showing promise for the utility of mHealth designs in effecting improvements in other health-related outcomes that are supplementary to physical activity.

Based on equal recruitment of males and females in this trial, interventions incorporating WAT appear to be attractive to males, which is an important finding given the poor uptake of men to lifestyle interventions (J. Ryan et al., 2019). Fitbit engagement was high throughout the intervention (86%), with an upward trend in step count, displaying promise for low-intensity interventions. Attrition was low throughout the trial with excellent adherence to the intervention. The analysis of accelerometer data using uniaxial (Freedson et al., 1998) and triaxial (Sasaki et al., 2011) cut-points facilitates the accessibility of WATAAP findings in this growing field of research. Triaxial data provides a rich insight based on three planes of movement, with Sasaki's cut-points for triaxial data recommended for use in older adults (Aguilar-Farias et al., 2019). The objectivity of accelerometer data is a key strength of our trial, given that approximately only 7% of physical activity, weight control, and diet interventions use accelerometery as the primary measure of activity (Goode et al., 2015).

9.4.1 Conclusions

9.4.1.1 Study Limitations

Limitations include a relatively brief intervention with a small sample of Caucasian survivors from private hospitals in Perth, Western Australia. This sample may be subject to a participation bias, as it is likely that a particularly motivated cohort has been recruited. Making efforts to recruit larger samples of endometrial cancer survivors, survivors of other cancers, and those from public hospitals may improve the external validity of the current findings. Our sensitivity analyses were insightful for providing insight on the effectiveness of the WATAAP interventions for a needs-based sample and when accounting for those who did not adhere to their allocated trial arm. However, these results should be interpreted with caution as they included a chosen sub-set of available data points. An intention-to-

treat analysis has greater external validity for representing everyday complications and individual differences.

9.4.1.2 Clinical Implications

The WATAAP intervention yielded a substantial increase in MVPA and a clinically meaningful reduction in DBP amongst intervention participants that were hypertensive, displaying promise for the use of low-intensity interventions using smart WAT. BMI and SBP also improved but not significantly between the groups. Investigation of the extended-term efficacy of WAT for physical activity maintenance and reduced sedentary behaviour is essential. Future work could examine the *active ingredients* of the intervention and explore the support needs required for prolonged engagement with WAT and long-term exercise adherence. Our findings have clinical implications for the potential of wearable devices to be utilised following the completion of treatment for survivors. With the support of allied health professionals, digital apps and respective trackers may supplement the promotion of physical activity as part of a feasible and broad-reaching protocol for aftercare.

Chapter Ten

10

General Discussion

Chapter Overview

This chapter discusses the predominant findings presented in this thesis. The findings of each separate study are reiterated before results are amalgamated to focus on and articulate the overall contribution of this project. Novel findings and limitations are considered, and the chapter ends with implications for clinical practice contexts, suggestions for future research, and a conclusion.

10.1 Key Findings

The aim of this project was to explore the barriers, motives, and attitudes of cancer survivors towards physical activity, and to implement a behavioural intervention to promote physical activity in cancer survivors. *Chapters Four, Five,* and *Six*, reporting on qualitative research and open-ended responses undertaken with survivors of colorectal, endometrial, and breast cancer, yielded novel insights concerning survivors' barriers, support needs, and motives regarding physical activity and dietary change. *Chapter Seven* identified preferences and psychological correlates of physical activity. *Chapters Eight* and *Nine* proposed and assessed the effectiveness of a HAPA-based behavioural intervention using WAT to promote physical activity in colorectal and endometrial cancer survivors at heightened risk of cardiovascular disease. The findings of this thesis can be summarised in four key areas:

1. Themes of a lack of motivation, practitioner support, and poor knowledge about physical activity and dietary recommendations were identified in *Chapters Four* and *Five*. These findings warrant initiatives to increase motivation, practitioner involvement, and didactic components within health behaviour programs seeking to promote uptake of physical activity and dietary change.

2. Motives for the uptake of physical activity and making positive dietary changes included the ability to enjoy pleasures in life, particularly those afforded by leisure, work, and family. These were identified and discussed in *Chapter Six*. Social support emerged as a factor affecting physical activity and dietary change, and this was prevalent across the barriers, motives, and support needs presented in *Chapters Four, Five,* and *Six*. This finding may implicate that survivors' households should be incorporated into programs seeking to improve health behaviours.

3. The key finding of *Chapter Seven* was that survivors' instrumental attitude was associated with physical activity behaviour. Additionally, most survivors were

found to prefer self-paced and moderate-intensity forms of exercise, particularly walking. In contrast, a preference for light-intensity physical activity was associated with less favourable attitudes, lower PBC, self-efficacy and intention, and ultimately, less physical activity behaviour.

4. The principal outcome of the WATAAP trial presented in *Chapter Nine* was a significant improvement of 45 minutes of weekly MVPA in the intervention group and a net change of approximately 66 minutes of weekly MVPA between groups at 12 weeks. Results were further amplified via a sensitivity analysis that excluded seven participants due to non-adherence. Non-significant improvements in secondary outcomes, including lower SBP and DBP, and reductions in BMI, were identified at 12 weeks in the intervention group.

10.2 Contribution to Existing Knowledge

The key findings of this thesis are discussed in the context of the existing knowledge on health behaviour change interventions during cancer survivorship.

10.2.1 Factors Affecting Physical Activity and Dietary Behaviour

Study findings contributed to the existing knowledge base regarding survivors' lack of motivation to engage in physical activity, knowledge of or disagreement with physical activity guidelines, and practitioner support (Maxwell-Smith et al., 2017). Amongst the psychological factors affecting engagement in physical activity and healthy dietary behaviours, lack of motivation and personality-related themes arose. Practising health behaviour was considered by survivors to require significant discipline and motivation. Physical activity, in particular, was considered suitable to "sporty" personality types. Survivors reported insufficient knowledge of physical activity guidelines, and also resisted or misinterpreted them. Within this theme, survivors expressed the view that the guidelines may be not be applicable to them or considered that they were "doing enough" by completing daily housework and errands. While some survivors reported receiving little advice and support from medical professionals, others considered medical surveillance and medication as alternatives to physical activity for reducing their cardiovascular risk (Maxwell-Smith et al., 2017). These findings from *Chapters Four* and *Five* emphasised a need for motivational, informational, and practitioner support within interventions to assist survivors in overcoming barriers to both physical activity and consumption of a healthy diet.

Barriers and support needs appeared to coincide, such that several support needs could assist in mitigating a related barrier. For example, survivors reported a lack of encouragement from clinicians and desired further practitioner support. Survivors also reported a lack of knowledge about the recommended health behaviours and how to implement change, which appeared to correspond to their desire for educational support. Barriers associated with a lack of social support appeared to coincide with a desire for encouragement from like-minded family members and health professionals. This approach to the examination of barriers and support needs, whereby stronger sources of support may be sufficient for overcoming perceived barriers, has facilitated a unique view into potential measures to foster adoption of health behaviours. The primary contributions of this research that concern the factors affecting uptake to physical activity and healthy dietary behaviours are considered below.

10.2.1.1 Perceptions About Identity May Underpin Discipline and Motivation to Participate in Physical Activity

Perceptions about identity appeared to underpin barriers of "not being the sporty type", in which participants often referred to their lack of skill or enjoyment, along with lack of discipline and motivation (Maxwell-Smith et al., 2017). Although psychological and motivational factors have been established throughout the literature in other samples of survivors (Blaney et al., 2013; Franks et al., 2009; Hardcastle, Glassey, et al., 2017; Hardcastle, Maxwell-Smith, Hagger, et al., 2018; Hardcastle, Maxwell-Smith, Kamarova, et al., 2018; Karvinen, Courneya, Campbell, et al., 2007; Ottenbacher et al., 2011), these findings extend the knowledge base on psychological barriers by including the aspect of psychographic profiling and personality factors. That is, lacking motivation and discipline were often described in conjunction with barriers to health behaviour related to survivors' perceptions of themselves. Psychological factors influencing physical activity and health promotion may be a result of survivors' perceived identity in which individuals perceive themselves as not being the "sporty" type of person to engage in physical activity or not being disciplined, in conjunction with their motives, preferences and needs (Hardcastle & Hagger, 2016; Wills et al., 2015). While these factors have been acknowledged previously as separate influences on health behaviours (Blaney et al., 2013; Hardcastle, Hancox, et al., 2015; Hardcastle, Glassey, et al., 2017; Ottenbacher et al., 2011; Rhodes & Smith, 2006), the conjunction of motivational and disciplinary factors with identity warrants consideration of individual differences and preferences in overcoming motivational barriers to health behaviours.

Previous research on personality profiling as a component of a disease management intervention in patients with chronic illness demonstrated that a peer-led program, that specifically targets self-efficacy, is most beneficial to patients with low conscientiousness, agreeableness, and extraversion, such that this sample is in particular need of more intensive support (Franks et al., 2009; Latimer et al., 2010). Further, conscientiousness was found to moderate the intention–behaviour gap, such that greater conscientiousness is more likely to result in behavioural outcomes (Rhodes et al., 2005). Consistent with this, in the current thesis, survivors with lower confidence and less positive attitudes report less physical activity (Maxwell-Smith, Hagger, et al., 2020).

Based on the findings presented in *Chapter Seven,* an instrumental attitude towards physical activity, self-efficacy to perform physical activity, and PBC towards physical activity were significantly associated with physical activity intentions and behaviour (Maxwell-Smith, Hagger, et al., 2020). The roles of these psychological constructs from separate, leading behavioural change frameworks support the proposition that there is significant overlap between theoretical constructs (McMillan & Conner, 2007). Further, there is a potential need to account for preferences within theories of behaviour change (Courneya et al., 2008). In the current project, less favourable attitudes and lower self-efficacy, PBC, and intention to engage in physical activity were associated with a preference for light-intensity exercise (Maxwell-Smith, Hagger, et al., 2020). This finding supports the implication that associations exist between social-cognitive constructs and preferences for engaging in exercise. Although profiling in concordance with these psychological constructs has been touched upon previously in the literature (Hardcastle & Hagger, 2016), there is scarce evidence concerning individual identity factors in health behaviour change (O'Connor, 2020). The development of profiles based on these factors may offer useful insight that facilitates the tailoring of interventions for survivors. Specifically, tailoring programs for those with lower conscientiousness and motivation to initiate health behaviour change has been recommended in future health behaviour programs (O'Connor, 2020).

10.2.1.2 Health Professionals and Behavioural Change Techniques Could Supplement the Effective Delivery of Lifestyle Advice

Informational needs, a lack of understanding, and resistance to physical activity and dietary recommendations were prevalent in the findings of *Chapters Four, Five,* and *Six.* Educational interventions tailored for survivors with lower knowledge have been effective for improving quality of life outcomes (Badger et al., 2013) and have been recommended to

reduce survivors' modifiable risk of future morbidity (Rabin & Pinto, 2006; G. Zhao et al., 2013). Greater health literacy, knowledge about recommendations for health behaviours, and knowledge of risk factors for disease are valuable for facilitating health outcomes (Berkman et al., 2011; Eckman et al., 2012; Ghisi et al., 2014; Halverson et al., 2013).

However, patient education alone is insufficient to prompt health behavioural change (Ghisi et al., 2014). This limitation of education is reflected by the HAPA explanation of behavioural change, whereby education relating to risk perceptions is necessary but insufficient to catalyse an intention to engage in a given behaviour (Schwarzer et al., 2011). The value of support from oncologists and allied health professionals in promoting knowledge of lifestyle-related modifiable risk is reflected in the fact that lacking practitioner support emerged as a barrier to physical activity identified in *Chapters Four* and *Five,* and the support need for practitioner involvement identified in *Chapter Five.* A review of clinical health behaviour interventions for cancer survivors has suggested the delivery of health recommendations and monitoring tools by oncologists for optimal impact and motivation to change (Demark-Wahnefried et al., 2015). Other research has indicated that the relationship between education and the practise of health behaviours is mediated by perceived control, indicating that education without encouragement to bolster perceived control and self-efficacy for implementing health behaviours may be limited in effecting lifestyle change (C. L. Park et al., 2018; Stacey et al., 2015).

The findings of the current thesis build upon the existing literature and emphasise the prevalence of informational needs and barriers, in conjunction with the need for practitioner support. Findings concerning the support needs of survivors in *Chapter Five* indicated that there is a significant role of clinicians and allied health professionals in implementing health behaviour changes. While oncologists may play a pivotal role in the initial recommendation for lifestyle change, referral to an allied health professional may address the support needs of survivors for encouragement and accountability from a practitioner in the longer-term. Oncologist-delivered advice on health behaviours, alongside sustained encouragement from general practitioners and allied health professionals, may be optimal for increasing uptake and motivation for lifestyle change (Hardcastle & Taylor, 2001), while addressing support and informational needs. As such, educational materials coupled with the effective delivery of BCTs have been recommended to foster perceived control and the formation of behavioural intention (Demark-Wahnefried et al., 2015). Taken together, these findings suggest that practitioner-delivered educational messages are likely

to be a valuable component of health behaviour change to reduce modifiable risk factors for future morbidity.

10.2.1.3 Medical Surveillance of Cardiovascular Disease Risk Factors as a Barrier to Lifestyle Change

The emergence of medical surveillance as a barrier to physical activity in *Chapter Four* conveyed the perception that change was unnecessary if survivors had been prescribed medication or were under medical surveillance for their risk of cardiovascular disease (Maxwell-Smith et al., 2017). In these instances, barriers related to the perceived adequacy of medical surveillance may instead be excuses for unhealthy lifestyle behaviours, underpinned by other barriers including a perceived lack of importance and lack of motivation (Courneya et al., 2005). Survivors who have low motivation and PBC to engage in change may benefit from a more intensive counselling approach to increase motivation and confidence to implement lifestyle change (Hardcastle, Hancox, et al., 2015). The objective of such initiatives should be to focus on the modifiable nature of risk factors for cardiovascular disease, cancer recurrence, and quality of life, supporting self-efficacy and control over lifestyle change. Alternatively, the finding that light-intensity exercise is preferred by survivors with lower self-efficacy and intention to change (Maxwell-Smith, Hagger, et al., 2020), as discussed in *Chapter Seven*, may be particularly relevant in such circumstances where survivors report medication or surveillance as a rationale to undermine the importance of self-regulated protective behaviours.

Medical Surveillance May Undermine Instrumental Attitude Towards Physical Activity Participation

As some survivors appear to believe that surveillance or medication could suffice as an alternative to engagement in health behaviours (Maxwell-Smith et al., 2017), the perceived importance of practising protective behaviours may be undermined. The importance of having and maintaining an instrumental attitude was further emphasised in *Chapter Seven*, as perceived importance of physical activity was positively associated with physical activity behaviour (Maxwell-Smith, Hagger, et al., 2020). Previous findings have indicated the value of affective and instrumental attitudes in physical activity engagement (Rhodes & Kates, 2015; Ungar, Wiskemann, & Sieverding, 2016). Instrumental attitude significantly predicted physical activity intention in kidney cancer survivors (Trinh et al., 2012b), indicating its likely role as a precursor to physical activity change. Given that instrumental attitude concerns the perceived benefit, usefulness, and importance of physical activity, this issue should be raised and reinforced by specialists who are considered to hold an

authoritative position for delivering lifestyle advice (Hardcastle & Cohen, 2017). Therefore, a valuable initiative for promoting perceived importance as a precursor to physical activity uptake may be oncologists' reinforcement of the importance of physical activity for reducing the risk of cardiovascular disease (Ozemek et al., 2018), cancer recurrence (Cormie et al., 2017), and quality of life (Buffart et al., 2017; Robertson et al., 2019).

10.2.2 Physical Activity Preferences May Not Coincide with Current Programs for Survivors

Survivors' preferences for unsupervised, self-paced, moderate-intensity physical activity that can be completed alone – specifically walking – were identified in *Chapter Seven* (Maxwell-Smith, Hagger, et al., 2020). These preferences are largely consistent with the existing literature concerning survivors' exercise preferences (Blaney et al., 2013; L. W. Jones & Courneya, 2002; Karvinen et al., 2006; Karvinen, Courneya, Venner, & North, 2007; H. J. Leach, Devonish, et al., 2015; McGowan et al., 2013; Rogers et al., 2008; Rogers, Malone, et al., 2009; Rogers, Markwell, et al., 2009; Stevinson, Capstick, et al., 2009; Trinh et al., 2012a; Vallance et al., 2006; Vallance et al., 2013). Although some survivors have previously expressed a preference for supervised exercise (Karvinen et al., 2006; H. J. Leach, Devonish, et al., 2015; Vallance et al., 2013), these appear to be a minority compared to those who preferred unsupervised exercise (L. W. Jones & Courneya, 2002; Karvinen, Courneya, Venner, & North, 2007; Rogers et al., 2008; Rogers, Malone, et al., 2009; Rogers, Markwell, et al., 2009; Trinh et al., 2012a; Vallance et al., 2006).

Based on the results presented in *Chapter Seven* (Maxwell-Smith, Hagger, et al., 2020), and their concordance with the existing literature, there is a disparity between survivors' exercise preferences and many of the programs offered. Some reviews of this issue have proposed that a balance must be struck between the abilities and preferences of survivors and the optimal exercise prescription for garnering health benefits (Buffart et al., 2014). Other initiatives have endorsed supervised and facility-based programs for improving fitness and reducing the comorbidities of survivors (Musanti & Murley, 2016; Newton et al., 2018; Rajotte et al., 2012; Santa Mina et al., 2017). However, the current findings indicate that some survivors have opposing preferences. Investigations of the uptake and adherence to physical activity in survivors has supported the role of positive attitudes and self-efficacy for engagement (Buffart et al., 2014; Latimer et al., 2010). This may be achieved by offering programs that suit the preferences of survivors and involve clinician endorsement (Hardcastle & Cohen, 2017). Thereby, confidence to engage in, and positive attitudes towards, physical activity may be more conducive to uptake.

A primary criticism of tailoring interventions to survivors' preferences for moderate-intensity, unsupervised walking programs is that survivors' preferences may not reflect the most impactful approach (Newton et al., 2018). Indeed, an optimal scenario may be for survivors to be willing and confident to engage in more frequent, higher-intensity physical activity that exceeds the minimum recommended guidelines. However, such designs may not appeal to the preferences and perceived capabilities of some survivors, and may therefore be detrimental to participation in physical activity programs for those who most need the support (Hardcastle, Maxwell-Smith, Hagger, et al., 2018).

Based on the findings presented in *Chapter Seven,* the survivors who prefer lighter-intensity exercise have poorer confidence and PBC, a weaker intention to engage in physical activity, and are less physically active (Maxwell-Smith, Hagger, et al., 2020). As such, it is critical to tailor interventions for this needs-based sample of survivors, by appealing to the exercise preferences that this cohort is more confident and ready to perform (Grimmett et al., 2019). Home-based programs have been considered superior for mitigating barriers associated with transport, time, and limited finances (Harcastle & Cohen, 2017; Hardcastle, Maxwell-Smith, Kamarova, et al., 2018; Pinto et al., 2005; Stull et al., 2007), which have often been reported as barriers to adherence in facility-based programs (Cheifetz et al., 2015; Hardcastle & Cohen, 2017; Hardcastle, Maxwell-Smith, Kamarova, et al., 2018). Furthermore, the external validity of facility-based programs has been questioned, as findings are unlikely to be feasibly replicated in the general population and results are likely to diminish following the cessation of structured programs (Glasgow et al., 2002; Goode et al., 2012; Hardcastle & Cohen, 2017). For programs that have little concordance with survivors' preferences for exercise structure, type or intensity, their relevance to activities that are likely to be practised in settings outside of supervised programs is limited.

10.2.3 Design of the WATAAP Trial

The behavioural intervention was designed based on the findings of *Studies One* and *Two*, in conjunction with the novel utility of wearable tracker interventions for colorectal and endometrial cancer survivors. The WATAAP intervention was linked to the HAPA model, and aimed to bridge the intention-behaviour gap by bolstering action planning, coping planning, accounting for support resources and barriers and encouraging maintenance of behavioural change during the volitional stage of change (Sniehotta, Scholz, & Schwarzer, 2005). The HAPA model is a

particularly suitable framework for the WATAAP intervention for cancer survivors, as it accounts for the role of support resources and barriers in fostering behavioural change and maintenance (Schwarzer et al., 2011), which appear to be important variables in effecting health behaviour uptake based on the results of *Studies One* and *Two*. Findings of significant barriers to physical activity which were revealed in *Study One* could be ameliorated through the identification support resources and engagement in coping planning during the follow-up phone call to foster maintenance self-efficacy (Maxwell-Smith et al., 2018; Schwarzer et al., 2011; Schwarzer, 2014). Materials presented in the WATAAP booklet and group sessions also encouraged coping planning, whereby survivors made 'if-then' plans to overcome potential barriers (Maxwell-Smith et al., 2018; Schwarzer et al., 2011). Action planning, logging and goal setting activities were incorporated into the WATAAP booklet and the intervention group sessions. As support needs often pertained to social support for survivors in *Study Two*, a group session dynamic was considered to be appropriate, along with a supportive booster phone call later in the intervention. The group environment facilitated group discussions, social comparison of experiences, and an opportunity for social support per the HAPA framework (Maxwell-Smith et al., 2018; Schwarzer et al., 2011; Schwarzer, 2014). Finally, the incorporation of educational components including print materials and didactic delivery of physical activity benefits was targeted to survivors' perceived importance and instrumental attitudes to participating in physical activity.

The use of wearable trackers in the WATAAP intervention was supported by the findings of *Studies One* and *Two*, in addition to high acceptability of trackers in cancer survivors (Hardcastle, Galliott, et al., 2018; Nguyen et al., 2017). Survivors reported barriers to physical activity, including a lack of motivation and not being the 'sporty type' *in Study One.* Components of WAT, and specifically the Fitbit system, including goal setting, provision of feedback and progress, real-time recording of activity and the opportunity for social comparison using the application are motivational for users (Asimakopoulos et al., 2017). Consumer wearables, and Fitbits in particular, also encourage the accumulation of incidental exercise and daily steps (Asimakopoulos et al., 2017), which may assist in allaying the perception that exercise is for the 'sporty type'.

The results of *Study Two* revealed a preference for unsupervised, self-paced, moderate intensity physical activity that can be performed alone. A strong preference

for walking was expressed amongst survivors. As such, the incorporation of WAT was posited to be an effective solution to meet the preferences of survivors in performing unsupervised activities such as walking, while efficiently delivering evidence-based BCTs such as self-monitoring, goal setting, the provision of feedback, prompts, and an opportunity for social comparison (Maxwell-Smith et al., 2018), which have typically been perceived as hallmarks of a more resource-intensive designs.

The Fitbit was also found to be acceptable and easy to use amongst cancer survivors (Gell et al., 2017; Hardcastle, Galliott, et al., 2018; Nguyen et al., 2017; Rosenberg et al., 2016; Rossi et al., 2018). As survivors expressed that ease of use was a priority (Hardcastle, Galliott, et al., 2018; Rosenberg et al., 2016) and preferences for a simple, wrist-worn, small model (Hardcastle, Galliott, et al., 2018; Nguyen et al., 2017), the Fitbit Alta was selected for the WATAAP intervention (Maxwell-Smith et al., 2018).

10.2.3.1 The Role of Oncologists in the WATAAP Trial and Future Programs

Primary themes of practitioner support were identified by colorectal cancer survivors in *Study One,* and these were consolidated by a larger sample of colorectal, endometrial and breast cancer survivors in *Study Two.* Throughout both studies, participants reported lacking support from their clinician as a barrier (Maxwell-Smith et al., 2017). This implies that successful physical activity initiatives offered to survivors following cessation of treatment are likely to involve oncologist participation (Hardcastle & Cohen, 2017; Stull et al., 2007). In light of these recurrent themes, the WATAAP aimed to capitalise on the value of an oncologist's recommendation by having the initial invitation letter and participant information sheet be sent from that survivor's oncologist. The objective of framing the WATAAP invitation from the oncologist was to encourage uptake for recruitment of survivors into the trial due to survivors' desire for accountability, as expressed via their support needs. Additionally, this design was intended to emphasise the oncologist's endorsement of WATAAP as a physical activity initiative to the invitee and capitalise on the role of instrumental attitudes by indicating the importance of physical activity. Although the response rate to invitations to participate in the WATAAP trial appears low compared to similar trials (Grimmett et al., 2019), few have published data on the how many individuals received an initial invitation.

Attrition was low throughout the WATAAP trial (<6%) compared to physical activity trials that have recruited cancer survivors (Grimmett et al., 2019), which may be attributed in part to the perceived involvement of the oncologist, but greater examination of oncologists' involvement in aspects of program design is warranted to clarify any influences.

10.2.4 Outcomes of the WATAAP Trial in the Context of Similar Studies

The WATAAP trial has contributed to the growing research concerning the effectiveness of smart WAT for promoting MVPA in cancer survivors (Maxwell-Smith et al., 2019). While other trials of smart wearable trackers amongst cancer survivors have since been conducted (Cadmus-Bertram et al., 2019; Ferrante et al., 2018; Gell, Grover, et al., 2020; Hartman, Nelson, Myers, et al., 2018; Kenfield et al., 2019; Lynch et al., 2019; van Blarigan et al., 2019), these were not published prior to the implementation of the WATAAP trial. Of these few, the evidence largely pertains to breast cancer samples (Cadmus-Bertram et al., 2019; Coughlin et al., 2020; Ferrante et al., 2018; Hartman, Nelson, Myers, et al., 2018; Lynch et al, 2019), despite significant comorbidities in colorectal and endometrial cancer survivors (Baade et al., 2006; Lynch, van Roekel, & Vallance, 2016; Ward et al., 2012; Weaver, Foraker, et al., 2013).

When considered in the context of other novel WAT trials in cancer survivors, the magnitude of the effectiveness of the WATAAP trial is proposed to be a result of the combination of BCTs and their delivery via WAT (Michie et al., 2017). Other initiatives that have utilised WAT as a vehicle for BCTs have been successful in producing significant improvements in physical activity (Cadmus-Bertram et al., 2019; Hartman, Nelson, Myers, et al., 2018; Lynch et al., 2019), but less successful when implemented in broader health behaviour programs (Kenfield et al., 2019). Breast cancer survivors who received a Fitbit One in conjunction with booster phone calls and update emails every three days significantly increased their MVPA by 102 minutes at 12 weeks compared to the baseline assessment (Hartman, Nelson, Myers, et al., 2018). However, MVPA change in the control group was not reported, so a between-group net change could not be determined.

The Prostate 8 feasibility trial utilised WAT and BCTs of personalised feedback, monitoring, and didactic instruction to promote health behaviours in prostate cancer survivors over 12 weeks (Kenfield et al., 2019). However, this pilot study was unsuccessful for improving physical activity.

The Smart Pace trial, which incorporated the Fitbit Flex coupled with daily text messages, produced a net change of approximately 70 minutes of weekly MVPA in colorectal cancer survivors, when compared to a print material-based control group (van Blarigan et al., 2019). Despite Smart Pace participants being verbally screened to capture an insufficiently active sample at baseline, recruited survivors were completing almost 300 minutes of accelerometer-derived MVPA at baseline. This limitation was also identified during the WATAAP recruitment process, indicating the prevailing difficulty to recruit a needs-based and inactive sample.

Using a similar design to the WATAAP intervention, the ACTIVATE intervention consisted of wearing a Garmin Vivofit tracker, telephone counselling, goal setting and feedback (Lynch et al., 2018). Although the ACTIVATE trial did not adopt a theoretical approach, it was similar to the WATAAP trial in that the focus was on the delivery of evidence-based BCTs and the utility of trackers to feasibly deliver these techniques (Lynch et al., 2018). The intervention itself was more intensive than the WATAAP trial, with participants receiving five telephone counselling calls over a 12-week period. The findings of a 69-minute net change in weekly MVPA at 12 weeks, between the intervention and control groups, is similar to that yielded by the WATAAP trial, which is presented in *Chapter Nine*. The ACTIVATE trial also produced a significant reduction in sedentary time accumulated in bouts of ≥20 minutes, which was a primary outcome of the trial. A notable difference was the recruitment of participants by a volunteer registry, advertisements in clinics, and media in the ACTIVATE trial (Lynch et al., 2018), compared to the oncologist-delivered invitation letter in the WATAAP trial (Maxwell-Smith et al., 2018). Recruitment of survivors via oncologists' letters may have assisted in reducing self-selection bias of particularly active, interested, or conscientious survivors (Chinn et al., 2006), thereby overcoming a limitation of the ACTIVATE design. This advantage of the recruitment method is reflected in the rate of exclusion due to survivors already completing sufficient physical activity, which was 6.4% in the WATAAP trial compared to 18.7% in the ACTIVATE trial (Lynch et al., 2019; Maxwell-Smith et al., 2019). This disparity in the activity level of survivors who expressed interest in participating presents promise for targeting survivors who may be at greater risk of cardiovascular disease by involving oncologists in the recruitment process.

10.2.4.1 Support for Wearable Activity Technology as a Vehicle for the Delivery of Behaviour Change Techniques

An important contribution of this thesis is the support of its findings for the utility of BCTs delivered via WAT, alongside supplementary intervention materials, to provide a broad-reaching and feasible design for behaviour change. The WATAAP intervention package was largely delivered remotely via the Fitbit Alta and smartphone application, HAPA-based support phone call and print materials, with two group sessions over 12 weeks (Maxwell-Smith et al., 2018). Based on the positive results of the WATAAP trial presented in *Chapter Nine*, and in the context of other recommendations for delivery of BCTs via wearable technology (Direito et al., 2014; Fisch et al., 2016; Mercer, Giangregorio, et al., 2016), future research may consider testing a fully home-based approach. In this instance, content-based BCTs, including self-monitoring of physical activity, goal setting, and intention formation, could be facilitated via wearable trackers, their respective smartphone applications, and the potential use of supporting print or digital materials.

Evidence indicates that amongst BCTs, self-monitoring accounts for the most variance in physical activity and healthy diet outcomes (Michie et al., 2009). Further, self-monitoring is most effective when coupled with complimentary self-regulatory BCTs, including goal setting and intention formation (Michie et al., 2009). In comparison to facility-based programs that involve the delivery of intervention materials in a face-to-face environment, there is substantial support for telephone delivered-counselling in which relational BCTs could be foregrounded (Harrigan et al., 2016; Mitchell et al., 2019; Pinto et al., 2013). Such designs should incorporate a comprehensive, remotely delivered range of BCTs and be examined for their potential to transition physical activity promotion in cancer survivors to a feasible and pragmatic process, which may be implemented as a part of routine follow-up care.

10.3 Clinical Implications

There are four major clinical implications of this thesis: (1) the need for motivational and educational initiatives to be incorporated into cancer aftercare and as a part of behavioural interventions, (2) the importance of the practitioner role in encouraging and supporting physical activity participation, (3) the utility of smart WAT as a component of feasible and scalable physical activity programs, and (4) the value of low-intensity interventions for reducing cancer survivors' potential healthcare burden.

10.3.1 Motivational and Educational Initiatives Should be Incorporated into Physical Activity Interventions in Cancer Survivorship

The implication that motivational and educational initiatives should be incorporated into physical activity interventions was garnered from recurring themes of a lack of motivation and informational barriers throughout *Chapters Four* and *Five* (Maxwell-Smith et al., 2017). Instrumental attitudes for completing physical activity were significantly associated with physical activity intention as part of *Chapter Seven* (Maxwell-Smith, Hagger, et al., 2020), indicating that an understanding of the benefits of physical activity may be an important precursor to forming intentions. These findings imply that education could be effective for increasing cancer survivors' perceived importance of physical activity, thereby fostering favourable instrumental attitudes towards engagement in physical activity. Based on these findings, and other promising results for didactic (Occa & Suggs, 2016; Pakiz et al., 2011) and print materials (Goode et al., 2015; Hirschey et al., 2016; Vallance et al., 2007) promoting health behaviours, educational and didactic components were incorporated in the WATAAP trial.

While the need for educational components in physical activity initiatives has been identified previously (Blaney et al., 2013; Clifford et al., 2018; Courneya et al., 2015), education alone is considered insufficient for eliciting behavioural change (Ghisi et al., 2014). Alongside education, efforts to overcome barriers and promote engagement in health behaviours are important for the implementation of health behaviour change (Ghisi et al., 2014). In *Chapters Four* and *Five*, survivors expressed poor motivation as a barrier to physical activity, and described support needs of accountability and monitoring in order to engage in health behaviour change (Maxwell-Smith et al., 2017). The WATAAP trial incorporated a wearable physical activity tracker, group sessions, and follow-up prompts to meet needs for accountability and extrinsic motivation in participants (Maxwell-Smith et al., 2018). However, self-selection bias likely resulted in participants in the WATAAP trial having greater motivation and intention to engage in physical activity, compared to those who did not respond to the trial invitation. Therefore, survivors who are lacking motivation to engage in health behaviour initiates may be the most in-need of targeted behaviour change (Hardcastle, Hancox, et al., 2015).

As survivors identified "independence" and "experiencing life's pleasures" as motives to engage in physical activity and healthy dietary behaviours in *Chapter Six*, programs may be more attractive to survivors if reframed in terms of their potential benefits for independence, quality of life, and longevity. The apparent value of survivors' autonomous

motives for physical activity and healthy dietary behaviours should be considered along with other psychological constructs affecting health behaviour uptake (Maxwell-Smith, Cohen, et al., 2020). While autonomous motives have been established as a determinant of health behaviour according to the Self-Determination Theory (Deci & Ryan, 1985; Ntoumanis et al., 2020), leading theories do not account for the impact of discrepancies between one's motives for health behaviours and the framing of programs offered. Health behaviour change frameworks could be further improved by acknowledging survivors' unique autonomous motives to engage in health behaviours that are not necessarily aligned with physiological benefits (Maxwell-Smith, Cohen, et al., 2020). Similarly, the framing of programs may be adjusted to reflect the benefits of physical activity in terms of independence, longevity, and maintaining capabilities, in order to increase uptake to programs (Maxwell-Smith, Cohen, et al., 2020). Taken together, these findings imply that educational and motivational components are critical and have unique roles in promoting lifestyle change (Maxwell-Smith et al., 2017; Maxwell-Smith, Cohen, et al., 2020). An understanding of the physical activity guidelines, and evidence-based strategies for meeting these guidelines, are necessary constituents of health literacy, but their impact could be boosted by targeting educational material to the internal motives and values that are more likely to support maintenance of behavioural change (Horne et al., 2012).

10.3.2 Oncologists' Support Could Significantly Impact the Uptake of Physical Activity

Several components of this project have elucidated the role of oncologists and health practitioners in effecting physical activity uptake. These components include the articulation of survivors' barriers and support needs regarding practitioner support and the role of instrumental attitude as a precursor to physical activity (Maxwell-Smith et al., 2017; Maxwell-Smith, Hagger, et al., 2020). Increased perceived importance of physical activity may be achieved via practitioners' recommendations for making lifestyle change (Nyrop et al., 2016; Ruiz-Casado & Lucia, 2014; J. Webb et al., 2016). Oncologists, specifically, are well placed to emphasise the importance of lifestyle change which may be achieved through verbal recommendations (Hardcastle & Cohen, 2017). Even brief recommendations have been found to significantly increase survivors' physical activity (L. W. Jones et al., 2004; Vallance et al., 2007) and are effective as components of physical activity interventions (J.-H. Park et al., 2015). However, it should be noted that self-reported recall of total physical activity is subject to bias (L. W. Jones et al., 2004). More recent evaluations of oncologists' recommendations have questioned the effectiveness of

recommendations when compared to other more rigorous programs (Groen et al., 2018). Mixed findings have called for further research with objective outcome measures and broader, more heterogeneous samples (Groen et al., 2018). Furthermore, memory of recommendations is noted to be a major limitation to verbal delivery, both in terms of the oncologist remembering to recommend physical activity (Nyrop et al., 2016) and the patient remembering the details of the recommendation (L. W. Jones et al., 2004).

The importance and prioritisation of lifestyle change may be supported by framing the recommendation as a prescription for exercise (Fisher, Smith, & Wardle, 2016), which could be delivered via a "green prescription" detailing the amount and type of recommended physical activity on a medical script (Martin et al., 2010). Moreover, reinforcement of referral pathways could improve oncologists' confidence and ease in recommending allied health professionals or secondary support resources (Fisher, Smith, & Wardle, 2016; Hardcastle, Kane, et al., 2018; Maxwell-Smith et al., 2017; Ruiz-Casado & Lucia, 2014). However, few oncologists feel confident to deliver a physical activity recommendation to patients (Hardcastle, Kane, et al., 2018) and approximately half would value further training on the provision of lifestyle advice (Anderson, Caswell, et al., 2013). Clinicians report barriers to physical activity promotion, including a lack of time during follow-up appointments, and a lack of allied specialists and access to referral pathways and physical activity programs (Anderson, Caswell, et al., 2013; Hardcastle, Kane, et al., 2018). Efforts to support clinicians in overcoming these barriers may involve education in delivering health promotion messages, increased opportunities for referral pathways, and greater involvement of allied health professionals throughout survivorship (Hardcastle & Cohen, 2017). Since cancer survivors are typically at greater risk of cardiovascular disease and have more comorbidities than their non-cancer counterparts (Bluethmann, Basen-Engquist et al., 2015; Reeves et al., 2016; Ward et al., 2012), the implementation of routine physical activity endorsement in this population could be a resource-effective, preventative approach to the treatment of future comorbidities (Schmitz et al., 2019).

10.3.3 Recommendation for the Implementation of Wearable Activity Technology in Routine Aftercare

As survivors acknowledge the authority of oncologists and value their recommendations, the implementation of a routine policy for physical activity promotion in survivorship may begin with oncologists providing the initial recommendation for physical activity upon cessation of active cancer treatment. Beyond the follow-up period, referrals by oncologists and general practitioners to allied health professionals may

provide the additional support desired by survivors, while addressing informational needs concerning physical activity and healthy dietary recommendations (Hardcastle & Cohen, 2017; Hardcastle & Taylor, 2001).

Financial support needs were not commonly alluded to in the current research, in comparison to practitioner and informational support. Although this may indicate that some survivors are willing to purchase an activity tracker upon their specialist's recommendation, future research might consider exploring options such as accruing banks of activity trackers that could be loaned to patients at heightened risk of cardiovascular disease, subsidising WAT purchases, or promoting more affordable means of tracking including smartphone applications, pedometers, and logs.

In addition to the use of WAT, web-based or text message-support from allied health professionals could be a feasible option to boost accountability and motivation to sustain physical activity. In a pilot study that involved a self-regulatory intervention and Fitbit wear for breast cancer survivors, Fitbit data was linked to participants' electronic health records, which allowed for clinicians to review their patients' physical activity data. All clinicians reported reviewing survivors' activity data, and 80% reported that this information was useful for gaining an understanding of patients' lifestyles (Cadmus-Bertram et al., 2019). Clinicians' acceptability of Fitbit data sharing demonstrates preliminary promise for WAT to be incorporated as a component of routine aftercare in cancer survivorship.

In accord with survivors' preferences to connect with others (Blaney et al., 2013; Gjerset et al., 2011; Zhu et al., 2017), the WAT applications and social media "friending" systems could be a low-cost and resource-efficient way to facilitate social support. Such support groups could be moderated by allied health professionals (Lyons & Swartz, 2017), who could provide frequent insights and tips to meet informational needs. However, connections among survivors themselves would facilitate the inclusion of the BCT of social comparison in order to address accountability and support needs (Michie et al., 2013). Following the initial stages of set up and planning, these suggestions for clinical implementation of e-interventions offer a low-cost and feasible option for the delivery of evidence-based BCTs to foster physical activity promotion. This targeted use of evidence-based techniques aligns with existing support for multi-model approaches in which key psychological correlates from various behavioural change frameworks are tailored to the needs of the cohort (Rock et al., 2015; Sheppard et al., 2016).

10.3.3.1 Remote Delivery of Wearable Tracker-Based Interventions for Cancer Survivors

The success of the WATAAP trial for promoting physical activity in cancer survivors via primarily remote intervention materials implies that similar initiatives may be carried out in broad-reaching designs that target underrepresented populations. Not only are survivors in non-metropolitan areas at greater risk of mortality, chronic morbidities, obesity, and physical inactivity (C. L. Paul et al., 2013; Singh et al., 2011; Weaver, Geiger, et al., 2013), but they are also underserved and underrepresented (Lai et al., 2006; Lyford et al., 2018; Sharrocks et al., 2014). A wearable tracker-based intervention could assist in recruiting this underrepresented sample by overcoming accessibility and distance-based barriers.

The rural environments and community health (REACH) online intervention involving self-monitoring of activity, feedback, and telephone support was tested in a sample of rural Australian adults to promote walking and reduce sedentary behaviour (Mitchell et al., 2019). Significant improvements in accelerometer-assessed MVPA, light-intensity physical activity, and decreased sedentary time were identified over the course of the 12-week intervention. Effects remained at 6 months for light-intensity physical activity, but all effects were diminished at the 12-month follow-up assessment (Mitchell et al., 2019). Although the REACH trial was implemented in rural adults, rather than cancer survivors, it shows promise for the utility of a completely online and telephone-based intervention for producing significant effects on physical activity for non-metropolitan samples. A less-intensive pedometer and web-based intervention successfully improved daily steps in rural cancer survivors at 12 weeks (Frensham et al., 2020). However, further investigation of the effectiveness of remote interventions for sustained change has been recommended (Frensham et al., 2020) and the role of BCT-intensive tools such as smart WAT may facilitate longer-term effects.

The success of the WATAAP trial for promoting physical activity over 12 weeks (Maxwell-Smith et al., 2019), in conjunction with the promise of remote intervention in non-cancer samples, suggests that the use of trackers as part of a remote and broad-reaching design may be a feasible and effective approach to target underserved groups.

10.3.4 Tracker-Based Interventions for Survivors at Heightened Cardiovascular Risk May Hold Potential for Reducing the Future Healthcare Burden

Cancer survivors are more likely to die from cardiovascular disease than cancer 5 years after their cancer diagnosis, which is considered to be a result significant lifestyle-related risk (Bradshaw et al., 2016; Ward et al., 2012; Weaver, Foraker, et al., 2013). Cardiovascular diseases have the greatest cost burden of any other disease group within Australia (AIHW, 2012b), accounting for 12% of all healthcare expenditure (AIHW, 2014). However, the burden of cardiovascular disease is predominantly lifestyle-related and preventable (Joseph et al., 2017).

Researchers propose that a window of opportunity exists to reduce cardiovascular risk factors in cancer survivorship (Bluethmann, Basen-Engquist, et al., 2015; Bradshaw et al., 2016). If the risk of subsequent chronic comorbidities and cardiovascular risk could be reduced via wearable tracker-based intervention implemented as part of routine aftercare for survivors, the future strain on the healthcare system could be substantially reduced (Bluethmann et al., 2016). A pragmatic and novel solution is warranted, given the unprecedented and continually increasing burden of disease (AIHW, 2012b, 2020; Waters et al., 2013).

Aerobic physical activity reduces risk of chronic disease and mortality (Meyerhardt et al., 2006; Ozemek et al., 2018; D. J. Ryan et al., 2015; Sternfeld et al., 2009; Warburton & Bredin, 2017). Fifteen minutes of daily MVPA can produce clinically significant change by reducing risk of all-cause mortality in older adults by 22% (Hupin et al., 2015). For cancer samples, the completion of 18 MET hours per week (~3 hours of MVPA) is associated with a 47% improvement rate of disease-free survival (Meyerhardt et al., 2006). The WATAAP intervention was a resource-efficient program that produced a significant increase in aerobic physical activity over 12 weeks and improvements in secondary risk factors (Maxwell-Smith et al., 2019). Similar programs have also yielded benefits using low-cost designs, showing promise for evidence-based BCTs delivered using WAT (Cadmus-Bertram et al., 2019; Hartman, Nelson, Myers, et al., 2018; Lynch et al., 2019). Further research is necessary to assess the utility of activity trackers specifically aimed at reducing the risk of cardiovascular disease, as such outcomes were secondary objectives of the WATAAP trial (Maxwell-Smith et al., 2019). However, this body of research provides a rationale for the prescription of WAT and evidence-based BCTs to be delivered as digital intervention materials to protect against the lifestyle-related risk of cardiovascular disease.

10.4 Strengths and Limitations

This thesis has several strengths and limitations that should be acknowledged. The use of multiple methods and inductive approaches to ascertain factors associated with physical activity has assisted in broadening the scope findings. Previous investigations of factors facilitating physical activity and health behaviour change in cancer survivors have tended to adopt deductive and quantitative approaches in larger samples (Blaney et al., 2013; Clifford et al., 2018). We consider the use of open-ended items to have both strengths and weaknesses. This method facilitates a bottom-up approach to identifying factors affecting physical activity and health behaviour change, which are directly informed by the sample of interest (McEachan et al., 2010). As such, these findings are not affected by previously established factors that appear on deductive questionnaires. This design has demonstrably assisted in elucidating unique factors associated with survivors' uptake of physical activity and health behaviours. However, this approach precludes the assessment of constructs based on psychological behavioural change theories, which could have provided further insight into interactions and potential modelling of the factors affecting health behaviour uptake. Moreover, the use of 'free responses' hinders the statistical analysis of data and the robust underpinnings of established quantitative instruments.

The primary limitations of *Chapter Seven* were the use of single items to assess psychological constructs of self-efficacy, readiness (as a proxy for intention), and instrumental attitude, and the incomplete testing of theories. That is, psychological constructs were assessed from SCT, TTM and TPB, but no single theory was completely assessed (Maxwell-Smith, Hagger, et al., 2020). Brief items were selected for each construct to ensure that the survey was manageable and to reduce attrition. However, single-item measures are compromised by potential misinterpretations of the item and subsequent variability within responses. High variability throughout the data may be ameliorated by using multiple-item measures in future surveys.

Studies that constitute this body of work may be subject to self-selection bias, whereby those more interested or motivated to engage in physical activity were more likely to participate (Chinn et al., 2006). Although the absence of information about non-responders hinders the ability to estimate the external validity of findings across the survey findings (*Chapters Five, Six,* and *Seven*), efforts were made to recruit underrepresented and needs-based samples in the interview study (*Chapter Four*) and WATAAP trial (*Chapters Eight* and *Nine*). To overcome this bias, only survivors at heightened cardiovascular risk were eligible to participate in these studies. Screening was completed

prior to enrolment in the WATAAP trial, to ensure recruitment of survivors who were insufficiently physically active, according to the guideline of 150 minutes of weekly MVPA completed in ≥10-minute bouts (Maxwell-Smith et al., 2018). Despite the rigour of the screening process, participants' physical activity at their baseline assessment was high compared to other trials (Broderick et al., 2013; James et al., 2015; von Gruenigen et al., 2012). Future initiatives may mitigate this issue by having survivors complete an accelerometer-derived assessment of physical activity levels prior to recruitment, although this would be resource-intensive.

The validity of the WATAAP trial was strengthened by its recruitment of equal numbers of males and females. Males are typically difficult to recruit and therefore underrepresented in the cancer survivor literature (J. Ryan et al., 2019). The eligibility of survivors up to the age of 80 years allowed for recruitment of older survivors, who have previously been excluded from or underrepresented in research trials (Bluethmann et al., 2016; Townsley et al., 2005). However, participants recruited throughout this body of work were primarily colorectal and endometrial cancer survivors from private hospitals, predominantly in Western Australia. The majority of survivors were Caucasian. Indigenous Australian survivors are typically underrepresented throughout the cancer survivor literature (Lyford et al., 2018), despite having substantial support needs (Cavanagh et al., 2016). This limitation extends to the samples of cancer survivors recruited throughout the current project.

Physical activity outcomes were assessed via accelerometer-derived estimates throughout the WATAAP trial, which is a strength of this trial. Technological and practical difficulties may have deterred a small proportion of participants from Fitbit wear, however adherence to the intervention and Fitbit wear was nevertheless excellent overall, which is consistent with findings from similar trials involving Fitbit wear (Hartman, Nelson, & Weiner, 2018; van Blarigan et al., 2019). Investigation of patterns of adherence to the intervention was touched upon in *Chapter Nine* but is an important area for future research.

Finally, it should be noted that the 2nd edition of the physical activity guidelines proposed by the DHHS (2018) has eliminated the requirement for MVPA to be conducted in ≥10-minute bouts. The updated guidelines focus on acquiring 150 minutes of weekly MVPA in any combination of accumulated minutes and a reduction of sedentary behaviour (DHHS, 2018). This largely aligns with the American College of Sports Medicine's (2019) recent iteration, which suggests 150 minutes of aerobic exercise, supplemented with two strength training sessions per week. The shifted focus of the government guidelines onto sedentary behaviour may result in new approaches to

screening, whereby sitting and other sedentary behaviours are brought into focus. Screening based on sedentary behaviour in addition to weekly MVPA may provide useful insights about chronic disease, morbidity, and mortality risk (Biswas et al., 2015; Lynch, 2010; Lynch et al., 2013; Rezende et al., 2014).

10.5 Directions for Future Research

The primary areas of suggested research following this thesis pertain to maintenance of outcomes, acceptability, and validity of the Fitbit Alta tracker, and the utility of the HAPA for explaining physical activity change in the WATAAP trial. A recommendation will be made for green prescriptions for physical activity to ameliorate primary barriers.

10.5.1 Maintenance of Outcomes Following the WATAAP Trial

Chapters Eight and *Nine* present the protocol and post-intervention effects of the WATAAP trial (Maxwell-Smith et al., 2018; Maxwell-Smith et al., 2019). However, given the dearth of interventions that are able to strike a balance between being resource-effective and achieving maintenance of behavioural change in the long-term, participants in the WATAAP trial also completed a 24-week assessment. This assessment measured survivors' physical activity, cardiovascular risk outcomes and HAPA-based psychological constructs 12 weeks after the cessation of the intervention. Intervention group participants kept their Fitbit Alta during this period but did not receive support from the research team or any further intervention materials. Additional follow-up assessments after 12, 18, and 24 months of tracker wear, with the incorporation of booster health coaching sessions (Fleig et al., 2013), would be optimal for the assessment of long-term engagement (Amireault et al., 2013). Maintenance of outcomes in the WATAAP trial as measured by the follow-up assessment are beyond the scope of this thesis, but sustained use of trackers indicates promise for this assessment. These results are currently under review for publication and are an important extension of the findings of the WATAAP trial given that similar designs have demonstrated small but sustained improvements in secondary outcomes at the follow-up assessment (Vallance et al., 2020).

10.5.2 Acceptability of Wearable Devices Following Long-Term Wear

Another avenue for future research is the acceptability and feedback concerning WAT to monitor physical activity in survivors. As Australian cancer survivors' average age is approximately 66 years (National Cancer Institute, 2015b), it is important that trackers are comfortable to wear and easy for an older cohort to use. Survivors have previously

reported that complicated trackers deterred their engagement and resulted in disinterest concerning technology-based behavioural change initiatives (Nguyen et al., 2017; Rosenberg et al., 2016). Post-intervention process evaluation interviews of interventions delivered to survivors would contribute valuable insights into the advantages and drawbacks of trackers and inform tracker selection for subsequent programs.

Although the preferences and experiences of survivors for WAT have been previously explored via qualitative methods (Hardcastle, Galliott, et al., 2018; Nguyen et al., 2017), this has been over shorter periods and not following a behavioural intervention. The use of a Fitbit One without self-regulatory support following a supervised program was insufficient for maintaining behavioural change for survivors, suggesting that reinforcement from the research team may be necessary for sustained effects (Gell, Grover, et al., 2020). Other research reinforces this finding, indicating that tracker use, without other support, tends to decline after 6 months (Kononova et al., 2019). However, characteristics of the tracker itself including the ease of use and outcomes measured are factors that influence long-term engagement (Kononova et al., 2019), which may suggest that optimal tracker selection is an important consideration for sustained use. Therefore, survivors' experiences of trialling the Fitbit Alta for 6 months during the WATAAP trial may glean novel insights to inform the selection of trackers for future programs. Process evaluation interviews concerning the WATAAP intervention and use of the Fitbit Alta tracker have been conducted and the findings are currently under review for publication.

10.5.3 Validity of Wearable Devices and Their Relevance in Future Research

At the time of the design and implementation of the WATAAP trial, there was little available evidence on the accuracy of wrist-worn Fitbit trackers for assessing MVPA. Validation of measures of physical activity is typically sought by comparing estimates of physical activity outcomes to those ascertained by a research-grade accelerometer (Evenson et al., 2015; J.-M. Lee, Kim, & Welk, 2014; S. S. Paul et al., 2015). In particular, ActiGraph triaxial accelerometers have been validated for estimating physical activity and energy expenditure over other research-grade accelerometers (Aadland & Ylvisåker, 2015; J.-M. Lee, Kim, & Welk, 2014; Plasqui & Westerterp, 2007; Vanhelst et al., 2012). Although it has been suggested that commercially available wearable trackers may have utility for motivating users, rather than accurately tracking their physical activity (Mercer, Li, et al., 2016; Shin et al., 2019), a greater understanding of their validity for estimating physical activity outcomes would elucidate any limitations of wrist-worn trackers and particular design or technological features associated with greater accuracy. Examination

of the validity of wearable activity trackers may also indicate whether a commercial wearable tracker is sufficient to replace a research-grade accelerometer as an assessment device, or whether a separate, research-grade device is necessary for physical activity assessments in future studies. Given recent amendments in physical activity guidelines to also encourage a reduction in sedentary behaviour, validation studies might consider the ability of wrist-worn trackers in discerning sitting from standing behaviours, and the presence of light-intensity physical activity (Walker et al., 2016). Moreover, the growing prevalence of HR monitors as a component of wrist-worn WAT provides support for the ability of trackers with in-built HR monitors to better ascertain physical activity intensity and detect MVPA, although there is still variation between trackers with respect to intensity estimates (Dooley et al., 2017).

Participants randomised to the intervention group in the WATAAP trial wore the Fitbit Alta alongside the ActiGraph accelerometer during assessment weeks. This provides an opportunity for a future research initiative to compare wrist-worn WAT and accelerometer estimates of physical activity in order to inform the limited knowledge base on agreement between these devices. A comparison of the accelerometer and Fitbit Alta physical activity estimates, as ascertained from WATAAP participants during the intervention, has been completed and is currently submitted for publication.

10.5.3.1 Concordance Between Fitbit Trackers and Guidelines for Physical Activity and Sedentary Behaviour

One feature of the Fitbit Alta and other tracker models that has received little attention in research to date is an hourly prompt, which encourages users to break up sedentary time each hour during their waking day (Fitbit, n.d.-a). The utility of Fitbit trackers for targeting sedentary time and distinguishing between sedentary behaviour and light-intensity physical activity may now be a relevant consideration, given the updated guidelines for reducing sedentary behaviour (DHHS, 2018) and the increasing attention to sedentary behaviour as an independent risk factor of chronic disease (Chau et al., 2019; Stamatakis et al., 2019). Further, the role of the Fibit-derived “active minutes” (Fitbit, n.d.-a) as a measure of MVPA completed in bouts of at least 10 minutes may have less relevance to the updated guidelines which no longer specify that the 150 minutes of recommended MVPA should be completed in bouts of a prescribed length (DHHS, 2018). Recent studies have concurred that the health benefits and improvements in mortality yielded by MVPA are independent of how activity is accrued (Saint-Maurice et al., 2018; Shiroma et al., 2019). As frequent bouts of a shorter duration and longer, less frequent bouts are

considered to yield similar levels of protective benefits for mortality (Saint-Maurice et al., 2018), a shift in focus to the total amount of MVPA accrued in accord with the guideline of 150 minutes of weekly MVPA is justified. While it has been recognised that MVPA beyond these guidelines produces a greater reduction in cardiovascular disease risk (Sattelmair et al., 2011), the endorsement of a definitive goal is likely to be optimal for fostering motivation as a part of WAT-based interventions (Conroy et al., 2014).

10.5.4 Utility of the Health Action Process Approach for Explaining Physical Activity Change

The WATAAP intervention was tethered to constructs of the HAPA model (Maxwell-Smith et al., 2018). This model proposes that the intention–behaviour gap can be bridged by self-regulatory and planning processes, including action planning and coping planning (Schwarzer, 1999; Sniehotta, Scholz, & Schwarzer, 2005). As such, these planning stages were incorporated into the WATAAP intervention in order to foster the transition of survivors to the volitional stage of action. Action planning activities were provided during group sessions, and supplemented by engagement with action planning sheets within the WATAAP trial booklet. Coping planning to anticipate and develop strategies for overcoming potential obstacles was incorporated into the second group session and discussed as part of the HAPA-based support phone call. Group sessions and the support phone-call appeared to be effective for boosting physical activity, based on spikes in the step count during the weeks following contact with research staff.

However, it cannot be ascertained from these results whether the effects are due to the HAPA-based intervention materials, or due to contact with the research staff irrespective of HAPA components. Although investigation of HAPA constructs for explaining behavioural change in the WATAAP trial falls outside the scope of this thesis, data was collected on HAPA constructs at each assessment and is currently under analysis. As the effectiveness of theoretical, compared to atheoretical, approaches for behavioural change have recently been debated (Gourlan et al., 2016; McEwan et al., 2019; Stacey et al., 2015), investigation into the role of HAPA in the effects of the WATAAP intervention would be of particular interest to inform the degree to which future programs are based on social cognition frameworks.

10.5.5 Physical Activity Prescription to Address Informational Barriers and Accountability Needs

Future initiatives may consider possible approaches to address the informational needs, practitioner support needs, and accountability needs expressed by survivors to facilitate physical activity uptake (Maxwell-Smith et al., 2017). An effective mode of delivery may be a green prescription of physical activity, whereby clinicians provide a physical prescription of weekly physical activity to be completed in accord with the recommended guidelines (Hardcastle & Cohen, 2017). Specifically, survivors would receive a green prescription from their oncologist specifying the amount and intensity of recommended weekly activity. The prescription could be signed and provided to survivors along with other prescribed medications during a follow-up appointment. This approach has been effective in other samples (Garrett et al., 2011; Hamlin et al., 2016) and would address the practitioner support, informational, and accountability needs of survivors identified throughout this project. Survivors would have their practitioner's involvement and be accountable to them to complete the recommended amount of exercise. Additionally, informational needs may be allayed for survivors who receive a hard copy prescription of the type, intensity, and duration of recommended physical activity. Given that the current iteration of the Australian Government's physical activity recommendations has shifted the focus from 10-minute bouts to a reduction in sedentary time, recommendations may also encourage light-intensity physical activity, in addition to MVPA (Lynch, 2010).

Survivors with greater support or informational needs may also receive a referral to a cancer nurse or allied health professional, such as an exercise physiologist, per their preferences (Blaney et al., 2013; Brandenbarg et al., 2017; Vallance et al., 2013). This professional could provide additional support, including information on the benefits to be garnered by meeting the physical activity guidelines and a means of accountability. Further studies might consider establishing survivors' preferences for the delivery of educational initiatives on the risk factors associated with the survivor's cancer type and advice for reducing cardiovascular and other chronic disease risk. This is warranted not only from a support needs perspective, but also from the view of reducing the future healthcare burden.

10.6 Conclusion

The majority of cancer survivors are insufficiently physically active, putting them at heightened risk of cardiovascular disease, chronic comorbidities, and mortality. This thesis sought to explore the barriers, motives, and attitudes held by cancer survivors towards physical activity behavioural change and to implement a WAT and action planning intervention to promote physical activity in colorectal and endometrial cancer survivors.

Findings have demonstrated that survivors have unique barriers and facilitators of physical activity that may be addressed via the support of oncologists, allied health professionals, motivational tools, and education about the importance of physical activity participation (Maxwell-Smith et al., 2017; Maxwell-Smith, Cohen, et al., 2020). Programs offered to survivors should foster perceived importance and positive attitudes by incorporating educational aspects and adhering to their preferences concerning self-paced, unsupervised, moderate-intensity physical activity, particularly walking (Maxwell-Smith, Hagger, et al., 2020). The WATAAP trial was designed in accordance with these findings (Maxwell-Smith et al., 2018) and yielded a 66-minute net change in weekly MVPA between intervention and control groups at 12 weeks, and non-significant improvements in SBP and DBP (Maxwell-Smith et al., 2019). The promising findings of the WATAAP trial provide a rationale for future research to assess the maintenance of behavioural outcomes following the cessation of the intervention and the potential for reducing cardiovascular risk factors.

This thesis has presented a comprehensive view of the factors affecting physical activity and conducted an effective trial to promote physical activity in cancer survivors. Provision of support and education to ameliorate barriers is essential to successful behavioural change in cancer survivorship. Wearable activity trackers present a valuable tool for the delivery of a resource-efficient behavioural change intervention for colorectal and endometrial cancer survivors, demonstrating promise for individuals living after cancer. As cancer survivors are at increased risk of cardiovascular disease, wearable tracker-based programs that are supplemented with low-intensity support sources may offer a feasible and pragmatic opportunity to promote physical activity as a part of routine survivorship aftercare.

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APPENDICES

Appendix A Maxwell-Smith et al. (2017) Publication

A.1 Banner Page: *Barriers to Physical Activity Participation in Colorectal Cancer Survivors at High Risk of Cardiovascular Disease*

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WILEY

PAPER

Barriers to physical activity participation in colorectal cancer survivors at high risk of cardiovascular disease

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Abstract

Background Lifestyle factors including inadequate physical activity may contribute to increased risk of developing cardiovascular disease in colorectal cancer survivors. Identification of the barriers to physical activity is important for forming an evidence base of factors to target in future physical activity programs aimed at improving cardiovascular health in this population.

Methods Colorectal cancer survivors (*N* = 24) from St. John of God Subiaco Hospital participated in semi-structured interviews about their current physical activity behaviors and perceived barriers to physical activity.

Results Inductive thematic analysis of interviews revealed 5 overarching themes relating to barriers to physical activity: psychological barriers, environmental barriers, knowledge of guidelines, lack of practitioner support, and energy/age barriers.

Conclusions Novel findings revealed participants' dependence on practitioner support, including a reliance on practitioners to recommend lifestyle change. Survivors also revealed that regular checkups to monitor cardiovascular risk replaced the need for healthy lifestyle changes. Implications: With survivors holding the advice of clinicians in high regard, an opportunity exists for clinicians to facilitate lifestyle change. Health care professionals such as nurses can implement motivational strategies and provide additional health information during follow-up visits, to ensure long-term adherence. Individuals who reported psychological, motivational, and environmental barriers may benefit from interventions to improve self-regulation, planning, and problem-solving skills.

KEYWORDS

cancer survivors, colorectal cancer, motivational barriers, oncology outpatient care, physical activity, practitioner support

Colorectal cancer (CRC) is the second most common type of cancer among Australians[1] and the third most common type of cancer worldwide.[2] There were 1.4 million new instances of CRC reported globally in 2012.[2] Although survival rates are increasing, many cancer survivors suffer with additional comorbidities that put them at risk of developing cardiovascular disease (CVD).[3] Lifestyle factors such as insufficient physical activity, low fruit and vegetable intake, smoking, and alcohol consumption make individuals susceptible to both cancer and CVD.[4–6] As a result, insufficiently active CRC survivors who fail to make healthy lifestyle changes posttreatment are likely to have substantially higher risk of developing CVD. Furthermore, only 53% of CRC survivors meet the physical activity guidelines (150 minutes of moderate intensity physical activity per week) pre-diagnosis, and 32% meet these guidelines post-diagnosis.[7] More recent data reveal that only 20% to 25% of CRC survivors currently meet the physical activity guidelines.[8]

Previous research has identified a range of physical activity barriers for cancer survivors such as lack of time or motivation,[9–12] and cancer-specific barriers concerning benefits and safety.[10,13,14] Breast cancer survivors (*N* = 23) identified barriers to physical activity, including competing priorities, lack of self-discipline, procrastination, fatigue, and lack of interest/time.[15]

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Appendix B Maxwell-Smith, Cohen, et al. (2020) Publication

B.1 Banner Page: *"To Be There for My Family" and "Keep My Independence": Metropolitan and Non-Metropolitan Cancer Survivors' Health Behaviour Motives*

Supportive Care in Cancer
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ORIGINAL ARTICLE

Check for updates

"To be there for my family" and "Keep my independence": Metropolitan and Non-Metropolitan Cancer Survivors' Health Behaviour Motives

Chloé Maxwell-Smith[1,2] · Paul A. Cohen[3,4] · Cameron Platell[3,5] · Jason Tan[6] · Christobel Saunders[3,5] · Sophie Nightingale[7] · Craig Lynch[7] · Frank Sardelic[8] · Jacob McCormick[9] · Sarah J. Hardcastle[2,10]

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Abstract

Purpose Cancer survivors are at risk of comorbidities and mortality, and those living outside of metropolitan areas are particularly susceptible given poorer socioeconomic, health and support resources. As engagement in health behaviours is affected by participants' autonomous motives, investigation of the motives of cancer survivors in metropolitan and non-metropolitan areas could elucidate the values and reasons for practising health behaviours, allowing programs to be tailored to these motives.

Methods Metropolitan ($n = 103$) and non-metropolitan ($n = 80$) Australian cancer survivors completed a survey item by describing their motives for physical activity and healthy diet change. Inductive thematic analysis of responses was performed to establish themes across health behaviour motives.

Results Analyses revealed four themes: *to be able to*, *longevity*, *psychological health* and *appearance*. Survivors primarily referred to being able to enjoy family, leisure activities, travel and staying independent, with these motives often linked to longevity. Motives were similar across locations; however, those in non-metropolitan locations reported continuation of work and pain relief more frequently. Female survivors more often reported weight loss.

Conclusions A predominant motive for health behaviour change in cancer survivors across geographical location was the ability to enjoy family and engage in leisure and work activities. Programs aiming to promote health behaviours in cancer survivors might consider framing interventions accordingly by emphasizing benefits of longevity and maintaining independence.

Keywords Cancer · Cancer survivors · Health behaviours · Lifestyle change · Oncology · Physical activity

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s00520-020-05690-9) contains supplementary material, which is available to authorized users.

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Appendix C Maxwell-Smith, Hagger, et al. (2020) Publication

C.1 Banner Page: *Psychological Correlates of Physical Activity and Exercise Preferences in Metropolitan and Non-Metropolitan Cancer Survivors*

Received: 18 May 2020 | Revised: 1 September 2020 | Accepted: 8 September 2020

DOI: 10.1002/pon.5553

PAPER

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Psychological correlates of physical activity and exercise preferences in metropolitan and nonmetropolitan cancer survivors

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Abstract

Objective: Interventions to increase physical activity (PA) in cancer survivors have often adopted a "one-size-fits-all" approach and may benefit from being tailored to psychological constructs associated with behavior. The study objective was to investigate the exercise preferences and psychological constructs related to PA among cancer survivors.

Methods: Posttreatment colorectal, endometrial, and breast cancer survivors (n = 183) living in metropolitan and nonmetropolitan areas completed survey measures of PA, exercise preferences, attitudes, self-efficacy, perceived behavioral control (PBC), and intention toward PA.

Results: A structural equation model with adequate fit and quality indices revealed that instrumental attitude and self-efficacy were related to PA intention. Intention was related to behavior and mediated the relationship between self-efficacy and behavior. Preferred exercise intensity was related to self-efficacy, PBC, attitudes, and intention, while preferred exercise company was related to self-efficacy and PBC. Participants preferred moderate-intensity PA (71%), specifically self-paced (52%) walking (65%) in an outdoor environment (58%).

Conclusions: Since instrumental attitude and self-efficacy were associated with PA, incorporating persuasive communications targeting attitudes in PA interventions may promote PA participation. As cancer survivors who prefer low-intensity exercise and exercising with others report lower self-efficacy and PBC, interventions targeting confidence and successful experience in this group may also be warranted.

KEYWORDS
attitudes, behavioral medicine, cancer, cancer survivors, health behavior, oncology, physical activity, psychological theory, psycho-oncology, self-efficacy

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D.1 Banner Page: *Wearable Activity Technology And Action-Planning (WATAAP) to Promote Physical Activity in Cancer Survivors: Randomised Controlled Trial Protocol*

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ORIGINAL ARTICLE

Wearable Activity Technology And Action-Planning (WATAAP) to promote physical activity in cancer survivors: Randomised controlled trial protocol

Chloe Maxwell-Smith[a,*], Paul A. Cohen[b,c,d,e], Cameron Platell[f,g], Patrick Tan[f], Michael Levitt[f], Paul Salama[f], Gregory B. Makin[h], Jason Tan[e], Stuart Salfinger[f], Ganendra Raj Kader Ali Mohan[i], Robert T. Kane[a], Dana Hince[d], Ruth Jiménez-Castuera[j], Sarah J. Hardcastle[a,c]

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KEYWORDS
Oncology;
Wearable tracker;
Physical activity;
Self-monitoring;
Cuasi-experimental study

Abstract
Background/Objective: Colorectal and gynecologic cancer survivors are at cardiovascular risk due to comorbidities and sedentary behaviour, warranting a feasible intervention to increase physical activity. The Health Action Process Approach (HAPA) is a promising theoretical framework for health behaviour change, and wearable physical activity trackers offer a novel means of self-monitoring physical activity for cancer survivors.
Method: Sixty-eight survivors of colorectal and gynecologic cancer will be randomised into 12-week intervention and control groups. Intervention group participants will receive: a Fitbit Alta™ to monitor physical activity, HAPA-based group sessions, booklet, and support phone-call. Participants in the control group will only receive the HAPA-based booklet. Physical activity (using accelerometers), blood pressure, BMI, and HAPA constructs will be assessed at baseline, 12-weeks (post-intervention) and 24-weeks (follow-up). Data analysis will use the Group x Time interaction from a General Linear Mixed Model analysis.

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Appendix E Maxwell-Smith et al. (2019) Publication

E.1 Banner Page: *A Randomized Trial of WATAAP to Promote Physical Activity in Colorectal and Endometrial Cancer Survivors*

Received: 28 November 2018 | Revised: 8 April 2019 | Accepted: 8 April 2019
DOI: 10.1002/pon.5090

PAPER

WILEY

A randomized controlled trial of WATAAP to promote physical activity in colorectal and endometrial cancer survivors

Chloé Maxwell-Smith[1] | Dana Hince[2] | Paul A. Cohen[2,3,4,5] | Max K. Bulsara[2] | Terry Boyle[6] | Cameron Platell[3,5] | Patrick Tan[5] | Michael Levitt[5] | Paul Salama[5] | Jason Tan[4] | Stuart Salfinger[5] | Gregory Makin[7] | Ganendra Raj Kader Ali Mohan[8] | Ruth Jiménez-Castuera[9] | Sarah J. Hardcastle[1,3]

[1] School of Psychology, Curtin University, Perth, Western Australia
[2] Institute for Health Research, University of Notre Dame, Fremantle, Western Australia
[3] Faculty of Medical and Health Sciences, University of Western Australia, Crawley, Western Australia
[4] Women Western Australia Oncology Menopause Endometriosis New Mothers, West Leederville, Western Australia
[5] St John of God Subiaco Hospital, Subiaco, Western Australia
[6] University of South Australia, Adelaide, South Australia
[7] St John of God Murdoch Hospital, Murdoch, Western Australia
[8] Hollywood Private Hospital, Nedlands, Western Australia
[9] Faculty of Sports Sciences, University of Extremadura, Cáceres, Spain

Correspondence
Sarah J. Hardcastle, School of Psychology, Curtin University, PO Box U1987, Perth, WA 6845, Australia.
Email: sarah.hardcastle@curtin.edu.au

Funding information
Tonkinson Colorectal Cancer Research Fund, Grant/Award Number: 57838; Junta of Extremadura, Spain

Abstract

Objective: The objective of this study was to ascertain whether wearable technology coupled with action planning was effective in increasing physical activity (PA) in colorectal and endometrial cancer survivors at cardiovascular risk.

Methods: Sixty-eight survivors who had cardiovascular risk factors and were insufficiently active were randomized to intervention and control arms. Intervention participants were given a wearable tracker for 12 weeks, two group sessions, and a support phone call. Participants in the control arm received print materials describing PA guidelines. Assessments at baseline and 12 weeks measured triaxial and uniaxial estimates of moderate-vigorous physical activity (MVPA), sedentary behaviour, blood pressure, and body mass index (BMI).

Results: The intervention group significantly increased MVPA by 45 min/wk compared with a reduction of 21 min/wk in the control group. Group by time interactions were significant for minutes of MVPA ($F_{1,126} = 5.14$, $P = 0.025$). For those with diastolic hypertension, there was a significant group by time interaction ($F_{1,66} = 4.89$, $P = 0.031$) with a net reduction of 9.89 mm Hg in the intervention group.

Conclusions: Significant improvements in MVPA were observed following the intervention. The results display promise for the use of pragmatic, low-intensity interventions using wearable technology.

KEYWORDS
cancer, cardiovascular diseases, exercise, oncology, wearable technology

1 | INTRODUCTION

Physical activity (PA) reduces the risk of cardiovascular disease (CVD),[1] cancer, and cancer-related death.[2] In cancer survivors, PA may reduce the risk of recurrence.[2] Sedentary behaviour may be an independent risk factor for cancer occurrence and mortality.[3] However, many cancer survivors fail to meet the current guidelines of >150 minutes of moderate-intensity PA per week,[4] and some are sedentary.[5]

Although survival rates are increasing, many colorectal and endometrial survivors have comorbidities and lifestyle-related risk factors for CVD[6] including insufficient PA, sedentary behaviour, poor diet, and obesity.[2,6,7] More than 58% and 63% of colorectal and endometrial survivors respectively are overweight or obese.[8] Further, approximately

E.2 Permission to Reproduce Maxwell-Smith et al. (2019) Publication

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Expected completion date	Sep 2020
Expected size (number of pages)	250
Requestor Location	Curtin University 41/11 Bennett Street East Perth, WA 6004 Australia Attn: Curtin University

Appendix F Conference Presentation Abstract

Annual Conference of the European Health Psychology Society presentation abstract: *Wearable Activity Technology And Action-Planning (WATAAP) Promoting Physical Activity in Colorectal and Gynaecologic Cancer Survivors: Randomised Controlled Trial*

Wearable Activity Technology And Action-Planning (WATAAP) Promoting Physical Activity in Colorectal and Gynaecologic Cancer Survivors: Randomised Controlled Trial

Background. Colorectal and gynaecologic cancer survivors are at cardiovascular risk due to comorbidities and sedentary behavior, warranting an intervention to increase physical activity. The Health Action Process Approach (HAPA) is a promising theoretical framework for health behaviour change, and wearable physical activity trackers offer a novel means of self-monitoring physical activity for cancer survivors.

Methods. Participants: Cancer survivors (n = 68) who were insufficiently active and presented cardiovascular risk factors were recruited.
Design: Participants were randomly allocated to treatment and control groups, following the baseline assessment. Each participant in the treatment group was given a Fitbit Alta to monitor activity for the trial duration, attended two HAPA-based group sessions, and a support phone call.
Measures: Trial assessments at baseline, the end of the 12-week intervention, and at 24-week follow-up measured physical activity (using accelerometer data), BMI, blood pressure, and HAPA outcomes.
Analysis: Data analysis used the *Group x Time* interaction from a General Linear Mixed Model analysis.

Findings. At 12 weeks mean weekly MVPA increased by 50 ± 120 min/week in the intervention group compared to controls who showed a mean weekly increase of 15 ± 107 minutes in the control group (mean baseline MVPA 82 mins per week).

Discussion. Findings at 12-weeks revealed a significant increase in physical activity in the intervention group. This intervention will provide a novel contribution concerning the use of wearable trackers and self-monitoring to improve physical activity in cancer survivors.

Australia New Zealand Clinical Trials Registry identifier: 2617000131358.
WHO UTN: U1111-1191-6268.

Appendix G Study 1 – Barrier Interviews: Supporting Documents

G.1 Ethical Approval

ST JOHN OF GOD
Subiaco Hospital

5 December 2014

Dr Sarah Hardcastle
School of Psychology and Speech Pathology
Curtin University
GPO Box U1987
Perth WA 6845

COPY

Dear Dr Hardcastle,

F/A

Re: A Qualitative study exploring perceptions of health and the factors influencing physical activity and healthy eating among colorectal cancer survivors *(Our ref No: 756)*

I refer to the letter of 5 December 2014, advising of ethical approval of the above project, as granted by the St John of God Health Care (SJGHC) Human Research Ethics Committee (HREC).

I am in receipt of the signed SJGHC Participating Site Operational Approval Form from St John of God Subiaco Hospital ("the participating site"). Accordingly, I confirm final approval for your study to be conducted at the participating site.

I wish you well with your research.

Yours sincerely

Dr Mark Lubliner
Group Director Medical Services & Risk
St John of God Health Care

✓ cc. Prof Cameron Platell, Director Colorectal Cancer Research Unit, SJG Subiaco Hospital (via email)
✓ cc. Dr Joe Pracilio, Director of Medical Services, SJG Subiaco Hospital (via email)

ST JOHN OF GOD
Subiaco Hospital

5 December 2014

Dr Sarah Hardcastle
School of Psychology and Speech Pathology
Curtin University
GPO Box U1987
Perth WA 6845

COPY

F/A

Dear Dr Hardcastle,

Re: A Qualitative study exploring perceptions of health and the factors influencing physical activity and healthy eating among colorectal cancer survivors *(Our ref No: 756)*

Thank you for forwarding the above project for review by the St John of God Health Care (SJGHC) Human Research Ethics Committee (HREC) ("the Committee"), and for addressing the queries raised, and amendments suggested by the sub-group of the Committee in the out of session review of your "low risk" project.

Accordingly, I advise that your project has been granted ethical approval based on an expedited review process, as per section 5.1.7 of the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research (NHMRC, 2007) ("the National Statement").

This project approval is granted for a time frame from the date of this approval letter to 31 May 2015. Should an extension of this timeframe be required, then you must seek continued approval from the Committee *before* the expiry of this time period.

The project will now be tabled for the information of the full Committee, at its next scheduled meeting on 10 December 2014. Please find attached a signed and dated Committee membership list.

You are reminded that this letter constitutes ***ethical approval only***. You must not commence this project at SJGHC until separate authorisation from SJGHC has been obtained.

The Committee is a HREC that is constituted and operates in accordance with the National Statement. In line with the National Statement requirements, researchers need to keep the Committee and the institution (specifically, the participating site of SJGHC: St John of God Subiaco Hospital promptly and regularly informed on the progress of their approved research including:

.../2

1. any adverse events or unexpected outcomes that may affect continued ethical approval of the project.
2. any proposed changes in the research protocol.
3. when the project is completed or abandoned.

The Committee would also appreciate receiving *at a minimum* an *annual* project progress report, as well as a final report on the project results and/or any subsequent publications.

I wish you well with your project.

Yours sincerely

Clinical Professor Dr Simon Dimmitt
Chairman
St John of God Health Care Human Research Ethics Committee

Enc.

cc. Prof Cameron Platell, Director Colorectal Cancer Research Unit, SJG Subiaco Hospital (via email)
cc. Dr Joe Pracilio, Director of Medical Services, SJG Subiaco Hospital (via email)

ST JOHN OF GOD HEALTH CARE HUMAN RESEARCH ETHICS COMMITTEE MEMBERSHIP

NAME	CORE MEMBER	SEX	APPOINTMENT	POSITION
Clinical Professor Simon Dimmitt	Core	M	Chair (with suitable experience whose other responsibilities will not impair the HREC's capacity to carry out its obligations under the National Statement).	Consultant Physician, General & Cardiovascular Medicine (accredited to St John of God Health Care)
Ms Tracey Piani	Core	F	Member with knowledge of and current experience in the professional care, counselling or treatment of humans (ie medical practitioner, clinical psychologist, social worker, nurse as appropriate)	Nurse; Clinical Leadership Coordinator, St John of God Hospital Subiaco
Fr Joe Parkinson	Core	M	Member who performs a pastoral care role in a community for example an Aboriginal Elder, a minister of religion	Minister of Religion; Bioethicist, Director L. J. Goody Bioethics Centre
Mr Peter Quinlan	Core	M	Member who is a lawyer, and where possible who is not engaged to advise the institution	Barrister; Francis Burt Chambers, Perth WA
Dr Janie Brown	Core	F	Member with current research experience that is relevant to research proposals to be considered at the meetings.	Nursing and Midwifery Research Coordinator, St John of God Subiaco Hospital
Sr Leonie O'Brien	Core	F	Laywoman who has no affiliation with the institution and does not currently engage in medical, scientific, legal or academic work.	Mercy Sister
Professor Sally Sandover	Core	F	Member with current research experience that is relevant to research proposals to be considered at the meetings.	Academic Co-ordinator Carrick Support Initiative, UWA Co-ordinator Regional Programs & PBL Consultant, University of WA
Mr Hamish Milne	Core	M	Layman who has no affiliation with the institution and does not currently engage in medical, scientific, legal or academic work	Director Diocesan Services Anglican Diocese of Perth
Mr Patrick O'Connor		M	Community member with expert knowledge in clinical psychology	Senior Clinical Psychologist, Health Dept WA (mental health services) *and* Clinical Psychologist, Hillarys Medical Centre
Mr Jeffrey Williams		M	Hospital Representative. Expert knowledge in Quality and Risk Management, public hospital management.	Director of Nursing, St John of God Midland Public & Private Hospitals
Mr Colin Keogh		M	Hospital Representative. Expert knowledge in Mission and culture.	Director of Mission, St John of God Murdoch Hospital
Ms Mary Rigby		F	Hospital Representative. Expert knowledge in nursing, particularly in palliative care & oncology.	Ward Nurse Manager, St John of God Subiaco Hospital

The St John of God Health Care Human Research Ethics Committee is a Human Research Ethics Committee that is constituted and operates in accordance with the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research (2007).

G.2 Participant Information Sheet and Consent Form

PARTICIPANT INFORMATION SHEET

Health Behaviour Change: A qualitative Study exploring the factors influencing physical activity and healthy eating among colorectal cancer survivors

Investigators: Dr Sarah Hardcastle[1]; Dr Moira O'Connor[1]; Prof Martin Hagger[1]; Prof Cameron Platell[2]
(1 Curtin University; 2 St John of God Hospital, Subiaco)

This project is being conducted by a collaborative team from Curtin University and Oncology at St John of God Hospital (SJOGH).

Please take time to read the following information carefully and to discuss it with others if you so wish. If any part of the information is not clear to you, or if you would like more information do not hesitate to ask us to explain it more clearly. Make certain you do this before you consent to participate in this study.

Introduction
You are invited to take part in this research project. The purpose of this study is to explore attitudes, motives and barriers towards lifestyle behaviour change among colorectal cancer survivors. In keeping with the Catholic foundations of St John of God Health Care, this research aims to reach out to people to improve health and wellbeing. The results of the project will be used to improve patient experiences and outcomes and provide quality care that is both compassionate and affirming.

In this study, participants will be invited to share their views and perceptions about lifestyle health behaviours such as physical activity and healthy eating during one-to-one interviews. Your contribution and valuable opinion will help us to better understand the needs of cancer survivors and inform strategies to improve lifestyle and health through the oncology team.

This Participant Information and Consent Form explain the study and include details such as:

- possible benefits and risks of the study
- what you will be asked to do if you choose to participate
- what your rights and responsibilities are if you agree to participate

Who is funding this study
The study is being funded by an internal grant from Curtin University and funds from the Western Australian Clinical Oncology group (WACOG).

Contact persons:
If you have any questions about the study you can contact:

Investigators:

Dr Sarah Hardcastle 0439226015
sarah.hardcastle@curtin.edu.au

Dr Moira O'Connor 08 9266 3450 or 0415 338 546
M.OConnor@curtin.edu.au

Decision to Participate
Participation in this research is voluntary, that is, you may decide to be in this study or not take part in it at all. If you do decide to participate, you are able to change your mind at any time during the study. However, before you make any decision, it is important that you understand why this study is being done and what it will involve, including your rights and responsibilities.

What is the purpose of the study?
We plan to explore the attitudes, motives and barriers towards lifestyle behaviour change (for example, physical activity, healthy eating) among colorectal cancer survivors by interviewing colorectal cancer survivors treated at SCGH or SJOGH.The information gained from these interviews will help to understand the experiences and perceptions of participants and enhance future oncology delivered in WA.

What does participation in this research project involve?
If you agree to participate in the study, we will ask you to sign and return the consent form (in the reply paid envelope provided or at the interview). The interview will be conducted in a location of your choosing and will last between 40 and 50 minutes. You may choose to not answer particular questions. With your permission, the interviews will be audio recorded and then later transcribed to protect the identity of the participants (e.g. names removed) before data is analysed.

How long will I be in this study?
If you agree to participate in this study we will ask you to take part in one interview that will be 40-50 minutes long. We will ask your permission to contact you via telephone if we feel that anything was missed during the course of the interview.

What are the costs to me?
There are no direct financial costs to you from taking part in this study.

Will I be paid to participate in this study?
You will not be paid to participate in this study.

What are the possible benefits?
At the end of the interview you will be given tailored information on the national guidelines for physical activity and healthy eating, including suggestions for how to meet these targets.

What are the possible risks?
There is a low level of risk for participation in this study. It is not likely that participating in an interview will cause you to become upset or distressed. The interviewer will ensure that the emotional well-being of the participant is supported throughout. You may keep quiet if you prefer not to answer a question. Afterwards, if you continue to be upset about something discussed in the interview please contact a member of the research team who will arrange for counselling or other appropriate support. Any counselling or support will be provided by staff who are not members of the research team.

What are my alternatives if I do not want to participate in this study?
If you decide that you do not wish to participate in this study, you do not need to do anything. Your decision to not participate will not disadvantage you in any way.

What if I withdraw from this research project?
You may withdraw from the interview at any time. If you decide to leave the project, the researchers would like to keep any data that has been collected. This is to help them make sure that the results of the research can be captured properly. If you do not want them to do this, you must tell them before you join the research project.

How can I find out the results of this study?
The results of this study will be published in peer-reviewed journals and presented at national and international conferences. You may find out about the study results by reading these articles or by contacting the lead investigators for the results after the study is complete.

Will my taking part in this study be kept confidential?
The audio recordings of interviews will be stored securely by the researchers until they are transcribed into scripts which have personal information (e.g. names) removed. After this has happened, the recordings will be destroyed and it will not be possible for the researchers to identify the name of the person with what they said.

All of your responses will be treated confidentially and the raw survey data will only be accessed by the research team at Curtin University for the purpose of this research project. Any information which would identify you will never be disclosed to your employer/s, or to any other source. It will only be disclosed with your permission, except as required by law.

All the information you provide will be coded so you cannot be identified by name, and only the research team will have access to the list that can link your name to your data. All information will be stored securely in a locked filing cabinet in the office of Dr Sarah Hardcastle at Curtin University during the study and in a locked archive for 5 years from the time study is closed and may be destroyed at any time thereafter. In any publication, information will be provided in such a way that you cannot be identified. You will not, for example, be mentioned by name in any future publication of the results.

Who has reviewed the study?
The St John of God Health Care Ethics Committee has given ethical approval for the conduct of this study. If you have any concerns or complaints regarding this study, you can contact the Executive Officer of the Committee (telephone number (08) 9382 6940) on a confidential basis. Your concerns will be drawn to the attention of the Committee that is monitoring the study."

If you have any question about the study, please contact Moira O'Connor (Researcher) on 08 9266 3450 or the Executive Officer of Human Rights and Ethics Committee on 08 9346 2999.

CONSENT

NOTE: If you are still unclear about anything you have read in the Participant Information Sheet, please speak to the researcher before signing this Consent.

Name of Participant	Signature of Participant	Date

Name of Researcher	Signature of Researcher	Date

G.3 Interview Guide

Physical Activity Interview Guide for Colorectal Cancer Survivors

- Can you tell me a bit about your journey with cancer & your treatment at this hospital?
- How do you consider your health now? Do you feel fully recovered?
- Have you received any advice/support from the oncology team/healthcare staff at hospital on how to stay active? If yes then what have you been advised and what resources have you been given?
- What strategies do you have/could you have to stay active or improve your physical activity levels?
- Have you got a care plan in regard to your physical activity? Is it written down? What sort of activities does it include? Do you adhere it this?
- Can you tell me a bit about your activity levels? How much exercise do you do & how active are you on a typical day? What about typical week?
- Do you consider your lifestyle to be physically active? In what way? Why not?
- What do you make of the role of physical activity to your health status?
- What are the main influences on your physical activity level?
- Are you familiar with the government guidelines for physical activity?
- Is there anything you would like to change about your physical activity levels? Are you content with your activity levels and their influence on your health?
- Are there any barriers to maintaining or achieving an active lifestyle?
- Are there any facilities/support/programs that can be offered by healthcare professionals to assist you in being more active?

Note: This guide allows interviewers to ensure a standard for consistency across interviews. However, the interviews were semi-structured and allowed participants considerable flexibility. These questions were used as prompts in circumstances where participants' dialogue went off-topic, or participants were uncertain of what to say next.

Appendix H Study 2 – Health Behaviour Survey: Supporting Documents

H.1 Ethical Approval

H.1.1 Approval #937

ST JOHN OF GOD
Subiaco Hospital

16 February 2016

Ms Chloe Maxwell-Smith
103 Charthouse Rd
WAIKIKI WA 6169

Dear Ms Maxwell-Smith,

Re: Survey of health behaviours, barriers and motives for health behaviour change in colorectal cancer survivors *(Our ref No: 937)*

Thank you for forwarding the above "low risk" study for review by the St John of God Health Care (SJGHC) Human Research Ethics Committee (HREC) ("the Committee"). A sub-group of the Committee has reviewed your study out of session.

I am pleased to advise that ethical approval of your study has been granted under an expedited review process for "low risk" research, as per section 5.1.7 of the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research (NHMRC, 2007) ("the National Statement").

Your study will now be tabled for the information of the Committee at its next meeting on 9 March 2016. Please find attached a signed and dated Committee membership list.

This study approval is granted for a time frame from the date of this approval letter to 1 August 2016. Should an extension of this timeframe be required, then you must seek continued approval from the Committee *before* the expiry of this time period.

You are reminded that this letter constitutes *ethical approval only*. You must not commence this research study at SJGHC until separate authorisation in writing has been obtained.

Final study approval is now subject to the following:
1. Signed Participating Site Operational Approval Forms (PSOA) from both SJG Murdoch Hospital and SJG Subiaco Hospital.

On receipt of the above, you will be advised of final study approval in writing.

The Committee is a HREC that is constituted and operates in accordance with the National Statement. In line with the National Statement requirements, researchers need to keep the Committee and the institution (ie St John of God Hospitals in Murdoch and Subiaco) promptly and regularly informed on the progress of the approved study including:
1. any adverse events or unexpected outcomes that may affect continued ethical approval.
2. any proposed changes in the study protocol.
3. when the study is completed or abandoned.

.../2

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The Committee and the participating site would also appreciate receiving *at a minimum* an *annual* study progress report as well as a final study report and any subsequent publications.

I wish you well with your research.

Yours sincerely

Clinical Professor Dr Simon Dimmitt
Chairman
St John of God Health Care Human Research Ethics Committee

Enc.

cc. Ms Dani Meinema, Chair MRC, SJG Murdoch Hospital (via email)
cc. Adjunct A/Prof. Nik Zeps, Director of Research, SJG Subiaco Hospital (via email)

12 Salvado Road, Subiaco, WA 6008
PO Box 14, Subiaco, WA 6904
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www.sjog.org.au/subiaco

ST JOHN OF GOD HEALTH CARE HUMAN RESEARCH ETHICS COMMITTEE MEMBERSHIP

NAME	CORE MEMBER	SEX	APPOINTMENT	POSITION
Clinical Professor Simon Dimmitt	Core	M	Chair (with suitable experience whose other responsibilities will not impair the HREC's capacity to carry out its obligations under the National Statement).	Consultant Physician, General & Cardiovascular Medicine (accredited to St John of God Health Care)
Ms Tracey Piani	Core	F	Member with knowledge of and current experience in the professional care, counselling or treatment of humans (ie medical practitioner, clinical psychologist, social worker, nurse as appropriate)	Deputy Director of Nursing, St John of God Midland Public & Private Hospitals
Fr Joe Parkinson	Core	M	Member who performs a pastoral care role in a community for example an Aboriginal Elder, a minister of religion	Minister of Religion; Bioethicist, Director L. J. Goody Bioethics Centre
Mr Eric Heenan	Core	M	Member who is a lawyer, and where possible who is not engaged to advise the institution	Retired Supreme Court Judge, WA
Dr Janie Brown	Core	F	Member with current research experience that is relevant to research proposals to be considered at the meetings.	Nursing and Midwifery Research Coordinator, St John of God Subiaco Hospital
Sr Leonie O'Brien	Core	F	Laywoman who has no affiliation with the institution and does not currently engage in medical, scientific, legal or academic work.	Mercy Sister
Professor Sally Sandover	Core	F	Member with current research experience that is relevant to research proposals to be considered at the meetings.	Academic Co-ordinator Carrick Support Initiative, UWA Co-ordinator Regional Programs & PBL Consultant, University of WA
Mr Hamish Milne	Core	M	Layman who has no affiliation with the institution and does not currently engage in medical, scientific, legal or academic work	Self-employed Consultant
Mr Patrick O'Connor		M	Community member with expert knowledge in clinical psychology	Senior Clinical Psychologist, Health Dept WA (mental health services) and Clinical Psychologist, Hillarys Medical Centre
Mr Jeffrey Williams		M	Hospital Representative. Expert knowledge in Quality and Risk Management, public hospital management.	Director of Nursing, St John of God Midland Public & Private Hospitals
Mr Colin Keogh		M	Hospital Representative. Expert knowledge in Mission and culture.	Director of Mission, St John of God Murdoch Hospital
Ms Mary Rigby		F	Hospital Representative. Expert knowledge in nursing, particularly in palliative care & oncology.	Ward Nurse Manager, St John of God Subiaco Hospital

The St John of God Health Care Human Research Ethics Committee is a Human Research Ethics Committee that is constituted and operates in accordance with the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research (2007).

Date of Ethics Committee Meeting: _9 March 2016_Chairman's Signature:

H.1.2 Approval #937 Extension

ST JOHN OF GOD
Subiaco Hospital

15 July 2016

Chloe Maxwell-Smith
103 Charthouse Road
WAIKIKI WA 6169

Dear Ms Maxwell-Smith,

Re: Survey of health behaviours, barriers, and motives for health behaviour change in colorectal cancer survivors
(Our ref. No. 937)

Thank you for keeping the St John of God Health Care (SJGHC) Human Research Ethics Committee (HREC) updated on the progress of the above study.

The Scientific Review Sub-Committee (SRC), a sub-committee of the SJGHC HREC, at its meeting on 15 July 2016, approved the following:

1. Amended proposal and survey
2. Extension of approval to 31/12/2016
3. Request to recruit patients from WOMEN Centre

as per your letter of 7 July 2016.

This SRC review will now be tabled for the information of the Committee at its next meeting on 10 August 2016. Please find attached a signed and dated Committee membership list.

Yours sincerely

Clinical Professor Dr Simon Dimmitt
Chairman,
St John of God Health Care Human Research Ethics Committee

Enc.

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NAME	CORE MEMBER	SEX	APPOINTMENT	POSITION
Clinical Professor Simon Dimmitt	Core	M	Chair (with suitable experience whose other responsibilities will not impair the HREC's capacity to carry out its obligations under the National Statement).	Consultant Physician, General & Cardiovascular Medicine (accredited to St John of God Health Care)
Ms Tracey Piani	Core	F	Member with knowledge of and current experience in the professional care, counselling or treatment of humans (ie medical practitioner, clinical psychologist, social worker, nurse as appropriate)	Deputy Director of Nursing, St John of God Midland Public & Private Hospitals
Fr Joe Parkinson	Core	M	Member who performs a pastoral care role in a community for example an Aboriginal Elder, a minister of religion	Minister of Religion; Bioethicist, Director L. J. Goody Bioethics Centre
Mr Eric Heenan	Core	M	Member who is a lawyer, and where possible who is not engaged to advise the institution	Retired Supreme Court Judge, WA
Dr Janie Brown	Core	F	Member with current research experience that is relevant to research proposals to be considered at the meetings.	HospitalSenior Lecturer, School of Nursing, Midwifery and Paramedicine, Curtin University
Sr Leonie O'Brien	Core	F	Laywoman who has no affiliation with the institution and does not currently engage in medical, scientific, legal or academic work.	Mercy Sister
Professor Catherine Cole	Core	F	Member with current research experience that is relevant to research proposals to be considered at the meetings.	Professor of Paediatric Haematology & Oncology, School of Paediatrics and Child Health, UWA
Mr Hamish Milne	Core	M	Layman who has no affiliation with the institution and does not currently engage in medical, scientific, legal or academic work	State Manager (WA), RACGP
Professor Sally Sandover		F	Community member with higher education and research administration experience.	Associate Dean (Medical Education), Curtin University Medical School
Mr Patrick O'Connor		M	Community member with expert knowledge in clinical psychology	Senior Clinical Psychologist, Health Dept WA (mental health services) *and* Clinical Psychologist, Hillarys Medical Centre
Mr Jeffrey Williams		M	Hospital Representative. Expert knowledge in Quality and Risk Management, public hospital management.	Director of Nursing, St John of God Midland Public & Private Hospitals
Mr Colin Keogh		M	Hospital Representative. Expert knowledge in Mission and culture.	Director of Mission, St John of God Murdoch Hospital
Ms Mary Rigby		F	Hospital Representative. Expert knowledge in nursing, particularly in palliative care & oncology.	Ward Nurse Manager, St John of God Subiaco Hospital

The St John of God Health Care Human Research Ethics Committee is a Human Research Ethics Committee that is constituted and operates in accordance with the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research (2007).

Date of Ethics Committee Meeting: _10 August 2016_Chairman's Signature:

H.1.3 Approval #1102

ST JOHN OF GOD Health Care

Human Research Ethics Committee

12 Salvado Road
SUBIACO WA 6008
T: (08) 9382 6940
E: ethics@sjog.org.au

21 November 2018

Ms Chloe Maxwell-Smith
Unit 41, 11 Bennett Street
EAST PERTH WA 6004

Dear Ms Maxwell-Smith,

Re: Behavioural intervention trial to increase physical activity in cancer survivors at cardiovascular risk
(Our ref: 1102)

I advise that as Chair of the St John of God Health Care (SJGHC) Human Research Ethics Committee ("the Committee"), I have reviewed out of session and grant approval for the addition of the survey sub-study post-intervention, and extension of study approval until 1 August 2019, as follows:

1. Protocol Version 4 dated 19 November 2018;
2. Survey Version 1 dated 9 June 2016;
3. Survey Information Sheet Version 1 dated 19 November 2018; and
4. Survey Ethics Protocol (app 937) Version 1 dated 9 June 2016,

as per your letter dated 19 November 2018.

This will now be tabled for the information only of the full Committee at its next scheduled meeting on 12 December 2018.

Thank you for keeping the Committee updated regarding the progress of this study.

Yours sincerely,

Clinical Professor Dr Simon Dimmitt
Chairman
St John of God Health Care Human Research Ethics Committee

The St John of God Health Care Human Research Ethics Committee is constituted and operates in accordance with the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research (2007)

H.1.4 Approval #1201

Human Research Ethics Committee

12 Salvado Road
SUBIACO WA 6008
T: (08) 9382 6940
E: ethics@sjog.org.au

09 May 2019

Dr Sarah Hardcastle
School of Psychology and Speech Pathology
Curtin University, GPO Box U1987
PERTH WA 6845

Dear Dr Hardcastle,

Re: (PPARCS) The promotion of physical activity to adult cancer survivors in regional and remote areas of Western Australia using Wearable technology and telephone health coaching

(Our ref: 1201)

I advise that at the meeting on 08 May 2019, the St John of God Health Care (SJGHC) Human Research Ethics Committee ("the Committee") approved the following:

1. Survey Ethics Proposal version 1 dated 09/06/2016;
2. Trial Research Protocol version 2 dated 24/04/2019;
3. Survey Information Sheet version 1 dated 24/04/2019;
4. Health Behaviour Survey version 1 dated 09/06/2016

as per your letter dated 26 April 2019.

Thank you for keeping the Committee updated regarding the progress of this study.

Yours sincerely,

Clinical Professor Dr Simon Dimmitt
Chairman
St John of God Health Care Human Research Ethics Committee

cc. Chloe Maxwell-Smith, Curtin University

H.1.5 Approval HR30/2016

MEMORANDUM

Curtin University

To:	Dr Sarah Hardcastle School of Psychology and Speech Pathology
CC:	
From	Professor Peter O'Leary, Chair HREC
Subject	Reciprocal ethics approval Approval number: HR30/2016
Date	29-Feb-16

Office of Research and Development
Human Research Ethics Office

TELEPHONE 9266 2784
FACSIMILE 9266 3793
EMAIL hrec@curtin.edu.au

Thank you for your application submitted to the Human Research Ethics Office for the project: 6253
Survey of health behaviours, barriers and motives for health behaviour change in colorectal cancer survivors

Your application has been approved through Curtin University Human Research Ethics Committee (HREC) through a reciprocal approval process with the lead HREC.

The lead HREC for this project has been identified as St John of God Health Care HREC

Approval number from the lead HREC is noted as: app937

Please note the following conditions of approval:

1. Approval is granted from **01-Mar-16** to **01-Aug-16**
2. Research must be conducted as stated in the approved protocol.
3. Any amendments to the approved protocol must be approved by the Ethics Office.
4. An annual progress report must be submitted to the Ethics Office annually, on the anniversary of approval.
5. All adverse events must be reported to the Ethics Office.
6. A completion report must be submitted to the Ethics Office on completion of the project.
7. Data must be stored in accordance with WAUSDA and Curtin University policy.
8. The Ethics Office may conduct a randomly identified audit of a proportion of research projects approved by the HREC.

Should you have any queries about the consideration of your project please contact the Ethics Support Officer for your faculty, or the Ethics Office at hrec@curtin.edu.au or on 9266 2784. All human research ethics forms and guidelines are available on the ethics website.

Yours sincerely,

Professor Peter O'Leary
Chair, Human Research Ethics Committee

H.2 Participant Information Sheet

Survey of health behaviours, barriers and motives for health behaviour change in cancer survivors

Investigators: Chloé Maxwell-Smith[1]; Dr Sarah Hardcastle[1]; Dr Paul Cohen[2]; Prof Cameron Platell[3]; Dr Raj Mohan[4]; Dr Paul Salama[3]; Dr Patrick Tan[3]; Dr Michael Levitt[3]; Dr Jason Tan[2]; Dr Stuart Salfinger[3]; Dr Greg Makin[5] (1 Curtin University; 2 Women Centre, West Leederville; 3 St John of God Hospital, Subiaco; 4 Hollywood Private Hospital; 5 St John of God Hospital, Murdoch).

You are invited to take part in the enclosed survey. The purpose of this survey is to explore health behaviours, motives and barriers towards lifestyle change among cancer survivors. Your contribution will help us to better understand the needs of cancer survivors and inform strategies to improve lifestyle and health through the oncology team.

Participation in the survey is voluntary. If you choose to complete the survey, please return it to the study investigator using the addressed reply-paid envelope enclosed. You will notice that sender and receiver details are written on reply-paid envelopes. However, the survey data will become anonymous once entered into our electronic database. If you decide that you do not wish to participate in this study, you do not need to do anything. Your decision to not participate will not disadvantage you in any way.

If you have been given this survey previously by your oncologist, please do not complete the enclosed copy.

The St John of God Health Care Ethics Committee has given ethical approval for the conduct of this study. If you have any concerns or complaints regarding this study, you can contact the Executive Officer of the Committee (telephone number (08) 9382 6940) on a confidential basis. Your concerns will be drawn to the attention of the Committee that is monitoring the study.

There is a low level of risk for participation in this study. It is not likely that completing this survey will cause you to become upset or distressed. However, if you do experience any concerns, please contact a study investigator as listed below.

Investigators:
Chloé Maxwell-Smith: 0449768269

chloe.maxwell-smith@curtin.edu.au

Dr Sarah Hardcastle: 0439226015

sarah.hardcastle@curtin.edu.au

H.3 Survey

Health Behaviour Survey for Cancer Survivors

Thank you for agreeing to participate in this important study. The aim of this study is to identify the health behaviours, attitudes, motives and barriers of cancer survivors. Your participation will assist us to improve the care of outpatients and prevent future health problems.

You will be asked several questions about your current health behaviours, particularly physical activity and diet. The survey will then move on to explore perceptions about health and perceived barriers and motives toward health behaviour change. There are no correct or incorrect answers, so please indicate the answer that best describes you. Your responses are **confidential and this survey is anonymous**. Please answer all questions as accurately as possible.

Part One: About you

Are you male or female?

Male ☐

Female ☐

What is your age? (Please write **number** in box) ☐

Please state the type of cancer(s) you received treatment for: ☐

Time since finishing cancer treatment (years): ☐

Are you a smoker?

Yes ☐

No ☐

If so, how many cigarettes do you smoke per day? ☐

Do you drink alcoholic beverages?

Yes ☐

No ☐

THIS SURVEY IS DOUBLE-SIDED

If so, how many standard drinks do you consume on an average day? ☐

Do you have access to the internet at home?

Yes ☐

No ☐

If so, what are your 3 primary uses for the internet?

1. _____

2. _____

3. _____

Do you have a smart phone?

Yes ☐

No ☐

If so, what are your 3 most used applications?

1. _____

2. _____

3. _____

THIS SURVEY IS DOUBLE-SIDED

Part Two: Your Physical Activity

Think about all the **vigorous** 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**. Think only about 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, digging, aerobics, or fast bicycling?

☐ Days per week

How much time did you usually spend doing **vigorous** physical activities on one of those days?

☐ Minutes per day

Think about all the **moderate** activities that you did in the last 7 days. Moderate activities **take moderate physical effort** and make you **breathe somewhat harder than normal**. Think only about 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, bicycling at a regular pace, or doubles tennis? **Do not include walking**.

☐ Days per week

How much time did you usually spend doing **moderate** physical activities on one of those days?

☐ Minutes per day

THIS SURVEY IS DOUBLE-SIDED

Think about the time you spent **walking in the last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

During the last 7 days, on how many days did you walk for at least 10 minutes at a time?

☐ Days per week

How much time did you usually spend walking on one of those days?

☐ Minutes per day

During the last 7 days, how much time did you spend sitting on a weekday?

☐ Minutes per day

Please circle **one** category from each question. Base you answer on what you **prefer** to do and not actually what you do

Preferred exercise company (please tick **one**)

Alone	☐	With a partner	☐
With a few people	☐	In a group	☐

Preferred exercise location (please tick **one**)

At home	☐	Fitness centre	☐	Outdoors	☐

THIS SURVEY IS DOUBLE-SIDED

Preferred exercise type (please tick **one**)

Aerobics ☐ Jogging ☐ Swimming ☐

Cycling ☐ Skating ☐ Walking ☐

Weight Training ☐

Preferred exercise intensity (please tick **one**)

Low ☐ Moderate ☐ High ☐

Preferred exercise structure (please tick **one**)

Supervised/instructed ☐ Unsupervised/self-paced ☐

Competitive ☐ Recreational ☐

Spontaneous/flexible ☐ Scheduled ☐

Reminder: Moderate activities take moderate physical effort and make you breathe somewhat harder than normal. (**Please tick one box on every line below**)

For me, being physically active at a moderate intensity in the next two weeks is…

	Extremely	Very	Quite	Quite	Very	Extremely	
Important							**Unimportant**
Enjoyable							**Unenjoyable**
Pleasant							**Unpleasant**

THIS SURVEY IS DOUBLE-SIDED

Whether or not I am physically active is entirely up to me. (Please tick **one** box)

Agree very strongly	Agree strongly	Agree moderately	Disagree moderately	Disagree strongly	Disagree very strongly

How much personal control do you feel you have over being physically active? (Please tick **one** box)

Complete control	A lot of control	Some control	A little control	Very little control	No control at all

There are likely to be plenty of opportunities for me to be physically active. (Please tick **one** box)

Agree very strongly	Agree strongly	Agree moderately	Disagree moderately	Disagree strongly	Disagree very strongly

I am confident that I would be able to be physically active. (Please tick **one** box)

Agree very strongly	Agree strongly	Agree moderately	Disagree moderately	Disagree strongly	Disagree very strongly

How ready are you to implement physical activity changes?

0 1 2 3 4 5 6 7 8 9 10

Not ready at all Extremely ready

THIS SURVEY IS DOUBLE-SIDED

Part Three: Your Diet

The following questions will ask about your consumption of a healthy diet. A healthy diet is defined as energy intake (calories) being equal to energy expenditure, with low levels of saturated fat, sugar and salt intake, and restricted trans-fat intake.

In the course of the past two weeks, how often have you eaten a healthy diet? (Please tick **one** box)

Everyday	Almost everyday	Most days	On about half the days	A few times, but less than half	A few times	Almost never

I ate a healthy diet in the past two weeks with the following regularity. (Please tick **one** box)

Never	Very seldom	Occasionally	Some days	Most days	Everyday

For me, eating a healthy diet in the next two weeks is…

(**Please tick one box on every line below**)

	Extremely	Very	Quite	Quite	Very	Extremely	
Important							**Unimportant**
Enjoyable							**Unenjoyable**
Pleasant							**Unpleasant**

Whether or not I eat a healthy diet is entirely up to me. (Please tick **one** box)

Agree very strongly	Agree strongly	Agree moderately	Disagree moderately	Disagree strongly	Disagree very strongly

THIS SURVEY IS DOUBLE-SIDED

How much personal control do you feel you have over eating a healthy diet? (Please tick **one** box)

Complete control	A lot of control	Some control	A little control	Very little control	No control at all

There are likely to be plenty of opportunities for me to eat a healthy diet. (Please tick **one** box)

Agree very strongly	Agree strongly	Agree moderately	Disagree moderately	Disagree strongly	Disagree very strongly

I am confident that I would be able to eat a healthy diet. (Please tick **one** box)

Agree very strongly	Agree strongly	Agree moderately	Disagree moderately	Disagree strongly	Disagree very strongly

How ready are you to implement healthy diet changes?

0 1 2 3 4 5 6 7 8 9 10

Not ready at all Extremely ready

Have you eaten any of the following foods in the last **24 hours**? Please tick the number of portion of foods eaten for every row

	Number of Portions				
	0	**1**	**2**	**3**	**4+**
Fruit as a dessert					
Fruit for breakfast, e.g., on cereal					
Fruit as a snack between meals					

THIS SURVEY IS DOUBLE-SIDED

	0	1	2	3	4+
A glass of pure, unsweetened fruit juice (not squash or fruit drink)					
Fruit as a starter to a meal					
A bowlful of home-made vegetable soup					
A portion of vegetables with a meal (include baked beans and pulses as vegetables but not potatoes)					
A vegetable-based meal					
A bowlful of salad					

Part Four: Your Wellbeing & Health Attitudes

These questions are about how you have been feeling during the past 4 weeks.
For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks...

Have you felt calm and peaceful?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

Did you have a lot of energy?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

Have you felt down-hearted and blue?

All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time

THIS SURVEY IS DOUBLE-SIDED

Please score the following items on a scale of 1-7, where 1=strongly disagree and 7=strongly agree.

	1 Strongly disagree	**2** Disagree	**3** Somewhat disagree	**4** Undecided	**5** Somewhat agree	**6** Agree	**7** Strongly agree
The healthiness of food has little impact on my food choices.							
I am very particular about the healthiness of food.							
I eat what I like and I do not worry about healthiness of food.							
I always follow a healthy and balanced diet.							
It is important for me to eat delicious food on weekdays as well as weekends.							
It is important for me that my daily diet contains a lot of vitamins and minerals.							
I do not avoid any foods, even if they may raise my cholesterol.							
The healthiness of snacks makes no difference to me.							
It is important for me that my diet is low in fat.							
I finish my meal even when I do not like the taste of food.							
I reward myself by buying something really tasty.							
I indulge myself by buying something really delicious.							

THIS SURVEY IS DOUBLE-SIDED

	1 Strongly disagree	**2** Disagree	**3** Somewhat disagree	**4** Undecided	**5** Somewhat agree	**6** Agree	**7** Strongly agree
I avoid rewarding myself with food.							
An essential part of my weekend is eating delicious food.							
In my opinion, comforting oneself by eating is self-deception.							
I try to avoid eating delicious food when I am feeling down.							
I do not believe that food should always be a source of pleasure.							
The appearance of food makes no difference to me.							
When I am feeling down I want to treat myself with something really delicious.							
When I eat, I concentrate on enjoying the taste of food.							

Please score the following items on a scale of 1-5, where 1=strongly disagree and 5=strongly agree.

	1 Strongly disagree	**2** Disagree	**3** Undecided	**4** Agree	**5** Strongly Agree
If someone was meant to have a serious disease, it doesn't matter what doctors and nurses tell them to do, they will.					
My health is determined by fate.					
If someone is meant to have a serious disease, they will get that disease.					

THIS SURVEY IS DOUBLE-SIDED

	1 Strongly disagree	**2** Disagree	**3** Undecided	**4** Agree	**5** Strongly Agree
How long I live is predetermined.					
If someone is meant to get a serious disease, it doesn't matter what kinds of food they eat, they will get that disease anyway.					
There is really no way I can solve some of the problems I have.					
I will have a lot of pain from illness.					
I will die when I am fated to die.					
If someone is meant to get a serious disease, they will get it no matter what they do.					
My health is determined by something greater than myself.					
Sometimes I feel that I'm being pushed around in life.					
I will suffer a lot from bad health.					
If someone gets a serious disease, that's the way they were meant to die.					
I will stay healthy if I am lucky.					
Everything that can go wrong for me does.					
If someone has a serious disease and gets treatment for it, they'll probably still die from it.					
My health is a matter of luck.					
I often feel helpless in dealing with the problems of life.					
I will get diseases if I am unlucky.					
How long I live is a matter of luck.					

THIS SURVEY IS DOUBLE-SIDED

Part Five: Barriers & Motives

Please list the most important factors that you believe **contributed to your cancer** and your reasons behind these beliefs.

1. _____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

Please list the main **barriers** for you to make **physical activity** changes and your reasons for these barriers.

1. _____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

THIS SURVEY IS DOUBLE-SIDED

Please list the main **barriers** for you to make **healthy diet** changes and your reasons for these barriers.

1. _____

_____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

Please list your main **motives** for **physical activity and healthy diet** changes and your reasons for these motives.

1. _____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

THIS SURVEY IS DOUBLE-SIDED

Please list forms of **support** that would be most helpful for making **physical activity and healthy diet** changes and your reasons.

1. _____

_____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

Thank you for taking the time to complete this survey! Please seal the survey in the enclosed reply-paid envelope and drop in an Australia Post regular post box at your earliest convenience ☺

THIS SURVEY IS DOUBLE-SIDED

Appendix I Study 3 – WATAAP Trial: Supporting Documents

I.1 Ethical Approval

Human Research Ethics Committee

Level 3, St John of God House
177-179 Cambridge St
WEMBLEY WA 6014
T: (08) 9382 6940
E: ethics@sjog.org.au

8 February 2017

Ms Chloe Maxell-Smith
103 Charthouse Rd
WAIKIKI WA 6169

Dear Ms Maxell-Smith,

Re: Behavioural intervention trial to increase physical activity in cancer survivors at cardiovascular risk ***(Our ref No: 1102)***

Thank you for your email reply of 8 February 2017, addressing the queries raised by the Scientific Review Sub-Committee (SRC).

Your study was reviewed at the St John of God Health Care (SJGHC) Human Research Ethics Committee (HREC) ("the Committee") meeting on 8 February 2017. I am pleased to advise that ethical approval for your study has been granted as satisfying the ethical requirements as set out in the National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research (NHMRC, 2007) ("the National Statement").

The study approval period is from 8 February 2017 to 10 December 2018. Should an extension of this timeframe be required, then you must seek continued approval from the Committee *before* the expiry of this time period.

In accordance with NHMRC guidelines, the Participating Site/Principal Investigator is responsible for:

1. Notification to the HREC of any adverse events or unexpected outcomes that may affect the continuing ethical acceptability of the study;
2. The submission of any proposed amendments to the study or previously-approved documents;
3. The submission of an annual progress report for the duration of the study which is due on the anniversary of HREC approval;
4. Reporting of any protocol deviations or violations, together with details of the procedure put in place to ensure the deviation or violation does not recur;
5. Notification and reason for ceasing the study prior to its expected date of completion (if applicable);
6. The submission of a final report and translation of results (including publications) upon completion of the study.

.../2

The following documents have been reviewed and approved:

Title	Version	Date
Protocol	2	7 February 2017
PICF	N/A	As per study original submission to the SJGHC HREC
Appendix A: Schematic of Intervention Design	1	30 December 2016
Appendix B: Quantitative Assessment	2	7 February 2017
Appendix C: Qualitative Feedback	N/A	As per study original submission to the SJGHC HREC
Appendix D: Invitation Letter	N/A	As per study original submission to the SJGHC HREC
Appendix E: Physical Activity Booklet	N/A	As per study original submission to the SJGHC HREC
Appendix F: Worksheet	N/A	As per study original submission to the SJGHC HREC
Appendix G: Demographic & Screening Instrument	1	7 February 2017
Appendix H: Intervention Participant Contact Sheet	1	19 December 2016

You are reminded that this letter constitutes *ethical approval only*. You must not commence this research study at SJGHC until separate authorisation in writing has been obtained.

I wish you well with your research.

Yours sincerely,

Clinical Professor Dr Simon Dimmitt
Chairman
St John of God Health Care Human Research Ethics Committee

cc. Ms Chris Hanna, A/CEO, SJG Subiaco Hospital (via email)

ST JOHN OF GOD
Health Care

8 February 2017

Ms Chloe Maxell-Smith
103 Charthouse Rd
WAIKIKI WA 6169

Dear Ms Maxell-Smith,

Re: Behavioural intervention trial to increase physical activity in cancer survivors at cardiovascular risk *(Our ref No: 1102)*

I refer to the letter of 8 February 2017, advising of the St John of God Health Care (SJGHC) Human Research Ethics Committee approval of the above study.

I am in receipt of the signed SJGHC Participating Site Operational Approval Form (PSOA) from the St John of God Subiaco Hospital ("the participating site").

I now confirm final approval for your study to be conducted at the participating site.

I wish you well with your research.

Yours sincerely,

Dr Mark Lubliner
Director of Medical Services
St John of God Health Care

cc. Ms Chris Hanna, A/CEO, SJG Subiaco Hospital (via email)

Ground Floor, 111 Coventry Street, South Melbourne, VIC 3205
T. 03 9205 6500 F. 03 9690 0633 E. mark.lubliner@sjog.org.au

HOLLYWOOD
PRIVATE HOSPITAL

Monash Avenue, Nedlands

Locked Bag 2002
NEDLANDS WA 6909

T 08 9346 6000
F 08 9389 8470

ABN 36 003 184 889

Ms Chloé Maxwell-Smith
School of Psychology and Speech Pathology
Curtin University
GPO Box U1987
Perth WA 6845

14 February 2017

Dear Ms Maxwell-Smith

Re: Physical Activity Intervention for Cancer Survivors

Thank you for your query regarding the above study proposal, in which some patients will be recruited from Dr Mohan's private rooms located on the Hollywood Private Hospital campus.

I note the study will be based at St John of God Hospital Subiaco and you are seeking ethical approval from that hospital's HREC.

Given HPH itself will have no involvement in the proposed research, there is no need for ethical review at this institution and we have no objection to the conduct of this study.

Kind regards

Dr Terry Bayliss
Coordinator Development Projects and Research.

www.hollywoodprivatehospital.com.au

RAMSAY
HEALTH CARE

I.2 Invitation Letter Template

St. John of God Hospital

12 Salvado road

Subiaco, WA

6008

Date 2017

Dear name,

The St. John of God Gynaecologic Oncology research group and colorectal research group is collaborating with researchers at Curtin University in a study that we invite you to take part in. The aim of this research study is to see whether a wearable activity tracker (i.e., a Fitbit wrist band) is a useful tool to increase physical activity levels in individuals who have completed treatment for certain cancers including gynaecological cancers/colorectal cancers.

The benefits to your participation will be to learn more about your overall health than the current available health services can provide. This will involve some monitoring of your health and physical activity which will be carried out at St. John of God Subiaco Hospital. Within the study, some people will be given the opportunity to receive a Fitbit and two group sessions with study investigators, to help improve their physical activity. Advice on exercise recommendations and a physical activity booklet will be available to participants, to assist them in making healthy lifestyle changes independently. We plan to monitor people in this study for approximately 6 months.

At your first visit, you will receive further information regarding the study. You can also ask any questions you may have before you decide to participate in the study and sign the consent form.

Please find a Participant Information Sheet enclosed which provides more information about the research study. Your participation is entirely voluntary and you are not under any obligation to be involved.

If you are interested in being involved in this study, or have any questions, please contact Chloe Maxwell-Smith, the study investigator by email at chloe.maxwell-smith@curtin.edu.au or by phone on 0449 768 269.

Your participation in this study would be most appreciated and will help to improve care for our patients.

Yours sincerely,

Dr…

St. John of God Gynaecological Research Group/St. John of God Colorectal Research Group

Behavioural Intervention Trial –Appendix D - Version 2 Clean – Dated 13 April, 2017

I.3 Participant Information Sheet

ST JOHN OF GOD Health Care

Curtin University

HOLLYWOOD PRIVATE HOSPITAL

PARTICIPANT INFORMATION SHEET

Health Behaviour Change:
A behavioural intervention to improve physical activity in cancer survivors

Investigators: Chloe Maxwell-Smith[1], Dr Sarah Hardcastle[1], Dr Paul Cohen[2], Prof. Cameron Platell[2], Dr Stuart Salfinger[2], Dr Jason Tan[2], Dr Raj Mohan[3], Dr Patrick Tan[2], Dr Michael Levitt[2], Dr Greg Makin[4]
(1 Curtin University; 2 St John of God Hospital, Subiaco; 3 Hollywood Private Hospital; 4 St John of God Hospital, Murdoch)

This project is being conducted by a collaborative team from Curtin University and the Departments of Colorectal & Gynaecologic Oncology at St John of God Subiaco Hospital (SJGSH), WOMEN centre in West Leederville, and Hollywood Private Hospital in Nedlands.

Please take time to read the following information carefully and to discuss it with others if you so wish. If any part of the information is not clear to you, or if you would like more information do not hesitate to ask us to explain it more clearly. Make certain you do this before you consent to participate in this study.

Introduction
You are invited to take part in this research project. The purpose of this study is to improve physical activity in cancer survivors. In keeping with the Catholic foundations of St John of God Health Care, this research aims to reach out to people to improve health and wellbeing. The results of the project will be used to inform the development of future physical activity programs for cancer survivors.

In this study, individuals will be invited to participate in a physical activity intervention, where some participants will have the opportunity to wear a Fitbit (a wrist band activity tracker) and attend two group sessions to assist with goal-setting and improving physical activity levels. Other participants will receive a booklet that includes the government recommendations for physical activity and tips about how to get active and stay active. We will be monitoring physical activity in participants for approximately 6 months. Your participation will help us to better understand the needs of cancer survivors and inform strategies to improve lifestyle change post-cancer.

This participant information sheet explains the study and includes details such as:
- possible benefits and risks of the study
- what you will be asked to do if you choose to participate
- what your rights and responsibilities are if you agree to participate

What is the purpose of the study?
We plan to assist individuals to increase their physical activity levels. Our previous research in this field has indicated that cancer survivors have support needs and barriers that may prevent

them from being sufficiently physically active. This study will aim to improve physical activity by addressing support needs, and providing a tool (Fitbit) for participants to monitor their physical activity.

What does participation in this research project involve?
You will be asked to wear an accelerometer (small electronic device worn on wrist or around waist to measure physical activity) for 7 days at the beginning of the trial, after 12 weeks of the trial, and after 24 weeks of the trial commencement. At these three time points, you will also be asked to attend a brief assessment at St. John of God Subiaco Hospital. At these assessments you will be asked to complete some questionnaires about your activity, and your blood pressure, height and weight will be recorded. These assessments will take approximately 15 minutes. You may also be invited to participate in two group sessions to assist with barriers to physical activity participation and strategies to help you become more physically active such as goal-setting.

How long will I be in this study?
If you agree to participate in this study, we would like to monitor your physical activity over a 6-month period at three time points: the first week of the study, after 12 weeks of the study, and again after 24 weeks.

What are the costs to me?
There are no direct financial costs to you from taking part in this study.

Will I be paid to participate in this study?
You will receive a $20 cash reimbursement to cover travel expenses for each visit you make to the hospital for the 3 assessment time points (i.e. $20 reimbursement at your baseline assessment on the first week, $20 reimbursement at 12-weeks and $20 reimbursement at 24-weeks). If you are invited to attend group sessions, you will also receive a $20 reimbursement for attending each of the two group sessions.

What are the possible benefits?
You will receive a booklet on the government guidelines for physical activity. You will receive printed worksheets to assist with action planning and goal setting. You may also be given the opportunity to use a Fitbit to monitor your own physical activity levels.

What are the possible risks?
There are no foreseeable risks to your participation in this study. This research study employs a client-centred approach to assist in improving the health of cancer survivors. You do not have to participate in this study. If you do choose to participate in this study, you are welcome to withdraw at any time. If you experience distress from your participation in this study, you will be offered counselling opportunities.

What are my alternatives if I do not want to participate in this study?
If you decide that you do not wish to participate in this study, you do not need to do anything. Your decision to not participate will not disadvantage you in any way.

What if I withdraw from this research project?
You may withdraw from the interview at any time. If you decide to leave the project, the researchers would like to keep any data that has been collected. This is to help them make sure that the results of the research can be captured properly. If you do not want them to do this, you must tell them before you join the research project.

How can I find out the results of this study?
The results of this study will be published in peer-reviewed journals and presented at national and international conferences. You may find out about the study results by reading these articles or by contacting the lead investigators for the results after the study is complete.

Will my taking part in this study be kept confidential?

All your data (activity levels, blood pressure, body mass index & questionnaire responses) will be treated confidentially and the raw survey data will only be accessed by the research team at Curtin University for the purpose of this research project. Any information which would identify you will never be disclosed to your employer/s, or to any other source. It will only be disclosed with your permission, except as required by law.

Once entered into our statistical software, all the information you provide will be coded so you cannot be identified by name. All print information will be stored securely in a locked filing cabinet at Curtin University during the study and in a locked archive for 5 years from the time study is closed and may be destroyed at any time thereafter. The data will be examined for group trends, and will not be considered individually. In any publication, information will be provided in such a way that you cannot be identified.

Who has reviewed the study?
The St John of God Health Care Ethics Committee and the Hollywood Private Hospital Ethics Committee have given ethical approval for the conduct of this study (Ref #1102). If you have any concerns or complaints regarding this study, you can contact the Executive Officer of the Committee (08) 9382 6940 on a confidential basis. Your concerns will be drawn to the attention of the Committee that is monitoring the study.

If you have any question about the study, please contact study investigators: Chloe Maxwell-Smith on 0449 768 269 or Dr Sarah Hardcastle on 0439 226 015.

Decision to Participate
Participation in this research is voluntary, that is, you may decide to be in this study or not take part in it at all. If you do decide to participate, you are able to change your mind at any time during the study. If you wish to express your interest to participate, please contact:

Chloe Maxwell-Smith	0449 768 269 chloe.maxwell-smith@curtin.edu.au

Chloe will begin with a quick phone screening of your current health condition to determine your eligibility to participate. If you are eligible, a baseline assessment at St. John of God Subiaco Hospital will be organised, where you will be asked for your formal consent to participate.

I.4 Accelerometer Wear Log

Daily log instructions

Please wear your accelerometer all day, from waking up in the morning to going to bed at night, EXCEPT for when swimming, showering or bathing. The accelerometer is NOT WATERPROOF.

For any period of time that you did NOT wear the monitor between getting up in the morning and going to bed at night, list:

- what activity you were doing
- the time you started the activity
- the time you stopped the activity

You may combine routine activities but other activities should be reported separately.

Examples of activities considered to be "routine activities" that may be combined are:

- Taking a shower
- Shaving or applying make-up
- Drying your hair
- Getting dressed
- Preparing & eating breakfast
- Brushing your teeth
- Getting ready to go to bed

* Only record activities lasting **10 MINUTES** or longer.

Example:
You went for a swim so you had to remove the monitor. You were swimming from 8:30 until 9:00 am then you changed into your clothes and put the monitor back on. In the daily log, you would list the following:

What activity were you doing? *Went Swimming*

At what time did you start this activity? 8 : 3 0 (24 Hour)

At what time did you stop this activity? 9 : 0 0 (24 Hour)

You do **NOT** need to list the time you spent changing into exercise clothes if it took less than 10 minutes.

You do **NOT** need to list the time you were showering and changing clothes if it took less than 10 minutes.

Frequently asked questions

1. **After I swim, I typically spend 20 minutes in the locker room getting ready to leave. What if I put on the monitor after I am done getting ready? What should I write in the log?**

   Answer: Because getting ready took more than 10 minutes, you need to tell us what activities you did in the locker room to get ready and leave. First, as in the example above, you would list the 30 minutes you went swimming. If from 9:00 to 9:20 am you took a shower, got dressed, and dried your hair, you would fill out the daily log as follows:

What activity were you doing?	*Took a shower, got dressed, dried my hair*
At what time did you start this activity?	*9* : *0 0* (24 Hour)
At what time did you stop this activity?	*9* : *2 0* (24 Hour)

2. **Why did you combine "took a shower, got dressed and dried my hair" into one statement? I would have separated those activities.**

   Answer: We consider taking a shower, getting dressed and drying hair to be routine activities. You can combine routine activities.

3. **What if I forget to wear the monitor for part of the day?**

   Answer: We hope you will wear the monitor throughout the day. However, if you do forget, you will need to list each activity you did during that period of time. For each activity, you will need to list the time the activity began and ended.

****Remember** - the only times that you need to **take off** the activity monitor during the day are when you are doing a water-based activity.

DAY 1

☐☐ / ☐☐ / 2 0 ☐☐
Day Month Year

M T W Th F Sa Su
O O O O O O O

(Shade bubble for day of week)

What time did you get out of bed this morning? ____:____ (24 Hour)

What time did you put on the monitor this morning? ____:____ (24 Hour)

What time did you take off the monitor this evening? ____:____ (24 Hour)

What time did you get into bed this evening? ____:____ (24 Hour)

Did you wear the monitor all day? (Shade bubble) Yes O No O

IF NO, answer the following questions.

For any period of time that you did NOT wear the monitor between getting up in the morning and going to bed at night, list: what you were doing, the time you began, and the time you stopped. You may combine routine activities but other activities should be reported separately. Only record activities lasting **10 MINUTES** or longer.

List activities you did when you were NOT wearing the monitor

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

DAY 2

	/		/	2	0		
Day		Month		Year			

M T W Th F Sa Su
O O O O O O O

(Shade bubble for day of week)

What time did you get out of bed this morning? ____:____ (24 Hour)

What time did you put on the monitor this morning? ____:____ (24 Hour)

What time did you take off the monitor this evening? ____:____ (24 Hour)

What time did you get into bed this evening? ____:____ (24 Hour)

Did you wear the monitor all day? (Shade bubble) Yes O No O

IF NO, answer the following questions.

For any period of time that you did NOT wear the monitor between getting up in the morning and going to bed at night, list: what you were doing, the time you began, and the time you stopped. You may combine routine activities but other activities should be reported separately. Only record activities lasting **10 MINUTES** or longer.

List activities you did when you were NOT wearing the monitor

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

DAY 3

☐☐ / ☐☐ / 2 0 ☐☐
Day Month Year

M T W Th F Sa Su
O O O O O O O

(Shade bubble for day of week)

What time did you get out of bed this morning? ____:____ (24 Hour)

What time did you put on the monitor this morning? ____:____ (24 Hour)

What time did you take off the monitor this evening? ____:____ (24 Hour)

What time did you get into bed this evening? ____:____ (24 Hour)

Did you wear the monitor all day? (Shade bubble) Yes O No O

IF NO, answer the following questions.

For any period of time that you did NOT wear the monitor between getting up in the morning and going to bed at night, list: what you were doing, the time you began, and the time you stopped. You may combine routine activities but other activities should be reported separately. Only record activities lasting **10 MINUTES** or longer.

List activities you did when you were NOT wearing the monitor

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

DAY 4

Day	Month	Year
		2 0

M T W Th F Sa Su
O O O O O O O

(Shade bubble for day of week)

What time did you get out of bed this morning? ____:____ (24 Hour)

What time did you put on the monitor this morning? ____:____ (24 Hour)

What time did you take off the monitor this evening? ____:____ (24 Hour)

What time did you get into bed this evening? ____:____ (24 Hour)

Did you wear the monitor all day? (Shade bubble) Yes O No O

IF NO, answer the following questions.

For any period of time that you did NOT wear the monitor between getting up in the morning and going to bed at night, list: what you were doing, the time you began, and the time you stopped. You may combine routine activities but other activities should be reported separately. Only record activities lasting **10 MINUTES** or longer.

List activities you did when you were NOT wearing the monitor

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

DAY 5

☐☐ / ☐☐ / 2 0 ☐☐
Day Month Year

M T W Th F Sa Su
O O O O O O O

(Shade bubble for day of week)

What time did you get out of bed this morning? ____:____ (24 Hour)

What time did you put on the monitor this morning? ____:____ (24 Hour)

What time did you take off the monitor this evening? ____:____ (24 Hour)

What time did you get into bed this evening? ____:____ (24 Hour)

Did you wear the monitor all day? (Shade bubble) Yes O No O

IF NO, answer the following questions.

For any period of time that you did NOT wear the monitor between getting up in the morning and going to bed at night, list: what you were doing, the time you began, and the time you stopped. You may combine routine activities but other activities should be reported separately. Only record activities lasting **10 MINUTES** or longer.

List activities you did when you were NOT wearing the monitor

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

DAY 6

☐☐ / ☐☐ / 2 0 ☐☐
Day Month Year

M T W Th F Sa Su
O O O O O O O

(Shade bubble for day of week)

What time did you get out of bed this morning? ____:____ (24 Hour)

What time did you put on the monitor this morning? ____:____ (24 Hour)

What time did you take off the monitor this evening? ____:____ (24 Hour)

What time did you get into bed this evening? ____:____ (24 Hour)

Did you wear the monitor all day? (Shade bubble) Yes O No O

IF NO, answer the following questions.

For any period of time that you did NOT wear the monitor between getting up in the morning and going to bed at night, list: what you were doing, the time you began, and the time you stopped. You may combine routine activities but other activities should be reported separately. Only record activities lasting **10 MINUTES** or longer.

List activities you did when you were NOT wearing the monitor

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

DAY 7

☐☐ / ☐☐ / 2 0 ☐☐
Day Month Year

M O T O W O Th O F O Sa O Su O

(Shade bubble for day of week)

What time did you get out of bed this morning? ____:____ (24 Hour)

What time did you put on the monitor this morning? ____:____ (24 Hour)

What time did you take off the monitor this evening? ____:____ (24 Hour)

What time did you get into bed this evening? ____:____ (24 Hour)

Did you wear the monitor all day? (Shade bubble) Yes O No O

IF NO, answer the following questions.

For any period of time that you did NOT wear the monitor between getting up in the morning and going to bed at night, list: what you were doing, the time you began, and the time you stopped. You may combine routine activities but other activities should be reported separately. Only record activities lasting **10 MINUTES** or longer.

List activities you did when you were NOT wearing the monitor

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? _____

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? ____________________

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? ____________________

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? ____________________

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? ____________________

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? ____________________

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

What activity were you doing? ____________________

At what time did you start this activity? ____:____ (24 Hour)

At what time did you stop this activity? ____:____ (24 Hour)

Thank You for Completing the Activity Monitor Daily Log!

Please return your Daily Physical Activity Log and your accelerometer to the study investigators in the enclosed prepaid Express Post envelope.

I.5 Self-Reported Physical Activity, Quality of Life, and HAPA Outcomes Described in Protocol Publication

Self-Reported Physical Activity

The IPAQ-SF (Craig et al., 2003) will assess self-reported physical activity at T1, T2, and T3. This questionnaire is scored based on the amount and intensity of accumulated minutes of exercise in the previous week, with activity being converted into MET minutes as a function of intensity. This tool is reliable (Cronbach's alpha of 0.8) and had demonstrated adequate validity across 12 countries (Craig et al., 2003; Mama et al., 2017).

Quality of Life

Quality of life will be measured using the Medical Outcomes Study Short-Form survey (Ware et al., 1996). This instrument is considered reliable across both mental and physical components (Cronbach's alpha of 0.87 and 0.84, respectively), and valid when compared to the 36-item version (Dritsaki et al., 2017; Ware et al., 1996).

Physical Activity Attitudes

Physical activity attitudes will be measured using previously published, validated items from the HAPA inventory, with Cronbach's alpha scores for the subscales below ranging from 0.73 to 0.87 (Parschau et al., 2014). Some items have been amended, based on the specific barriers identified by survivors (Bennett et al., 2007; Hardcastle, Glassey, et al., 2017; Maxwell-Smith et al., 2017; Short et al., 2012), and physical activity guidelines for survivors (Rock et al., 2012). The following constructs will be assessed:

Outcome Expectations.

Twelve items will assess outcome expectations. Five items are derived from the validated exercise pros subscale (Plotnikoff et al., 2001) and 7-items are tailored based on formative research with cancer survivors (Bennett et al., 2007; Hardcastle, Maxwell-Smith, et al., 2017; Short et al., 2012). The items measure the extent to which participants agree or disagree (1 = disagree very strongly to 6 = agree very strongly) that regular physical activity over the next 12-weeks will help to: reduce tension or stress; feel more confident about my own health; sleep better; have a positive outlook; control my weight; regain lost strength; prevent cancer recurrence; increase fatigue; increase joint pain; weaken my immune system; feel better about my body, and increase my longevity. For example, 'Doing regular physical activity over the next 12-weeks will help me to reduce tension or stress'.

Action Self-Efficacy.

Four items will assess action self-efficacy, based on previous research with breast cancer survivors (Rogers et al., 2005). Items assess participants' confidence to complete 150-minutes of physical activity per week, with the item stems: 'I believe I have the ability to…'; 'I am confident I can do…'; 'If I wanted to I could…' and 'For me to do…'. For example, 'I

am confident I can do 150-minutes of moderate intensity physical activity per week for the next 12-weeks'. Possible responses range from 1 = extremely difficult, disagree very strongly, extremely unconfident to 6 = extremely easy, agree very strongly, extremely confident.

Maintenance Self-Efficacy.

Thirteen items will assess maintenance self-efficacy, with based on formative research (Hardcastle, Maxwell-Smith, et al., 2017; Short et al., 2012). Items measure confidence to participate in regular physical activity over the next 12-weeks when: I lack discipline; exercise is not a priority; the weather is bad; I am feeling tired; I lack time; I do not enjoy exercising; I do not have someone to encourage me to exercise; I am in a bad mood or feeling depressed; I have to exercise alone; I can't notice any improvements in physical fitness; I feel stiff or sore; I feel unwell, and I can't notice any improvements in my body. Responses are scored on a six-point Likert scale from 1 = disagree very strongly to 6 = agree very strongly.

Action Planning.

Four items will assess action planning for the next 3-weeks, based on an amended scale (Rhodes et al., 2006). Participants will be asked to respond on a scale of 1 = disagree very strongly to 6 = agree very strongly about whether they have made plan concerning *what*, *when*, *where*, and *how* they will engage in regular physical activity.

Risk Perception.

Four items will measure risk perception, based on a previous scale (Graham et al., 2006). Items are scored on a six-point Likert scale from 1 = disagree very strongly, extremely unlikely, very much lower, to 6 = agree very strongly, extremely likely, very much higher. Items measure 'perceived risk…', 'vulnerability…', 'likelihood…' and 'chance…of developing health problems related to an inactive lifestyle, compared to the average person'.

Intention.

Two items will measure intention to engage in moderate intensity physical activity for at least 150-minutes per week in the next 12-weeks, based on previously established measures (Ajzen et al., 2004). Items are 'I intend…' and 'I will try…to participate in moderate intensity physical activity for at least 150-minutes per week in the next 12-weeks'. Items will be scored on a six-point Likert scale from 1 = disagree very strongly to 6 = agree very strongly.

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I.6 Demographic Questionnaire

Baseline Demographic Instrument Participant Name: ID:

Age		
Sex (please check one)		Male
		Female

Marital Status (please check one)		Married
		In a relationship
		Single
		Divorced/separated

Ethnicity (please check one)		Caucasian		Indian
		Pakistani		Bangladeshi
		Other Asian		Black Caribbean
		Black African		Chinese
		Other ethnic group		

Highest educational qualification (please check one)		University degree
		Post-school training/college/equivalent
		Secondary/high school
		Other qualifications
		No qualification

What is your average total household income per year before taxes?		Under $30,000
		$30,001-$52,000
		$52,001-$104,000
		$104,001-$156,000
		$156,001-$208,000
		$208,001-$260,000
		More than $260,000

Please list below the type of cancer that you received treatment for (bowel/colorectal or gynecologic)

Please tick all of the following cancer therapies that you received during your treatment

	Surgery
	Chemotherapy
	Radiation therapy
	Brachytherapy
	Hormone therapy
	Immunotherapy
	Other: (please list)

Smoking status (please check one)

	Non-smoker
	Light smoker (less than 10 per day)
	Moderate smoker (10-20 per day)
	Heavy smoker (20 or more per day)

Diabetes status (please check one)

	None
	Type 1
	Type 2

Do you currently have any form of cardiovascular disease?	Yes		No	
Do you know of angina or heart attack in a first degree relative <60?	Yes		No	
Chronic kidney disease (stage 4 or 5)?	Yes		No	
Atrial fibrillation?	Yes		No	
On blood pressure treatment?	Yes		No	
Rheumatoid arthritis?	Yes		No	

Do you have any of the following conditions or risk factors for cardiovascular disease? (please tick all that apply)		
	Yes	No
Smoker		
High blood pressure		
Depression		
High stress		
Overweight/obese		
High cholesterol		

I.7 Consent Form

ST JOHN OF GOD
Subiaco Hospital

Consent form

Title	Behavioural intervention trial to increase physical activity in cancer survivors at cardiovascular risk
Principal investigator	Chloe Maxwell-Smith

Note: All parties signing the consent section must date their own signature.

Declaration by participant

- I have read, or have had read to me, and I understand the participant information and consent form.
- I have had an opportunity to ask questions and I am satisfied with the answers I have received.
- I understand the purposes, procedures and risks of the research described in this research study.
- I intend to adhere to the study requirements to the best of my ability.
- I give permission for the medical practitioners, other health professionals, hospitals or laboratories outside this hospital, to release information concerning my disease and treatment which is needed for this trial and understand that such information will remain confidential.
- I understand that I will be given a signed copy of this document to keep.

Signature _____ Date_____

Name of participant (please print) _____

Declaration by trial doctor/senior researcher†

I have given a verbal explanation of this study, its procedures and risks and I believe that the participant has understood that explanation.

Signature _____ Date_____

Name of trial doctor/ researcher† (please print) _____

† A senior member of the research team must provide the explanation of, and information concerning, the research study.

I.8 Illustrative Excerpt of WATAAP Trial Booklet

Physical Activity for Cancer Survivorship

INFORMATION & EXERCISE BOOKLET

Introduction

This booklet has been designed to assist individuals who have been recruited into our physical activity and cancer survivorship program.

Please use the following information and tools to help you work towards your physical activity goals.

What do you hope to get out of this program?

1. _____

2. _____

3. _____

Physical Activity

How much should I exercise?

According to the Australian Government guidelines, the optimal level of aerobic physical activity per week for adults aged 18-65 is 150-300 minutes of moderate intensity physical activity, or 75-150 minutes of vigorous intensity physical activity, or an equivalent combination of the two. Although this may seem like a lot, it can be broken down into daily chunks. For example, 30 minutes of moderate physical activity such as brisk walking on 5 days per week would meet these guidelines.

For adults aged 65 and over, 30 minutes of moderate intensity physical activity on most days is recommended. It is also suggested that older adults engage in a range activities to improve strength, fitness, balance and flexibility twice weekly. Examples of strength-based exercises include lifting weights in a gym or completing body weight exercises at home such as push-ups, sit-ups and squats.

For further information on physical activity guidelines, please see: http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines

"Doing any physical activity is better than doing none. If you currently do no physical activity, start by doing some, and gradually build up to the recommended amount." —Australian Government, Department of Health

How hard should I exercise?

Moderate intensity exercise should make you breathe a little harder, but not make you feel completely out of breath. If you are doing moderate intensity aerobic activities such as brisk walking, you should be walking at an intensity where you can talk, but cannot sing.

If you are doing moderate intensity strength activities such as lifting weights, you should be able to complete 8-12 repetitions before you need to take a break.

Incidental exercise

Some regular daily activities such as housework or gardening may count towards your weekly target of 150 minutes. These activities are referred to as incidental exercise. Incidental exercises will still count towards your weekly goal, if they are at least moderate in intensity. Remember, this means a shortness of breath, feeling warm, or breaking a light sweat.

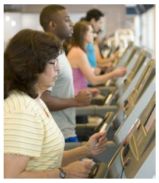
Examples of daily incidental exercise to include in your routine:

- Using the stairs instead of an elevator/escalator
- Parking further away from destination to increase walking
- Walking to nearby destinations instead of driving (school, shops, post-box)
- Walking the dog
- Household tasks such as cleaning or vacuuming

Aerobic activity examples

Below is a list of aerobic activities you may wish to try:

- Brisk walking
- Jogging
- Cycling
- Swimming
- Water aerobics
- Rowing
- Dancing
- Classes at fitness center
- Group sports



Goal-setting criteria

Forming realistic and specific goals for physical activity can be an effective step towards living a healthier life.

Effective goals must be SMART.

Specific
Exactly what do you wish to achieve? (Who, what, when, where, how)

Measurable
How will you measure progress towards the goal? How will you know once you have achieved this goal? How many minutes/times/days of physical activity are you aiming for?

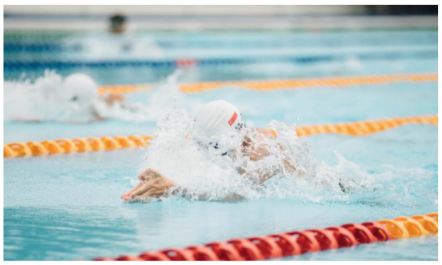
Achievable
Are you realistically able to achieve this goal in the time frame you have specified? Do you have the means necessary, and is your body capable?

Relevant
How does this goal fit with your long-term plans? Is it worthwhile? Will this goal fit with your lifestyle?

Time-oriented
How long will it take you? Does your goal include a realistic timeframe?

SMART Goal Examples

I will increase my physical activity by walking for 30 minutes around my local park 4 days per week on Mondays, Wednesdays, Fridays and Sundays, starting at 9am tomorrow morning.



I will increase my physical activity by swimming at the pool for at least 20 minutes 3 days per week on Mondays and Wednesdays at 10am with Jess, and on Saturdays at 1pm.

Setting your own goals…

With the SMART criteria in mind, please create some of your own goals below.

My short-term goal

Write down a short-term goal that you would like to work towards. For example, write down the exercise you would like to do this week.

I will exercise/start exercising on _____. I will _____ _____ (type of exercise) for _____ minutes, _____ times a week. If I do this for _____weeks, I will reward myself by _____.

For example, "I will start exercising on Tuesday. I will go swimming or walking for 30 minutes, five times a week. If I do this for five weeks, I will reward myself by getting a massage or manicure!"

Setting your own goals…

With the SMART criteria in mind, please create some of your own goals below.

My long-term goal

Write down a long-term goal that you would like to work towards. For example, what long-term benefit you would like to achieve from exercising, and when you would like to achieve it by.

I would like to _____

by _____. My reward will be _____.

For example, "I would like to lose 5 kilograms before my birthday this year. If I manage to do this, I will reward myself by booking a weekend trip away."

Barriers

It is likely that you will encounter some barriers along the way. Please list below any psychological, social, physical, or environmental barriers you may encounter while aiming to increase your physical activity, and a possible solution to help you overcome each barrier.

Barrier	Solution
1 I won't want to walk outside when it is raining.	I could do a home-based exercise DVD instead.
2	
3	
4	
5	

Making 'if-then' plans

Sometimes difficult or unexpected circumstances will make it hard to stay on track. It is important to have plans for responding to these situations to avoid sedentary behaviour.

Use the following table to think of difficult situations that may occur, and ways to manage them.

Difficult situation	Way to avoid or cope with it
1 If I become bored of the exercise regime and lose motivation	I will try a new activity or walk a new route instead
2 If…	Then…
3 If…	Then…
4 If…	Then…
5 If…	Then…

Rewards

It is important to reward yourself when you make progress towards a goal. Although some rewards cost money, other rewards are just as satisfying – and virtually free!

Remember, some rewards may be unhealthy or counter-productive in helping you reach your goals. For example, do not reward your weight loss with a big slice of cake!

Cost money	Do not cost money
Buying a new outfit	Having a bubble bath
Going out for dinner	Inviting friends over
Going to the cinema	Watching your favourite film/television program
Going away for the weekend	Asking family to look after the kids so you can have some time to yourself
Having your hair done	Going to the beach or out for a walk

Rewards for you

Please list below achievements that you would reward yourself for and what those rewards would be.

Achievement	Reward
1 I have exercised on 3 out of 7 days this week	Go for coffee with a friend
2	
3	
4	
5	

Confidence assessment

People with a high level of confidence in their ability to change are more likely to achieve their goals, and are more likely to solve problems that get in their way. It is important to be aware of your own confidence level, and try to boost your confidence to achieve your goals.

On a scale of 1 to 10, how confident do you feel about achieving this goal? If 1 was not confident and 10 was very confident, what number would you be at? Please circle a number on the scale below.

Not confident 1..... 2..... 3..... 4..... 5.....

6..... 7..... 8..... 9..... 10 Very confident

Confidence boosting

List below 5 times in the past when you have been successful at reaching a goal. This may be a big accomplishment like completing a qualification or degree, or a smaller one such as ticking off your to-do list or eating healthily for a whole day.

1
2
3
4
5

Weekly worksheets for you

We hope you have found this booklet informative. As a part of your participation in this program, we also encourage you to complete the following action planning and self-monitoring worksheets for each week of the 12-week program.

Action Planning

Forming a detailed plan about how you will achieve your goals will help you to measure your progress and re-evaluate your plan if you go off track.

Fill out details about your plans to be physically active at the beginning of each week. The more detail you include here about your plans, the more likely you are to carry them out. A completed example of the action planning worksheet can be seen on page 25.

Self-monitoring

Tracking your physical activity is useful for acknowledging how your time is spent, and whether you are on track with progressing towards your goals.

Begin by completing the program week number at the top of the page. Fill out the details of any physical activity that you completed for each day of the week. Remember to also write down how long you did each activity for. A completed example of the physical activity diary can be seen on page 38.

Action planning example

Week beginning: 3rd April 2017

My goal

I would like to be able to walk 5km comfortably by 3 months from now (July 2017).

My action plan

What am I going to do?

Walk for 30 minutes twice per week.

Where am I going to do it?

The local park & around my neighbourhood.

When am I going to do it?

Every Tuesday and Thursday morning after breakfast.

With whom am I going to do it?

I will go alone on a Tuesday and with my daughter on a Thursday.

Action planning – Week 1

Forming a detailed plan about how you will achieve your goal will help you to measure your progress and re-evaluate your plan if you go off track.

My goal:

Week beginning:

I would like to _____

by _____.

My action plan

What am I going to do?

_____

Where am I going to do it?

_____

When am I going to do it?

_____

With whom am I going to do it?

_____

Physical activity diary - Example

Physical Activity Self-Monitoring Diary

Week beginning: 3rd April 2017

Use this diary to record any physical activity you do for **longer than 10 minutes** at a time – this includes activities like walking or carrying light loads, as well as sports and going to the gym. Remember to write down how long you do each activity for.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Morning		30-minute walk around neighbourhood		30-minute walk around park with Jess			
Afternoon					1 hour yoga class at gym with Sam		30-minute swim at local pool
Evening	20-minute walk to the shops						

Physical activity diary – Week 1

Physical Activity Self-Monitoring Diary

Week beginning:

	Morning	Afternoon	Evening
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			
Sunday			

Resources

Australian Government Guidelines for Physical Activity

http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines

Cancer Council WA Life Now Exercise Program

https://www.cancerwa.asn.au/patients/support-and-services/life-now/

Cancer Counselling Services

Phone: 13 11 20

Diet and Exercise for Cancer Survivors

https://www.cancercouncil.com.au/cancer-prevention/diet-exercise/

Information and Exercises References

Department of Health. (2017). Australia's physical activity and sedentary behaviour guidelines and the Australian 24-hour movement guidelines. http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines

National Institute on Aging. (2017). Exercise and physical activity. https://www.nia.nih.gov/health/four-types-exercise-can-improve-your-health-and-physical-ability

The British Psychological Society (2008). *Improving health: Changing behaviour. NHS health trainer handbook.* Department of Health. https://uwe-repository.worktribe.com/output/1011599/improving-health-changing-behaviour-nhs-health-trainer-handbook

I.9 Follow-Up Phone Call Interview Guide

WATAAP Trial: Week 8 Interview Guide

How are you?

How has the last four weeks been since the group session?

Are you measuring your physical activity progress? What sort of progress has been made? (interviewers: BOLSTER SELF-EFFICACY WITH VERBAL ENCOURAGEMENT, ENCOURAGE MORE PA WHERE NEEDED (ie, optimal gains will be achieved for doing moderate-intensity PA for 50 mins-60 mins most days of the week)

Have you completed strength-based exercises as well as cardiovascular?

Give feedback with reference to intensity vs. steps message (i.e., if meeting steps goal say "It's great that you're meeting your steps goal. Also remember there are further/better benefits to be gained from doing aerobic activities at the higher intensity (brisk walking, moderate cycling etc.).

Reminder: Moderate-intensity PA makes you breathe harder than normal and bouts of at least '10 minutes' continuously are better (aka, Fitbit doesn't record intensity minutes if less than 10 minutes in duration). Strength based exercise is important as well, ideally twice a week…").

Are you on track with your initial goals, or have you amended your goals/plans?

Any obstacles (physical, psychological)? (IF THERE ARE, TROUBLESHOOT, HOW COULD THEY GET AROUND THAT OBSTACLE? TRY TO COME UP WITH A PLAN TOGETHER THAT THEY WILL EXECUTE)

How is the Fitbit going? Any problems?

What do you plan to do/achieve in the next few weeks?

Thanks for your time.
Next time we will need you is at the 12-week assessment.