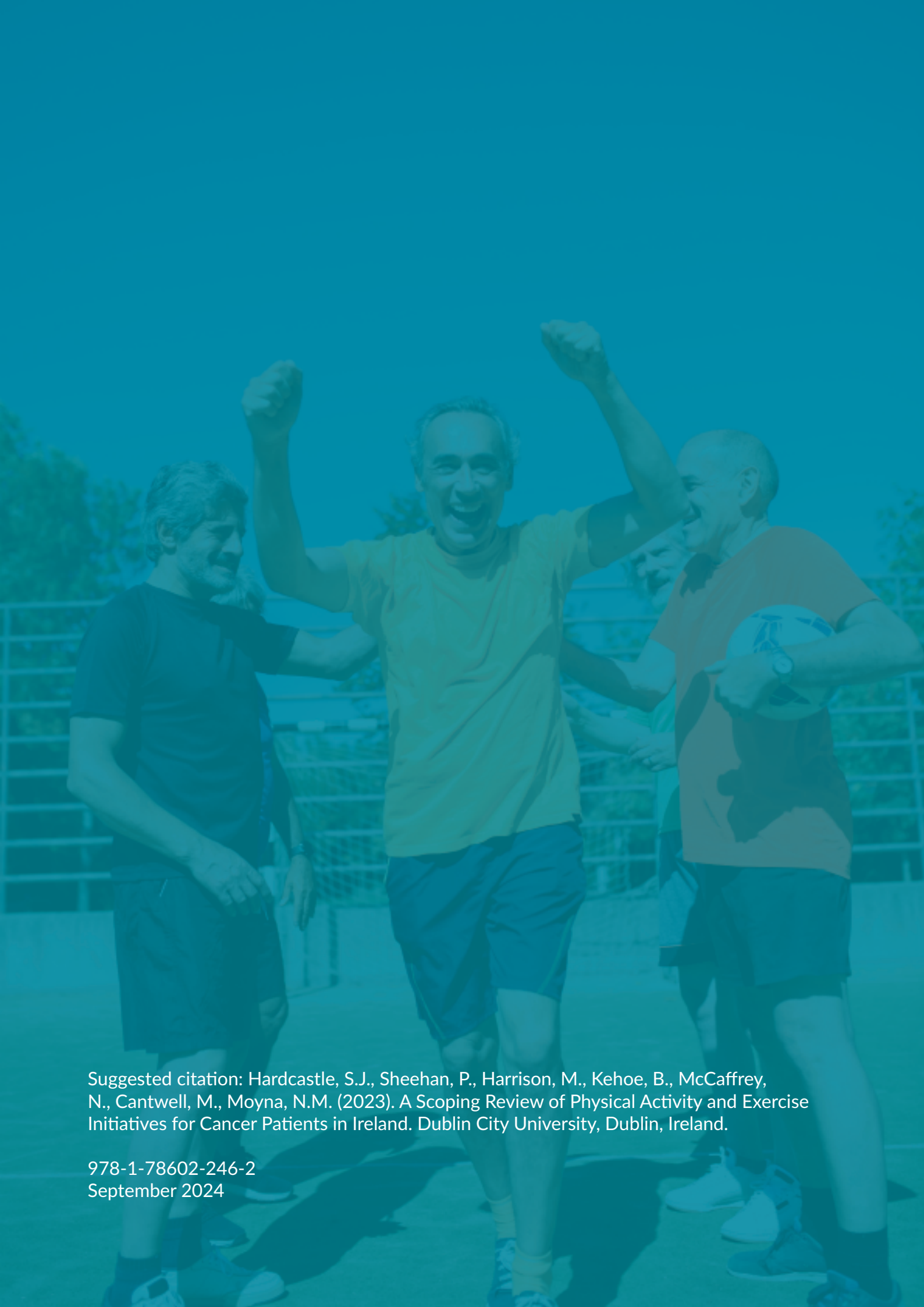
National Cancer Control Programme

A Scoping Review of Physical Activity and Exercise Initiatives for Cancer Patients in Ireland



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Introduction

The authors would like to extend their sincere appreciation to all the individuals who gave up their precious time to contribute to this research. A special thank you to colleagues from the National Cancer Control Programme for their continued support including Ms Bernie O'Loughlin (Programme Co-ordinator, Cancer Survivorship), Ms Louise Mullen (National Lead for Cancer Survivorship), Ms Cathleen Osborne (Assistant Director of Nursing, Survivorship) and Ms Dorothy Thomas (Patient Engagement Manager) and members of the Physical Activity and Exercise Sub-group. We also acknowledge the Health Service Executive/National Cancer Control Programme for funding this research.

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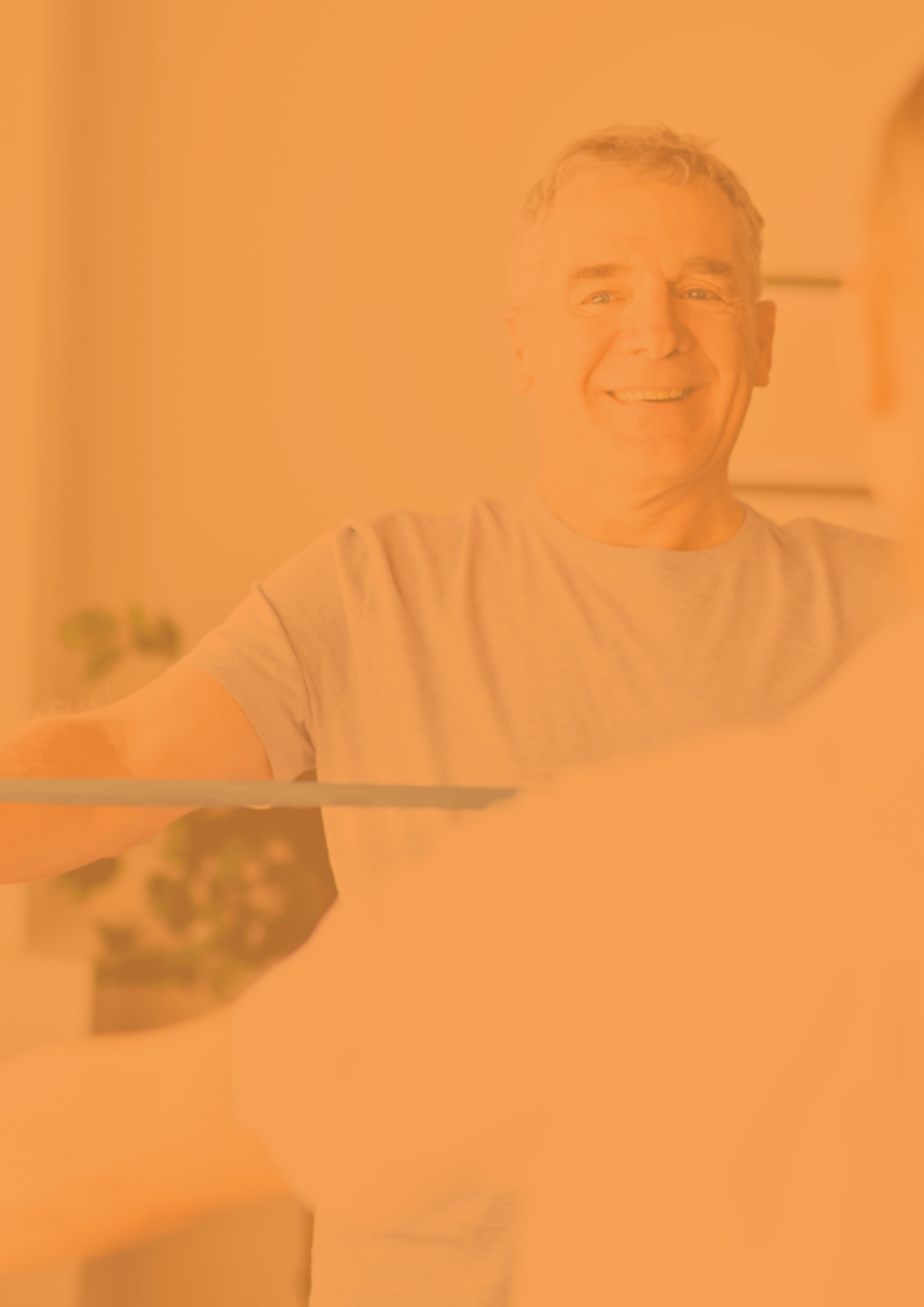
Authors' contributions and Competing Interests.
All authors contributed to the conception of the work and submission of the tender. SH was the independent, external consultant and took the lead role in data collection, analysis and report writing. MH took the lead on WE8: Education and Training. SH, MH, PS, MC, BK and NM contributed to the report writing and editing. As director for ExWell Medical, NMc does have a competing interest to disclose as ExWell was identified in the scoping review as a current provider of exercise services to individuals with cancer. However, NMc did not contribute beyond the initial conception of the work and did not have any oversight of the scoping review findings or interpretation of data. MH, PS, MC, BK and NM also disclose previous research collaborations with ExWell. However, SH worked independently on data collection and analysis.



Foreword

Physical activity is associated with better outcomes in cancer patients. The recommendations in the National Cancer Strategy 2017-2026, and the priority actions of the National Cancer Survivorship Needs Assessment 2019 provide an opportunity for strategic action in the area of physical activity. This includes a collective responsibility to develop and implement survivorship programmes, which will emphasise physical, psychological, and social factors that affect health and well-being, while being adaptable to patients with specific survivorship needs. In addition, the NCCP has a cancer prevention function, working in conjunction with the broader Healthy Ireland initiative and community sector, in relation to the development and implementation of policies and programmes focused on cancer prevention.

In 2022, the survivorship team in the NCCP commissioned external researchers to undertake a scoping review of physical activity and exercise services available for cancer patients related to the cancer continuum (secondary prevention, prehabilitation, during treatment, rehabilitation and for those living with and beyond cancer).

The work elements included:

- Describing the physical activity and exercise services available in Ireland
- Identifying actions to expand physical activity services for cancer patients in Ireland
- Proposing national recommendations

The outcomes of this current scoping review will help the NCCP and stakeholder partners to strategically develop actions for progressing implementation of recommendations to promote and provide physical activity.

This report shows there are a number of excellent physical activity initiatives, services and programmes in Ireland that aim to address the needs of cancer patients but they are not provided in all geographical regions and as a standard of care in our cancer centres and cancer services.

It is my sincere hope that this report serves as a baseline of knowledge and a resource about physical activity services and programmes in Ireland and that healthcare professionals, community leaders, and policymakers find inspiration to prioritise and integrate physical activity initiatives into the standard of care. There is much to be done, but I am heartened by the great enthusiasm and commitment I see to make progress in the coming years.

I would like to thank Dr. Sarah Hardcastle and all the research team for their hard work developing this report. I would like to thank the Physical Activity & Exercise Sub-group for their commitment to this process. We received extensive feedback and engagement that helped to shape the final report. I would also like to thank both Bernie O'Loughlin and Ellen Stafford NCCP team members for their work and dedication to this project and the production of the report.

Sincerely,

Ms Louise Mullen
National Lead for Cancer Survivorship
NCCP

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ABBREVIATIONS

6MWT	6-Minute Walk Test
ACSM	American College of Sports Medicine
BCC	Behaviour Change Counselling
BCTs	Behaviour Change Techniques
BECCI	Behaviour Change Counselling Index
BMI	Body Mass Index
CCs	Cancer Councils
CPD	Continuous Professional Development
CPEP	Community Providers of Exercise Programmes
CPET	Cardiopulmonary Exercise Test
CRC	Colorectal Cancer
CCSC	Community Cancer Support Centre
CTS	Cancer Thriving and Surviving
CVD	Cardiovascular Disease
EasCaR	The Exercise and Cancer Research Consortium
EHNA	Electronic Holistic Needs Assessment
EORTC	European Organisation for Research and Treatment of Cancer
HBP	Home-based Prehab
HCP	Healthcare Professional
HE	Health Education
HIIT	High-Intensity-Interval Training
HLAC	Healthy Living after Cancer
HNA	Holistic Needs Assessment
IG	Intervention Group
IMPACT	Improve Physical Activity after Cancer Treatment
LACES	Life After Cancer Enhancing Survivorship
LIPA	Light Intensity Physical Activity
MD	Mean Difference
MDT	Multi-disciplinary Team
MECC	Make Every Contact Count
MIPA	Multicenter International Prospective Analysis
MOP	Moving on Programme
MVPA	Moderate-to-Vigorous Physical Activity
NCCP	National Cancer Control Programme
NCT	Neoadjuvant Cancer Treatment
NEXT	Nutrition and Exercise during Adjuvant Treatment
NICE	National Institute for Health and Care Excellence
PA	Physical Activity
PEACH	Prescribed Exercise after Chemotherapy
PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews
QALY	Quality-adjusted Life Year
QOL	Quality of Life
RCT	Randomised Control Trial
RESTORE	Rehabilitation Strategies in Esophagogastric Cancer
SMD	Standardised Mean Difference
SPPB	Short Physical Performance Battery
WE	Work Element

Executive Summary

Background

Improved early detection and treatment has led to an increase in the numbers of people surviving cancer and it is estimated that 200,000 patients previously diagnosed with cancer were living in Ireland at the end of 2019 (National Cancer Registry Ireland, 2021). Ireland's National Cancer Strategy (2017-2026) aims to improve cancer outcomes for the Irish population and with increased survival rates comes an increase in the number of individuals concerned with their quality of life in survivorship and potentially living with the side effects of cancer and its treatment. These side effects can include declines in cardiorespiratory fitness and physical function, adverse changes in body composition, and fatigue, neuropathy, pain and lymphoedema (Ligibel et al., 2022). These side effects may have detrimental effects on functional capacity and quality of life (QoL), but also cause cancer survivors to be susceptible to comorbidities such as cardiovascular disease (CVD), diabetes (Ligibel et al., 2022) and increased risk of secondary cancers (Siegel et al., 2022).

The National Cancer Control Programme (NCCP) commissioned this scoping review of existing physical activity and exercise programmes in Ireland to determine the current provision in this area. A strategic steering group was set up to support the work with key stakeholders including patients and knowledge experts. This steering group was available to feedback, oversee and support the work of the research group.

Introduction

One strategy that can have positive effects across the cancer journey is to engage patients and survivors in physical activity (PA). PA can mitigate many of the effects of cancer treatments. There is consistent evidence for the effectiveness of exercise interventions during active treatment across cancer types to maintain or improve cardiorespiratory fitness (Bjorke et al., 2019; Scott et al., 2018) and physical function (Sweegers et al., 2018). PA interventions during treatment also reduce fatigue (Oberoi et al., 2018; Hilfiker et al., 2018). There has also been increasing interest in the benefits of PA prior to surgery or treatment (often referred to as prehabilitation) for cancer patients to reduce post-operative stress, duration of hospital stays and improve cardiopulmonary function (Carli & Scheede-Bergdahl, 2015; Nelson et al., 2019). Being physically active post diagnosis and post treatment is vital to reduce the risks of cancer-specific and all-cause mortality and improve survival (Patel et al., 2019). Cancer survivors who are physically active have lower CVD-related morbidity, lower recurrence risk, and improved survival compared to those who are inactive (Keats et al., 2016; Brown & Gilmore, 2020).

Given the myriad of benefits of PA, several international guidelines recommend PA for those living with and beyond cancer (Campbell et al., 2019; Rock et al., 2022; Campbell et al., 2011). The American Cancer Society recommends that adult cancer survivors participate in 150 minutes of aerobic moderate-intensity PA per week and muscle-strengthening activities on two or more days a week (Rock et al., 2022) for improved health outcomes and longevity. The American College of Sports Medicine (ACSM) have also proposed similar exercise recommendations (i.e., moderate-intensity aerobic PA such as brisk walking three times per week and twice-weekly resistance training) for targeting specific symptoms for those undergoing cancer treatment such as fatigue, anxiety, depression, QoL, physical function, sleep, and bone health (Campbell et al., 2019). Physical activity is also recommended for those living with advanced cancer to maintain or improve physical function and QoL with an ACSM guideline making five recommendations for this cohort in addition to the standard PA recommendations (Campbell et al., 2022).

The above recommendations have been developed based on the conclusion that exercise is generally safe for cancer survivors and is therefore, suitable for the majority of patients. There is a small proportion of cancer survivors who may be unable to achieve or tolerate the recommendations due to the nature and extent of their side effects and physical limitations (Campbell et al., 2019). Patients with complex needs may require more individualised or intensive rehabilitation and appropriate assessment can inform suitable modifications to an individual's PA prescription (Schmitz et al., 2019). Every cancer survivor should avoid inactivity (Campbell et al., 2019).

Despite the increasing evidence that PA improves cancer outcomes, international literature indicates that most survivors (~75%) fail to meet the PA guidelines. Therefore, efforts and resources need to be made to find strategies to effectively promote PA to cancer survivors across the cancer continuum. A first step is the identification of existing PA provision for cancer survivors living in Ireland and an exploration of the main barriers to PA promotion to form national recommendations in this area.

Aim of Scoping Review

The aims of the scoping review were to:

- identify the existing cancer-related PA services and programmes in Ireland across the cancer continuum
- identify gaps in current provision and the differences between research-led interventions and existing community or facility-based programmes
- identify potential ways to expand PA services for cancer in Ireland
- identify the main barriers to PA promotion in cancer survivors and potential solutions
- propose national recommendations and strategies to implement PA programmes and services in this area.

Methodology

The methodological approach included three stages.

Stage 1. The first stage involved a scoping review to identify current provision of exercise programmes and PA services in Ireland.

Stage 2. The second stage involved a review of systematic reviews of international literature on the types and effectiveness of PA interventions in cancer survivors to identify evidence-based interventions in this area. PA was chosen as the primary outcome to delimit the scope of the literature review. This was to ensure a manageable output in the timeframe of the project. The literature has focused on the effects of PA on numerous outcomes in cancer patients and PA is beneficial at all stages of the cancer journey. However, once short-term interventions are complete, the effect on PA behaviour is important to maintain health outcomes and to provide more long-term health benefits and survival.

Stage 3. The final stage involved roundtable discussions with a variety of stakeholders to identify barriers to PA promotion and potential solutions concerning the expansion of PA services for cancer in Ireland.

Based on the findings from these three stages, potential strategies on the way forward and national recommendations to implement PA programmes and services in this area were proposed.

Key Findings

1. The results from this scoping review indicate that availability of existing community exercise provision and PA interventions nationally in this area is limited. Limited access to PA programmes included availability in general, but also the costs of referral to some community programmes.

2. It is apparent that most cancer survivors do not routinely receive PA assessment, information, advice, or counselling as part of usual care and that referral to PA programmes is not standard practice.

3. There are some existing exercise programmes available for cancer survivors in the community and in some hospitals. However, most existing PA services are not consistently available. Overall, there is very little dedicated PA provision for cancer survivors.

4. Little is known concerning the overall effectiveness of existing PA services for cancer survivors within community or hospital settings in Ireland. Research in exercise oncology in Ireland is limited to a small number of settings and tumour groups, with both positive and mixed findings in terms of efficacy.

5. There have been few eHealth and mHealth interventions in Ireland yet internationally there is growing support for the efficacy of wearable interventions to increase PA in cancer survivors. Similarly, few PA interventions in Ireland have been based on a theory of behaviour change or utilised counselling approaches.

6. The primary barriers to PA promotion in cancer survivorship included (i) a lack of awareness by healthcare professionals concerning the importance of and benefits of PA in cancer, (ii) a lack of knowledge concerning the PA guidelines for cancer survivors including ways to effectively counsel patients for exercise, and (iii) a lack of availability of PA programmes or services specifically for cancer survivors.

7. There was little referral to existing community exercise programmes by consultants and hospital staff, and the lack of a simple triage and referral mechanism for healthcare professionals was noted as a barrier to referral.

8. The dominant mode internationally and in Ireland has been the delivery of facility and group-based exercise programmes for cancer survivors. However, access and cost were identified as barriers to facility-based programmes and there was recognition that many survivors prefer individual 1:1 support and programmes.

9. The NCCP was viewed as the entity with the authority to ensure that PA promotion becomes part of routine practice in the oncology setting and integrated into the cancer pathway nationally. The summary and overarching recommendations to the NCCP, based on the scoping review are detailed below.

Summary of Recommendations

Overarching Recommendations

1. Structural and policy change is needed to ensure that PA promotion is implemented in practice. The NCCP should ensure that guidance and recommendation for PA is *standard of care for cancer patients through the development and implementation of a PA cancer care pathway* with appropriate triaging and to include monitoring and impact evaluation.

2. Healthcare professionals should verbally encourage cancer patients to be physically active throughout the cancer pathway. This should include provision of appropriate written materials, support, referral and signposting to both hospital and community-based supports where available.

3. PA services should incorporate evaluation and further research is required to identify patient-centred PA interventions for cancer survivors that are appropriate, acceptable, effective, and scalable in the Irish context. The NCCP should support the development of PA interventions which are evidence-based and adhere to international and national guidance and the PA cancer care pathway.

Clinical Practice

- PA should be embedded into the cancer care pathway and a PA model of care developed, implemented and supported by the relevant stakeholders.

- PA should be assessed and discussed as part of usual care throughout the cancer pathway.

- All newly diagnosed cancer patients should receive written information on the importance of PA in cancer survivorship and should be provided with the PA guidelines.

- From diagnosis and throughout the cancer pathway, patients should be advised and encouraged to participate in regular PA by every healthcare professional that they meet (MECC - Make Every Contact Count).

- All healthcare professionals should verbally encourage patients to be physically active during and following active treatment.

- PA interventions should be individualised and tailored according to stage on the cancer pathway, treatment-related impairments, comorbidities, exercise preferences and support needs of individual cancer survivors.

- A stepped care approach should be considered and incorporate cancer-specific considerations (e.g., cachexia, lymphoedema, chronic pain) in tailoring an exercise prescription. All patients with complex needs or high symptom loads should be given the opportunity to be assessed by a physiotherapist and/or exercise physiologist who are the recognised specialists in this area, and can assist with mobility concerns and with PA tailoring.

Education and Training

- All healthcare professionals should be offered bespoke exercise oncology training (as Continuous Professional Development (CPD)) to help embed PA into routine practice.

- Bespoke training should include (i) the rationale for PA; (ii) the PA guidelines for cancer survivors; (iii) ways to briefly counsel patients for PA and promote behaviour change.

- Community cancer support centre managers and support staff should receive training on PA and

cancer and be supported to offer appropriate exercise programmes by the NCCP.

Capacity Building and Development of an Evidence Base

- Identify patient-centred PA interventions that are acceptable and effective and support the implementation of evidence-based PA strategies in Ireland.

- Further research is needed to evaluate the potential and effectiveness of eHealth and mHealth interventions and consultant and nurse-delivered interventions.

- Research trials should include objective measures of PA, be adequately powered to detect change in PA, utilise implementation science and assess PA maintenance following intervention cessation.

- Health economic research will be valuable to assess the cost-effectiveness of PA interventions and services.

In conclusion, a number of recommendations have been made to further encourage and embed physical activity into the cancer care pathway. Stakeholders from across the system should be encouraged to review the results and consider the recommendations from this scoping study. The NCCP is committed to addressing these recommendations and will design action plans to begin working on them. This will require a collaborative approach and will need to utilise both the expertise of Irish specialists such as physiotherapists and exercise physiologists working both in oncology and those in the wider community services. Awareness and knowledge of the importance of physical activity to cancer patients is key and education and training for oncology professionals and primary and community care healthcare professionals will need to be ongoing. The importance of the promotion and engagement with physical activity for people living with and beyond cancer is evident from this review and national and international evidence. Sustained effort, resourcing and further policy will be required to implement these recommendations. Policy in this area should align with national health policy for prevention, chronic disease management, and community based health promotion. Progress in these areas and oncology care will create great benefit for cancer patients and wider population health.

Introduction and Background

On average 24,000 cancers (excluding non-melanoma skin cancers) were diagnosed in Ireland annually between 2017 and 2019 and the 5-year survival rate between 2014 and 2018 was 65% compared to 42% between 1994 and 1998 (National Cancer Registry Ireland, 2021). Prostate and breast cancer were the most commonly diagnosed invasive cancers overall between 2017 and 2019, and each accounted for almost one-third of all invasive cancers in men and women respectively. Colorectal (bowel) and lung cancer were the second and third most common cancers in males and lung and colorectal were ranked second and third for females in the same period (National Cancer Registry Ireland, 2021). Improved screening, early detection, and treatment has led to an increase in the number of people surviving cancer (Bellizi et al., 2005; Jemal et al., 2011). It is estimated that 200,000 patients previously diagnosed with cancer (4% of the population) were living in Ireland at the end of 2019 (National Cancer Registry Ireland, 2021).

Cancer survivors face many side effects of cancer and its treatment, including declines in cardiorespiratory fitness and physical function, adverse changes in body composition, fatigue, neuropathy, pain and lymphedema (Ligibel et al., 2022). These side effects may have detrimental effects on functional capacity and QoL, but also cause cancer survivors to be susceptible to comorbidities such as CVD and diabetes (Ligibel et al., 2022). Alongside cancer recurrence, cardiovascular mortality is becoming a significant competing cause of mortality in cancer survivors (Curigliano et al., 2016; Scott et al., 2018). Therefore, interventions that focus on reducing comorbidities and CVD as well as improving physical and psychological well-being are essential for healthy survivorship trajectories (Demark-Wahnefried et al. 2005).

One strategy that can have positive effects across the cancer journey is to promote physical activity (PA). PA during and after cancer treatment can mitigate some of the treatment-related side effects. There is consistent evidence (i.e., from meta-analytic findings) for the effectiveness of exercise interventions during active treatment across cancer types to maintain or improve cardiorespiratory fitness (Bjorke et al., 2019; Scott et al., 2018) and physical function (Sweegers et al., 2018). PA interventions during treatment also reduce fatigue (Oberoi et al., 2018; Hilfiker et al., 2018) with superior effects for exercise compared to pharmacological interventions on fatigue (Mustian et al., 2017). In addition, there is some evidence for improved QoL following participation in PA interventions during treatment (Sweegers et al., 2018), including reductions in anxiety and depression (Singh et al., 2018).

There has also been increasing interest in the benefits of PA prior to surgery or treatment (often referred to as prehabilitation) for cancer patients to reduce post-operative stress, duration of hospital stays and improving cardiopulmonary function (Carli & Scheede-Bergdahl, 2015; Nelson et al., 2019). Meta-analytic evidence has found that preoperative exercise reduced postoperative length of hospital stay and postoperative pulmonary complications among lung cancer patients (Rosero et al., 2019; Li et al.,2019). There is also evidence of improved functional capacity and reduced hospital length of stay in gastro-intestinal cancer patients (Waterland et al., 2021). Preoperative PA may also provide benefits for other cancer types, but evidence is currently weaker outside of lung cancer. Nevertheless, prehabilitation is an emerging field within exercise oncology.

Being physically active post diagnosis and post-treatment is vital to reduce the risks of cancer-specific and all-cause mortality and improve survival (Patel et al., 2019). Survivors who are physically active have lower CVD-related morbidity (Keats et al., 2017), lower recurrence risk (Morishita et al., 2020; Friedenreich et al 2016; Deli-Cartwright et al., 2016; Hamer & Warner, 2017), and improved survival compared to those who are inactive (Morishita et al., 2020; Holick et al, 2008). Increased PA post-

diagnosis has been demonstrated to reduce both cancer-specific mortality and all-cause mortality in colorectal cancer (CRC) survivors (Friedenreich et al. 2019; Schmid and Leitzmann 2014).

Given the myriad of benefits of PA in people living with and beyond cancer several international guidelines recommend PA for those living with and beyond cancer (Campbell et al., 2019; Rock et al., 2022; Campbell et al., 2011). The American Cancer Society recommends that adult cancer survivors participate in 150 minutes of aerobic moderate-intensity PA per week (or 75 minutes per week of vigorous-intensity PA) and muscle-strengthening activities on two or more days a week (Rock et al., 2022) for improved health outcomes and longevity. The ACSM has also proposed exercise prescriptions targeting specific symptoms for those during or following cancer treatment such as fatigue, anxiety, depression, QoL, physical function, sleep, and bone health (Campbell et al., 2019). Despite some variations in prescription, the predominant exercise prescription to address symptoms associated with cancer treatment is moderate-intensity aerobic activity (e.g., brisk walking) three times per week and twice-weekly resistance exercise that includes all major muscle groups. Physical activity is also recommended for those living with advanced cancer to maintain or improve physical function and QoL with an ACSM guideline making five recommendations for this cohort in addition to the standard PA recommendations (Campbell et al., 2022).

Exercise is generally safe for cancer survivors and all survivors should avoid physical inactivity. However, due to the nature and extent of side effects or physical limitations, a small number of cancer survivors may be unable to achieve or tolerate the recommended levels of PA. Referral to rehabilitation may be required to address a particular therapeutic outcome or for assessment, triaging and onward referral to appropriate exercise services or prescription of adapted PA recommendations (Schmitz et al., 2019).

Despite the increasing international evidence that PA improves cancer outcomes, most survivors (~75%) (Arem et al., 2020) fail to meet the current aerobic guidelines of at least 150-minutes of moderate-intensity PA per week and very few (14%) meet both the aerobic and strength-based guidelines (Campbell et al. 2019; Rock et al., 2022). The primary aim of this project was to comprehensively examine the landscape of PA interventions for cancer survivors in Ireland, focusing on various stages of the cancer journey, including prehabilitation, active treatment, and post-treatment phases. By mapping existing programmes, identifying gaps, and exploring the barriers to PA promotion, the goal was to pave the way for evidence-based, patient-centered interventions to increase PA and improve health and well-being for cancer survivors in Ireland.

Scoping Review Aim

This scoping review was commissioned by the NCCP and its aim was to identify and map interventions for the promotion of PA in Ireland that are specifically related to cancer. This includes prehabilitation, during treatment or following active treatment (Work Element 1: WE1). Firstly, a comprehensive scoping exercise was undertaken to document the existing cancer-related PA services and programmes in Ireland (stage 1). This scoping exercise provided a starting point for the identification of gaps in current provision and the differences between research-led interventions and existing community programmes (WE3). The scoping review of the international literature (stage 2) helped to identify differences between existing community-based programmes in Ireland and research-led interventions in the cancer field ensuring that evidence-based PA interventions inform community services and recommendations effectively.

Following the scoping exercises, the aim of stage 2 was to identify potential ways to expand PA services for cancer in Ireland (WE2) and identify the main barriers to PA promotion to cancer survivors and potential solutions concerning the expansion of PA services for cancer in Ireland (WE4). This involved roundtable discussions with a variety of stakeholders. Based on the findings from these three stages, the aim was to i) identify methodologies deemed acceptable, feasible and useful to further develop the national recommendations proposed (WE5) and ii) propose national recommendations for PA

intervention during the patient pathway (WE7).

***Specific Work Elements:**

- WE1- Describe PA and exercise services available in Ireland and international examples related to the cancer continuum.
- WE2- Identify actions to expand PA services for cancer in Ireland.
- WE3- Identify the gaps that exist between existing programmes and those in a research or treatment setting and consider how these gaps can be bridged.
- WE4- Identify the main barriers to PA promotion to cancer survivors and potential solutions.
- WE5- Identify methodologies to be used for developing national recommendations in this area.
- WE6/7- Propose national recommendations and strategies to implement programmes and services in this area (and for different points on the patient pathway).
- WE8- Identify the education/accreditation and training needs for those involved in the delivery and implementation of programmes for cancer patients in Ireland.

*The following work element was included in the project brief but was not progressed by agreement with the NCCP "Identify how to refer between programmes run in hospital and community based settings and how to link them together."

Scoping Review of Exercise Programmes in Ireland: Stage 1

Scoping Review of Exercise Programmes in Ireland: Stage 1

To obtain an overview of existing interventions, the first stage of the project identified and mapped interventions for PA in Ireland that are specifically related to cancer including prehabilitation and during or following active treatment. A comprehensive scoping exercise was undertaken to document the existing cancer-related PA services and programmes in Ireland. This scoping exercise provided a starting point for the identification of gaps in current provision and the differences between research-led interventions and existing community or facility-based programmes. This stage was primarily an audit exercise, with key contact details (i.e., names and emails) of organisations and providers (e.g., community cancer support centres, oncology services within hospitals, hospices) obtained from the NCCP steering group and publically available sources. This stage of the scoping review was conducted between February and April 2022. Each community cancer support centre (CCSC) in Ireland (n=46) was sent personalised emails to ask for details of their current exercise provision. In addition, known providers of community exercise provision for cancer and known research groups were also contacted to identify both community and research-led programmes. Contact details for these providers are readily available to the public and were obtained from an internet search. Each provider/organisation was contacted by email. If they did not offer exercise programmes or offer a single exercise class (e.g., yoga), this was noted, and the provider was not asked to meet for a Zoom interview. If the provider offered multiple programmes or research-based programmes, they were invited by email to attend a Zoom interview to discuss their offerings in further detail. Permission was sought to record these interviews. With permission, interviews were audio-recorded and uploaded to secure data storage for transcription. In stage 1, data was obtained from email and Zoom interviews (see Appendix A for the interview guide). If permission to record was not given, notes were typed up from the Zoom interviews and entered into a Word document.

Results

Identification of Exercise Programmes within Community Cancer Support Centres

There are 46 community cancer support centres within the Republic of Ireland. Each centre was contacted by email to ascertain existing community cancer support centres' services and programmes. Follow-up emails were sent to non-responders. Twenty-six CCSCs (57%) responded to the email. Of these, 8 centres did not offer any PA services or exercise programmes. Reasons provided for the lack of provision included (i) Covid 19 (n=3), (ii) insufficient resources or funding (n=2), (iii) vacant physiotherapy position (n=1), (iv) primarily offering counselling services (including a lack of space for PA programmes) (n=1), and (v) provision of caregiving services only (n=1). The websites of non-responders (n=20) were checked for evidence of PA services. Of these, 2 offered exercise services; one offered yoga and tai chi and the other offered tai chi and a bone and muscle strengthening activity.

Eighteen community cancer support centres (39%) reported providing existing PA services and exercise programmes for cancer survivors (43% including the two non-responder centres). Most programmes were aimed at those who had completed active treatment but also included cancer survivors during treatment. An overview of the PA provision within community cancer support centres in Ireland is provided in Table 1. The most common activity offered through the community cancer support centres was yoga with 13 of the community cancer support centres providing yoga classes or courses, either online or in person. The joint second most provided activity was a blended of aerobic and resistance exercise programme delivered once a week provided by 5 community cancer support centres and a led walking group provided by 5 centres.

Table 1: Existing Physical Activity and Exercise Programmes at Community Cancer Support Centres (*Data collected February and April 2022)

Community Cancer Support Centre	Yoga	Pilates	Tai Chi	Walking Group	Gym	Circuit training	Referral to Community Provider	Other	Notes
Cork ARC	•	•	•					Resistance & aerobic training 1x wk, 6 wks +3 educational sessions (such as stress management, sleep quality, diet). Men only programme. During & post-treatment.	Run by CNS & Physio. Team hoping to transition participants to public gym to continue exercise. Pre and post assessment including 6-minute walk test (6MWT), Hip/waist, sit to stand and EORTC.
ARC Dublin	•	•							All via Zoom, drop-in classes. Yoga & Pilates 2 x wk
Cuisle Cancer Support (Portlaoise)	•	•		•				'Next steps': Online Physio-led prescribed aerobic/strength classes (15 wk programme)	Walking every Monday. Chair Yoga & Pilates 1 x wk, 6 wks course
Dochas Cancer Support (Offaly)	•								1 x wk for 6 wks, 3 courses running at local Yoga studio
East Galway & Midlands	•			•		•			Yoga 1 x wk. Nordic walking group 2 x wk, circuits in gym 2 x wk. All 12 wk courses. Circuit Programme in gym (2 x wk for 12 weeks) during treatment
Eist Cancer Support (Carlow)	•			•					Yoga 1 x wk for 6 wk (online). Walking group every Monday. Continuous.
Gary Kelly Centre (Drogheda)	•		•					B Fit'. Detail not available	Yoga via Zoom (Tues & Friday). Tai Chi 1 x wk.
Hope Cancer Support (Enniscorthy)								Exercise & Movement programme (bespoke in-house programme designed by nurse, physio & manager).	1 x wk for 6 wks. Range of movement & resistance training. Booklet & resistance band provided. Based on Campbell et al (2019) Exercise guidelines for cancer survivors. Open to prehab, during and post-treatment
Purple House (Bray)	•			•	•		•	Cancer Rehab Gym programme 1 x wk, 10 weeks. Cardio & resistance and/weights & balance with physio (1 hr)	Yoga 1 x wk for 10 weeks. 'Strides for life' walking programme 1 x week for 16 wks. Gym on site but cannot be used unsupervised.

Table 1: Existing Physical Activity and Exercise Programmes at Community Cancer Support Centres (*Data collected February and April 2022)

Community Cancer Support Centre	Yoga	Pilates	Tai Chi	Walking Group	Gym	Circuit training	Referral to Community Provider	Other	Notes
Recovery Haven (Tralee, Co Kerry)	•	•						Hydrotherapy at Kerry Sports Academy for 6 wks. During & post-treatment.	All 6 wks programmes. Yoga & Pilates led by volunteers. Pilates (beginners & intermediate on a Tuesday online). Yoga is in person on Thursday morning.
Roscommon Cancer Support	•								Gentle Yoga
Solas Cancer Support (Waterford)				•					Walking group 1 x wk. Refer to ExWell Medical programme 2 x wk for 12 wks in Kilkenny or Waterford.
Tuam Cancer Care (Tuam, Co Galway)	•							Due to start 'Can-React' programme with NUIG Exercise programme via Zoom 1x wk for 12 wks in gym with Physio 1:1.	Yoga 1 x wk via Zoom. 'Can-React' is a 1 x week 12 wk programme delivered on-line or in person and involves aerobic & resistance training. Prescribed exercise.
Cancer Care West (Galway)					•			Survivorship programme (exercise & well-being), 1 x wk, 12 weeks online. Drop-in class Tues am by appointment	On site gym facilities.
Cois Nore (Kilkenny)							•		Referral to ExWell Medical Exercise programme (2 x wk for 12 weeks) in a local leisure centre.
Cork Cancer Care Centre	•							Yoga 2 x wk	Yoga 2 x wk
Gort Cancer Support (Co Galway)			•						Tai Chi 1 x wk

Interviews with Community Cancer Support Centres

Interviews were conducted with 14 of the community cancer support centres that offered existing exercise programmes (n= 18) to further explore (i) the processes of recruitment for exercise programmes; (ii) whether programmes included monitoring and evaluation; (iii) the costs involved in the delivery of services and programmes and (iv) the obstacles concerning the provision of further PA services and exercise programmes as well as uptake of offerings for cancer survivors. Interviews were conducted by Zoom, audio-recorded (with permission) and continued for approximately one hour.

Self-referral and Generalised Support

Recruitment of cancer survivors to exercise programmes tended to be informal and involved signposting from cancer support centre staff. For example, "by support workers…there are two to five at (CCSC 1) and each community cancer support centre has a list of clients and can email out to" (CCSC 1) and "patients are those that come in for other services, for example counselling, prosthesis or reflexology and are signposted by cancer support centre staff to exercise" (CCSC 2). Cancer survivors did not attend the centres for PA but usually for other services such as counselling: "90% are self-referrals and some via the Irish Cancer Society for counselling" (CCSC 3), lymphatic manual drainage or other holistic therapies: "mainly they come for other services like lymphatic manual drainage, reflexology, counselling" (CCSC 1). Attendance at the cancer support centres tended to be based largely on self-referral and word of mouth: "self-referral, social media and word of mouth" (CCSC 4). Some community cancer support centres noted receiving some referrals from oncology teams, although these tended to be for counselling or general support rather than for exercise specifically: "oncologists sometimes refer for general support but not exercise directly" (CCSC 5) and "few oncologists are referring in general to the support centre…if a nurse doesn't hand you a leaflet you don't get it" (CCSC 6). Others referred to the lack of formal referral pathways that was a barrier to patient engagement with the local support centres: "there's no official pathway between oncology in hospital and the community cancer support centre… many of the cancer survivors don't know we're here" (CCSC 3) and that few oncologists refer to the community cancer support centre: "oncologists are not referring" (CCSC 2). None of the support centres interviewed reported receiving direct referrals from the oncology team for exercise. For example, "we don't get general referrals from the oncology team or nurses for a specific exercise programme" (CCSC 3). Another manager explained that less than 20% of new clients attending the centre were actively referred from the oncology team: "each month we have a few referrals…say out of 25-28 new clients per month, about 3 or 4 of these would come from oncology services but not for specific programmes but for general support" (CCSC 7).

Types of Exercise Programmes and Costs

The most common PA offered at support centres was yoga (offered by 13 support centres). Interestingly yoga is unlikely to count towards meeting the PA guidelines for cancer survivors since it is low-intensity, although it may derive some benefits in terms of muscle strength and balance (UK Chief Medical Officer's Physical Activity Guidelines, 2019). Several centres explained that yoga was commonly offered because it is an activity associated with holistic therapies deemed to be helpful for cancer survivors: "a lot of focus (within cancer support centres) is on holistic therapies and counselling services because that's what people think is beneficial" (CCSC 3). A physiotherapist reinforced this point explaining that some activities are offered for psychological wellbeing rather than for improved physical health: "there's a lack of understanding of the benefits of exercise, many do it just to feel better" (Chartered Physiotherapist, CCSC 6).

Almost all exercise programmes offered through the community cancer support centres did not include inclusion and exclusion criteria and invitations to join exercise programmes were not based on current PA level.

There was little evidence of monitoring and evaluation of exercise services and programmes other than informal feedback from participants and attendance records. Evaluation was more likely to be conducted through funded pilot studies though no formal evaluations were provided to the research team as part of this scoping review.

The funding of exercise programmes and PA services at the community cancer support centres was variable with some activities led by volunteers (e.g., yoga, led walking groups). Most services carried a cost to cover time for a physiotherapist, exercise specialist or nurse and these costs tended to be covered through local fundraising activities or small community grants, including some provided by the NCCP. Two community cancer support centres paid for clients to attend the ExWell Medical exercise programme (a group-based exercise programme twice per week for 12 weeks) at a cost of €220 per client. It should be noted that the programme referred to by these community cancer support centres is not a cancer-specific exercise programme but one that is designed for patients with any long-term conditions such as heart disease, neuromuscular disease, mental health, diabetes, arthritis, and cancer. At one centre (CCSC 13), the board have approved referral of up to 24 clients a year to ExWell for the 12-week Move On programme. Despite positive feedback on the programme from attendees, the centre reported low uptake to the programme.

CCSC 3 pays a local yoga studio to run its Yoga courses (1 x week for a 6-week course) and runs three courses at any one time. Each class costs €50 and participants have the choice to continue the Yoga course for a further 6-weeks. Therefore, €1800 is required to cover three courses of 12 weeks. Some community cancer support centres such as CCSC 3 ask for a donation of €20 per course to contribute to costs. Several cancer support centres, including their board members who advocated for PA, were keen to provide exercise services: "at the moment we're ok to fund 3 to 4 courses every 6 weeks…the board were very clear that we would find the funding if we had 40 or 50 people wanting to do it" (CCSC 3). The centre manager reported that "the chairman of the board is a GP and keen to include exercise as part of cancer care rather than just offering counselling and massage".

The 'Next Steps' online prescribed exercise programme (15 weeks) was funded through a NCCP grant and is a pilot study with 15 cancer survivors. The exercise programme is led by a physiotherapist and costs €150 per person. The 'Exercise and Movement programme (CCSC 1) is an in-house initiative funded by a small grant (i.e., the community foundation; €5000). It is a relatively low-cost intervention with the main costs to date expended on printing exercise booklets, purchasing exercise mats and resistance bands.

The 'Can-React' exercise programme operated out of CCSC 12, in partnership with the NUIG (and initially funded by NCCP) is run from an internal grant awarded to NUIG. The Can-React programme is an example of a more intensive personalised exercise programme that is run online or in person according to patient preferences, with formal monitoring of fitness parameters and delivered by an exercise physiologist. The programme is low cost since MSc. students (Exercise Physiology and Rehabilitation) from NUIG deliver the programme and conduct assessments as part of their work experience for the course. However, to date, published data on the efficacy and sustainability of the 'Can-React' programme is not available.

Challenges to Physical Activity Promotion: Referral, Personnel and Cost

The main barriers to offering exercise programmes and/or increasing uptake of PA services through community cancer support centres were related to lack of referral, having access to trained personnel and cost. Several community cancer support centres mentioned the lack of referrals to their services from clinicians and felt that PA was not viewed as a priority for cancer survivors. For example, "getting referrals from oncologists or GPs…physical activity is not on their agenda. It is not highly valued…we need to find a way to sell exercise to clinicians" (CCSC 2) and "there's not enough signposting in hospitals to cancer support centres…nine times out of ten if a consultant referred for counselling, they would attend" (Senior Oncology Nurse, HOSP14). Another manager highlighted the lack of referrals and insufficient emphasis on the importance of PA: "survivors are not encouraged to exercise…public health messaging needs to improve. The NCCP can help with that. We have very few direct referrals" (CCSC 1). The lack of emphasis by clinicians on the importance of PA for cancer survivors reinforced views held by the families of some cancer patients: "the family thinks you need to rest and not move" (CCSC 1).

Further, the majority of cancer survivors attend the community cancer support centres primarily for counselling services and PA is a secondary activity offered: “about 90% ring in for counselling and then sign up or are signposted to relaxation, yoga and pilates” (CCSC 8). The community cancer support centres in general reach only a proportion of patients diagnosed and therefore “making sure that people know we’re here” (CCSC 9) is essential for greater impact.

Access to trained personnel to lead exercise programmes or PA services was also considered a barrier to provision. For example, “access to proper professionals…we’re not experts in exercise…we have to outsource exercise and there’s no drive from gyms to run courses” (CCSC 3) and “the main challenges are the funding to run programmes and getting physiotherapists can be difficult” (CCSC 10).

Financial challenges concerning the provision of exercise services were commonly cited. Community cancer support centres reported receiving core funds for other services such as counselling but not for other activities and relied on fundraising: “the financial model of cancer support centres in Ireland is based on fundraising…our main funder is the Irish Cancer Society who provide funding for counselling, but they don’t provide funds for our holistic therapies or day-to-day running” (CCSC 3). Other centres also referred to costs: “financial difficulty of offering exercise programmes…ExWell charge (CCSC 8). Indemnity concerns were also raised: “there are indemnity issues, we have to get their GPs to sign waivers to say they’re safe to attend these courses (yoga)” (CCSC 3).

Identification of Exercise Programmes for Cancer

Other community providers of exercise programmes (CPEP) for cancer patients (i.e., Exwell Medical, Siel Bleu, 5k your way, Dragon Boat, Irish Cancer Society) were contacted and met with to identify and discuss PA services and exercise programmes. Siel Bleu were not currently providing any cancer-specific exercise programmes. For completeness, Siel Bleu did run an exercise service for cancer patients during 18-months of the Covid-19 pandemic called “staying well while staying home” funded by the Irish Cancer Society. This was a once-a-week exercise session via YouTube. Sessions generally had low attendance (some with only 30 or 40 views). However, one session in January 2021 received 245 views. An overview of the PA provision through community providers in Ireland is provided in Table 2.

Table 2: Existing Physical Activity and Exercise Programmes through Community Providers (*Data collected February and April 2022)

Community Provider	Name of Programme	Cancer Type/ Stage on Pathway	Type of Exercise	Location	Day/Time	Cost	Notes
ExWell Medical (via UPMC Institute for Health)	ExWell Medical Exercise Programme	Post-treatment	Supervised exercise classes. Mix of aerobic, strength & core stability. (2x wk, 12 weeks)	The Watershed, Kilkenny. WIT Arena, Waterford	Kilkenny- Monday & Wednesday Waterford- Tuesday & Thursday	€220 for 24 classes	*not cancer specific programme but for chronic conditions
ExWell Medical	MOVE ON Programme	Post-treatment	Supervised exercise classes Mix of aerobic, strength & core stability. (2x wk, 12 weeks)	National Indoor Arena, Abbottstown, Dublin. Irish Wheelchair Association, Clontarf, Dublin.	Abbottstown- Monday & Wednesday 12.15pm Clontarf- Tuesday & Thursday 12pm	€70 per month for 8 classes or €10 per class	Medical referral. The 'Move on' Manual can be purchased for €15.
ExWell Medical	Exwell@Home for cancer	Prehab, during or post-treatment	Bespoke personalised programme including daily exercise incorporating aerobic, strength, flexibility and core stability work. May include attendance at gym/classes at Clontarf.		Initial group Zoom meeting and home assessment (6MWT, Sit to Stand etc), followed by personalised exercise programme. Exercise diary. Retesting at 6-wks & 3-months. There is no set structure in terms of follow-up phone support/Zoom calls.		ExWell report problems re: time constraints with running the home-based programme.
ExWell Medical	Cancer Prepare	Prehab for patients that have yet to start treatment or have surgery	Bespoke personalised programme. May take part in ExWell classes, gym or an at home programme.			€20 per month for home programme, otherwise €70 per month for 8 classes or €10 per class	Small number of referrals from Cork in 2022. Programme operating via Zoom. No current referrals from clinicians elsewhere.
MOVE Charity	5k Your way move against cancer	Anyone living with or beyond cancer	Support groups meet up on last Saturday of the month for parkrun but online resources to help (e.g., building up to a 5km). Also, various 'move your way' exercise sessions via youtube on the Move website	5 Parkrun locations: Ballincollig, Cork, Oranmore, Co Galway, Tralee, Co Kerry Marlay, Rathfarnham, Dublin Porterstown parkrun, Annfield, Dublin	9.30am last Saturday of the month		Limited views of the YouTube exercise sessions on the MOVE website (less than 50 views for each)

Table 2: Existing Physical Activity and Exercise Programmes through Community Providers (*Data collected February and April 2022)

Community Provider	Name of Programme	Cancer Type/ Stage on Pathway	Type of Exercise	Location	Day/Time	Cost	Notes
Irish Dragon Boat Association	Dragon Boat	Following treatment or surgery. For breast cancer survivors in particular but open to all cancer types.	Clubs open March-November or all year. Most clubs train 2-3 x wk at moderate intensity	Plurabelle Paddlers, Dublin. Nore Dragon Paddlers, Kilkenny. Suir Dragon Paddlers, Clonmel. 9 other clubs with a proportion of standard paddlers.		€30 for annual membership of the Dragon Boat Association	Advertised via social media, newspapers, radio and some link up with local cancer nurses and physios
Irish Cancer Society in partnership with NCCP	Life and Cancer-Enhancing Survivorship (LACES)	For those recently completed treatment.	Half day educational workshop rather than an exercise programme.	Online and facilitated by specialist cancer nurses	Each Tuesday morning	Free	The workshop is not exercise specific but covers exercise, diet, well-being, finance and self-management

To summarise, there is limited community provision of exercise programmes for cancer survivors. The main community providers of exercise programmes for cancer survivors in Ireland are ExWell and community cancer support centres. ExWell offers programmes for prehabilitation (i.e., Cancer Prepare); post-treatment (i.e., Move On) and for any stage on the cancer pathway (i.e., Exwell@Home for cancer). The 'Move On' exercise programme is based solely in Dublin. Two community cancer support centres that refer cancer survivors to ExWell refer to the Exwell Medical Exercise programme (which is not specifically for cancer survivors but covers a range of chronic health conditions). Senior managers for ExWell and their cancer lead were interviewed as part of the scoping review. The interview revealed overall poor referral, low uptake to programmes and logistical difficulties to offering more personalised and tailored interventions. An example of referral working well was in relation to breast cancer patients in one hospital where an oncologist arranged for an opt-out process so that all patients would be referred by the nurse. In this example, CPEP1a explained that: "we had 290 people referred, 130 inducted and up to 90 active". The small proportion that engaged in the programme from the total proportion of referrals (31%) indicates the challenges in providing physical activity options for cancer survivors. Overall, referral to ExWell appears to be variable and healthcare professional-specific:

"We've had a couple of very strong Exwell advocates within the hospital, particularly in HOSP 4…and they actually referred dozens…believes really strongly on what we do and was informing patients about Exwell and the Move on programme. We might only have 6 or 10 referring cancer specialists, not a huge number but we don't need a huge amount if people are referring at a good rate". (CPEP1a)

Few cancer patients or survivors are being referred by oncology or primary care teams to ExWell despite it being a well-established exercise provider in Ireland. Uptake to exercise programmes was also identified as an issue, but one that staff do not have the resources or time to investigate: "out of say 100 referrals, 50 complete the induction/exercise testing but then within a 2-week period more drop out…We need to book them in for a class and there has to be follow up if they don't turn up for a class. I'd love (CPEP1b) to just focus on the cancer programme but he does more than that…it's too time intensive" (CPEP1a). The staff at ExWell were conscious of the need for more personalised approaches to PA behaviour change but encountered conflicts between offering more personalised and intensive programmes and time constraints given that they operate as a private company:

"It's very difficult to do phone support; we're a private company but also a not-for-profit company and so we find it really difficult for staff to work on these projects when there is no financial return. There could be hours of work for each individual…you could be on the phone for 30 minutes rather than 10 minutes that you've allocated and then that can be very difficult when that is competing with other programmes we run. We want to offer a high-level service that doesn't demand a huge amount of time. We're slowly moving to more group programmes and less phone calls" (CPEP1a).

ExWell staff that deliver exercise programmes are trained in exercise and physical activity (i.e., usually holding a degree or an MSc in Exercise Physiology or Sport and Exercise Science). However, CPEP1b confirmed that he had received no formal behaviour change training. He also noted that: "some I can't get them to exercise…if they're going through treatment, it's really tough to get them to do it". The CPEP1b also stated that he believed training in motivational interviewing might be helpful.

The remaining community-driven exercise provision in Ireland was 5k your way (parkrun) and dragon boat racing. However, it should be noted that these are not exercise programmes per se, but rather PA opportunities and exercise support networks for cancer survivors. Finally, the Life and Cancer – Enhancing Survivorship (LACES) is a one-stop workshop that includes an element on PA and has been included for completeness. However, LACES is a single educational workshop for adult cancer survivors post-treatment and could not be considered a PA service or an exercise programme.

Hospital-based Exercise Programmes for Cancer in Ireland

Hospital oncology contacts were provided by the NCCP (n=23) and contacted by email to identify exercise provision within hospital settings. Thirteen hospitals (56%) responded to the email. The Daffodil centres in Ireland (n=13) were also contacted by email to identify exercise provision. One Daffodil centre responded to the email and stated that patients were signposted to the 'Moving on programme' (MOP) highlighted in Table 3 or to LACES (see Table 2). The Daffodil centre also identified referral to 'the local cancer support centres who provide mainly activities like yoga'. Most hospitals reported not offering any exercise programmes for cancer patients (n=8). These hospitals reported providing verbal advice to be physically active in the absence of programmes: "as part of pre-treatment teaching by medical and nursing staff, patients are encouraged to walk, take light exercise while on treatment" (HOSP 5) and "I'm afraid we don't but we do encourage it" (HOSP 2) and "most of them discuss exercise but no active classes are provided" (HOSP 15). A few referred to signposting to local community cancer support centres and community providers. For example, "we don't have any exercise programmes within the hospital for cancer patients. However, we have access to the local community cancer support centres who do so" (HOSP 13) and "the only exercise programme currently on offer is the Drogheda Physiotherapy & Rehabilitation Clinic. This is available for us to refer to. In truth the choices for our patients are limited" (HOSP 8). Another hospital referred to the support centres, but not specifically for PA: "we do refer patients to support centres for activities like Reiki". Another hospital referred to exercise being discussed as part of other survivorship programmes such as LACES and Cancer Thriving and Surviving (CTS) (HOSP 15). CTS is a survivorship workshop (2.5 hrs 1 x a week for 6 weeks) that is run in community cancer support centres and acute hospital settings by two trained leaders (at least one leader who is a cancer survivor) and is focused on self-management, well-being, cancer prevention, information on long-term consequences of treatment and psycho-social support. Another hospital made referrals to several community-based exercise programmes: "we refer patients to the ExWell Medical programme….the can-react exercise programme…the strides for life programme" (HOSP 6). Two hospitals reported offering individual exercise prescription for inpatients by physiotherapists (e.g., "we do prescribe individual exercise programmes for inpatients in HOSP 14").

Exercise programmes were provided in some hospital settings with dedicated oncology physiotherapists (HOSP 10); a prehabilitation programme for lung cancer patients at HOSP 14; and the 'Moving on' programme at HOSP 3. The latter is not specifically an exercise programme but rather a multi-disciplinary survivorship programme but is included here for completeness. A one-off session with a physiotherapist was available at HOSP 9 for cancer survivors. It is included in this review since prior to the pandemic, it operated as a 4-week exercise programme. Table 3 provides an overview of the five hospital-based exercise programmes.

Table 3: Hospital-based Exercise Programmes for Cancer Patients (*Data collected February and April 2022)

Hospital Provider	Name of Programme	Cancer Type/ Stage on Pathway	Type of Exercise	Location	Cost	Notes
St James's Hospital (Dublin)	OpFit	Prehab: Prior to surgery (Upper GI, Thoracic, Colorectal, Head & Neck, Breast, Prostate, Kidney, Uterine)	Supervised Exercise classes. Mix of aerobic, strength & flexibility. (Face-to-face classes 2 x wk) gym/circuit based. Online classes held 3 x wk- Aerobic & strength-based circuit (45 mins). Participants encouraged to work between an 11 & 13 on the Borg breathlessness scale. No set time depending on surgery (from 2 x wks to 6 mths)	Face-to face classes at St James's Hospital Online	Free to participant.	Rolled out since July 2019. Service is based on temporary hospital funding, staffed by a 1.0 WTE Clinical Physiotherapist. Between March 2020-March 2021, 566 referrals (primarily from Thoracic/upper GI; n=200)
St James's Hospital (Dublin)	Cancer Rehab	Post-treatment (up to 2 yrs. Post-treatment)	Circuit Exercise (Mix of aerobic, strength) (2 x wk, 8 weeks). If at home, partic-ipants sent resistance band(s).	Online or in-person according to preferences	Free to participant.	Started in October 2021. Received 200 referrals to date (mainly Thoracic).
University Hospital Galway	Enhanced Recovery Programme (in operation for 3-4 years)	Prior to surgery for lung cancer	Personalised exercise prescription based on capability & exercise preference	Face-to-face (one off session)	Free to participant.	Primarily to assess for appropriateness for surgery (only lung cancer patients). Patients may be encouraged to start brisk walking and using the Borg scale to exercise at an appropriate intensity.
Sligo University Hospital	One-to-one physio-therapy session	Any stage of cancer pathway: referred on a needs basis usually for something specific (e.g., prehab for lung surgery, breast patient for shoulder stiffness, lymphoedema, mobility decline.	30-60 min assessment tailored to patient reported barriers to exercise: grip dynamometer, balance and mobility scales, sensation and reflexes, range of motion, muscle strength testing.	Face-to-face or phone call depending on restrictions		Prior to the pandemic, this ran as a 4 wk programme (n= 4-8) and included 30 mins of exercise & 30 mins of education (on fitness and exercise, return to work, lymphoedema awareness, pelvic floor health, fatigue management. 2-3 referrals per month.
Letterkenny University Hospital, Donegal	Moving on Programme (MOP)	Post-treatment	Half day educational session (run by physio, psychologist, dietician & nurse) to support healthy eating and increasing PA. The workshop is supported by an online platform with new content posted on platform 2 x wk to support healthy lifestyle.	Currently operating 100% online (Zoom). Face-to-face workshop planned post COVID.	Free to participant.	Referred by Oncology/Haematology or signposted by LACES Started 17.01.22 and is under a pilot roll out based on a research project at LUH in 2018

Hospice-based Exercise Programmes

Ten hospices (HPE) in Ireland (Dublin (Harolds Cross, Blackrock, Raheny, Blanchardstown), Cork, Waterford, Galway, Letterkenny, Limerick, Kildare) were contacted by email to identify PA services and exercise programmes in the palliative care setting. Three responses were received. HPE 3 responded to say that no day services or outpatient services were operating at present. However, their plan was to start a palliative care rehabilitation group exercise programme in the coming months (May 2022).

HPE 2 was in the process of setting up their breathlessness and exercise class for palliative care patients (as of May 2022). The largest hospice provider (HPE 1) with capacity for 240 inpatients across three sites was the only current provider of exercise programmes in the palliative care setting.

HPE 1 operate a 1 x week (60 minutes) (two programmes on a Wednesday), 6-week circuit-based exercise programme in the dedicated gym for outpatients. PA/exercise sessions are offered to patients in a dedicated gym. Each hospice site has a dedicated physiotherapy gym for patients attending their services for palliative care either on an in-patient or on an out-patient basis.

Research-based Exercise Programmes

A scoping review of research-based studies was conducted in order to examine the extent, range, and nature of research activity in this area of exercise and cancer in the Republic of Ireland. The scoping review will also serve to identify gaps in the existing literature. In this stage, we broadly followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) reporting guidelines (Page et al., 2021).

Search Strategy

The search strategy included searching across six databases (PubMed, Medline, CINAHL, PsychINFO, Scopus and the Cochrane Library) to identify studies, published between January 2010 and May 2022, which were conducted in the Republic of Ireland. Search terms were developed by the research team in consultation with a university librarian. The search was restricted to English language papers only. The search strategy adopted a multi-field search using the following terms: 'cancer' AND 'exercise or PA or aerobic training or strength training' AND 'intervention or treatment or programme or programme or prescription' AND 'Ireland or Irish or Republic of Ireland'.

Eligibility Criteria

The specific scope of this stage of the overall scoping review is to identify research-based studies where exercise or PA has been utilised as an intervention to improve PA and health parameters of cancer patients and survivors. The remit was wide and included cancer survivors of all ages, any type of cancer, and at all stages along the cancer pathway (prevention, prehabilitation, during treatment and post-treatment (either in remission or in the palliative care setting). To be included, studies had to report on one or more PA-related outcomes and be conducted in Ireland. A single outcome of focus was required to ensure the output was manageable within the time constraints of the project. PA was chosen as the primary outcome since changes in PA will impact other health outcomes and is important in terms of long-term health benefits and survival. Studies also had to report an intervention with a design as either pre-post, quasi-experimental or as a controlled trial. Protocols were included since the purpose of the review is to identify studies in this area rather than efficacy or feasibility. Studies from Northern Ireland and elsewhere were excluded unless participants were recruited from the Republic of Ireland. Individual case studies, surveys, qualitative studies, and cross-sectional studies were not eligible for inclusion.

Quality Appraisal

The quality of each study was reviewed according to an adapted version of the CONSORT statement. Methodological study quality was examined using a template based on the work and scoring of Van der Windt (1999), Zaza et al (2000) and the PEDro scale (Maher et al., 2003). A methodological quality score was calculated (such that one point was awarded for each of the ten criteria), according to the following: 1) eligibility criteria and study population are clearly described; 2) random allocation is reported; 3) concealed allocation is reported; 4) groups similar at baseline on key outcomes; 5) full description of intervention; 6) validity and reliability of outcome variables; 7) blinding of assessors following randomisation; 8) measures of at least one outcome variable obtained from at least 80% of the participants enrolled in the study OR use of intent-to-treat (or equivalent) analysis conducted for >80% at follow-up; 9) results of between-group statistical comparisons are reported for at least one key outcome; 10) point measures and measures of variability reported for at least one key outcome of intervention. Each study was assessed against the quality criteria and awarded a score out of 10. A total study quality score of 0-3 was considered 'poor', 4-5 'fair', 6-8 'good', and 9-10 'excellent'. However, Cashin & McAuley (2020) contend that for trials evaluating complex interventions such as exercise, a total PEDro score of 8/10 is optimal. Therefore, a score of 8 or more was deemed as having high methodological quality. Only studies that have a comparison group were subject to the study quality check.

Data Extraction

The first step involved the screening of titles and abstracts of records. Full text versions of papers considered potentially eligible for inclusion were read and their suitability for inclusion assessed. Data

were extracted from each eligible paper on: (a) first author/ year/title of study; (b) study design; (c) sample size/type(s) of cancer/age (Mean and ± SD); (d) stage on cancer pathway; (e) details on the intervention; (f) follow-up time points; (g) primary outcome measure(s), and (h) summary of results).

Results

A total of 405 records were attained from databases and hand searches. Of these, 385 remained following removal of duplicates. Once abstracts and titles were reviewed, 25 records were selected for full text review. Nine papers did not meet eligibility criteria and were subsequently excluded. An additional 5 papers were identified through grey literature searches and personal communication. This resulted in 21 papers (one of which was an unpublished doctoral thesis) that met the inclusion criteria and 16 unique research studies. Appendix B shows the number of papers identified, screened and included.

Characteristics of Studies

A total of 16 individual studies were included and only 12 studies with completed results. Sample sizes across studies were generally small ranging from 26 to 123 participants. Most studies (n=12) recruited participants through cancer centres or oncology services within hospitals. A variety of cancer types were investigated: breast cancer (n=4); oesophageal/gastric/lung (n=4); prostate cancer (n=2 papers); colorectal cancer (n=1), colorectal/appendix/ovarian (n=1); mixed cancer populations (n=3). Most studies recruited participants post-treatment (n=10) or for prehabilitation (n=4). Only one study recruited participants during treatment and one other in cancer prevention (although not solely cancer prevention). Most studies recruited mostly females except for 3 (i.e., RESTORE, ExPeCT, and a community-based prehabilitation programme) that recruited mostly males with 81%, 100% and 88% respectively. The mean age of participants (excluding the cancer prevention study) across studies was 55.2 (± 6.9) years. Most studies were randomised controlled trials (n=10) or single arm pre-post designs (n=4). Table 4 provides a summary of demographic details, study design, intervention content, outcome measures and an overview of the results.

Table 4: Research-based Physical Activity and Exercise Interventions for Cancer Survivors in Ireland

Author, Year, Intervention name	Design (& Quality score)	Sample size, Age group, Cancer type(s)	Stage on cancer pathway	Intervention	Follow-up	Primary Outcome(s)	Results Summary
Broderick, J. et al. (2013). Prescribed Exercise After Chemotherapy' (PEACH) trial. J Cancer Surviv, 4, 551-562. Broderick, J. et al. (2014). Calculating the costs of an 8-week, physiotherapy-led exercise intervention in deconditioned cancer survivors in the early survivorship period. Physiotherapy, 100, 2, 182-184.	RCT 8	N= 43, Mean age: 51.0 (9.3). 86% Female. Primarily Breast cancer (n=31), Colon (n=5); Lymphoma (n=3); Oesophageal (n=3); Gynaecological (n=2). Exercise group (n=23) vs usual care.	Post	8 wk, 2 x wk group aerobic exercise in hospital + prescribed home programme (walking). Exercise group advised to maintain brisk walking or other aerobic exercise to at least 45 min for 5 days of the week.	8 wks & 3 months	Fitness (modified Bruce protocol) & objective PA (accelerometer)	Improvements in both groups but no significant difference between exercise group & usual care at 8 wks or 3 months for aerobic fitness or objective PA.
O'Neill, L, et al. (2018). Rehabilitation Strategies in Esophagogastric cancer (RESTORE) Trial. Ann Surg, 268, 5, 747-755.	RCT 9	N= 43, Mean age; 51.0 (9.3). 81% male. Oesophageal (n=39) or gastric cancer (n= 4). Exercise group (n=21).	Post	12 wk multidisciplinary programme comprised of supervised aerobic & resistance exercise (n=14 sessions) and unsupervised exercise, dietary counselling, and group education.	12 wks & 3 months	Aerobic fitness: VO2peak (cardiopul-monary exercise test (CPET)	Exercise group had significantly higher VO2peak at both T1, 22.20 (4.35) versus 21.41 (4.49) , P < 0.001, and T2, 21.75 (4.27) versus 20.74 (4.65) mL P = 0.001, compared usual care however these difference are barely clinically significant given the 1 MET difference deemed to be the minimum for clinical significance. Improved moderate-to-vigorous physical activity (MVPA) (measured via GT3x accelerometer) in both groups with no differences between them.
Walsh, J. et al (2021). mHealth Behavior Change Intervention with a Brief In-Person Component for Cancer Survivors with Overweight or Obesity (rolled out as 'Moving on' Programme at LUH). JMIR MHealth & UHealth, 9, 7, e24915. Groerke, J. et al. (2019). Examining the impact of a personalized self-management lifestyle programme using mobile technology on the health and well-being of cancer survivors: protocol and rationale for a randomized controlled trial (the moving on study). JMIR Res Protoc; 8, 8:e13214.	RCT 7	N= 123, Mean age: 55.6 (8.05). 74% Female. Primarily Breast cancer (n=99); CRC (n=17); Prostate/testicular (n=6); Lung (n=1). Exercise group (n=62) vs control group (n=61). The control group received a Fitbit Flex 2 for the 24 wks	Post	Two elements: (i) A 4-hour lifestyle education session (week 1) was delivered by health care professionals (3 physiotherapists, 1 dietician, and 1 clinical psychologist) covering appropriate PA (aerobic & strength), nutrition and evidence-based behavioural change techniques. In this face-to-face session, participants were given a Fitbit Alta. (ii) an 8 wk goal-setting intervention (weeks 4-12) with weekly text messages with feedback on daily step count and a goal of increasing their step count by 10% in the following week.	12 wks & 24 wks	6MWT, step count, Godin leisure-time exercise questionnaire.	Both groups improved on distance walked with no significant difference between the groups. Participants in the intervention group (IG) had significantly higher step count during both the intervention phase (8 out of the 12 weeks) and the follow-up phase (5 out of the 12 weeks) than those in the control group. Overall, there were no significant changes in functional exercise capacity, dietary behaviour, or psychological outcomes.

Table 4: Research-based Physical Activity and Exercise Interventions for Cancer Survivors in Ireland

Author, Year, Intervention name	Design (& Quality score)	Sample size, Age group, Cancer type(s)	Stage on cancer pathway	Intervention	Follow-up	Primary Outcome(s)	Results Summary
Skelly, F. (2020). Unpublished doctoral thesis on evaluation of MedEx Wellness Exercise programme.	Pre-post	N= 403 (cancer only n=92), Mean age: 62.93 (11.0). Mixed group (CVD= 140; Respiratory= 75; Metabolic= 45; other= 51) *50.6% men	Post	2x wk supervised group exercise (60 mins of aerobic & resistance-based exercise) at DCU	3, 6 & 12 months	ActivPAL (light intensity PA; LIPA & MVPA)	Significant improvement in LIPA only between baseline & 6-months (p= 0.014) from 66mins per day to 78mins per day. Mean class attendance over 12 months was 22.97 (out of a possibility of 92). A 49% dropout rate over 12 months.
Loughney, L. et al. (2019). Community-based pre-operative exercise programme: a pilot study. Perioper Med, 8, 17.	Pre-post	N=32, Mean age: 60.05 (10.9). 88% Male. Prostate (n=15) & Colorectal (n=17)	Prehab	Group-based supervised. Run by ExWell. 3–5 sessions per week depending on the time interval before surgery. Interval RPE 13-15 or high intensity (moderate to high-intensity (RPE 16) & resistance training (40-60mins).	The median duration of prehab was 2 & 4 weeks for CRC & prostate cancer patients respectively	6MTT & strength (hand grip dynamometer) and sit-to-stand	Significant improvement in lower body strength (Sit-tostand) (p= 0.001). No changes were found for the 6MTT or upper body strength. 75% compliance to study.
Haberlin, C. et al. (2019). eHealth-based intervention to increase physical activity levels in people with cancer: a feasibility trial in an Irish acute hospital setting. BMJ Open, 9:e024999.	Pre-post	N= 45. Mean age: 50.7 (11.8). 78% Female. Haematological cancer (n=16); Gynaecological (n=2); Breast (n=9); CRC (n=7) & Testicular (n=1) Recruited from cancer clinics	Post	12 wk eHealth programme (provision of a Fitbit in conjunction with specific PA goals remotely prescribed and monitored by a physio-therapist (14 calls over 12 wks) review of goals & problem solving.	12 wks & 24 wks follow-up	Recruitment, adherence, objectively measured PA (ActiGraph GT3X-BT accelerometer)	39 (86.6%) remained at 12 wks & 31 (68.8%) at 24 wks. No change in objectively measured MVPA from baseline to 12 wks or 24 wks. A significant increase in 6MWT from baseline to follow-up.
Sheehan, P et al. (2020). Exercise is more effective than health education in reducing fatigue in fatigued cancer survivors. Supportive Care in Cancer, 28, 10, 4953-4962.	Quasi-experimental 7	N=37, Mean age: 55 (2.0). 89% Female. Primarily breast cancer (n=30); Prostate (n=2); endometrial/cervical (n=2); Lung (n=1); Oesophageal (n=1); Multiple myeloma (n= 1). Exercise group (n=19) or health education (HE) (n=18) comparison group.	Post	Supervised exercise classes 2 x wk for the first 5 weeks & reduced to 1 x wk for final 5 wks, during which an increase in home-based exercise was targeted. Based on SCT with a focus on increasing confidence, feedback & self-monitoring.	10 wks & 26 wks (26 wks only for exercise group)	Fatigue (FACT-F). QoL (EORTC QLQ-C30). 6MWT & self-reported PA (IPAQ)	Both groups reduced fatigue with signifi-cantly greater reduction in the exercise group. Significant improvement in QoL. Significant improvement in 6MWT test & self-reported MVPA.

Table 4: Research-based Physical Activity and Exercise Interventions for Cancer Survivors in Ireland

Author, Year, Intervention name	Design (& Quality score)	Sample size, Age group, Cancer type(s)	Stage on cancer pathway	Intervention	Follow-up	Primary Outcome(s)	Results Summary
Devenny, K. et al (2020). The feasibility of implementing an exercise programme for deconditioned cancer survivors in a national cancer centre: FIXCAS Study. HRB Open Res, 2, 24.	Single arm (pre-post)	N=40, Mean age: 60.0 (10.6). Breast cancer (n=12); Lung cancer (n= 11); Prostate cancer (n=7); CRC (n= 5); other (n= 5). Outpatients from a National Cancer Centre.	Post	10 wk group-based exercise sessions 2 x wk with Physio (60 mins of aerobic, resistance and balance and flexibility exercises; (20-30 min aerobic & 15-20 min resistance). Home-based exercise encouraged in addition to supervised sessions.	Baseline & 10 wks	Primary: Feasibility. Secondary: physical function (6MWT), QoL (EORTC-QLQ-C30) & self-reported PA (IPAQ).	In total 82% (n=33) participants completed follow-up. Adherence to the supervised exercise classes and home exercise programme was high (78% and 94% respectively).
Guinan, E. et al. (2013). The effect of aerobic exercise on metabolic and inflammatory markers in breast cancer survivors—a pilot study. Supportive Care in Cancer, 21, 7, 1983-1992.	Pilot RCT 10	N= 26, Mean age: 48.1 (8.8). Breast cancer; exercise group (n=16) vs control group (n=10).	Post	8 wk, 2 x wk supervised group aerobic intervention (rotated between bike, treadmill & rower) and a home-exercise programme (from 1 day/wk at baseline to 5 days at study completion). Participants wore HR monitors to monitor compliance.	8 wks & 3 months	Anthropometric and blood biomarkers for breast cancer risk, including the metabolic syndrome & PA level (RT3 accelerometer)	Intent-to-treat analyses revealed no significant differences between groups on anthropometric, metabolic outcomes or objective PA.
O'Neill, L. et al. (2020). Rehabilitation strategies following oesophagogastric and Hepatopancreaticobiliary cancer (ReStOre II). BMC Cancer, 20:415.	RCT	N=120 (anticipated). Cancer types: oesophagus, stomach, pancreas and liver,	Post	Prescribed 12 wk exercise programme (including 12 supervised group sessions, 32 home-based sessions, 6 1:1 dietetic sessions & 7 group education sessions (benefits of PA, nutrition, fatigue management, and mindfulness). Group sessions with doctor, dietician, OT & physio.	12 wks, 3 months & for QoL only 12 months.	CPET, Functional performance (Short Physical Performance Battery (SPPB), PA (Actigraph GT3X) & QoL (EORTC-QLQ-C30)	RECRUITING
Cantwell, M. et al. (2022). Study protocol for the investigation of the clinical effectiveness of a physical activity behaviour change intervention for individuals living with and beyond cancer. Contemp Clin Trials Commun.	Quasi-experimental	Comparison of MedEx IMPACT (IMprove Physical Activity after Cancer Treatment) (IG), compared to MedEx 'Move on' Exercise programme for cancer survivors (control group)	Post	Both groups attended 12 wk group programme (ExWell). The IG received an independent PA programme (which consisted of a PA manual, PA logbook and a pedometer) & 4 PA information sessions and a single 1:1 exercise consultation.	3, 6 & 12 Months	PA (ActivePAL), CRF, QoL & Sedentary behaviour	RECRUITING

Table 4: Research-based Physical Activity and Exercise Interventions for Cancer Survivors in Ireland

Author, Year, Intervention name	Design (& Quality score)	Sample size, Age group, Cancer type(s)	Stage on cancer pathway	Intervention	Follow-up	Primary Outcome(s)	Results Summary
Boran, L. et al. The PANO Trial: Perioperative Exercise and Nutrition Optimisation Prehabilitation in Cancer Patients with Peritoneal Malignancy. ClinicalTrials.gov.NCT05305820.	RCT	Anticipated (n=50). Surgery & hyperthermic intraperitoneal chemotherapy for colorectal/appendix/ovarian peritoneal disease or pseudomyxoma peritonei (+/- completed neoadjuvant cancer treatment). Age 18+	Prehab	6 wk Exercise Programme (home, supervised, or both) exercise programme while undergoing treatment and for a 6 wk period post-surgery.	Baseline, pre-surgery, post surgery & 6 wk follow up	Feasibility & cardiorespiratory fitness pre-surgery (6MWT)	RECRUITING
Tully, R. et al. (2020). The role of exercise on physical fitness of patients with oesophagogastric cancer undergoing neoadjuvant treatment and surgery: report of a feasibility study and the protocol of a multi-centre Randomised Control Trial (The PERIOP-OG Study). Trials 21, 638. **Loughney, L. et al (2021). The effect of a pre- and post-operative exercise programme versus standard care on physical fitness of patients with oesophageal and gastric cancer undergoing neoadjuvant treatment prior to surgery (The PERIOP-OG Trial): A RCT. British Journal of Surgery,108, 9. znab430.114,**	RCT 6	N= 71; Exercise Group (n=36). Multi-centre randomised controlled trial (PERIOP-OG) comparing peri-operative exercise training with standard care in Oesophogastric cancer treated with Neoadjuvant cancer treatment (NCT) and surgery.	Prehab	Community-based exercise training	Baseline to pre, pre surgery & 6 wks after	6MWT	Significant increase in 6MWT in IG from baseline (522 SD, 17.4) to pre-surgery (582 m, SD, 20.1) vs. 498 m (18.2) to 506 m (28.7) in the control group (p= 0.050).

Table 4: Research-based Physical Activity and Exercise Interventions for Cancer Survivors in Ireland

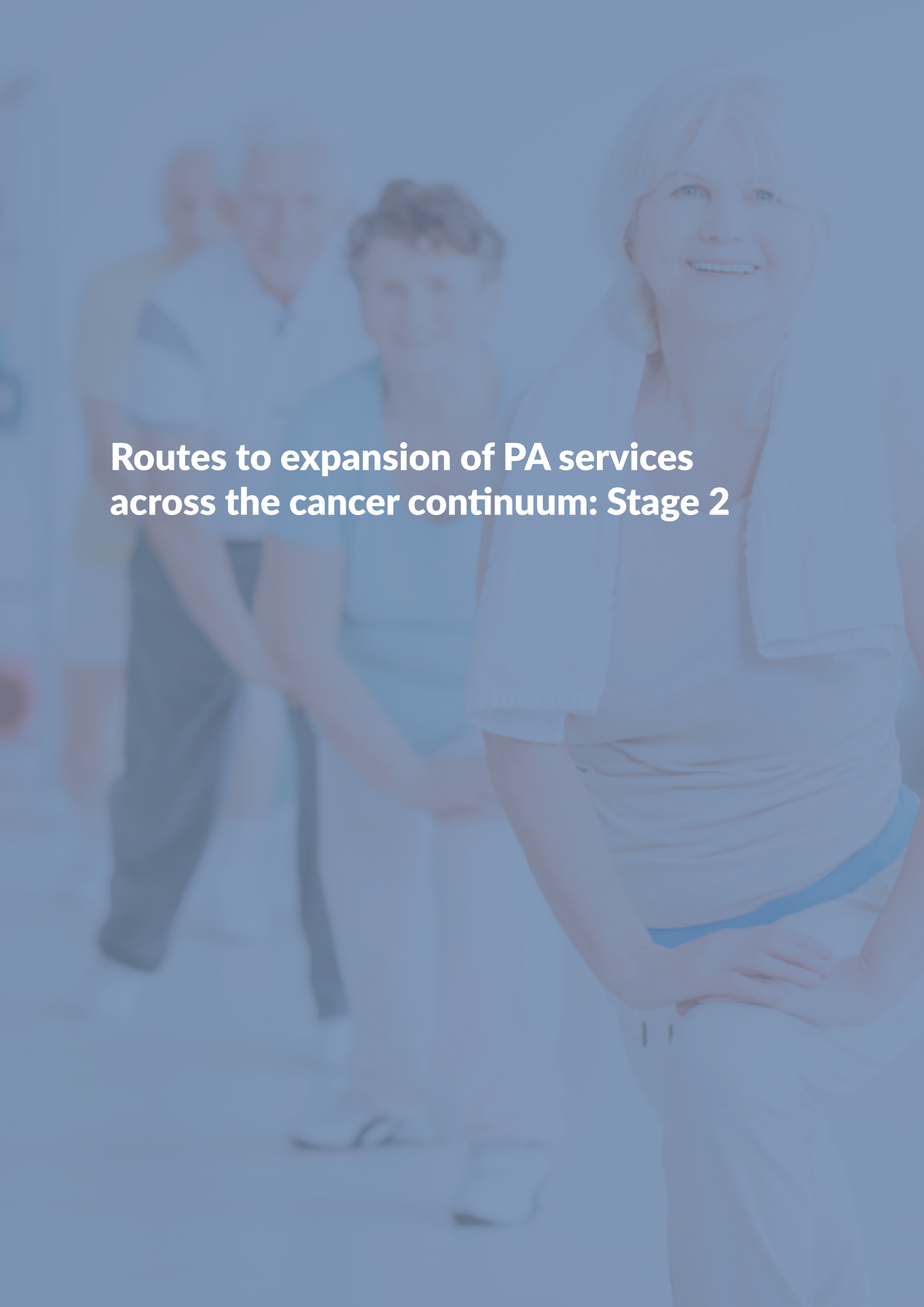
Author, Year, Intervention name	Design (& Quality score)	Sample size, Age group, Cancer type(s)	Stage on cancer pathway	Intervention	Follow-up	Primary Outcome(s)	Results Summary
Sheill, G. et al. (2020). Preoperative exercise to improve fitness in patients undergoing complex surgery for cancer of the lung or oesophagus (PRE-HIIT): protocol for a randomized controlled trial. BMC Cancer, 20,1:321.	RCT Protocol	Anticipated (n=78). Lung and oesophageal cancer patients who are > 2 wks pre-surgery.	Prehab	High-intensity-interval training (HIIT) will be supervised & completed for at least 2 wks, up to 5 x wk (40 mins session). HIIT will be performed on an electro-magnetically braked cycle ergometer in the exercise physiology room at the CRF in St. James's Hospital under the supervision of a physio-therapist. Lactate threshold, measured during the baseline CPET, will be used to determine the exercise intensity.	Baseline, post intervention & 30 day post op	Cardiopul-monary exercise test (CPET) & self-reported PA (IPAQ)	RECRUITING
The ExPeCT trial aimed to examine the effectiveness of a structured exercise programme in modulating levels of circulating tumour cells and platelet cloaking in patients with metastatic prostate cancer. **Sheill, G et al. (2017). Protocol published in Trials, 4;18(1):456.** **Sheill, G. et al. (2019). A randomized trial of exercise on quality of life in men with metastatic prostate cancer: The ExPeCT Trial. DOI: 10.1200/JCO.2019.37.31_suppl.97, 97-97.** **Brady, L. et al. (2020). Platelet cloaking of circulating tumour cells in patients with metastatic prostate cancer: Results from ExPeCT. PLOS ONE**	RCT (Multisite, Dublin & London) 5	N=67 Randomised, Mean age: 69.4 (7.3). Prostate cancer (Metastatic cancer); exercise group (n=30) vs control group (n=31).	During treatment	Supervised weekly (1 hr) group-based aerobic for 3 months (with Physio) & 3 month home-based aerobic programme. Partic-ipants received a Polar heart rate monitor for the 6 months & were prescribed heart rate range during class and home sessions. Target to reach 180 mins/wk of MVPA by end of 2 months.	Baseline, 3 & 6 months	PA was not the primary outcome. Self-reported PA (Questionnaire) & adherence via Polar heart rate data.	54 (81%) of participants completed the 3-month assessment. Adherence to the supervised sessions was 83% (329 out of 396 sessions attended). Adherence was 72% for the first 3 months of supervised exercise & 67% for the final 3 months. There was no significant difference in physical activity levels, sedentary time or QoL between groups at any time point.

Table 4: Research-based Physical Activity and Exercise Interventions for Cancer Survivors in Ireland

Author, Year, Intervention name	Design (& Quality score)	Sample size, Age group, Cancer type(s)	Stage on cancer pathway	Intervention	Follow-up	Primary Outcome(s)	Results Summary
Glynn, L. et al. (2014). Effectiveness of a smartphone application to promote physical activity in primary care: the SMART MOVE randomised controlled trial. Br J Gen Pract, 64, 624, e384-91.	RCT in Primary Care (three primary care centres that make up the North Clare Primary Care Team) 9	N=90, Mean age: 44.1 (11.5). Exercise group (n=45) vs control group (n=45). 64% female.	Cancer prevention	8 wk Smartphone App to log step count. Participants were encouraged to interact with the app and were given a goal of 10 000 steps/day. Controls were given a goal of walking for 30 mins/day. At the end of wk 1, 2, & 8, participants were reminded via SMS to email their step-count data to the research team.	Baseline, week 1, 2 & 8 wks.	Mean daily step count.	No intent-to-treat analyses. On treatment analysis revealed a significant improvement in step count of 1631 (3842) from wk 1-8 vs controls -386 (3281) (p= 0.025). However, the mean step count for baseline and follow up were low overall (from a mean of 4365 at baseline to 855 at follow-up).

Summary

Most hospital-based research studies included interventions that adopted an 8- to 12-week exercise programme (n=13). Most interventions involved supervised or prescribed exercise and were group-based programmes (n=13). Others included electronic-health interventions or wearable technology (n=3) or a combination of supervised and home-based exercise. Most interventions were delivered by physiotherapists (n=9) and in the outpatient hospital setting. Other interventions were delivered in the community by exercise specialists/physiologists (n=5) or by private community providers. All studies used an objective exercise outcome measure including for example, cardiorespiratory fitness (e.g., 6MWT); cardiopulmonary fitness (CPET), strength or PA. Only five studies used an objective measure of PA (i.e., using an accelerometer). Eight completed studies that had a comparison group were subject to the methodological quality check; the mean quality score was 7.7 (1.75), with 50% achieving a high-quality score of 8+. In relation to effectiveness, most studies (n=6; 54.5%) observed no significant differences between groups in either aerobic fitness parameters or MVPA outcomes. Two randomised controlled trials (RCTs) reported significant improvements in cardiorespiratory fitness (i.e., RESTORE, PERIOP-OG) in the IG compared to the control group at follow-up (although there was no significant improvement in MVPA in the RESTORE trial). There were significant improvements in the 6MWT, fatigue and self-reported MVPA in the exercise group compared to the health education group in Sheehan et al study (2020). Of the five that assessed PA objectively (45%), no significant increase in MVPA was observed. However, there were significant increases in light-intensity PA following participation in the MedEx Wellness Exercise programme (Skelly, unpublished PhD), and a significant improvement in daily steps in the cancer prevention study (Glynn et al., 2014).



Routes to expansion of PA services across the cancer continuum: Stage 2

Routes to expansion of PA services across the cancer continuum: Stage 2

The aim of stage 2 was to (i) identify potential ways to expand PA services for cancer in Ireland (WE2); (ii) identify the gaps that exist between existing programmes and those in a research or treatment setting and consider how these gaps can be bridged (WE3); (iii) Identify the main barriers to PA promotion in cancer survivors (WE4); and (iv) develop national recommendations in this area (WE5).

Stage 2 included three steps:

- Step 1 consisted of a review of reviews of international literature of PA/exercise interventions for survivors of cancer where exercise programmes and evidence-based interventions based on meta-analyses and systematic reviews will be identified. Findings from step 1 will be described separately by cancer pathway stage, setting or group as follows: (i) prehabilitation; (ii) exercise intervention during and post-treatment for adult cancer survivors; (iii) PA for advanced cancer and the palliative care setting; and (iv) PA for children and adolescents.

- Step 2 included three case studies of international examples whereby PA interventions have been implemented in the 'real world' setting or rolled out nationally in practice.

- Step 3 involved comparing the results from the scoping review in stage 1, (i.e., existing exercise programmes for cancer survivors in Ireland) with findings from the review of international reviews and meta-analyses, with a particular focus on effectiveness and translation. This final step in stage 2 assisted in the identification of gaps between existing programmes and those conducted in both research and real-world settings (WE3).

Step 1: Review of Systematic Reviews and Meta-analyses

A review of systematic reviews and meta-analyses of PA/exercise interventions for cancer survivors was conducted in order to identify evidence-based interventions. The review helped to identify the range and nature of research activity in this area internationally. In this stage, we broadly followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) reporting guidelines (Page et al., 2021).

Search Strategy

The search strategy included searching across six databases (PubMed, CINAHL, PsychINFO, Scopus, Web of Science and the Cochrane Library) to identify studies published between 2012 and 2022 to be included in the review. Search terms were developed by the research team in consultation with a university librarian. The search was restricted to English language papers only. The search strategy adopted a multi-field search using the following terms: 'cancer' AND 'exercise or PA or aerobic training or fitness' AND 'intervention or treatment or programme or programme or therapy or prescription' AND 'systematic review or meta-analysis'.

Eligibility Criteria

The specific scope of this stage of the overall scoping review is to identify studies where exercise or PA has been utilised as an intervention to increase PA of cancer patients and survivors. The remit included cancer survivors of all ages, and at all stages along the cancer pathway (prehabilitation, during treatment and post-treatment/in remission, advanced cancer/ palliative care setting). To be included, reviews had to report on one or more PA-related outcomes with PA as the primary outcome (for cancer survivors during or post-treatment). Reviews with a primary aim of improving physical function or fitness (rather

than PA) were excluded. However, reviews that included physical function as a primary outcome within prehabilitation or palliative care settings were deemed eligible. The justification for this in prehabilitation is because improvements in physical function or cardiorespiratory fitness has been associated with improvements in physical and mental health, a faster recovery and an overall better quality of life following surgery (Minella et al., 2017; Santa Mina et al., 2018; Gillis et al., 2019). Likewise, in the palliative care setting or for those with advanced cancer, the PA guidelines may be less applicable with the goal being focused more on the utility of exercise as therapy in the management of fatigue and quality of life and hence the inclusion of reviews in this area for these population groups. Reviews that focused primarily on the impact of quality of life or fatigue or other patient reported outcomes were excluded (other than in prehabilitation or the palliative care setting). Similarly, reviews with primary outcomes of survival were excluded as were reviews of observational studies or qualitative studies. Further, to ensure that the remit of the review of reviews was manageable, only reviews that included multiple cancer types (i.e., cancer patients or survivors in a broad sense) were included. Systematic reviews or meta-analyses that were limited to one cancer type such as breast cancer or lung cancer were excluded from the review.

Data Extraction

The first step involved the screening of titles and abstracts of records. Full text versions of papers considered potentially eligible for inclusion were read and their suitability for inclusion assessed. Data were extracted from each eligible paper on: (a) first author/year/title of study; (b) study design; (c) sample size/type(s) of cancer/age (Mean and ± SD); (d) stage on cancer pathway; (e) details on the intervention; (f) follow-up time points; (g) primary outcome measure(s), and (h) summary of results.

Results

A total of 1,014 records were attained from databases and hand searches. Of these, 959 remained following removal of duplicates. Once abstracts and titles were reviewed, 64 records were selected for full text review. Twenty-three reviews did not meet eligibility criteria and were subsequently excluded. Thirteen reviews were excluded because they focused on a specific cancer type (i.e., 6 were exclusively breast cancer, followed by prostate (n=4) and colorectal (n=3). A further 10 were excluded because they did not include exercise behaviour change or physical function (n=7) or were focused on predictors of adherence (n=1), exercise preferences (n=1) or group dynamics (n=1). This resulted in 41 systematic reviews (and/or meta-analyses) that met the inclusion criteria. Appendix C displays the number of papers identified, screened and included in this scoping review. The selected reviews and meta-analyses were further broken into the following four stages of the cancer pathway or distinct groupings: (i) prehabilitation, (n=5) (ii) during or post-treatment (n=18), (iii) advanced cancer/palliative care (n=9), and (iv) children and adolescents (n=9).

Prehabilitation

The role of prehabilitation along the cancer pathway is in its infancy, reflected by the fewer number of reviews (n=5) and small number of included studies within the reviews. All reviews conclude that prehab exercise interventions are safe and feasible for cancer patients. The largest review by Michael et al (2021) reported high levels of acceptability of prehabilitation evidenced by high uptake (87.7%) and high retention rate. The meta-analysis conducted by Michael et al (2021) also demonstrated statistically significant improvements in functional capacity (i.e., between group mean difference (MD) on the 6MWT of 58 metres) following surgery indicating that prehab can improve postoperative functional capacity. Similar improvements in functional capacity following a home-based exercise programme were observed by Van Gestel et al. (2022).

There is little evidence to support the role of prehabilitation in reducing postoperative complication rates, hospital length of stay, readmission rates or emergency room attendance. For example, Van Gestel and colleagues (2022) found no significant differences between prehabilitation and control groups across all studies for 30-day post-op complication rate. Piraux et al (2018) only observed reduced postoperative

pulmonary complications in two out of six studies compared to controls and only one for reduced length of stay in hospital. In the only meta-analysis to determine the impact of HIIT on preoperative fitness, there was no significant difference in post-intervention VO2peak in the HIIT group vs usual care or moderate intensity exercise (Smyth et al., 2021). Therefore, at present, there is insufficient evidence to support HIIT as a method of improving preoperative fitness for cancer patients prior to surgery. Home-based prehabilitation programmes display promise for improving functional capacity (Van Gestel, 2022) and further research comparing the effects of hospital-based vs home-based prehabilitation would be worthwhile. Due to the multifactorial nature of prehabilitation and the relatively short window of time for prehabilitation to be employed in practice, studies included in these reviews might underestimate the effect of prehabilitation. Findings are limited by small sample sizes, underpowered studies and considerable risk of bias. There is a need for high-quality data including large sample sizes and more standardised exercise programmes and outcome measures. Given recent findings that delayed surgery in colorectal cancer is not associated with adverse survival outcomes (Hangaard Hansen et al., 2018; Bagaria et al., 2019), there may be a greater window of opportunity to optimise the functional capacity of patients before surgery with prehabilitation.

Table 5: Overview of Prehabilitation Systematic Reviews

Author, Date.	Number of studies (in total/and in meta-analysis)	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Michael et al., 2021	21/5	1223/346	Determine the impact of prehab re: acceptability, feasibility, safety & physical function (6MWT)	Among 1564 patients approached for participation, 1371 accepted (87.7%); of these 1230 (89.7%) completed prehab. 5 studies did not include data on no of patients approached. 6MWT significantly improved 4–8 weeks postop in the prehab group compared to controls (MD = −58.0 m, 95% CI: −92.8; −23.3). Meta-analysis demonstrated a decrease in meters walked postoperatively (MD 27.9; 95% CI: 9.3, 46.6) in the control group and an increase in the distance walked in the prehab group (MD −24.1; 95% CI: −45.7, −2.6).	Only 5 studies included in the meta-analysis. High risk of bias due to lack of blinding (lack of blinding of outcome assessment). Not all studies were randomised.	Prehab found to be feasible and acceptable with no significant toxicities. The meta-analysis demonstrated statistically significant improvement in 6MWT postoperatively indicating that prehab can improve postop functional capacity.
Smyth et al., 2021	6/5	384/309	Determine impact of HIIT on preoperative fitness & whether this impacted on postoperative complications.	There was no significant difference in post-intervention VO2peak in the HIIT group (n = 155) vs usual care or moderate intensity exercise (n = 154) (MD 0.83, 95% CI-0.51 to 2.17) kg/ml/min, p = 0.12). Postop morbidity was only reported in one study & did not differ between groups (p = 0.018).	Few studies (& small sample sizes) included in the review. Insufficiently powered to detect changes in postop outcomes.	There is insufficient evidence to support HIIT as a method of improving preoperative fitness prior to surgery
Piraux et al., 2018	10 (5 reporting fitness)	360/184	Determine the effects of prehab (endurance & resistance training) on fitness & postop outcomes	Endurance & resistance training improved physical capacity (3 of 5 studies), muscle strength (2 of 3 studies) & reduced postoperative pulmonary complications (2 of 6 studies) compared to controls. Shortened LOS (1 of 6 studies).	Heterogeneous interventions in terms of FITT.	Endurance & resistance training training may improve CRF. Conclusions limited due to the large heterogeneity of the prehab programmes & measurement tools.
Van Gestel et al., 2022	5 /4	351/278	Determine effect of home-based prehab (HBP). The primary outcome was postop functional capacity (6MWT).	Significant improvement in 6MWT in the HBP vs control group preoperative (MD 35.06; 95% CI 11.58 to 58.54; p = .003) & 8-wks postop (MD 44.91; 95% CI 6.04 to 83.79; p = .02) compared to baseline. Adherence rate varied from 63% to 83%. No significant difference between prehab & control groups across all studies on 30-day postop complication rate (OR 0.78; 95% CI 0.47 to 1.32; p = .36, I2 = 0%). Four studies reported readmission rate and emergency visits. None of the studies found a significant difference between groups in either readmission rate or emergency visits.	Small samples & potential location bias (4 studies in Canada). Loss to follow-up was substantial among four studies.	HBP may enhance overall functional capacity of patients receiving oncological surgery compared to standard of care. This could be a promising alternative to hospital-based prehab.

Table 5: Overview of Prehabilitation Systematic Reviews

Author, Date.	Number of studies (in total/and in meta-analysis)	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Loughney et al., 2016	4/2	85/55	Determine the safety, feasibility, outcome (in terms both of physical fitness) of exercise interventions in people undergoing both neoadjuvant cancer treatment and surgery.	Adherence rates were between 66% & 96%. Some evidence that supervised exercise training improved physical fitness (VO2 peak): MD (MD) 3.76, 95% CI 3.43 to 4.1 (I2 of 0%).	Few studies & small samples.	All studies reported that exercise training was safe and feasible in the neoadjuvant setting in both breast and rectal cancer.

Physical Activity Intervention During and Post-Treatment

Eighteen systematic reviews (with ten including a meta-analysis) were identified that focused on the effectiveness of PA interventions for increasing PA for cancer patients either during or post-treatment. Most studies included in the reviews recruited cancer survivors post-treatment although some included both. Many of the more recent reviews (n=7, 39%) focused on the effectiveness of eHealth and mHealth interventions with three that assessed the efficacy of consumer wearable devices on PA. Four reviews focused on exercise intervention effects more broadly; with the remainder covering the effectiveness of distance or telehealth (n=2), face-to-face counselling (n=1), healthcare provider delivered physical activity interventions (n=1), high intensity interval training (n=1), social cognitive theory-based interventions (n=1) and home-based interventions.

The reviews examining broad intervention effects found that interventions tended to have a small but significant effect on PA among cancer survivors compared to usual care (Stacey et al., 2015; Turner et al., 2018; Goode et al., 2019; Grimmett et al., 2019; Sheeran et al., 2019). There is also some evidence to support short-term (6-month) PA maintenance following intervention (Turner et al., 2018; Grimmett et al., 2019). Goode et al (2019) found support for broad-reach modalities, particularly the telephone, in the delivery of PA interventions with 11 of 16 studies (69%) reporting a significant end of intervention improvement in favour of the intervention. Across all PA interventions among cancer survivors, Sheeran et al. (2019) identified an average effect size (i.e., d+) of small-to-medium magnitude (d+ = .35). This effect size equates to ~ 47 extra minutes of MVPA/wk and is likely to be clinically meaningful. Sheeran and colleagues found that major differences in intervention effectiveness were attributable to supervised versus unsupervised programmes (d+ = .49 vs. .26). Intervention contact time was associated with larger effect sizes for supervised programmes. Effect sizes for trials above and below the median contact time (Median = 24 hr) were d+ = .69 and .36, respectively. Greater contact time was associated with larger effects in unsupervised programmes too (d+ = .42 vs. .23). Targeting overweight or sedentary participants (d+ = .35 vs. .20) and establishing outcome expectations (i.e., the belief that exercise will achieve specific outcomes) (d+ = .51 vs. .22), were also associated with larger intervention effects in unsupervised programmes. Meyer-Schwickerath et al's (2021) review on the efficacy of face-to-face behaviour change counselling interventions on PA compared to usual care found significant differences likely to be clinically meaningful (equivalent to ~47 min/wk increase in MVPA) were evident in favour of the IG. Behaviour Change Techniques (BCTs) labelled "graded tasks", "self-monitoring of behaviour", "action planning" and "habit reversal" were more frequently coded in more efficacious interventions in Meyer-Schwickerath's review. Grimmett et al (2019) also found that exercise interventions were effective in achieving modest increases in PA at least 3 months post intervention (with a mean net difference between intervention and control groups of 39.88 mins/wk of MVPA). Given that small improvements were also evident in control groups (i.e., a mean increase of 27.48 mins/wk of MVPA), Grimmett and colleagues suggest that low-intensity interventions may be sufficient in promoting small changes in PA. Ineffective interventions had fewer contacts, were less likely to include a supervised element or include BCTs of 'action planning', 'graded tasks' and 'social support (unspecified)'. In relation to potential active ingredients, Turner et al (2018) observed that the most frequent BCTs used in successful interventions were 'setting of graded tasks', 'goal setting' and 'instruction of how to perform behaviour'.

In support of low-intensity interventions, the review by Brunet et al. (2020) suggests that healthcare provider-delivered PA interventions may help to increase PA in cancer survivors with nine studies (of 11) reporting between-group differences in PA behaviour favouring the intervention. Although the evidence base in this area is sparse, Brunet found that interventions deemed "lower intensity"(i.e. involving a single recommendation for PA given in person during a regularly scheduled appointment) may help to increase PA behaviour. For example, Jones et al. (2004) and Park et al. (2015) found that cancer survivors who received a PA recommendation from their oncologist engaged in more PA at follow-up than cancer survivors who did not receive the recommendation. Findings from these two studies provide some preliminary support that if integrated into practice, PA recommendations alone may be enough to change cancer survivors' PA behaviour.

There is increasing interest in low-intensity PA interventions that are more likely to be scalable. Groen et al's (2018) meta-analysis on distance-based PA interventions in cancer survivors indicated a statistically significant but small effect (standardised mean difference (SMD) of 0.21 of distance-based interventions on MVPA. These effects are much lower than those reported in other reviews (e.g., Sheeran et al., 2019, Turner et al., 2018, Stacey et al., 2015 & Singh et al., 2022). However, few studies included in Groen's review examined mHealth or eHealth interventions. Most studies relied on print and telephone modes of intervention delivery and may explain the smaller effects observed. In more recent years, there has been increasing interest in the implementation of eHealth and mHealth interventions to increase PA in cancer survivors. Indeed, this is evidenced by the number of reviews in this area published in the last 5 years (n=7) and the efficacy of wearable activity trackers. These reviews suggest that wearable activity trackers are effective tools that increase PA in individuals with cancer (Singh et al., 2022; Khoo et al., 2021; Schaffer et al., 2019; Roberts et al., 2017; Coughlin et al., 2020). The most recent meta-analysis in this area provides strong support for wearable interventions. Singh et al (2022) found that wearable devices had moderate-to-large effects on moderate-intensity PA (SMD = 0.87), MVPA (SMD = 0.61) and total PA (SMD = 0.54). Singh also found that theory-based interventions (SMD = 0.93) had larger effects on total PA than non-theory-based interventions (SMD = 0.40). Interventions that included baseline counselling had larger effects on moderate-intensity PA (SMD = 1.13 vs 0.26). The meta-analysis of digital interventions by Roberts et al. (2017) found an increase in MVPA of approximately 40 min per week favouring the intervention. The reviews by Khoo, Coughlin and Schaffer observed significant between-group effects for digital health interventions on MVPA in favour of the intervention in 87.5%, 75% and 67% of included studies respectively. Ester et al's (2021) review revealed more mixed results finding that 52% of eHealth interventions resulted in significant increases in PA. The mixed findings in Ester's review could be related to the inclusion of studies that were underpowered to detect change in physical activity (i.e., feasibility/pilot trials), in addition to intervention heterogeneity (i.e., varied duration, delivery modalities, use of theory, and BCTs). In contrast to previous reviews in exercise oncology, Ester et al (2021) found that a higher percentage of unsupervised interventions (56%; those without face-to-face interaction) were successful at increasing PA compared with those that were partially supervised (41%; those with one or more face-to-face component). Ester and colleagues also found that use of theory, problem solving and action planning BCTs may be linked to greater effectiveness.

Home-based PA interventions in cancer survivors show promise with Batalik's (2021) review demonstrating high adherence rates (71–88%) among seven studies. Five of the seven studies (71%) reported a significant increase in PA following home-based intervention. However, only two described a statistically significant increase in PA in the IG compared to controls. PA behaviour change was not a primary outcome in most studies. Home-based interventions display promise, but further research is needed to determine efficacy. The review and meta-analysis by Mugele et al (2019) to determine if high intensity interval training (HIIT) positively affects physical fitness and health-related outcomes in cancer patients during any stage of treatment and aftercare did not fit the criteria to be included in this section of the review (i.e., it did not include PA behaviour change). However, the review is included because it covers all stages of the cancer pathway and includes relevant outcomes such as physical function. The review found that HIIT was superior compared to usual care in improving physical fitness across the cancer pathway. However, the review found no evidence for the benefits of HIIT compared to aerobic training of moderate intensity for changes in cardiorespiratory fitness.

In summary, there is strong evidence that exercise interventions in cancer survivors effectively increase PA and provides small but clinically meaningful changes in MVPA relative to usual care. The main limitations of studies in this area include the over reliance on self-reported PA and small sample sizes that lack power to detect changes in PA between groups. There is also a dearth of research on the maintenance of PA following intervention cessation.

Notwithstanding these limitations, in general, greater effects on PA were provided by interventions with:

- greater contact time
- theory-based interventions and
- interventions using evidence-based BCTs (e.g., graded tasks, self-monitoring, action planning, goal setting, and social support).

Preliminary evidence also supports low-intensity interventions (i.e., involving a single recommendation for PA given in-person during a regularly scheduled appointment) delivered by clinicians, to change cancer survivors' PA behaviour. The most recent reviews provide strong support for digital and wearable interventions for increasing PA in cancer survivors with Singh et al (2022) reporting large effects on moderate-intensity PA (SMD = 0.87). The greatest effects of wearable interventions on moderate-intensity PA were found in those that included baseline activity counselling.

Table 6: Overview of Systematic Reviews of Physical Activity for Cancer Survivors (During and/or Post-Treatment)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Singh et al., 2022	35/13 (MIPA)	4255/1168 (MIPA)	To evaluate the effect of wearable devices for improving physical activity in cancer survivors.	Wearable devices had moderate-to-large effects on moderate-intensity PA (SMD = 0.87, 95% confidence interval (95%CI): 0.43−1.32); MVPA (SMD = 0.61, 95%CI: 0.36−0.86), total physical activity & daily steps (SMD = 0.54, 95%CI: 0.30−0.78). Theory-based interventions (SMD = 0.93) had larger effects on total physical activity than non-theory-based interventions (SMD = 0.40; $\chi 2 = 6.05$, $p = 0.01$). Interventions with baseline counselling had larger effects on moderate-intensity physical activity (Yes SMD = 1.13; no: SMD = 0.26; $\chi 2 = 5.69$, $p = 0.02$)	A wide range of interventions & many using pedometers (n=25) rather than smart wearables. Interventions consisted of multiple components, and the effect of each individual component cannot be determined.	Wearables & pedometers are effective tools that increase physical activity in individuals with cancer.
Mugele et al., 2019	12	448 (249, 69 & 134 received HIIT, moderate intensity & usual care respectively)	Determine impact of HIIT on preoperative fitness & whether this impacted on postoperative complications.	Changes in VO2peak revealed a large effect for HIIT compared to usual care (MD 3.73, 95% CI 2.07, 5.39; $p < 0.001$, I2 = 0%, n=292). However, no additional benefit of HIIT was found compared to moderate intensity (MD 1.36; 95% CI − 1.62, 4.35; $p = 0.370$).	The overall number of included studies was low & the included patients varied considerably in cancer diagnoses and statuses as well as treatments (i.e., in treatment vs. aftercare).	HIIT is superior compared to usual care in improving physical fitness across the cancer pathway. Currently, there is no evidence for the benefits of HIIT compared to aerobic training of moderate intensity (for changes in cardiores-piratory fitness.
Meyer-Schwickerath et al., 2021	14/12	1666/1488	Determine the efficacy of face-to-face behaviour change counselling (BCC) interventions on physical activity compared to usual care.	The SMD between groups favoured the IG with a small effect (SMD 0.22; 95% CI 0.11, 0.33; $p < 0.0001$). The BCTs "graded tasks", "self-monitoring of behaviour", "action planning" and "habit reversal" were more frequently coded in more efficacious interventions.	Only 2 studies used objective measures of PA. Trials included variety of components which limits interpretation of effective intervention components.	Significant differences (likely to be clinically meaningful equivalent to ~47 min/wk increase in MVPA are evident in favour of the IG.
Khoo et al., 2021	31	1977	To identify, evaluate, and synthesize the impact of mHealth interventions to promote PA in cancer survivors.	The most commonly used mHealth technology was activity trackers with 10 studies using only activity trackers. MVPA was most common PA outcome (n=18). Out of 8 controlled trials (with low risk of bias), seven (87.5%) reported significant effects of mHealth interventions with personal contact on MVPA.	Variety of study designs, including weaker designs & several with small sample sizes. Also, heterogeneity in interventions and study designs.	There is strong evidence for mHealth interventions, including personal contact components, in increasing MVPA in cancer survivors. Interventions that include personal contact components are likely more effective in increasing PA than mHealth interventions without such components.

Table 6: Overview of Systematic Reviews of Physical Activity for Cancer Survivors (During and/or Post-Treatment)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Brunet et al., 2020	11	1893	Determine if health care provider-delivered physical activity interventions are effective at promoting physical activity among cancer survivors.	The majority of studies (n=9, 82%) found significant increases in PA in the IG vs controls. Interventions deemed "lower intensity", (i.e., a single recommendation for physical activity was given in-person during a regularly scheduled appointment), may help to increase physical activity behaviour.	The majority of studies (n=8, 73%) used only self-report measures of PA.	Health care provider-delivered interventions may help to increase cancer survivors' physical activity. Recommending physical activity to their patients may be enough to prompt physical activity behaviour change
Goode et al., 2019	27/16	1475 (PA only studies)	Evaluate the efficacy of physical activity, dietary, and/or weight control interventions for cancer survivors in which telephone, SMS, print, and/or Web is the delivery mode.	Eleven of 16 studies (69%) reported a significant end of intervention improvement in favour of the intervention. With almost three quarters of studies using the telephone as the primary means of intervention delivery, the preponderance of support is for telephone-delivered interventions among cancer survivors.	Only 7 reported on PA maintenance with only 2 out of 7 finding a significant maintenance effect. Overrepresentation of breast cancer survivors in the review	This review provides support for broad-reach modalities, particularly the telephone, in the delivery of PA interventions to cancer survivors.
Schaffer et al., 2019.	12	1450	The primary aim of the review was to evaluate retention and adherence rates to exercise interventions using digital activity trackers (E-DATs). The secondary aim was to assess the effects of E-DATs on activity level,	All 8 RCTs with adherence data reported adherence of >70% in at least one adherence measure. Median adherence to E-DATs was not significantly higher when it involved an in-person training component (75%) compared with those involving solely self-directed training (60%; P=.40). E-DATs had significantly higher overall PA levels in 6 of 9 RCTs (67%).	Most studies (8 of 12) used pedometers only without smart features/associated app. Many used self-reported PA.	Exercise interventions using digital activity trackers are feasible to implement in cancer survivors with evidence supporting their effectiveness.
Ester et al., 2021	67	6655	To provide a comprehensive, updated overview of evidence on eHealth PA interventions for cancer survivors by describing the current state of the literature, exploring associations between intervention characteristics and effectiveness.	Significant increase in PA were noted in 35 studies (52%) & PA maintenance was noted 5 of 12 (41%) that included a follow-up. Interventions that were unsupervised (i.e., no in-person elements during the intervention period; 50/67, 75%) had a weight of 0.560, whereas those with some supervision (17/67, 25%) had a weight of 0.412.	Many studies were underpowered to detect changes in PA levels. 30 studies (45%) used only subjective measures of PA.	A range of eHealth PA interventions may increase PA in cancer survivors & specific components (e.g., use of theory, problem solving & action planning) may be linked to greater effectiveness.

Table 6: Overview of Systematic Reviews of Physical Activity for Cancer Survivors (During and/or Post-Treatment)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Grimmett et al., 2019	27/19	5792/3910	Evaluate the effectiveness of interventions in supporting maintenance of physical activity change among cancer survivors & explore which intervention components and contextual features are associated with effectiveness	SMD in MVPA between groups 0.25; 95% CI = 0.16–0.35, I2 = 36%). Within-group pre-post intervention analysis yielded a mean increase of 27.48 (95% CI = 11.48-43. 49) mins/wk of MVPA in control groups and 65.30 (95% CI = 45.59–85.01) mins/wk. The MD between the intervention and controls groups was 39.88 (95% CI = 22.78-56.97) MVPA mins/wk., p < 0.01). Ineffective interventions had fewer contacts, were less likely to include a supervised element or the BCTs of 'action planning', 'graded tasks' and 'social support (unspecified)'. PA maintenance (at least 6-months post intervention) found a similar SMD; 0.21; 95% CI = 0.12–0.29, p < 0.01, I2 = 13%)	16 of 19 studies used self-report measures of PA. Considerable variation in outcome measures used across studies.	Existing interventions are effective in achieving modest increases in PA at least 3-months post intervention. Small improvements were also evident in control groups suggesting low-intensity interventions may be sufficient in promoting small changes in behaviour.
Roberts et al., 2017	15/7 (MVPA)	1335/1034	Conduct a systematic review and meta-analysis of interventions using digital technologies in cancer survivors in order to assess their efficacy in promoting PA	Interventions resulted in significant increases in MVPA mins/ week (MD = 41; 95% CI 12, 71; p = 0.006) with very high levels of heterogeneity (I2 = 81%).	All studies used self-report measures of PA. Studies were generally of low quality with high risk of bias.	The meta-analysis found that digital health behaviour change interventions resulted in an increase in MVPA of approximately 40 min per week.
Furness et al., 2020	24/15	11 studies used a synchronous approach (n= 11) & asynchronous approach (n= 11). Mixed (n= 2) Meta-analysis for PA (n= 2545)	To systematically review the success of eHealth behaviour change delivered by synchronous, asynchronous, or combined methods compared with a control group.	eHealth interventions improved exercise behaviour (SMD 0.34, 95% CI 0.21-0.48, I2= 48.8%; p= 0.017). The intervention delivery mode of synchronous, asynchronous, or combined did not impact the outcome effect.	Most studies relied on self-report measures of PA. High heterogeneity of data.	eHealth interventions delivered to cancer or survivors have a small to moderate impact on PA. There is insufficient evidence to determine whether asynchronous or synchronous delivery modes yield superior results.

Table 6: Overview of Systematic Reviews of Physical Activity for Cancer Survivors (During and/or Post-Treatment)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Sheeran et al., 2019	128	13,050	To quantify the magnitude of intervention effects on PA & to determine what combination of intervention strategies maximizes behaviour change.	The sample-weighted average effect size was of small-to-medium magnitude (d+ = .35, 95% confidence interval [CI] [.29, .41]. This effect size equates to 1,149 additional steps per day and 47.16 extra minutes of MVPA/wk among cancer survivors (based on data from wearable activity monitors presented by Gresham et al., 2018). There was no difference in the effect size observed in studies that used an immediate follow-up assessment after the intervention and those using a longer-term follow-up (d+ = .36 and .33, respectively). Meta-regression and subgroup analyses indicated that supervised programmes exhibited a larger effect than unsupervised programmes (d+ = .49 vs. .26). Intervention contact time, was associated with larger effect sizes for supervised programmes. Effect sizes for trials above and below the median contact time (Mdn = 24 hr) were d+ = .69 and .36, respectively. Greater contact time (d+ = .42 vs. .23), targeting overweight or sedentary participants (d+ = .35 vs. .20), and establishing outcome expectations (d+ = .51 vs. .22), were each associated with larger intervention effects in unsupervised programmes.	The majority of included studies involved breast cancer survivors that may or may not be applicable to other cancer types. Follow-up periods were generally short (M = 12 weeks) and longer- term follow-ups would be desirable.	Interventions have a small but significant effect on physical activity among cancer survivors. Meta-CART indicated that the major difference in effectiveness was attributable to supervised versus unsupervised programmes (d+ = .49 vs. .26). Greater contact time was associated with larger effects in supervised programmes.
Turner et al., 2018 (updated from Bourke et al., 2013)	23/10	1372/604	To assess the effects of interventions designed to promote exercise behaviour in sedentary people living with and beyond cancer.	Aerobic exercise was significantly higher in intervention vs control groups (SMD 0.54, 95% CI 0.37 to 0.70). Aerobic exercise was significantly higher at six months (based on 7 studies & n= 591) in intervention versus control groups (SMD 0.56, 95% CI 0.39 to 0.72). The most frequent BCTs used in successful interventions were 'setting of graded tasks', 'goal setting' and 'instruction of how to perform behaviour'.	Primarily breast cancer (20 studies). The certainty of the evidence was graded due to variations in effect sizes and concerns over small sample sizes. Success was defined on adherence to the Rock et al. (2012) guidelines during the intervention rather than behaviour change per se pre-post.	Exercise interventions were found to significantly improve aerobic exercise compared to usual care at eight to 12 weeks and six months follow-up. However, there is low to very low-certainty evidence due to issues of high risk of bias.

Table 6: Overview of Systematic Reviews of Physical Activity for Cancer Survivors (During and/or Post-Treatment)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Stacey et al., 2015	12 (Meta)	1586	This review examined the effect of Social Cognitive Theory-based physical activity interventions in cancer survivors & identified factors associated with their efficacy.	The impact of interventions on PA immediately post intervention was significant (SMD= 0.33 [0.23, 0.44], Z=6.34, I2= 39% [P<0.00001]).	Most studies include small samples & 10/12 used self-reported PA. Most interventions included breast patients & post active treatment.	This review supports the efficacy of Social Cognitive Theory-based interventions in changing PA behaviour in cancer survivors.
Groen et al., 2018	29/24	5218/4203	The primary objective of this study was to provide a systematic review and meta-analysis of distance-based PA behaviour change interventions for cancer survivors.	Seven studies (27%) found a significant increase in PA. A significant intervention effect was found: SMD of 0.21 (95% CI 0.11–0.32), (Z = 3.87, p < 0.001). There was significant & moderate heterogeneity (I2 = 60%). Few studies examined mHealth or eHealth interventions; most studies relied on print and telephone modes of intervention delivery.	The majority of studies used only self-report measures of PA (n= 23; 79%). Small sample sizes & lack of statistical power.	The meta-analysis indicated a significant but small effect of distance-based PA interventions on MVPA. Drawing conclusions from these trials remains challenging given major limitations including poor methodological design, small sample sizes, lack of statistical power, & subjectively reported PA.
Blackwood & Rybicki 2021	5	682	The purpose of this review was to describe the type of technology used and outcomes of telehealth-delivered PA programmes in adult cancer survivors	Only 2 studies reported significant differences in PA from baseline to post-intervention (one in resistance exercise) & MVPA between the intervention and control groups. The between-group difference reported in this study was likely the result of the decrease in PA in controls as participants in the telehealth group did not significantly increase MVPA. This was the only study to use a Fitbit to track PA. Although both groups received this device, the telehealth group also received 25 text messages and biweekly phone calls from a health coach over the 8-wk study, resulting in a modest, yet non-significant increase in MVPA. Using a wearable alone was not sufficient to maintain or increase PA level as indicated by the decline in PA in the control group.	Limited no of studies included in the review & most (n=4) used self-report measures of PA.	A limited amount of evidence is available to indicate that telehealth-delivered PA programme outcomes are significantly better than programmes that do not use telehealth. More research is needed.

Table 6: Overview of Systematic Reviews of Physical Activity for Cancer Survivors (During and/or Post-Treatment)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Coughlin et al., 2020	13/4 RCTs on PA	220	To review the efficacy of wearable devices to promote physical activity in cancer survivors.	Three studies observed significant between-group differences in MVPA favouring the IG. One study (Van Blarigan et al., 2019) found no significant difference. The largest study (Lynch et al., 2019) found a significant between group difference of 69 mins/wk of MVPA favouring the IG. Cadmus-Bertram et al., (2019) found an increase of 69mins/wk MVPA vs -20 min/wk in intervention & controls respectively.	Only four studies were RCTs with mostly small sample sizes (n= 42-83). Maintenance of the intervention effects are unknown.	The review provides evidence of preliminary efficacy of the use of consumer wearable devices to promote PA among breast, prostate, and colorectal cancer survivors.
Batalik et al., 2021	9	630	To identify the literature on the health effects of home-based exercise interventions in cancer survivors.	High adherence to intervention was reported (71–88%). Five of the seven studies reported a significant increase in PA levels with home-based exercise in the IG. However, only two described a statistically significant increase in PA vs controls. Three studies reported a non-significant difference between home-based exercise and usual care.	Six of seven (86%) used self-report measures of PA. PA behaviour was not a primary outcome in most studies.	Research evidence is lacking in the field of home-based exercise interventions in cancer survivors. However, all studies were limited in terms of methodology and reporting of results. Nevertheless, the evidence suggests that home-based exercise interventions are feasible.

Physical Activity for Advanced Cancer and the Palliative Care Setting

Of the nine systematic reviews of PA in advanced cancer, four primarily assessed safety, feasibility and acceptability of exercise interventions in the advanced cancer setting (i.e., Toohey et al., 2022; Shiell et al., 2019; Dittus et al., 2017; De Lazzari et al., 2021). PA programmes were found to be safe, acceptable, and feasible for people with advanced cancer in the palliative care phase. The average recruitment rate varied from 49% (Dittus et al., 2017 & Sheill et al., 2019) to 68% (De Lazzari et al., 2021). Sheill et al. (2019) noted that the highest recruitment rate of 74% in one study included in their review (i.e., Cormie et al., 2013) was in advanced prostate cancer whereby patients were directly referred to the exercise programme by their oncologist. Attrition was mostly consistent and ranged between 20% (e.g., Toohey et al., 2022) and 23/24% (DeLazzari et al., 2021 and Sheill et al., 2019 respectively). Adherence was variable with rates as low as 44% (reported by Grainne et al., 2019), to a median of 69% (Toohey et al., 2022) and a high (median) of 86% observed by De Lazzari et al. (2021). The primary reasons for dropout were cancer progression followed by death. If feasibility is determined using cut-off values considered clinically relevant based on previous research, an acceptable recruitment rate is ≥ 25% (De Jesus et al., 2017), an acceptable attrition rate is ≤25% (Newton et al., 2011) and an adherence rate of ≥ 75% (Newton et al., 2011). Overall, the recruitment and attrition rates display feasibility and acceptability of PA programmes for advanced cancer. Although adherence is lower than the cut-off in some reviews, given the high disease burden of this cohort an adherence rate of 69% in the most recent review (Toohey et al., 2022) likely represents a positive outcome in terms of exercise adherence.

Two reviews (De Lazzari et al., 2021; Toohey et al., 2022) assessed safety of exercise for advanced cancer patients. De Lazzari et al. (2021) found that only 2% of patients (9/493) in exercise therapy reported exercise-related adverse events. The meta-analysis by Toohey et al. (2022) of 20 RCTs involving 1840 participants revealed no difference in the risk of a grade 2–4 adverse event between exercise and usual care ($p = 0.24$). Subgroup analyses showed that adverse event risk was similar irrespective of exercise mode (aerobic, resistance, combined and other exercise; $p = 0.98$), intervention supervision (supervised and unsupervised; $p = 0.94$), intervention duration (<12 weeks versus ≥12 weeks; $p = 0.62$) and cancer type (breast, prostate, lung or mixed; $p = 0.60$). Toohey and colleagues (2022) found that there were no differences in adverse event risk between exercise and usual care. Only 3% of adverse events were exercise related, which were low severity.

In relation to exercise outcomes, the reviews provide strong evidence that exercise interventions significantly improve physical function, lower-body strength and aerobic fitness in advanced cancer patients (Toohey et al., 2022; Yang et al., 2020; Dittus et al., 2017; Chen et al., 2020; Nadler et al., 2019). Three reviews found significant improvements in sleep quality following exercise intervention (Rodrigues-Canamero et al., 2022; Chen et al., 2020; Heywood et al., 2018) and two reviews identified significant improvements in dyspnoea relative to controls (Rodrigues-Canamero et al., 2022; Chen et al., 2020). There was mixed evidence concerning the impact of exercise interventions on fatigue and quality of life. Two meta-analyses revealed that compared with usual care, there were small but significant improvements favouring exercise for fatigue (Toohey: SMD= 0.30; Chen: SMD= 0.25) and quality of life (Toohey: SMD= 0.27; Chen: SMD= 0.22). However, four systematic reviews found that fatigue and quality of life improved in just half or slightly over half of all included studies (Heywood et al., 2018; Dittus et al., 2017; Rodríguez-Cañamero., 2022, De Lazzari et al., 2021).

In summary, the review of reviews has demonstrated that exercise programmes are safe, acceptable, and feasible with physical and psychosocial benefits experienced by the participants. Improvements from exercise were most evident for physical function, fitness and strength. The strongest evidence (i.e., meta-analyses) also supports the role of exercise in advanced cancer to improve fatigue and quality of life. In several reviews, analysis was limited due to inconsistent outcome measures reported across studies and small sample sizes that were likely underpowered to detect change in outcomes. Some reviews found that high numbers of potential participants were ineligible to participate in exercise interventions due to multi-morbidity exclusion criteria (Toohey et al., 2022; Sheill et al., 2019). Given

the increasing evidence supporting the safety and efficacy of exercise training for advanced cancer, future studies may consider including patients with a higher disease burden and shorter life expectancy. Overall, the analysis of the literature in this review demonstrates that exercise is likely to be a valuable tool for individuals living with advanced-stage cancer to improve physical function and well-being.

Table 7: Overview of Systematic Reviews of Physical Activity for Cancer Patients with Advanced Cancer (Palliative Care setting)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Rodríguez-Cañamero et al., 2022	15	1072	To determine impact of exercise on advanced-stage cancer patients and to identify the physiological benefits in this cohort.	Findings were mixed. The majority (75%) reported significant improvements in 6MWT or measures of physical function in the IG vs controls. There were also significant improvements in dyspnoea and sleep quality. Improvements in QoL were less clear. Mixed evidence for fatigue with 57% showing an improvement between groups.	Small sample sizes of most of RCTs.	Aerobic, strength or combined training has a positive impact on advanced-stage cancer patients. Exercise training can improve the fatigue/dyspnoea, & sleep. The training prescription with the reported greatest benefits was aerobic/strength training sessions (60-90 mins) with a moderate-vigorous intensity.
Toohey et al., 2022	20	1840	To evaluate the safety, feasibility and effectiveness of exercise for people with advanced cancer in the palliative care phase.	Compared with usual care, there were small to moderate effects (all $p<0.05$) favouring exercise for lower body strength (SMD= 0.48, CI 0.12, 0.84) I2=85%); aerobic fitness (SMD= 0.30, CI 0.12, 0.49, I2=57%); Fatigue (SMD= 0.30, CI 0.13, 0.47), I2=61%) & QoL (SMD= 0.27, CI 0.14, 0.39) I2=1%). No significant subgroup effects for exercise mode, supervision, duration and cancer type. Meta-analysis showed no difference in the risk of a grade 2–4 adverse event between exercise and usual care ($p= 0.24$) The median recruitment, retention and adherence rates were 56%, 80% and 69%, respectively.	Small sample sizes & moderate to high hetero-geneity of data. 41% (n=9) of studies excluded individuals with comorbidities. Therefore, the findings may be less generalisable to those with a higher disease burden.	Physical activity programmes were found to be safe, acceptable & feasible for people with advanced cancer in the palliative care phase. Exercise interventions significantly improve lower-body strength, aerobic fitness, fatigue and QoL in advanced cancer patients.
Heywood et al., 2018	25	1188	To analyse the literature surrounding the efficacy of exercise interventions in patients with advanced cancer.	Significant between- and within-group improvements were reported with exercise in 50% of studies assessing physical function (83%), QoL (55%), fatigue (50%), body composition (56%), psychosocial function (56%), and sleep quality (100%).	Inconsistent outcome measures reported across studies limit the ability to draw conclusions based on the pooled results. Effects on specific efficacy domains was confounded due to the range of assessment tools used across studies.	Most studies reported significant between- and/or within-group improvements in physical function, QoL, fatigue, psychosocial function & sleep quality in patients with advanced cancer. The effects on pain and survival rates are unclear.

Table 7: Overview of Systematic Reviews of Physical Activity for Cancer Patients with Advanced Cancer (Palliative Care setting)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Sheill et al., 2019	18	952	To investigate the recruitment, adherence, & attrition rates of patients with advanced cancer participating in exercise interventions & components of exercise programmes that may affect these.	Recruitment, adherence, and attrition rates varied widely among the studies reviewed. The mean recruitment rate was 49% (SD = 17; range 15–74%). Reported barriers to recruitment included time constraints and travel/logistical difficulties. Adherence ranged from 44% to 95%. The average attrition rate was 24% (SD =8). The highest recruitment rate (74%) was with advanced prostate cancer whereby patients were referred directly from an oncologist (i.e., Cormie et al., 2013)	Small sample sizes, heterogeneity in populations, and definitions of key variables, Limited to acceptability and feasibility rather than efficacy.	Exercise programmes are feasible for those with advanced cancer. With increasing evidence supporting the safety of exercise training in patients with advanced cancer broadening the inclusion criteria for eligibility may increase recruitment. Direct referrals from Oncologists may also favour higher levels of recruitment, adherence and retention.
Yang et al., 2020	11	922	To determine the effectiveness of supervised exercise on physical function, QoL, or fatigue in patients with advanced cancer.	Among the physical function outcomes, “strength” & “physical activity” improved. Two synthesized studies showed a significant increase in the METs (MD, 0.29; 95% CI, 0.07–0.51) (n=2 studies). Global QoL on the EORTC-QLQ-C30, substantially increased after rehabilitation (MD, 10.28; 95% CI, 2.53–18.02) as did role functioning (MD, 18.83; 95% CI, 5.20–32.46)	Most studies included were single arm pre-post (n= 7, 64%). Efficacy exploration was confounded due to the range of assessment tools across studies.	Structured exercise interventions for patients with advanced cancer show promise for improving physical activity, strength, and QOL. However, evidence is weak due to the small number of studies and the variety of outcome measurements used.
Dittus et al., 2017	15	1208	To determine the effectiveness of exercise interventions for patients with advanced-stage cancer in improving cancer-related symptoms and functional status outcomes.	Compared with usual care, exercise showed a significant improvement in QoL (SMD= 0.22; CI 0.06–0.38, P = 0.009); fatigue (SMD= −0.25, CI −0.45 to −0.04, P = 0.02); insomnia (SMD= −0.36, CI −0.56 to −0.17, P = 0.0002); physical function (SMD= 0.22, CI 0.05–0.38, P = 0.009); social function (SMD= 0.18, CI 0.02–0.34, P = 0.03); and dyspnoea reduction (SMD= −0.18, CI −0.34 to −0.01, P = 0.03).	Heterogeneity in exercise programmes. Limited outcomes were reported in trial, preventing the performance of comparisons between interventions. Different measures were used to assess outcomes.	Supervised exercise serves as an effective intervention to improve QoL and alleviate fatigue, insomnia, dyspnea, and physical and social functions for patients with advanced-stage cancer.

Table 7: Overview of Systematic Reviews of Physical Activity for Cancer Patients with Advanced Cancer (Palliative Care setting)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Nadler et al., 2019	16	1318	To determine effects of exercise for improving, maintaining, and/or slowing decline in QoL, fatigue, and function relative to controls. As a secondary aim, to assess benefits and risks in those with the most fatigue and lowest function at baseline.	Among patients with scores at the mean or 2SD above, exercise was not associated with significant or clinical difference in QoL or fatigue. In patients with baseline scores 2SD below mean, exercise was associated with non-significant but minimally clinically important difference in QoL (−2.8 vs. 4.6, P = 0.28). For patients at the mean for physical function, clinically meaningful difference in the 6MWT (14.7 vs. 29.0 m, P = 0.44) were observed. In patients 2 SD below the mean, a clinically meaningful improvement in the 6MWT (−7.5 vs. 27.0 m, P = 0.34) was observed.	Small sample sizes insufficiently powered to detect change in outcomes. Cancer staging was omitted in some studies limiting firm conclusions on the number of patients that were metastatic.	Exercise interventions are associated with clinically meaningful improvements in QoL, function, and 6-MWT in those with metastatic cancer. The effects are seen in patients with baseline score at the mean and lower.
De Lazzari et al., 2021	14	940	To assess the safety, feasibility, and benefits of exercise for patients with advanced cancer.	Recruitment revealed a median of 68.3% (range: 25–87.6%) (n=12). Reasons for non-participation included health-related deterioration/medical eligibility criteria, followed by distance to study site & time. For adherence (n=8), the median was 86% (range: 72–89%). Attrition was 23.4% overall (primary reason of dropout was cancer progression followed by death). Only 9 of 493 (2%) in exercise therapy reported exercise-related adverse events. No further serious adverse events related to exercise were reported. Five studies demonstrated a decreased QoL in controls while the exercise group remained unchanged or slightly increased but without significant statistical values. In three studies QoL remained stable/ slightly increased in exercise and control groups without significant p-values. Two studies found a significant improvement in QoL in favour of the exercise group. Improvements in fatigue were found in 6 studies with 6 other findings no change between the groups. A deterioration in fatigue was found in one study.	High heterogeneity across studies. Small sample sizes, & some studies were unclear about the comparison to exercise, and intensity of exercise performed.	Exercise interventions seem to be safe and feasible in advanced cancer patients. The summarized evidence indicates beneficial effects of exercise on physical performance and QoL, and a potential reduction of fatigue

Physical Activity for Children and Adolescents

Of the nine systematic reviews of PA in children and adolescents (some included young adults), five primarily examined safety, feasibility, and acceptability of exercise interventions in the paediatric cancer setting (i.e., Mizrahi et al., 2017; Cheung et al., 2021; Bauman et al., 2013; Rustler et al., 2017; Kopp et al., 2017). Only one review included recruitment rates and reported a mean recruitment rate of 64% across thirteen studies included in the review (Mizrahi et al., 2017). Study retention was reported as adequate in two reviews with averages of 85% and 82% observed by Mizrahi et al. (2017) and Kopp et al. (2017) respectively. Retention was observed to be more variable in the review by Cheung et al. (2021) ranging from 69.8% to 100%. Adherence was high in the review by Mizrahi et al (2017) with a mean of 88% across thirteen studies. Adherence was reported as more variable in other reviews ranging from 59%-98% (Rustler et al., 2017; Cheung et al., 2021; Bauman et al., 2013). No adverse events were reported in four reviews (Cheung et al., 2021; Bauman et al., 2013; Rustler et al., 2017; Mizrahi et al., 2017). Overall, the systematic reviews on exercise interventions in paediatric oncology confirm that engaging childhood and adolescent cancer patients in PA is feasible, acceptable and safe.

In relation to PA behaviour change there were positive yet inconsistent findings across the reviews. Cross et al. (2020) found significant improvements in PA following intervention in 67% of included studies and two other reviews reported significant increases in IGs in 50% of included studies (i.e., Cheung et al., 2021; and Munsie et al., 2019). Another found significant improvements in the studies that assessed PA (n=2; Morales et al., 2020). In contrast, Kopp et al. (2017) found no differences in PA between groups post intervention across studies. In the only meta-analysis (including 4 studies) in this cohort, Mizrahi et al. (2017) found that distance-delivered interventions did not significantly increase PA. Caution is urged concerning the interpretation of these findings since most reviews included studies with very small sample sizes (i.e., many having less than 10 participants) that lack statistical power to detect changes in PA. Further, it is difficult to compare the data both within and across reviews due to heterogeneity of outcome measures used in different studies (i.e., pedometer step count, metabolic equivalents, MVPA and days/week training). The three studies that reported MVPA in Mizrahi's (2017) review found non-significant improvements in MVPA (Yeh et al., 2011, Huang et al., 2014, Sabel et al., 2016). However, in these three studies, on average, participants were already achieving the recommended PA guidelines at baseline (i.e., the recommended exercise guidelines for child and adolescent cancer survivors are ≥60 min/day of MVPA, ≥5 days a week) (Rock et al., 2012). The latter suggests a potential bias as childhood cancer survivors recruited for these studies may be more motivated to engage in exercise prior to study enrolment.

In relation to health outcomes, there were more promising effects of interventions on physical functioning. Distance-delivered interventions collectively improved physical function (which included cardiovascular fitness, muscular strength, functional capacity, and flexibility) (n = 2 studies, p = 0.008) (Mizrahi et al., 2017). Crowder et al. (2020) found significant improvements in physical function in 5 studies (62.5%) and Morales et al. (202) found significant improvements in physical function in two studies (33%). Few studies assessed quality of life or psychological health and outcomes were inconsistent. Morales et al. (2020) found a significant improvement in health-related quality of life in one study and a decrease in another following intervention. Crowder et al. (2020) observed no improvements in quality of life in five studies (71%). Mizrahi et al. (2017) found significantly improved psychological function in two studies following exercise intervention.

Only one review (i.e., Cross et al., 2020) assessed BCTs and intervention components associated with the promotion of PA for children and young people living with and beyond cancer. Cross and colleagues found that 75% (n= 9) of interventions showed sustained improvements in PA at follow up (range 1-12 months). The most prevalent BCTs used across the interventions were instruction on how to perform the behaviour, followed by demonstration of the behaviour, behavioural practice/rehearsal, and credible source. Almost all the interventions included in Cross's review were structured exercise classes led by an exercise professional. However, Cheung and colleagues (2021) suggest that eHealth and mHealth

interventions appear to be increasingly important strategies to promote PA among paediatric and adolescent cancer survivors with two effective interventions in their review (i.e., one employing a web- and text- and phone counselling-based tailored weight management intervention for paediatric cancer survivors (Huang et al., 2014), and another using phone psycho-educational sessions and web-based resources to improve health behaviours in paediatric cancer survivors with obesity (Stern et al., 2018). Kopp et al. (2017) also found preliminary support for web-based interventions to increase PA.

In summary, research on exercise interventions in paediatric oncology is in its infancy. However, preliminary evidence, while hindered by small sample sizes, poor methodological quality, and heterogeneous designs and outcome measures supports the feasibility, acceptability, and safety of PA interventions in this cohort. With satisfactory retention and adherence rates, and interventions with a low reported rate of adverse events, there was an overall trend toward PA providing benefit to children and adolescent cancer patients.

Table 8: Overview of Systematic Reviews of Physical Activity for Cancer Patients (Children, Adolescents/Young Adults)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Crowder et al., 2022	9	659	The purpose of this study was to conduct a systematic review of the literature pertaining to the prevalence of physical activity interventions in childhood and young adult cancer survivors and their associated health and QOL outcomes.	Two studies reported improvements in physical activity (5 more with partial increases & 2 with no change in PA). Significant improvements in physical functioning were noted in five studies & no improvements in 3. Non-significant improvements or no improvements in QoL were noted in five studies & significant improvement found in 2 studies.	Self-reported PA was used in most studies (n=6; 67%). Only two studies included adolescent and young adults. The heterogeneity of the studies (e.g., intervention length, outcomes).	There are inconsistent findings across studies. Two reported improvements in physical activity, five reported partial improvements, and two reported no improvement. Only a handful of studies examined health-related outcomes including physical functioning & QoL.
Mizrahi et al., 2017	13/4	270/102	To determine the feasibility of distance-delivered PA interventions in childhood cancer survivors & assess the effect on PA level & physical, physiological and psychological outcomes.	Interventions yielded a mean recruitment rate = 64%, retention rate = 85% and adherence rate = 88%. Interventions did not increase PA levels ($p = 0.092$) but had a positive effect on physical function ($p = 0.008$) and psychological outcomes ($p = 0.006$).	Reliance on self-report measures of PA. The majority of studies (n=8, 61.5%) were single arm studies & only 3 (23% were deemed of 'strong' quality.	Distance-delivered PA interventions are feasible in childhood cancer survivors. Despite not increasing PA levels, partici-pation may improve physical and psychological health; however, larger randomized controlled trials are warranted.
Cheung et al., 2021	8	620	To evaluate the effects of interventions on PA among paediatric cancer survivors who had completed active cancer treatment.	Retention across studies ranged from 69.8 to 100%. Adherence (assessed in 5 studies) ranged between 71.5 and 91.5%. Only four studies (50%) found an increase in PA. Two were eHealth & mHealth interventions. The other two included a 4-day adventure-based training programme. The only educational-based intervention to promote physical activity showed insignificant results.	Heterogeneous tools to assess physical activity. Only two studies (25%) had a low risk of bias.	eHealth and mHealth interventions appear to be increasingly important strategies to promote physical activity among paediatric cancer survivors. Educational approaches are unlikely to be sufficient to elicit PA behaviour change.

Table 8: Overview of Systematic Reviews of Physical Activity for Cancer Patients (Children, Adolescents/Young Adults)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Bauman et al., 2013	17	282	To summarise the evidence of physical activity in paediatric oncology.	Exercise interventions are feasible and safe. No adverse effects were reported. Adherence (examined in 8 studies) ranged between 67 and 98%. Positive effects were found on fatigue, strength, and quality of life. Single studies present positive effects on the immune system, body composition, sleep, activity levels, and various aspects of physical functioning.	Most studies pilot & descriptive with 10 having no more than 10 partic-ipants and 6 without control groups.	Clinical exercise interventions in paediatric oncology are feasible and safe. Relatively good evidence is given in terms of positive effects of supervised exercise programmes during medical treatment on fatigue, muscle strength, and quality of life.
Cross et al., 2020	12	346	To identify the BCTs and intervention components associated with the promotion of PA for children and young people living with and beyond cancer.	8 (67%) were shown to change PA following intervention & 9 showed sustained improvements in PA at follow up (range 1-12 months). The most prevalent BCTs were instruction on how to perform the behaviour (k = 12), followed by demonstration of the behaviour (k = 9), behavioural practice/rehearsal (k = 9), and credible source (k = 9); almost all of the interventions included structured exercise classes run or recommended by an exercise professional.	Study quality overall was low-moderate; with most studies designs being exploratory (pilot or feasibility). 5 had 10 or less participants.	Interventions designed to increase physical activity participation and adherence during and beyond cancer treatment for young people should integrate psychosocial (behavioural, cognitive-emotional, social), environmental and medical intervention components.
Morales et al., 2020	12	109	To systematically review the evidence available on the effects of exercise intervention (duration ≥ 4 weeks) in childhood survivors after finishing treatment for at least 1-year.	Physical exercise improved endothelial function, reduced waist circumference, and waist-to-hip ratio and increased physical activity levels. Only 2 of 6 showed improvements in physical function. Only 2 assessed PA with both demonstrating improvements. Two studies reported exercise-related adverse events.	Low methodological quality & small sample size of most studies. Heterogeneity of studies (age, cancer types, treatments) & interventions.	No consistent benefits were observed review. Exercise interventions appear as a safe and, at least partly, effective for the improvement of health-related markers.
Munsie et al., 2019	6	135	To investigate the current evidence for exercise interventions in Adolescent and young adult cancer populations, both during and after treatment.	Four of the six included assessed PA. Two studies reported increased PA at post intervention follow-up. Five of six studies reported no adverse events. PA interventions were feasible with acceptable adherence.	Direct comparison on intervention outcomes was not possible due to the heterogeneity of the studies. No randomised trials included. Low methodological quality & self-reported PA.	The preliminary evidence, while hindered by small sample sizes and poor methodological quality, supports the feasibility of physical activity interventions in this cohort. With satisfactory attendance rates, and safe interventions with a low reported rate of adverse events, there was an overall trend toward physical activity providing benefit to adolescent and young adult cancer patients.

Table 8: Overview of Systematic Reviews of Physical Activity for Cancer Patients (Children, Adolescents/Young Adults)

Author, Date.	Number of studies	Total population (included in the analysis)	Review Aim	Overall Qualitative review of results	Overall limitations	Overall Recommendations from study
Rustler et al., 2017	10	204	To summarise & evaluate inpatient exercise interventions for paediatric cancer populations during acute treatment.	No adverse events occurred & adherence rates of 59– 85% were reported. Significant improvements in perceived physical function in 2 studies. For those receiving stem cell treatment (4 studies), there were significant improvements in aerobic fitness in 2 studies (another study reported a decrease) & non-significant improvements in upper & lower body strength (4 studies).	Studies in review are explorative & pilot (3 single arm), with small & heterogeneous samples (6–30 participants. Mixed outcome measures.	Exercise interventions for patients with paediatric cancer during inpatient care are safe, feasible, and hold potential for positive health effects. The problem of low PA during inpatient care is possible with exercise interventions; however, there is insufficient evidence concerning effective interventions.
Kopp et al., 2017	6	199	To summarise the literature regarding lifestyle interventions for childhood & adolescent/young adult cancer survivors delivered using e/m health	All but one of the studies demonstrated high retention rates (82%), acceptability & feasibility. Four focused solely on PA. No differences in PA between groups post intervention across studies. One of these studies randomized 86 patients to either a Facebook group promoting PA or an enhanced intervention consisting of a Facebook group promoting PA plus tailored behavioural guidance designed to increase MVPA. After 12-weeks, there were significant increases in PA, although there was no significant between-group difference (Valle et al., 2013). A second study randomized 18 participants to information about cancer-related Websites or a PA intervention Web site designed to promote PA with tailored information and strategies based on participant's stage of readiness to engage in PA. The PA Web site group had high retention rate (94%) and increased PA compared with control group (PA increased by 161.25 min/week in the tailored intervention vs. 55.5 min/week in the active control group); ns (Rabin et al., 2012).	Small samples & heterogeneous interventions. Self-reported physical activity & mixed outcome measures.	Few lifestyle interventions have addressed prevention of chronic conditions in childhood and adolescent and young adult cancer survivors, and even fewer have used eHealth or mHealth interventions. There is an opportunity to incorporate technology to broaden the reach and impact of lifestyle interventions for this underserved population.

Step 2: International Case Studies

Two case-studies of PA interventions for cancer survivors that have been rolled out in practice internationally will be described and evaluated. The first is taken from Australia (Healthy Living after Cancer) and the second from the UK (The Macmillan 'Move More' Physical Activity Behaviour Change Care Pathway). A third case that has not been rolled out nationally will be described. The third case-study is from Canada and is called 'Nutrition and Exercise during Adjuvant Treatment (NExT)'. The NExT programme provides an example of real-world translation of an exercise intervention into a clinical care setting. The first two case studies involve community-based PA interventions. The RE-AIM framework (Glasgow et al., 1999) will be used to assess the efficacy of these 'real world' programmes in terms of reach, adoption, implementation, and maintenance. The RE-AIM framework was developed to help translate effective interventions (in the research setting) into practice, and especially into public health impact and policy. The RE-AIM dimensions include reach (R) and effectiveness (E)–which operate at the individual-level (i.e., those who are intended to benefit), and adoption (A), implementation (I), and maintenance (M), which focus on the staff and setting levels (Glasgow et al., 2019). In brief, reach tends to refer to the absolute number, proportion and representativeness of individuals engaging in an intervention from the target group. Effectiveness tends to refer to the overall impact of the intervention on important outcomes (e.g., PA behaviour change, physical function, quality of life). Adoption refers to the absolute number, proportion, and representativeness of (i) settings and (ii) intervention agents (i.e., those who deliver the intervention) who are willing to initiate an intervention. Implementation tends to refer to the fidelity of the intervention (i.e., the agent's delivery of the intervention as intended, as per protocol, including consistency in delivery in terms of content and style. Implementation may also include time required to deliver interventions and the costs involved, with a view to cost-effectiveness and scalability. Implementation at the individual level also includes for example patient engagement with the intervention and utility of specific intervention components. Finally, maintenance includes indices at the individual level (i.e., long-term effectiveness; sustained PA behaviour change), and the setting-level (i.e., sustainability of the intervention after original research funded is completed and withdrawn).

AUSTRALIA

Case Study: Healthy Living after Cancer

Healthy Living after Cancer (HLaC) was a national dissemination and implementation study of an evidence-based lifestyle intervention for cancer survivors in Australia. The programme was imbedded into existing telephone cancer information and support services delivered by Australian state-based Cancer Councils (CCs). The HLaC Partnership Project evaluated the effect of a 6-month, telephone-based lifestyle intervention for cancer survivors delivered by four Australian state-based CCs (non-government organisations) as part of their Cancer Information and Support Service (Eakin et al., 2020). The CCs were highly aligned partners for this work and each had a mandate to provide survivorship services on a state-wide basis, noting that 30% of Australians with cancer live outside of metropolitan areas; and they had the infrastructure and staff to implement the project.

HLaC Intervention

The 6-month intervention is aimed at increasing PA, promoting healthy eating, and assisting with weight loss (if indicated) and was delivered by study-trained, CCs nurses/allied health professionals with expertise in cancer care. A Training Manual detailing the intervention protocol, including example call scripts, was made available to those involved in delivering the intervention prior to a group-based training workshop (2 days), which makes extensive use of role-playing. Using a train-the-trainer approach, the training was video-taped and a lead nurse from each CC took on responsibility for the initial training of any new staff requiring training during the study. The intervention was based on Social Cognitive Theory and its key constructs of self-efficacy, social support and outcome expectancies (Emmons & Rollnick, 2001), and guided by motivational interviewing (Eakin et al., 2010) and health coaching techniques (Bandura, 2004). The intervention focused on developing skills in evidence-based BCTs including goal setting, self-monitoring, problem solving, identifying social support, stimulus control, positive self-talk and self-reward (Michie et al., 2009). Cancer survivors received up to 12 coaching calls over the six-month programme and a participant workbook. Each call followed a structured protocol including (i) assessment of progress; (ii) problem-solving; (iii) advice/education; and (iv) collaborative goal setting/goal progression (following SMART principles of effective goal setting). The PA component of the intervention focused on identifying enjoyable activities that could be easily incorporated into the participant's lifestyle (e.g., walking), with gradual increases in PA aimed at meeting or exceeding the recommended target of 150 mins/week of MVPA. Resistance exercise (2–3 sessions/week) was also encouraged, with detailed photographs and instructions, guidelines on the number of sets and repetitions of each exercise, and options for progression (see Eakin et al., 2015 for further detail).

Participant Eligibility

Participants were referred to the programme between June 2015 and September 2018. The eligibility criteria were: Adults (18+ years); diagnosed with cancer of any type that was localised, non-metastatic and treated with curative intent; Completed primary treatment (ongoing hormonal treatment/ trastuzumab was permitted); No contraindications to engaging in unsupervised PA, including but not limited to active heart disease, breathing problems, planned knee/hip replacement, pregnant/ intending to become pregnant in the next 6 months; no cognitive/mental health impairments that would hinder participation.

Primary Outcomes

Outcomes were mapped against the RE-AIM framework (Glasgow et al., 1999) and included Reach: number of referrals, referral source; programme uptake, participant characteristics, and implementation: study retention, programme completion and call delivery (number and duration of calls). Maintenance was determined by the number of CCs continuing the HLaC programme following the end of the study. Secondary outcomes included effectiveness; specifically, minutes of MVPA/week, self-reported through the Active Australia Survey (AIHW, 2003).

Adoption/Reach

Four of the five CCs approached participated in the study. In total, 1183 participants were referred to the HLaC programme. Of these, 886 were eligible and 786 (uptake of 88.7%) participated in the programme. Participants were mostly women (88.0%), mostly Caucasian (89.7%), had an average (mean ± SD) age of 57.5 ± 11.4 years, body mass index (BMI) of 28.8 ± 6.5 kg/m2, were on average 1.9 ± 3.0 years since diagnosis, and many (44.3%) lived in areas with postcodes ranked in the highest 30% for their state regarding socioeconomic position. At baseline, many participants already had BMI < 25 kg/m2 (67.4%) and many reported achieving the recommended PA guidelines of 150 mins/week of MVPA (49.9%).

Implementation

Study retention was 63.4%, with 498 participants completing the post-programme evaluation. Programme completion was 60.6% overall, with 476 participants completing ≥4 intervention calls. Programme delivery costs were estimated at AU$504,980 (€340,116) for the 1183 referred cancer survivors, equating to a mean cost of AU$427 (€288) per referred cancer survivor or AU$673 (€453) per programme completer (n = 476).

Maintenance

One CC was in the process of adapting the programme for web-based delivery and two were going to continue to offer it at a reduced scale and as a means of promoting PA maintenance among cancer survivors completing their existing exercise classes.

Effectiveness

There were substantial improvements in self-reported MVPA (148 min/week, 95% CI: 125, 171, p<0.001), reduced sitting time (− 1.19 h/day, 95% CI: − 1.42, − 0.96, p<0.001) and in the proportion of participants meeting the PA guidelines from baseline (50%) to post intervention (79.1%).

Conclusions

This study is one of the first to report on the effectiveness and feasibility of a scaled up and national implementation of an evidence-based, telephone-delivered, lifestyle programme for cancer survivors implemented in conjunction with a cancer control partner. Evidence supports the feasibility and implementation of the intervention including scalability. However, there are doubts regarding the reach and effectiveness of the intervention. Over a 3-year period and across four CCs, approximately ~98 survivors were recruited per year for each CC (i.e., from an est. 150,000 newly diagnosed cancers in 2020). Most participants were women (88%), primarily diagnosed with breast cancer (n= 484; 61.6%), and in the higher socioeconomic brackets, and therefore not representative of the national cancer survivor cohort. Half of those recruited were deemed sufficiently active (i.e., meeting the guidelines) at baseline and therefore were not most in need of intervention. In relation to effectiveness, although there were significant improvements in MVPA, and, in the proportion meeting the PA guidelines from baseline to follow-up, such observations should be treated with caution since they rely on self-reported PA, known to overestimate PA engagement (Boyle et al. 2015).

UNITED KINGDOM

Case-study:
The Macmillan 'Move More' Physical Activity Behaviour Change Care Pathway

The Macmillan PA Behaviour Change Care Pathway (more commonly known as the 'Move More' service) is an evidence-based service providing tailored, one-on-one behaviour change support to help people living with cancer to become more active or maintain a level of PA, depending on their stage of the cancer journey. It comprises five elements: (i) raising awareness, (ii) referral, (iii) behaviour change intervention, (iv) PA offer and (v) on-going behaviour change support. The model is based on the NHS adult PA care pathway, Let's Get Moving (UK Department of Health, 2012). It also draws on guidance from the National Institute for Health and Care Excellence (NICE) on behaviour change (NICE, 2014).

The Intervention

The behaviour change intervention is designed to increase the service user's level of PA. The initial intervention should last for a minimum of 30 minutes and be delivered by a practitioner who has completed their level 4 cancer rehabilitation training and a course in behaviour change (such as Macmillan's two-day course on motivational interviewing). The practitioner takes a person-centred approach and works collaboratively with the service user concerning the design and delivery of appropriate support. The intervention incorporates an assessment of needs (looking at previous activity levels and the appropriateness of activities to the service users' cancer type and treatment history), and a discussion of behaviour change support. The latter covers the service user's motivations, confidence and barriers to achieving and maintaining behaviour change. Practitioners help individuals to set goals and plan how these goals will be met. The practitioner may use the Macmillan Move More guide to shape the conversation. As part of the initial intervention, plans for longer-term support should be agreed. Ongoing support should be provided at a time, location and in a format appropriate to the service user. Regular reviews should be undertaken to check progress against goals, suitability of activities chosen, cancer status and to provide information and/or signposting to wider Macmillan services such as financial advice and psychological support, if required. In relation to activity choice, service users are able to choose from a range of activities according to their exercise preferences and support needs. As a minimum, service users should be able to choose from the following: Macmillan Move More DVD, health walks, sports, community activities (such as Zumba, gentle exercise etc.), cancer/long term condition specific sessions where appropriate, and encouragement to increase PA in daily life (e.g., active travel, carrying shopping). Raising awareness begins with service teams building good relationships with cancer care teams and professionals are encouraged to access the Understanding PA and cancer training. The model is based on services being integrated into the local delivery of the Recovery Package. The Recovery Package is a series of key interventions which, when delivered together, can improve outcomes for people living with and beyond cancer. The Recovery Package is made up of (i) an assessment and care plan using Holistic Needs Assessment (HNA), (ii) a Treatment Summary, (iii) a Cancer Care Review, and (iv) a Health and Wellbeing event. In brief, the HNA identifies the needs of the person living with cancer and ensures that they are met. It is a questionnaire that is completed and which allows a person to highlight the most important issues to them including those concerned with PA. This then informs the development of the care and support plan produced by the healthcare professional. A HNA should be undertaken at each different stage of a patient's treatment journey. The HNA is also available in an electronic format (eHNA) where a referral for PA can be indicated by a tick box. A cancer care review is a discussion between a patient and their GP or practice nurse about their cancer journey. It is designed to signpost what information and support is available to them in their local area. This review should occur within six months of cancer diagnosis. Health and Wellbeing events are designed to help patients to access the support that they may need during and after cancer treatment. They typically provide information and support on a range of issues including diet and exercise, treatment side effects, benefits and financial support and the local services available. Referral will be via healthcare professionals (HCP) including GPs, oncologists, clinical nurse specialists, physiotherapists, occupational therapists or by self-referral.

Evaluation

Fourteen services were included in a national evaluation of the intervention across England, Wales and Scotland between September 2014 and July 2017. Most service users have been referred to the service by HCPs, most commonly by clinical nurse specialists (32%) or they had self-referred (26%) (Moreton et al., 2018). There were no significant referrals by GPs to the service. The majority (64%) of interventions were delivered face-to-face and delivered by a qualified Move More practitioner. Fidelity to the intervention was somewhat lacking. The average (mean) behaviour change counselling index (BECCI) (Lane et al., 2005) score was 22.8 (out of a possible total of 44). This indicated that the practitioners were generally delivering motivational interviewing consistent behaviour change interventions only 'to some extent'.

Self-reported data suggests service users generally maintained or increased their levels of PA following engagement with the service. The mean change was from 345 mins/week of PA at baseline (n=2607) to 475 mins/week at 3-months (n=1112). There were further increases at 6-months (509 mins/week (n=580)) and 12-months (521 mins/week (n= 305)). These increases in PA were statistically significant. However, this data is for completers only, rather than on an intent-to-treat basis (i.e., including all those assigned an intervention), and is very likely to be biased towards those who continued to engage in sustained PA. Furthermore, at baseline 69% reported achieving 150-minutes of PA per week and therefore did not appear to recruit those most in need of exercise intervention. Only 13% of participants were classified as inactive (i.e., less than 30 mins/week of PA) at baseline. There were statistically significant improvements to quality of life (using EQ-5D), self-assessed health and fatigue (FACIT) between baseline and 3 months, 3 and 6 months and 6 and 12 months. However, the largest increase was observed between baseline and 3 months, with more modest increases thereafter. In relation to costs, taking the (recommended) cost per completer approach the mean cost per completer was £291 (£265 excluding set-up costs) with a range from £64 to £531. The economic analysis within the evaluation provides estimates of cost per quality-adjusted life year (QALY). The signposting-to-physical-activity model achieved a much lower cost per QALY than the direct delivery model of physical activities within the service. This indicates that a model that focuses on providing long-term person-centred behaviour change support, with access to a wide variety of PA opportunities that meet the needs of the cancer population, is likely to be cost-effective (Moreton et al., 2018).

Conclusions

It is difficult based on the evidence from this evaluation to state whether the 'Move More' PA behaviour change care pathway is effective or cost-effective. The evaluation demonstrates feasibility in terms of scaling up of an intervention and in terms of maintenance, the intervention has been rolled out to 14 services nationwide. However, in consideration of the RE-AIM framework (Glasgow et al., 1999), the reach of the intervention would appear to be modest and retention/programme completion is low. One of the main barriers to assessing effectiveness is the use of self-reported PA (using the Scottish Physical Activity Questionnaire) which is likely to overestimate true levels of PA engagement. Further, given that a high proportion is meeting the PA guidelines at baseline (i.e., 69%), the programme may be recruiting motivated cancer survivors and not serving those most in need of a PA intervention. Despite these limitations, the intent-to-treat approach to the economic evaluation suggests that the signposting-to-physical-activity model may be cost-effective in terms of QALYs.

CANADA

Case-study:
Oncologist Referred Exercise and Healthy Eating Programme

The NExT study (Kirkham et al., 2018) was designed to assess the effectiveness of a supervised exercise and healthy eating programme offered as part of supportive care in a real world setting. New breast cancer patients who were receiving adjuvant chemotherapy were referred to the programme by medical oncologists using a prescription to facilitate with patient screening and enhance enrolment. The programme was evaluated using the RE-AIM framework to report on reach, effectiveness, maintenance, and implementation. For the purposes of this review, only the physical activity components and outcomes will be described.

The Intervention

The exercise intervention included aerobic and resistance training based on the guidelines for cancer survivors. Supervised sessions took place at a stand alone fitness facility used for individuals with cancer or other chronic diseases located near the cancer treatment centre. The goal of the combined supervised and home-based prescription was to meet the recommendations for cancer survivors of 150 weekly minutes of moderate-intensity aerobic exercise, and whole-body resistance training two to three times per week. The exercise programme was divided into three phases: treatment (length of chemotherapy, plus radiation if received) (3 supervised sessions per week), post treatment (10 weeks, 2 supervised sessions per week), and maintenance (10 weeks, 1 supervised session per week). The latter two phases were designed to step down the number of supervised sessions offered and increase the amount of home-based exercise encouraged.

Participant Eligibility

Participants were newly diagnosed breast cancer patients (stage I–IIIA) who were scheduled to receive adjuvant chemotherapy (with or without radiation) and were invited to enrol within the first half of their chemotherapy treatments. Exclusion criteria were conditions requiring closer monitoring of exercise supervision (e.g., uncontrolled/unstable cardiovascular disease or diabetes mellitus), BMI >40 kg/m2, use of mobility aids, and stage IV/metastatic disease. Patients were referred by a medical oncologist. Referrals via word of mouth were also accepted for patients treated at the centre. A team of eight medical oncologists completed and signed a prescription for eligible patients to participate in the programme. The prescription form included documentation of comorbid health conditions and medications and provided clearance to exercise. Recruitment was opened for 12 months as a measure of yearly intake for a potential clinical programme. Additional funding allowed recruitment to be extended to a total of 15 months.

Primary Outcomes

Reach

The programme referral rate was 53% (82/154). The master list generated 938 patients who attended a medical oncology consultation during the study recruitment dates, of whom 772 (82%) were ineligible and 154 were eligible (16%) for the study. Reasons for ineligibility included the following: not receiving adjuvant chemotherapy (n=620), living outside of Vancouver lower mainland (n=45), non-English speaking (n=37), non-invasive breast cancer (n=34), having stage IV or metastatic breast cancer (n = 17), not having decided on an adjuvant treatment plan prior to study closure (n=8), disability/mobility issues (n=6), multiple comorbidities and safety concern for group-based exercise (n=3), or male gender (n=2). Medical oncologists referred 82 eligible patients and 12 non-eligible patients who were part of this master list. An additional 15 patients were referred who were not part of this list (n=109 referrals total) due to having their consultation prior to the start of programme recruitment (n=5) and unknown reasons (n=10).

Uptake of the programme was 78% (73/93). Sixteen of the 109 patients referred were ineligible, and 20 declined to participate. Of the 93 who were referred and eligible, 73 enrolled in the programme. Nine participants withdrew from the study between enrolment and completion of chemotherapy due to living too far from gym (n=4), illness (n=2), work schedule (n=1), family obligations (n=1), and personal reasons (n = 1); therefore, retention was 88% for the treatment phase. Five of these participants withdrew prior to starting the programme. Following treatment completion, an additional seven participants did not attend any further sessions due to moving away (n=2), returning to work (n=2), treatment symptoms (n=1), mental health (n=1), and unknown reasons (n=1). Therefore, retention for the entire programme duration was 78%. The programme length was 45.0 ± 8.3 weeks. Regarding representativeness, participants in the programme were significantly younger (50.8 ± 10.6 years) than eligible women who were not referred (55.6 ± 10.6 years, $p < .01$).

Implementation

Adherence was defined as the number of sessions attended out of the number of prescribed sessions. The average exercise adherence across participants was 60% (± 26%) for the treatment phase and 52% (± 33%) for the post-treatment phase and 50% (± 38%) for the maintenance phase. The estimated cost of the NExT programme for the first year and for subsequent years was $44,821 and $41,766 USD (i.e., €41,783 and €38,935. Authors estimated the average cost per participant starting the programme to be $1,273 USD (€1187). Regarding safety, no major adverse events occurred.

Effectiveness

Weekly minutes of MVPA significantly increased from baseline (115 ± 14) to end of programme (156 ± 14) (p=.008) and was maintained between end of programme and 1-year follow-up (172 ± 23) (p=.465) and remained significantly higher than baseline at 1-year follow-up (p=.009). However, it should be noted that a high proportion (i.e., 44%) were meeting or exceeding the MVPA guidelines at baseline. The proportion meeting the guidelines increased to 65% at end of programme ($p = .034$). At 1-year follow up, 55% were meeting the guidelines. From baseline to end of programme, The average minutes of resistance training per week increased from baseline (11 ± 4) to end of programme (39 ± 4) ($p < .017$) and decreased between end of study and 1-year follow-up ($p < .017$). At 1-year follow-up, resistance training (19 ± 5) was not significantly higher than baseline ($p > .017$).

Conclusions

The NExT study provides an example of real-world translation of an exercise intervention into a clinical care setting. The programme was successful in receiving referrals from a team of medical oncologists. The majority (66%) of patients that attended a breast medical oncology consultation were excluded because they were not receiving adjuvant chemotherapy. Uptake to the programme was high and retention rates were reasonable. Similar to the previous two case-studies, one of the main barriers to assessing effectiveness of NExT was the use of self-reported PA (Minnesota Leisure Time PA Questionnaire) which is likely to overestimate true levels of PA engagement. Further, almost half the participants were meeting the PA guidelines at baseline (44%). As such, the programme may be recruiting motivated cancer survivors and not serving those most in need of a PA intervention. Further, despite the statistically significant improvements in MVPA, only 11% more were meeting the MVPA guidelines at 1-year follow up.

Step 3: Comparison of national provision in Ireland with international evidence

This scoping review has found that overall, there is very little systematic PA provision for cancer patients and survivors in Ireland. In regards to community provision, 43% of community cancer support centres currently offer PA opportunities or programmes. The most common activity provided through community cancer support centres was yoga (offered at 13 centres). Only 5 community cancer support centres provided an exercise programme that included a blend of aerobic and resistance training. Two community cancer support centres funded and referred clients to ExWell Medical for a 12-week group-based exercise programme for those with chronic conditions (not a cancer specific programme). Both CCSCs reported low interest and low uptake to the programme. The only other provider of community-based exercise programmes specifically for cancer survivors was ExWell Medical. Despite an established reputation in Ireland, ExWell reported overall low levels of referral, low uptake to exercise programmes and logistical difficulties to offering more personalised and tailored interventions to improve uptake and adherence.

Similarly, there were few standard of care exercise programmes provided in the hospital setting; two involved supervised group-based exercise programmes in the outpatient setting at HOSP 10 (with dedicated oncology physiotherapists). Another involved a single session/exercise prescription with a physiotherapist (only for lung cancer patients) at HOSP 14. The only other programme identified was the 'Moving On' programme at HOSP 3. However, 'Moving On' is not specifically an exercise programme, but rather a multi-disciplinary survivorship half-day educational workshop (supported by an online platform). Only one hospice-care provider (HPE 1) provided a supervised once per week exercise programme for outpatients in the palliative care setting.

The scoping review identified activity in the research setting with 15 exercise interventions underway or completed. Most interventions involved supervised or prescribed exercise and were group-based programmes (n=11) and included those post-treatment (n= 10). Others included eHealth interventions or wearable technology (n=3) or a combination of supervised and home-based exercise (n=1). Most interventions were delivered by physiotherapists (n=9) and in the outpatient hospital setting. In relation to effectiveness, most studies (n=6; 54.5%) observed no significant differences between groups in either aerobic fitness parameters or MVPA outcomes. Of the 5 that assessed PA objectively, no significant increase in MVPA was observed.

Similar to research in Ireland, most international studies (across 18 reviews) also focused on PA interventions for cancer patients post-treatment. In contrast to the exercise oncology research in Ireland with only about 20% of interventions to date using eHealth or wearable technology, many of the more recent international reviews (n=7, 39%) focused on the effectiveness of eHealth and mHealth interventions with three that assessed the efficacy of consumer wearable devices on PA. In terms of efficacy, the research in Ireland has reported disappointing results with over half finding no significant effect between group differences on PA outcomes. In contrast, the international reviews on broad intervention effects found that interventions tended to have a small but significant effect on PA among cancer survivors compared to usual care (Stacey et al., 2015; Turner et al., 2018; Goode et al., 2019; Grimmett et al., 2019; Sheeran et al., 2019). There is also some evidence to support short-term (6-month) PA maintenance following intervention (Turner et al., 2018; Grimmett et al., 2019). Across all PA interventions among cancer survivors, Sheeran et al. (2019) identified an average effect size of small-to-medium magnitude (d+=.35). This effect size equates to ~ 47 extra minutes of MVPA/wk and is likely to be clinically meaningful.

Most exercise oncology interventions in Ireland have involved supervised twice weekly programmes (i.e., 73%). The international literature supports the effectiveness of supervised programmes with major differences in intervention effectiveness attributable to supervised versus unsupervised programmes (d+=.49 vs. .26) (Sheeran et al., 2019). Intervention contact time was associated with larger effect sizes for supervised programmes. Greater contact time was associated with larger effects in unsupervised programmes too (d+=.42 vs. .23).

Despite the effectiveness of supervised exercise programmes for cancer survivors, the international literature reveals an increasing interest in low-intensity PA interventions that are more likely to be scalable. In more recent years, internationally there has been increasing interest in the implementation of eHealth and mHealth interventions to increase PA in cancer survivors. Indeed, this is evidenced by the number of reviews in this area published in the last 5 years (n=7), and the efficacy of wearable activity trackers. Such interventions have been largely absent in the Irish context other than two recent studies (i.e., Walsh et al., 2021 & Haberlin et al., 2019). The international reviews suggest that wearable activity trackers are effective tools that increase PA in individuals with cancer (Singh e al., 2022; Khoo et al., 2021; Schaffer et al., 2019; Roberts et al., 2017; Coughlin et al., 2020). The most recent meta-analysis in this area provides strong support for wearable interventions. Singh et al (2022) found that wearable devices had moderate-to-large effects on moderate-intensity PA (SMD=0.87) and MVPA (SMD=0.61). Singh also found that theory-based interventions (SMD=0.93) had larger effects on total PA than non-theory-based interventions (SMD=0.40). Interventions that included baseline counselling had larger effects on moderate-intensity PA (SMD=1.13 vs 0.26). In comparison, very few interventions in Ireland have been based on a theory of behaviour change (except for Sheehan et al., 2020 and Walsh et al., 2021) and none have included baseline counselling.

The scoping review of exercise oncology interventions in Ireland also found an absence of healthcare provider-delivered (i.e., oncologist/consultant) PA interventions. There have been relatively few studies in this domain internationally. However, Brunet et al's (2020) review suggests that healthcare provider-delivered PA interventions may help to increase PA in cancer survivors with nine studies (of 11) reporting between-group differences in PA behaviour favouring the intervention. Although the evidence base in this area is sparse, Brunet found that interventions deemed "lower intensity" (i.e., involving a single recommendation for PA given in-person during a regularly scheduled appointment), may help to increase PA behaviour. For example, Jones et al. (2004) and Park et al. (2015) found that cancer survivors who received a PA recommendation from their oncologist engaged in more PA at follow-up than cancer survivors who did not receive the recommendation. PA recommendations provided by an oncologist alone may be enough to achieve small changes in cancer survivors' PA behaviour.

Four exercise oncology research studies in Ireland examine the effectiveness of PA interventions for prehabilitation (with two of these actively recruiting at present). This reflects a growing interest in prehabilitation for cancer patients internationally with five international reviews that met the criteria for inclusion in the present scoping review. In the Irish context, there were mixed findings concerning efficacy. One study found a significant difference between groups in physical function (6MWT) favouring the intervention (Tully et al., 2020) whereas Loughney et al. (2019) found no significant improvement in the 6MWT performance. The most contemporary meta-analysis in this area demonstrated statistically significant improvements in functional capacity (i.e., between group mean difference on the 6MWT of 58 metres) following surgery indicating that prehabilitation can improve postoperative functional capacity (Michael et al., 2021). Similar improvements in functional capacity following a home-based exercise programme were observed by Van Gestel et al. (2022). However, the international literature to date provides little evidence to support the role of prehabilitation in reducing postoperative complication rates, hospital length of stay, readmission rates or emergency room attendance. Home-based prehabilitation programmes display promise for improving functional capacity, as evidenced by Van Gestel's (2022) meta-analysis and further research comparing the effects of hospital-based vs home-based prehabilitation would be worthwhile.

The scoping review of exercise oncology research in Ireland did not locate any research in either the palliative care setting or in childhood and adolescent cancer patients or survivors, and only one existing exercise programme in the community setting for those with advanced cancer. The review of reviews analysed as part of the present overarching review demonstrates that exercise is safe and feasible in this cohort and likely to be a valuable tool for individuals living with advanced-stage cancer to improve physical function, aerobic fitness, and sleep quality. Internationally, research concerning exercise

interventions in children and adolescent cancer survivors is in its infancy with 56% of reviews in this area primarily assessing the safety, feasibility, and acceptability of exercise interventions in the paediatric cancer setting (i.e., Mizrahi et al., 2017; Cheung et al., 2021; Bauman et al., 2013; Rustler et al., 2017; Kopp et al., 2017). Overall, the systematic reviews on exercise interventions in paediatric oncology confirm that engaging childhood and adolescent cancer patients in PA is acceptable, feasible and safe. There were inconsistent findings across the systematic reviews concerning the effectiveness of interventions on PA behaviour change. Cross et al. (2020) found significant improvements in PA following intervention in 67% of included studies and two other reviews reported significant increases in IGs in 50% of included studies (i.e., Cheung et al., 2021; and Munsie et al., 2019). Overall, the preliminary research on exercise interventions demonstrates a trend toward PA providing benefit to children and adolescent cancer patients.

In summary, there is strong evidence from international reviews that exercise interventions in cancer survivors following active treatment effectively increases PA and provide small but clinically meaningful changes in MVPA relative to usual care. The main limitations of research in exercise oncology apply to both existing work in Ireland and internationally, that is; (i) an overreliance on the use of self-reported PA, rather than objective measures; (ii) small sample sizes that lack statistical power to detect changes in PA between groups; (iii) a dearth of research on the maintenance of PA following intervention cessation. The latter makes it difficult to draw conclusions concerning the most effective types of interventions.

In general, interventions with greater contact time, theory-based interventions and interventions using several evidence-based BCTs (e.g., graded tasks, self-monitoring, action planning, goal setting, and social support) provided greater effects on PA in cancer survivors. In a recent review (excluded from inclusion in the present scoping review because it was limited to breast cancer survivors only), BCTs with the highest potential to increase PA were adding objects to the environment, (pedometer or accelerometer) followed by goal setting and self-monitoring of behaviour (Hailey et al., 2022). Preliminary evidence also supports the potential efficacy of low-intensity interventions (i.e., involving a single recommendation for PA given in-person during a regularly scheduled appointment) delivered by clinicians to change cancer survivors' PA behaviour. Further, the most recent reviews provide strong support for digital and wearable interventions for increasing PA in cancer survivors with Singh et al (2022) reporting large effects on moderate-intensity PA (SMD = 0.87). The greatest effects of wearable interventions on moderate-intensity PA were found in those that included baseline counselling activity. It is worthwhile to consider the factors influencing PA participation and exercise preferences among cancer survivors to increase adoption and maintenance of exercise. Although an examination of the dimensions influencing exercise participation or exercise preferences was not part of the present scoping review, recent reviews in this area (for adult cancer survivors) have been included below for completeness.

Factors Influencing Exercise Engagement and Exercise Preferences among Survivors

Four systematic reviews were identified through databases (i.e., Scopus, Web of Science, CINAHL, Pubmed) that examined either the facilitators and barriers to exercise engagement amongst cancer survivors or PA preferences. Only reviews that comprised of multiple cancer types in adults were included. In Wong et al's (2018) systematic review (with 41 studies), participants in most studies expressed an interest in participating in an exercise programme. Twenty-four studies explored exercise programme start preferences. There were varying preferences for when to start a programme. However, most studies found participants to prefer starting a programme 3–6 months after treatment. Three studies assessing mixed cancer survivors (bladder & breast) found their participants to prefer starting an exercise programme immediately after treatment. Four studies, two assessing lung cancer survivors and two with mixed cancer survivors found their participants to prefer starting a physical activity programme before treatment and three studies found survivors to prefer starting a PA programme during treatment or at diagnosis or soon after.

In relation to exercise preferences, almost all studies indicated a specific preference for walking as a preferred mode of PA suggesting that walking-based programmes are likely to increase interest in participation. Wong et al. (2018) found no consensus on preferred PA companion. Generally, studies were divided, with around a third of quantitative studies finding cancer survivors to predominately prefer exercising alone, to have no preference, or to exercise with a companion.

In relation to delivery of PA interventions, cancer survivors indicated a preference to receive PA counselling or information from a fitness expert associated with a cancer centre or a PA specialist. For example, Forbes et al. (2015) found that breast, prostate and colorectal cancer survivors most commonly preferred to receive PA information from a fitness expert from a cancer centre and this was the strongest preference across six studies. A clinical specialist (i.e., oncologist, GP, specialist nurse) was the second most common preference for PA counselling or information delivery. These findings were reinforced in a study by Craike et al. (2017) who found multiple myeloma survivors to mostly trust healthcare clinicians (i.e., general practitioners, haematologists, oncologists) to deliver appropriate PA information. Wong et al. (2018) also found a strong preference for unsupervised PA (in 68% of studies) whilst almost a third (32%) preferred supervised exercise.

Wong et al. (2018) also found a preference for home-based exercise in most studies (64.5%). However, there were some alternate exercise location preferences amongst the included studies. For example, two studies with lung and colorectal cancer survivors respectively identified a preference for gym-based exercise (i.e., Philip et al., 2014; Spence et al., 2011). The gym was attractive to colorectal cancer survivors because of the wide variety of machine selection, regulated temperatures, and ability to regulate exercise intensity. In another qualitative study participants highlighted the importance of having PA location options that accommodate participants, since cancer survivors may face location barriers that may influence their ability to engage (Whitehead & Lavelle, 2009).

In a more recent systematic review, Elshahat et al. (2021) also found walking to be the most preferred type of PA amongst cancer survivors across cancer types during the treatment and post-treatment stages. Elshahat and colleagues also found that oncologists were the most preferred source of PA information among patients across cancer types, followed by physiotherapists and nurses. Around 60–80% of mixed cancer patient participants across quantitative and qualitative studies preferred to receive exercise information from oncologists (Phillip et al., 2014; Avancini et al., 2020; Smaradottir et al., 2017). Elshahat et al. (2021) also found that cancer patients preferred to begin an exercise programme after completing cancer treatment. A preference to exercise alone, and in the morning was commonly observed across cancer types and treatment stages. In relation to the factors influencing PA participation, Elshahat's review found low self-efficacy and motivation/self-discipline were common barriers amongst cancer patients across treatment stages. Lack of social support was also reported as a key barrier to PA across cancer types. Cancer survivors described that discouragement by family and limited support/guidance by clinicians hindered their exercise engagement. Financial issues (e.g., being unable to afford a gym membership) were identified as a major economic barrier to exercise participation among patients across cancer types. Inaccessible facilities also represented a significant barrier to participation among cancer patients and this included limited availability of cancer-specific exercise services and inaccessible parking areas. On the other hand, availability of affordable exercise programmes was a common facilitator of PA engagement among cancer patients. Perceived health benefits and positive previous experiences with exercise were identified as strong facilitators of exercise engagement in cancer survivors (Elshahat et al., 2021).

The systematic review by Clifford et al. (2018) also found walking to be the preferred type of exercise, at a moderate intensity, beginning either immediately after completing treatment or 3–6 months following treatment completion. Clifford et al. (2018) found that a lack of knowledge or a lack of information was a significant barrier to the adoption and maintenance of exercise. The review identified a lack of PA information from health professionals and a lack of knowledge amongst survivors concerning

exercise type and intensity that is safe and effective. In relation to exercise counselling or advice, cancer survivors preferred to receive PA information face-to-face but with the option to exercise at home either supervised or unsupervised.

The final review by Hoedjes et al. (2022) explored the psychosocial determinants of PA behaviour change following diagnosis. Hoedjes found social support to be significantly positively associated with changes in PA. Frequently mentioned barriers of PA amongst qualitative studies in the review included a lack of information or advice from healthcare professionals, competing time demands and issues with facilities or resources (i.e., proximity/access). Consistent with the wider literature on behaviour change, self-efficacy was found to be a significant determinant of change in PA. Likewise, a lack of motivation was a commonly reported barrier to exercise engagement. The qualitative studies included in the review found that self-monitoring and feedback on behaviour were frequently mentioned as facilitators of exercise.

To summarise the reviews, concerning exercise preferences, walking is the most preferred type of PA amongst cancer survivors and survivors prefer to start an exercise programme either immediately after or 3–6 months following treatment completion. Cancer survivors had a strong preference for unsupervised PA and predominately preferred to exercise alone and in the morning. The reviews identified a lack of PA information from health professionals and a lack of knowledge amongst survivors concerning exercise recommendations. Further, oncologists were either the most preferred or second most preferred source of PA information among patients across cancer types. Wong et al. (2018) identified a preference to receive PA counselling or information from a fitness expert associated with a cancer centre or a PA specialist. Overall, low self-efficacy and motivation/self-discipline and a lack of social support were common barriers amongst cancer patients across cancer types. Financial issues (e.g., being unable to afford a gym membership) were identified as a further barrier to exercise participation alongside limited availability of cancer-specific exercise programmes.

Proposal of national recommendations and strategies to implement physical activity and exercise services for cancer survivors: Stage 3

Proposal of national recommendations and strategies to implement physical activity and exercise services for cancer survivors: Stage 3

The final stage of the project involved stakeholder engagement to contribute to various work elements (i.e., WE2, WE4) including the development of national recommendations in this area (WE5) and strategies to implement programmes and services in this area (WE6/7). Key stakeholders (including individuals living with and beyond cancer, representatives from patient advocacy groups and cancer charity organisations, oncology healthcare professionals, exercise oncology service and programme providers and exercise oncology researchers) were invited to attend an online roundtable discussion. At the beginning of each roundtable discussion findings from stage 1 and stage 2 of the present scoping review were shared with attendees, who were asked to discuss key topics identified (e.g., how can PA services for cancer in Ireland be expanded?) (WE2); ii) how can the gaps between research and practice be bridged? (WE3). Participants for this stage were generally those recruited from a previous stage that had consented to be contacted again to be invited for a focus group discussion. The only additions were oncologists that were sought out to participate in the discussion and consumer representatives. Oncologists were invited on the basis that they were known to be exercise advocates in cancer survivorship in Ireland. Consumer representative contact details were provided by the NCCP through their Physical Activity & Exercise Sub-group and had consented to participation in the discussions prior to their contact details being shared by the NCCP with the research team. A participant information sheet was provided to participants and written consent obtained prior to the roundtable discussion. Permission was provided for recording the interviews. Each discussion was transcribed verbatim using a professional transcription service. Following transcription, the data was coded and analysed using thematic analysis to identify themes in relation to topics covered in the interview guide (see Appendix C) (Braun & Clarke, 2006).

Forty participants covered in 4-5 roundtable discussions was considered an adequate number to obtain various perspectives on the ways forward regarding the expansion of exercise programmes and PA services in Ireland for cancer survivors. Research also supports these numbers. For example, in a large focus group study with 40 focus groups, the authors observed that 90% of all themes identified were discovered within 3 to 6 focus groups and that 3 focus groups were sufficient to identify all the most prevalent themes within the data set (Guest, Namey & McKenna, 2016).

The Roundtable Discussions

Five roundtable discussions were conducted between July and September 2022. Focus group discussions were conducted by Zoom and audio-recorded (with permission) using an Olympus digital voice recorder (WS-811). Each discussion lasted for approximately two hours. In total, 40 participated in the roundtable discussions including oncologists (n=3); oncology nurses or advanced nurse practitioners (n=5); physiotherapists (n=6); academics working in physiotherapy or exercise physiology (n=5); community cancer support centre managers (n=6); consumers (n=5); exercise specialists (n=3); representatives from the NCCP (n=4); community providers of exercise programmes (n=2) and a chartered psychologist (n=1). Each discussion began with brief introductions followed by the lead author (SH) providing a summary of the findings from stage 1 and 2 of the scoping review before opening for discussion on the ways forward to promote PA more effectively to cancer survivors.

Results

Four primary themes and five sub-themes were identified: (i) embedding PA into the cancer pathway (including sub-themes of 'singing from the same hymn sheet', 'PA as an essential element of treatment', and 'intervention opportunities and models of care'); (ii) education and training; (iii) access to appropriate PA interventions (including sub-themes of 'limited access to exercise specialists' and 'ineffective exercise referral and lack of PA services'); and (iv) tailored and effective programmes.

Embedding PA into the Cancer Pathway

The dominant theme across the roundtable discussions was the importance of embedding PA into the cancer pathway. This theme includes the sub-themes of 'singing from the same hymn sheet' and 'PA as an essential element of treatment' and 'intervention opportunities and models of care'. Participants referred to the importance of oncologists and that PA promotion should start with them: "this all has to emanate from the consultant. If it's not coming from top down, I feel there's no buy in" (Academic 1) and "it's that top down… from the oncologists to engage and the clinical nurse specialists who are dealing quite intimately with the patients…that's really where the core of information will come" (Physiotherapist, HOSP 15). Participants stated unequivocally that PA should be embedded as a key part of their treatment and assessed in the same way that other clinical parameters are measured as part of usual care: "it should become embedded as a key element of care, just like measuring your blood pressure or checking your blood count" (CPEP1) and "if we could give everyone a Godin leisure time questionnaire…to describe the intensity level of activity they do per week and then using that information to inform what level of support people need" (Exercise Physiologist, NO 1). It was also deemed important to begin on a PA pathway upon diagnosis: "it's important to have the exercise specialist involved in the treatment plan from day one and that is embedded in there as part of the cancer care continuum" (Academic 3) and "getting to people early is important because if you wait until they have finished treatment you are missing out on the benefits that accrue during their treatment" (Physiotherapist, CCSC 6). In some cases, PA may not be a high priority to oncologists: "the doctors come in and out and they have different views…some people view this as not a priority" (Medical Oncologist, HOSP 1). Participants also believed that the NCCP played an essential role in reaching oncologists: "it has to be through the NCCP…if we have the buy in through the NCCP we will get the Oncologists" (Cancer Nurse Specialist, HOSP 1).

Singing from the same hymn sheet

As part of the theme to embed PA into practice, it was deemed important that all healthcare professionals were involved in the promotion of PA: "we need to get all of the oncologists and oncology nurses and ANPs on board…keep it on the agenda all the time and that it is not just oncologists, it is the surgeons, the diagnostics, it is the Radiation Oncologists, all of these people have a role to play in promoting exercise from the beginning" (Advanced Nurse practitioner, HOSP 1). Another commented "absolutely we have to have clinicians stressing the importance of this whether it is the consultant, the nurse or anybody in the multi-disciplinary team (MDT)…The MDT stressing the importance of exercise…and I think it is important then that the self-managed part is emphasised, you know, that the patient takes responsibility for their health because this will benefit them regardless of their cancer" (NCCP1d). It was also seen as important that all healthcare professionals sing from the same hymn sheet: "they have to give the same message that exercise is extremely important part of your journey and keep hearing that no matter where they go" (Academic 1) and "if a service user comes into your service everyone is telling them the same thing" (breast cancer survivor) and "it requires absolutely everybody from day one to be saying the same thing" (Advanced Nurse Practitioner, HOSP 1). The continuity in PA messaging was viewed as particularly important given a consumer's recollection of negative feedback on her exercise participation by a cancer nurse specialist "it's more negative, you should be taking it easy" (breast cancer survivor). The importance of consistent messaging to patients by the whole oncology team was underlined: "you can't underestimate the value of your nursing staff in terms of, you know, that whole collaborative piece. You know, when someone is getting chemotherapy, they're in the day ward for a number of hours. They're in the chair. They're talking to the nurses…and it's not that we want to burden already very busy healthcare staff with giving out exercise prescription, but we just want them to reiterate the message that it is ok to exercise and giving that encouragement" (Academic 4).

PA as an essential element of treatment

All participants believed that PA should be an integral and essential part of cancer treatment: "to evoke/embed exercise as a normal part of the pathway, and an essential part of the pathway" (CPEP1a). Participants stated that PA intervention should be viewed as part of the treatment package for the patient "to say you are finished with your treatment part and now I want you to go to this end of treatment workshop please so that is your next appointment" (NCCP1a). There was a strong sentiment amongst participants that PA promotion to patients should be mandatory and prescriptive with appropriate rationale provided, for example: "we're prescribing this as a measure to counteract and limit some of the side effects of treatment initially" (Physiotherapist, HOSP 10) and "this is what you're supposed to be doing…exercise is safe and not only is it safe but you have to exercise…if you don't exercise you know you're more at risk of recurrence" (Physiotherapy Manager, HOSP 7). One oncology unit at HOSP 1 provides exercise prescriptions to patients: "we print it out and give it when we are discussing chemotherapy or hormone therapy" (Medical Oncologist, HOSP 1). Prescribed exercise was also advocated by a consumer: "my initial meeting with my oncologist and my radiation oncologist both said to me…the best things you can do for yourself are keeping active and keeping your weight down… but I heard them at the beginning and never again…it really needs to be prescribed…I want to see you walking. Exercising for x amount or at least aiming for it" (breast cancer survivor).

Intervention opportunities and models of care

Potential intervention opportunities and other models of care that could be translated to the PA domain was a sub-theme of embedding PA into the cancer pathway. One such intervention opportunity is the integration of PA information within the chemotherapy education session that all patients receiving chemotherapy receive: "we do chemo education, and I would spend usually up to an hour with the patient…I give many a week, I have never been asked about exercise. We cover it. We normally tell people to keep moving, keep to the level you are at if you can, but it is a sentence or two in an hour, there is something to be done there I think" (Cancer Nurse, HOSP 3). The potential of such sessions was echoed by the NCCP "the daffodil nurses in all centres do a chemo education session at the start of treatment…maybe we could be stronger in our messaging as regards to exercise… even using some of the pieces you have talked about earlier in terms of time [minutes] and you know and importance of the type of moving [exercise intensity] that you do" (NCCP1b). The meeting with the physiotherapist following surgery was also identified as an intervention opportunity to promote PA behaviour change rather than short-term mobility: "when I was in for surgeries you'd have a visit from physio and they go through the exercise…to stretch and all of that…there would be a real opportunity there for a physio to give people permission to start walking…so it's not just your exercise for the next 10 days or whatever" (breast cancer survivor).

Other models of care that could be transferred to exercise oncology were raised including that for cardiac rehabilitation: "when someone has their myocardial infarction…the cardiac rehab pathway almost starts straight away" (Academic 4) and "other patients need help and need assistance and for those patients they need to have, in the same way as it is standard of care for post MI, you go into your Phase II or Phase III your Cardiac Rehab Programme. You have a short intensive block where you can get focused intervention" (Physiotherapy Manager, HOSP 7). Others referred to existing models in cancer care including that for psycho-oncology that adopts a stepped care approach to intervention. It was noted that existing programmes (primarily group-based exercise programmes or one-on-one interventions with an exercise specialist or physiotherapist) were not required for all survivors: "everybody doesn't need a structured programme and I would be going towards a model of care (like) psycho-oncology…that is stepped so we know we're going to start off at the top for people who just need written information, advice or recommendations from healthcare professionals" (Physiotherapist, HOSP 8). Although a psycho-oncology model of care has been implemented in Ireland, uptake of the service may not be high: "the national cancer centre [NCCP] actually says that all patients should have the opportunity to see psycho-oncology and nobody in Ireland seems to want to take up the psycho-oncology service, patients I mean…the next best thing and maybe even better is exercise" (Radiation Oncologist, HOSP 11 and

HOSP 10). A stepped care approach and innovations in exercise interventions was also highlighted as crucial to reach the large number of newly diagnosed patients every year: "we don't have anywhere near the capacity to take all patients. So, I think we have to be pragmatic and take a staged approach here. It is obvious that centre-based facilities probably just won't work…so I think we have to be innovative in how we can facilitate PA" (Academic 1).

Education and Training

Education and training were identified as a theme and included training for healthcare professionals and allied workers in the cancer space concerning the importance of PA for cancer survivors, knowledge of the guidelines and appropriate PA primarily. It seems that patients do not tend to receive written information or specific recommendations concerning PA: "there's very much a lack of information regarding exercise… no oncologist or breast surgeon or nurse suggested it to me" (breast cancer survivor). Cancer survivors may also not be aware of the importance of PA for their health or survivorship trajectory: "a lot of patients don't realise the importance of exercise when they are diagnosed" (CCSC manager). Related to education on the PA guidelines for cancer survivors, there were concerns raised regarding some of the physical activities offered at community cancer support centres that do not align well with the PA guidelines: "at our local centre they have yoga or pilates but that is not meeting your activity guidelines…you can't put them in the same bracket as getting your cardiovascular exercise and the importance of that imparted to the patient" (Physiotherapy manager, HOSP 7). In the summary of the scoping review to date provided at the beginning of each roundtable, the lead author described that yoga was the most common PA provided at community cancer support centres, offered at thirteen community cancer support centres. Participants believed this reflected the perception that survivors should only participate in gentle exercise or a lack of knowledge concerning appropriate PA: "I think that highlights that we still tend to think that people are not able to do that 150 minutes [of moderate-to-vigorous PA]…Yoga is provided because it's seen as gentle sport…a kind of gentle way of half exercising, but not going to hurt them…I think that sends the wrong message" (Cancer Nurse, HOSP 3). Other participants echoed the point on the need for education on appropriate PA for survivors and for those involved in the promotion of PA to cancer survivors: "the understanding of the benefits of exercise for the patients is just…not out there the way it should be…You get into that conversation when….even in our place, well you say go to the gym or…oh I don't really feel like it, I will do yoga, as if it is comparable, and it is not, you know" (Physiotherapist, CCSC 6). Another expanded on the need to focus on the exercise intensity of PA, rather than promoting PA per se: "walking is one of the preferable forms of exercise, but actually when I get down to the conversation about somebody who is walking every day, when you actually talk to them about it they are not really pushing themselves…They might be walking for an hour a day but not doing the appropriate intensity to get benefit" (Advanced Nurse Practitioner, HOSP 1). The nurse explains that her PA knowledge has been derived from her own self-interest in the area, but that clinicians, nurses and support centre staff would benefit from receiving education in this area to promote awareness and more effective PA messaging and counselling to survivors: "I am only trying to learn all of this myself by my own interest in it. Whereas I suppose if doctors and nurses and the support centres and all those kinds of supports have had some sort of a module that they could attend to learn all of this, it would be really useful to promote the awareness piece…healthcare professionals actually need some form of module or CPD around exercise guidelines and the programmes available and how to coach and mentor your patient in a clinic in relation to exercise" (Advanced Nurse Practitioner, HOSP 1). Another participant recognised the importance of the psychology of health behaviour change and the need for training in motivation and behaviour change and how to support patients in ways that are not expert driven: "training healthcare professionals such as nurses like myself in how to facilitate and give these programmes… .snippets of techniques like motivational interviewing, teaching those types of coaching approaches to our medics and nursing staff and physio staff rather than the expert approach 'you should exercise'. I think we can do much better than that" (Cancer Nurse Specialist, HOSP 1).

Access to Appropriate Physical Activity Interventions

A dominant theme related to access to appropriate PA interventions included two sub-themes; (i) limited access to exercise specialists and (ii) ineffective exercise referral and lack of PA services.

Limited access to exercise specialists

Limited access to appropriate personnel to lead exercise programmes or PA services was also considered a barrier to provision. This access issue was raised primarily by those managing community cancer support centres: "access to proper professionals…we're not experts in exercise…we have to outsource exercise and there's no drive from gyms to run courses" (CCSC 3) and "the main challenges are the funding to run programmes and getting physiotherapists can be difficult" (CCSC 10). Another refers to the unequal geographical distribution of exercise specialists in Ireland: "we serve seven counties, but people may be living in Donegal for example and there may not be a service where an exercise specialist who specialises in cancer is there to support those people" (Exercise specialist, CCSC 2). Limited access to exercise specialists was also related to cost incurred in the provision of PA programmes: "the only thing that is stopping us is finances…getting the physio in more often. She's here two days a week" (CCSC 6) and financial difficulty of offering exercise programmes" (CCSC 6). In some cases, cancer survivors had been prevented from joining a community gym because of their medical status (i.e., recent cancer treatment): "the amount of people who bounce back to me who couldn't do their gym registration because once they heard that they had recent cancer treatment, there was a level of hesitancy" (Physiotherapist, HOSP 10).

Ineffective Exercise Referral and lack of PA services

This sub-theme included low rates of referral to community exercise programmes such as ExWell and those offered through community cancer support centres, the need for a simple referral mechanism and a clear referral pathway. In addition to problems with opt-out referral mechanisms and issues related to uptake and attrition following referral. Participants noted generally low rates of referral for exercise and "oncologists sometimes refer for general support but not exercise directly" (CCSC 5) and "getting referrals from oncologists or GPs. Physical activity is not on their agenda. It is not highly valued…we need to find a way to sell exercise to clinicians" (CCSC 2). Low rates of referral were also noted by the NCCP: "across a number of initiatives referrals can be quite low from the hospital settings to programmes in the community…so we are looking at other options like self-referral being allowed to programmes" (NCCP1c). Self-referral protocols albeit attractive are somewhat problematic because such protocols are likely to include primarily physically active survivors or those with an interest in exercise rather than targeting those who are insufficiently physically active: "our referrals are where people have an interest in exercise…so we refer to ExWell where somebody during our introduction conversation expresses an interest in exercise, you know, but we are not prescribing it" (CCSC 13).

A simple and quick referral mechanism was noted as an important step to improve exercise referral rates: "it has to be made as simple as possible - that there is no cumbersome paperwork, or licking stamps or putting them on letters, you know, it is….like Healthlink is great because it is just press a button and it is done" (CPEP1a) and "Healthlink is the software they use and if something was built in there that they could refer to…as a means of referral…sending out paperwork about interventions doesn't work" (Academic 3). An opt-out exercise referral was also viewed as useful: "making the referral easy and also making the referral almost an opt-out rather than opt-in, that is an important concept" (CPEP1a). However, the opt-out option is unlikely to be effective if it bypasses the oncologist giving a clear message about the importance of PA and explicitly stating that the patient is being referred: "we were quite shocked that we would phone somebody and they had never heard of us, even though they had been referred" (CPEP1a).

The establishment of a clear referral pathway was considered an important endeavour but so too was having the appropriate PA services or exercise programmes in place to refer to: "if there's not a referral pathway there from the consultants, just they [exercise programmes] won't be as used as they need to

be…we're trying to build those links with the consultants here in Galway…It's really a two-pronged approach really. We need the referrals, and they need to have the services available too" (Exercise Specialist, CCSC 2). The same sentiment concerning clear referral pathways and appropriate exercise programmes was echoed by others: "there should be a referral pathway out to the community, a very strong referral pathway out to the community that are running the specialised programme or that have the expertise…not everyone who comes to us needs that detailed medical assistance…they just need guidance (Manager, CCSC 6) and "our research that we did a few years ago showed very clearly that patients wanted to be referred in from the hospital. They had confidence in the hospital staff" (Advanced Nurse Practitioner, HOSP 3). It was highlighted that there were few PA services or exercise programmes to refer survivors to: "I really struggle with where to send them…if I had a magic wand it would be that those levels of support are there and then we keep those people who need it the most at the bottom" (Physiotherapist, HOSP 10) and "you can get swamped quite quickly in potentially inappropriate referrals…not everyone with cancer might need a specialised group to come in to" (Physiotherapist, HOSP 15). There was a recognition that many survivors did not need a supervised hospital-based exercise programme but that there was a gap in provision of appropriate PA programmes in the community setting: "I think a proportion of those (I've seen) should have been an assess and advice session and straight out into the community but when I struggle to link people with the community, then I have to keep them for a little bit longer" (Physiotherapist, HOSP 10).

Tailored and Effective programmes

The final theme concerned the importance of tailored programmes that align with survivors' exercise preferences and support needs, in addition to the importance of identifying effective programmes that could be endorsed as such by the NCCP. Tailored PA programmes included many aspects including the types of PA programmes offered to survivors with a recognition that "there is no one size fits all and I think we have to have the breadth, the flexibility that allows us to ensure that every individual, regardless of the circumstance, is going to get access to some form of intervention" (Academic 1) and catering for varying exercise preferences: "to tailor it according to the needs of those patients…sometimes people like it in a group. Some people like it single. Some people like it online. Some people like it face-to-face. Some don't want to sit in with a load of cancer survivors because they don't identify themselves as cancer survivors. They just want to put it behind them and never think about it again" (Medical Oncologist, HOSP 12) and "one size doesn't fit everyone at all. Personalisation is important" (Academic 2). Some will not want to participate in exercise programmes alongside other cancer survivors: "I was told that very forcibly by a metastatic cancer patient…that the last thing she wants is to walk into a room and see other frail, bald, wearing scarves patients doing exercise who have cancer" (CPEP1a).

The dominant model has been the delivery of facility and group-based exercise programmes for cancer survivors. However, there is generally poor uptake and high attrition to such group-based programmes as articulated by a community exercise provider: "of those who attended, those who started and those who are currently active you're down to 25% of the whole lot very quickly" (CPEP1a). There may be several reasons for low uptake and high attrition in such exercise programmes including motivation, exercise preferences, time, cost, and access and some of these were noted by participants. For example, cost was viewed as a barrier to participation: "some wouldn't have the budget to go to a gym" (prostate cancer survivor) and "funding is a huge issue for my patients. I'd love them all to go to ExWell" (Physiotherapist, HOSP 10). Along with cost, logistical issues including access and availability of programmes were also noted as barriers to participation: "so many of these people go back to work, and that affects our classes because they are not on in the evenings" (CPEP1c) and "a number of people on treatment are not able to drive themselves so to some extent that sort of disenfranchises them from being to attend gym sessions" (Physiotherapist, HPE 1). Access and cost were identified as barriers to participation: "the service is up and running in a fantastic facility…there is no bus stop or any bus accessing the facility so the only way you can access is if you drive. The next one is cost, not being able to afford it…these were barriers for uptake to these types of programmes" (Academic 3). In relation to exercise preferences, there was also recognition that many survivors prefer individual rather than group-based programmes: "a lot of people

work with me one-on-one. They don't want groups" (Physiotherapist, HOSP 10). Some participants also referred to the limitations of group-based exercise programmes in terms of sustained PA behaviour change: "I agree with... about the group-based programmes that it is not something that you can keep up or sustain, like they run for a certain length of time and then finishes…once the programme finishes they are not going to sign up for it again so there is limited scope with those" (NCCP1c).

Some participants highlighted the importance of effective or approved exercise programmes in which survivors could be referred to: "and I suppose if there was a framework in place there where there was approved physical activity programmes that we can send patients" (Physiotherapist, HOSP 15) and "whether it's through NCCP endorsement or somewhere, there's a set of programmes that oncologists can stand over…So you know, something like the Can-React, but something that's already been tested… so that it comes in an approved set of programmes nationally (Manager, CCSC 12). Some community cancer support centres had received funding for pilot exercise programmes from the NCCP with a view to identifying effective programmes: "the point of funding the research in centres was to try and get some sort of an efficacy and the idea being that if we can show efficacy for a programme, then the NCCP might be able to coordinate it nationally and roll it out to all the centres, do a train the trainer model… so that people would be able to avail of the same thing in your local Cancer Support Centre regardless of where you live" (NCCP1a). Future research will need to examine different PA interventions more thoroughly focusing on acceptability, feasibility, and efficacy. At present there may be erroneous views held concerning the effectiveness of current PA interventions. For example, "we're running at the moment, so it's research backed, you know, it has proven results" (Manager, CCSC 12).

Summary of Roundtable Discussions

In summary, the roundtable discussions highlighted the importance of embedding PA into the cancer pathway such that PA is viewed by clinicians and patients as a key part of their treatment and assessed in the same way that other clinical parameters are measured as part of usual care. Participants also believed that the promotion of PA should begin at diagnosis and that the NCCP played an essential role in reaching the oncologists and ensuring that exercise is integrated into the cancer pathway. Opportunities for exercise intervention within existing practice were highlighted such as the chemotherapy education sessions and end of treatment workshops (LACES) run by Daffodil nurses and physiotherapy patient visits following surgery. Participants discussed the utility of the development of a model of care for PA and cancer, like that developed for psycho-oncology in recognition of a stepped care approach to PA intervention. Education and training needs for healthcare professionals and allied workers in the cancer space was highlighted and included (i) the importance of PA for cancer survivors, (ii) knowledge of the guidelines and appropriate PA (i.e., MVPA). It was deemed essential that healthcare professionals receive continuing professional development and/or undertake a module that includes the exercise guidelines and how to coach and mentor cancer patients concerning PA in clinic. The final theme identified as a dominant barrier to PA promotion was limited access to appropriate PA interventions. Limited access to appropriate programmes included access to appropriate personnel to lead exercise programmes or PA services in addition to financial impediments including the costs of group or gym-based programmes. Participants also emphasised the lack of referral to existing exercise programmes by oncologists and hospital staff and the lack of a simple and quick referral mechanism such as through Healthlink to make it easier for healthcare professionals to refer patients. A gap in provision of appropriate programmes or PA services in the community setting to refer cancer survivors to, was also highlighted by those working in the hospital setting. Finally, participants highlighted the need for tailored programmes that align with survivors' exercise preferences and support needs, in addition to the importance of identifying effective programmes that could be endorsed as such by the NCCP. The dominant mode internationally and in Ireland has been the delivery of facility and group-based exercise programmes for cancer survivors. However, access and cost were identified as barriers to facility-based programmes and there was also recognition that many survivors prefer individual rather than group-based programmes. Further research is needed to examine different types of PA interventions more thoroughly with a central focus on reach, acceptability, efficacy, and scalability.

Exercise Oncology

The final WE involved ascertaining the education/accreditation that is available in Ireland regarding PA for cancer patients (WE8). At present, there is no specific Irish qualification or training organisation based in Ireland for either industry exercise professionals or graduate sport and exercise scientists who require exercise instruction or exercise physiology/behaviour change education relevant to working with cancer cohorts. However, online education opportunities do exist. The most common online accessed course is 'CanRehab', out of the UK and is presented in further detail below. There are additional training opportunities such as 'Pinc and Steel' cancer rehabilitation available exclusively to physiotherapists and occupational therapists with 5-years clinical experience. The Pinc and Steel is a 12-week programme in cancer rehabilitation and includes the following four modules: (i) Pre and Postoperative phase, (ii) Medical management phase; (iii) Recovery and Fitness and Survivorship Phase (including information on late effects of cancer treatment and the latest evidence-based best practice on exercise and fatigue, and (iv) Advanced cancers / Palliative care and Marketing information to increase referral.

CanRehab

CanRehab, a UK-based (Glasgow) organisation. CanRehab provides "evidence-based specialist training in Cancer and Exercise for health and fitness professionals". They offer a 6-day training course targeted at industry exercise professionals, but also a 2-day programme targeted at physiotherapists. The 6-day programme for industry professionals has been delivered online since the start of Covid-19. The CanRehab website references entry requirements for the programme including specific requirements for Irish professionals. The 6-day programme is delivered in two 3-day blocks (both online). The current cost is £714 GBP. In the UK, the entry requirement is a personal trainer qualification and ideally and exercise referral qualification. In Ireland, they indicate that REPS Ireland members should have the EQF Level 5 Exercise for Health Specialist qualification.

The learning outcomes for the CanRehab instructor programme are as follows:

Learning Outcomes

1. Design of a safe, effective and individualised programme adapted to your patient/client using relevant principles of training.

2. Delivery of planned activities with your patient/client (and carer if appropriate), predetermined in the referral and assessment process.

3. Provision of an on-going system of monitoring and assessing your client in order to ensure activity goals are met and/or adapt them according to clients' evolving needs and abilities.

4. Provision of an on-going system of monitoring and assessing the risk of continuing an exercise session / programme.

5. Competency in being able to communicate and consult with your patients/clients with sensitivity and empathy on issues to do with their physical activity programme and progress.

6. Aptitude in modifying programme for your patients/clients with common co-morbidities and treatment side effects.

7. Provision of support for your patient/client in a way which will motivate and promote sustained change in physical activity levels whether within a structured exercise programme or elsewhere.

8. Ability to design programmes which enable your patients/clients to take part in unsupervised exercise.

9. Competency in the monitoring of your patient/client's progress against agreed goals and adapting the programme accordingly.

There may be an opportunity in Ireland to design bespoke training courses in the area of PA for cancer survivors that could be offered to individuals with differing backgrounds (e.g., exercise science graduates, physiotherapists, nurses, community cancer support centre workers or volunteers etc) and focused on brief counselling for PA behaviour change and evidence-based strategies likely to support PA behaviour change in patients.

Other training opportunities

A 5-day online training course in Cancer Rehabilitation is provided by the Wright Foundation, aimed at industry exercise professionals. The Wright Foundation provides other exercise professional-oriented training relevant to other clinical cohorts (e.g., pulmonary rehabilitation, general exercise referral).

Conclusions and Recommendations

Conclusions and Recommendations

The overarching aim of this scoping review was to identify and map the existing PA interventions and exercise services for cancer survivors in Ireland, and to provide a starting point for the identification of gaps in current provision. The other primary aims were to identify barriers to PA promotion and potential ways to expand PA services for cancer survivors in Ireland, including the proposal of national recommendations and strategies to implement exercise programmes and PA services in cancer survivorship. The results from this review indicate that existing community exercise provision and PA interventions nationally in this area are limited. Overall, it is apparent that most cancer survivors do not routinely receive PA information, advice, or counselling as part of usual care and that referral to PA programmes is cumbersome and not standard practice. There are some existing exercise programmes available for cancer survivors both in the community, at community cancer support centres and through not-for-profit community providers and in some hospitals. Overall, there is very little PA provision for cancer survivors and no systematic approach to PA intervention nationally.

It is also unclear whether existing PA services for cancer survivors within community or hospital settings in Ireland are effective. Research in exercise oncology in Ireland is growing but is relatively sparse, and with mixed findings in terms of efficacy of PA interventions. The effectiveness of promising PA interventions (i.e., existing interventions in Ireland and internationally) should be examined in the Irish setting. This will ensure ecological validity and address elements of implementation science.

The effects of PA on numerous outcomes has been explored in the literature, including treatment-related side effects, physical conditioning and function, and psychological wellbeing. The focus of this review was on PA behaviour. Internationally, there is strong evidence that PA interventions have a small but significant effect on PA among cancer survivors compared to usual care equivalent to ~ 47 extra minutes of MVPA/wk and is likely to be clinically meaningful. There have been few ehealth and mhealth interventions in Ireland yet internationally there is growing support for the efficacy of wearable activity tracker interventions to increase PA in cancer survivors. Similarly, few PA interventions in Ireland have been based on a theory of behaviour change or utilised counselling approaches. However, in general, theory-based interventions, interventions that include baseline counselling and interventions that use several evidence-based behaviour change techniques (e.g., graded tasks, self-monitoring, action planning, goal setting, adding objects to the environment) provide greater effects on PA engagement in cancer survivors.

The primary barriers to PA promotion in cancer survivorship noted in the roundtable discussions included a lack of awareness by healthcare professionals concerning the importance of and benefits of PA in cancer and a lack of knowledge concerning the PA guidelines for cancer survivors including ways to effectively counsel patients for exercise. Limited access to appropriate PA programmes was also a key barrier and this included availability in general, but also the costs of referral to community programmes. There was little referral to existing and well-established exercise programmes by oncologists and hospital staff, and the lack of a simple and quick referral mechanism for healthcare professionals was noted as a barrier to referral. Finally, participants highlighted the need for tailored programmes that align with survivors' exercise preferences and support needs, in addition to the importance of identifying effective programmes that could be endorsed as such by the NCCP. The dominant mode internationally and in Ireland has been the delivery of facility and group-based exercise programmes for cancer survivors. However, access and cost were identified as barriers to facility-based programmes and there was also recognition that many survivors may prefer or require individual rather than group-based programmes.

A PA cancer care pathway should be embedded into clinical practice as exemplified in other countries and should signpost and refer patients to appropriate services and supports based on their needs and preferences (Cormie et al., 2018). Overall, the NCCP was viewed as the entity with the authority to ensure that PA promotion becomes part of routine practice in the oncology setting and to ensure that PA is integrated into the cancer pathway nationally. The summary of recommendations to the Health Service Executive and the NCCP, based on the present scoping review are detailed below.

Summary of Recommendations

Overarching Recommendations

1. Structural and policy change is needed to ensure that PA promotion is implemented in practice. The NCCP should ensure that guidance and recommendation for PA is *standard of care for cancer patients through the development and implementation of a PA cancer care pathway* with appropriate triaging and to include monitoring and impact evaluation.

2. Healthcare professionals should verbally encourage cancer patients to be physically active throughout the cancer pathway. This should include provision of appropriate written materials, support, referral and signposting to both hospital and community-based supports where available.

3. PA services should incorporate evaluation and further research is required to identify patient-centred PA interventions for cancer survivors that are appropriate, acceptable, effective, and scalable in the Irish context. The NCCP should support the development of PA interventions which are evidence-based and adhere to international and national guidance and the PA cancer care pathway.

Clinical Practice

- PA should be embedded into the cancer care pathway and a PA model of care developed, implemented and supported by the relevant stakeholders.

- PA should be assessed and discussed as part of usual care throughout the cancer pathway.

- All newly diagnosed cancer patients should receive written information on the importance of PA in cancer survivorship and should be provided with the PA guidelines.

- From diagnosis and throughout the cancer pathway, patients should be advised and encouraged to participate in regular PA by every healthcare professional that they meet (MECC - Make Every Contact Count).

- All healthcare professionals should verbally encourage patients to be physically active during and following active treatment.

- PA interventions should be individualised and tailored according to stage on the cancer pathway, treatment-related impairments, comorbidities, exercise preferences and support needs of individual cancer survivors.

- A stepped care approach should be considered and incorporate cancer-specific considerations (e.g., cachexia, lymphoedema, chronic pain) in tailoring an exercise prescription. All patients with complex needs or high symptom loads should be given the opportunity to be assessed by a physiotherapist and/or exercise physiologist who are the recognised specialists in this area, and can assist with mobility concerns and with PA tailoring.

Education and Training

- All healthcare professionals should be offered bespoke exercise oncology training (as Continuous Professional Development (CPD)) to help embed PA into routine practice.

- Bespoke training should include (i) the rationale for PA; (ii) the PA guidelines for cancer survivors; (iii) ways to briefly counsel patients for PA and promote behaviour change.

- Community cancer support centre managers and support staff should receive training on PA and cancer and be supported to offer appropriate exercise programmes by the NCCP.

Capacity Building and Development of an Evidence Base

- Identify patient-centred PA interventions that are acceptable and effective and support the implementation of evidence-based PA strategies in Ireland.

- Further research is needed to evaluate the potential and effectiveness of eHealth and mHealth interventions and consultant and nurse-delivered interventions.

- Research trials should include objective measures of PA, be adequately powered.to detect change in PA, utilise implementation science and assess PA maintenance following intervention cessation.

- Health economic research will be valuable to assess the cost-effectiveness of PA interventions and services.

In conclusion, a number of recommendations have been made to further encourage and embed physical activity into the cancer care pathway. Stakeholders from across the system should be encouraged to review the results and consider the recommendations from this scoping study. The NCCP is committed to addressing these recommendations and will design action plans to begin working on them. This will require a collaborative approach and will need to utilise both the expertise of Irish specialists such as physiotherapists and exercise physiologists working both in oncology and those in the wider community services. Awareness and knowledge of the importance of physical activity to cancer patients is key and education and training for oncology professionals and primary and community care healthcare professionals will need to be ongoing. The importance of the promotion and engagement with physical activity for people living with and beyond cancer is evident from this review and national and international evidence. Sustained effort, resourcing and further policy will be required to implement these recommendations. Policy in this area should align with national health policy for prevention, chronic disease management, and community based health promotion. Progress in these areas and oncology care will create great benefit for cancer patients and wider population health.

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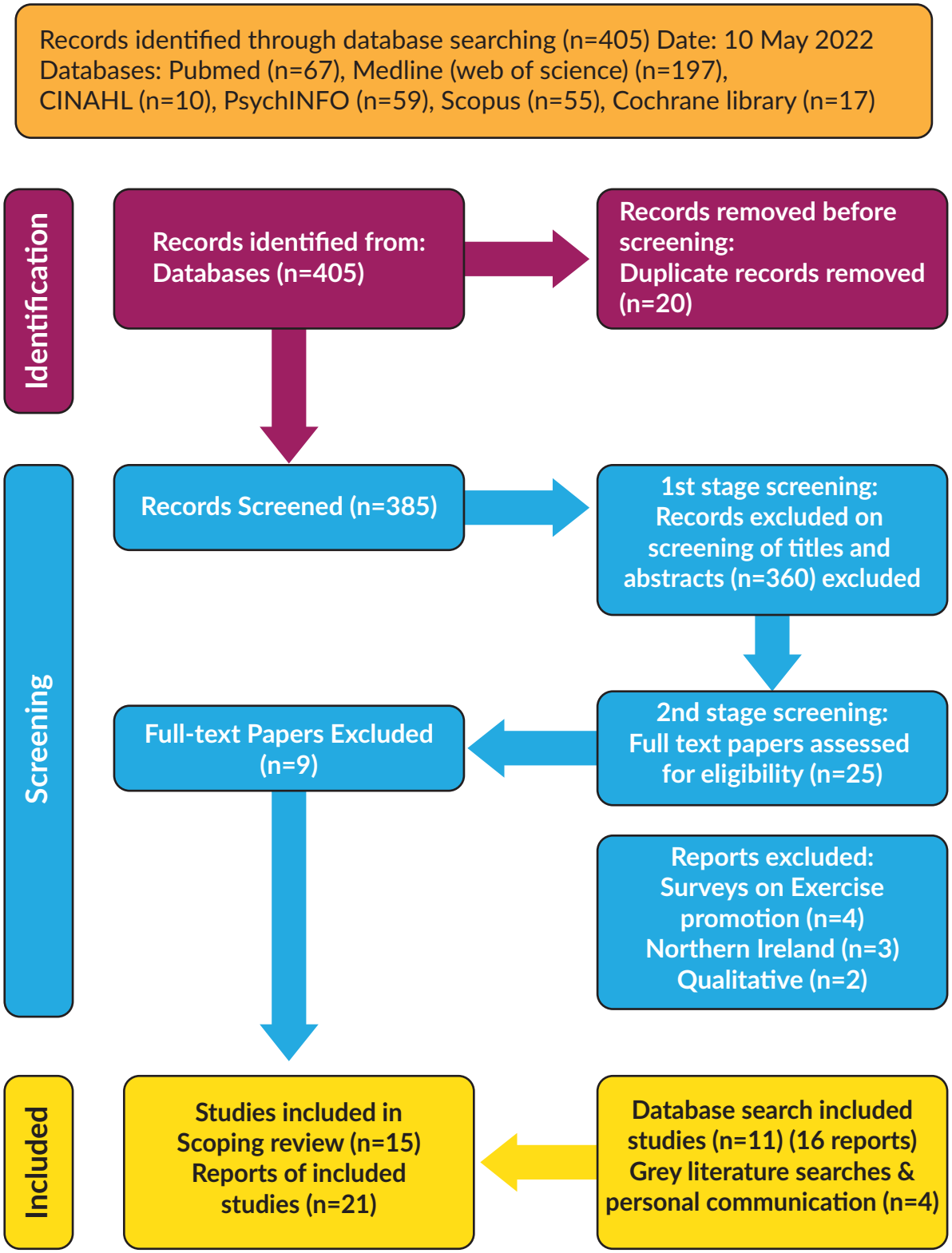
Appendix A:

Scoping Review with providers of exercise programmes Discussion Guide

- When/how was the programme set up?
- Target population group (along cancer pathway)/Target cancer(s)/ Aim of intervention & intended outcomes
- How are participants recruited/referred (or how is programme advertised)?
- What is the content of the intervention? (Including number of sessions, minutes, intervention length) & mode of delivery?
- Rationale for intervention/is it underpinned by theory/research?
- Is it evaluated? If so, outcome measures?
- Is adherence or attendance assessed? If so, are you able to share data/info on that?
- Are there follow-up assessments or transition to independent PA?
- Programme costs/funding structure
- Staffing/ staff qualifications, accreditation, cancer specific exercise training?
- What are the main challenges? What do you consider the main barriers to delivery or effectiveness?

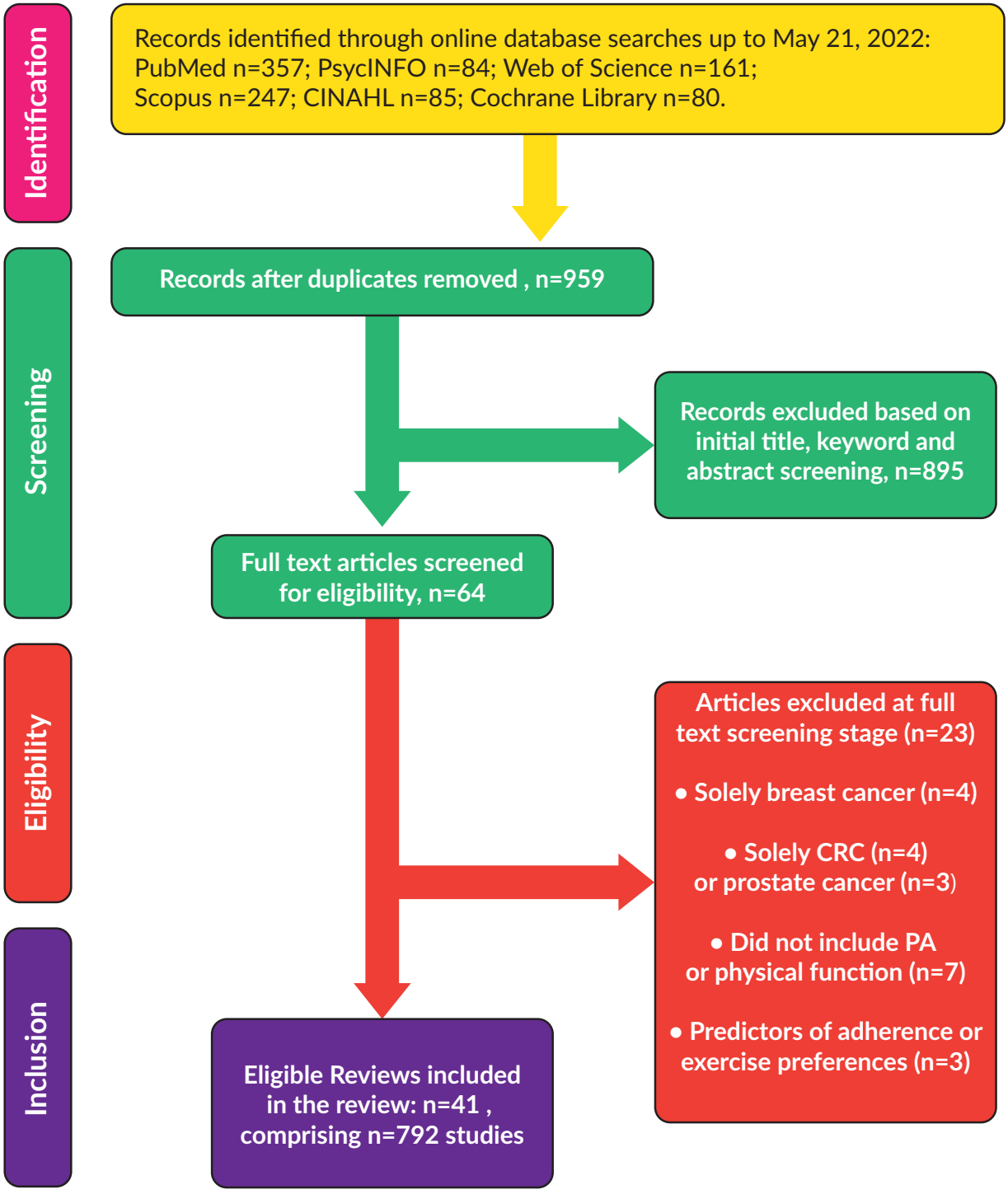
Appendix B:

Flow Diagram of Study Search and Inclusion Procedures (Research in Ireland)



Appendix C:

Flow Diagram of Review Search and Inclusion Procedure (International Literature)



Appendix D:

Roundtable Discussion Guide

How can physical activity (PA) services for cancer be expanded in Ireland?

- Few exercise programmes include monitoring and evaluation; how will we know which are more effective? Facilitator give the example of rolling out of the 'moving on' exercise programme

- How could gaps between research and practice could be bridged? (Facilitator gives some examples of research-based programmes & existing provision in the community). How could a more systematic approach to exercise promotion be set up? What would it look like?

- How could we create more direct links between hospital and community-based exercise programmes? How could referral be optimised? Who should/could refer?

- How could we more effectively implement exercise programmes and PA services for cancer patients? Including recommendation for different points on the patient pathway (i.e., prior to surgery or treatment, during treatment, following surgery)

- How could we create more evidence-based PA promotion? What about adherence?

- How to deal with conflicting research (e.g., Both Cantwell et al (2017) and Hardcastle et al (2018) found that clinicians cite low motivation or interest from cancer survivors concerning PA. However, in several studies with cancer survivors (e.g., Maxwell-Smith et al., 2017; Hardcastle et al., 2017, Hardcastle et al.,2019) found consistently that patients desire to receive PA information & advice from their Oncologist.

- How other clinician barriers to PA promotion could be overcome (e.g., Limited time with patients; Lack of community-based exercise rehabilitation programmes to refer to; Lack of resources regarding physical activity for cancer survivors (e.g. education leaflets and materials; Lack of knowledge regarding physical activity prescription for cancer survivors; Patients' family/friends advise patients to rest and avoid activity)

Appendix E:

Physical Activity and Exercise Sub-group Membership

Name	Title & Organisation
Ms. Louise Mullen (Chair)	National Lead for Survivorship, NCCP
Ms. Cathleen Osborne	Assistant Director of Nursing (Survivorship), NCCP
Ms. Bernie O'Loughlin	Survivorship Programme Co-ordinator, NCCP
Ms. Dorothy Thomas	Patient Engagement Manager, NCCP
Ms. Aine Lyng	Cancer Prevention Officer, NCCP
Dr. Noel McCaffrey	Clinical Director, ExWell Medical
Ms. Ada Kinneally	ANP Oncology, Waterford University Hospital
Dr. Janice Richmond	ANP Oncology, Donegal Hospital
Ms. Fionnuala Keane	cANP Surgery, Mater Hospital
Dr. Mairead Cantwell	Assistant Lecturer in the Department of Sport & Health Sciences, Athlone Institute of Technology
Prof. Catherine Woods	Chair Physical Activity for Health, Department of Physical Activity and Sports Sciences University of Limerick
Mr. Matthew O'Brien	Senior Physiotherapist, University Hospital Limerick
Ms. Eileen Lombard	Senior Physiotherapist, Mercy University Hospital
Ms. Sarah Moore	Clinical Specialist Physiotherapist in Prehabilitation, St James Hospital
Dr. Grainne Sheil	Clinical Specialist Physiotherapist in Cancer Rehabilitation, St. James' Hospital
Ms. Niamh Moylan	Physiotherapy Manager, St Lukes Hospital
Dr. Emer Guinan	Associate Professor in Cancer Rehabilitation and Survivorship, Trinity College
Dr. Naomi Algeo	Irish Research Council Scholar 2018-21 | PhD Researcher, Trinity Centre for Health Sciences, St. James' Hospital
Dr. Louise Brennan	Chartered Physiotherapist and Post-Doctoral Researcher, Trinity Exercise Oncology Research Group
Ms. Tracy MacDaid	Manager, Solas Cancer Support Centre
Ms. Mary Ruddy	Manager, Cuisle Cancer Support Centre
Ms. Sinead Osgood	Patient Representative
Ms. Catriona Kennedy	Patient Representative
Ms. Marie Kelly	Patient Representative
Mr. Noel Mullins	Patient Representative
Mr. Feargal Keenan	Patient Representative
Ms. Dara Delaney	Patient Representative
Ms. Marion Egan	Patient Representative

Notes

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