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THE IMPACT OF PREOPERATIVE EDUCATION ON POSTOPERATIVE OUTCOMES IN PATIENTS WITH COLORECTAL CANCER IN JOHANNESBURG, SOUTH AFRICA

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A thesis submitted to the Faculty of Health Sciences, University of the Witwatersrand, in fulfilment of the requirements for the degree of Doctor of Philosophy.

Johannesburg, 2023

DECLARATION

I, Megan Jennifer Whelan, declare that the work contained in this thesis is my own work, except to the extent indicated in the acknowledgement section. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg, South Africa. This work has not been submitted before for any degree or examination at this or any other University.



……

Signature of Candidate

March 2023

DEDICATION

To my husband Darryn, thank you for your continuous support during my incredibly long journey of being a postgraduate student. You have always been my biggest fan. Thanks for wiping away my tears when things became a little too overwhelming.

To my parents, thank you for moulding me into the person I am and for supporting my dreams. Thanks for always being game to assist with editing my work – even if you didn't understand what you were reading.

To Michele Carr and her team from Carr and Associates Physiotherapy Practice as well as Marelee Fourie, thank you for assisting with the data collection and for supporting my project right from its inception.

To the team at the Wits Donald Gordon Medical Centre (especially Dr June Fabian from the research unit and Dr Bebington from the colorectal unit), thank you for guidance and co-authoring support.

Lastly, to my supervisors Prof Heleen van Aswegen and Prof Ronel Roos, thank you for your guidance and patience. Thank you both for being such amazing mentors and for always pushing me to be the best clinician and academic that I can be.

PEER-REVIEWED PUBLICATIONS EMANATING FROM THE WORK CONTAINED IN THIS THESIS

Whelan M, van Aswegen H, Roos R, Fabian J, Bebington B, Neph C. The association between lifestyle-related risk factors and survival in patients with colorectal cancer in an urban South African cohort. *Afri Health Sci*. 2022;22(1):312-21. https://dx.doi. org/10.4314/ahs.v22i1.38

Whelan M, van Aswegen H, Roos R, Fabian J, Bebington B. Preoperative physical activity and functional performance levels are predictors of acute postoperative outcomes in a private South African colorectal cancer cohort. *South African Journal of Physiotherapy*. 2021;77(1). https://doi.org/10.4102/sajp.v77i1.1526

Whelan MJ, Roos R, Fourie M, Van Aswegen H. Preoperative physiotherapy education for patients undergoing colorectal cancer resection. *South African Family Practice*. 2022;65(1), a5614. https://doi.org/10.4102/safp. v65i1.5614

Whelan M, van Aswegen H, Roos R. Preoperative education content provided by physiotherapists to patients undergoing open abdominal surgery for colorectal cancer: a Delphi study. *Journal of Acute Care Physical Therapy (under review)*

CONFERENCE PROCEEDINGS EMANATING FROM THE WORK CONTAINED IN THIS THESIS

World Confederation for Physical Therapy Congress, 2019 (Geneva, Switzerland)

Whelan M, van Aswegen H, Roos R. Demographic and clinical profiles and factors that influence post-operative outcomes in patients with colorectal cancer: a record review.

Session format: Poster display

School of Therapeutic Sciences Biennial Research Day, 2019 (University of the Witwatersrand, South Africa)

Whelan M, van Aswegen H, Roos R. Demographic and clinical profiles and factors that influence post-operative outcomes in patients with colorectal cancer: a record review.

Session format: Poster display

Faculty of Health Sciences Virtual Research Day, 2020 (University of the Witwatersrand, South Africa)

Whelan M, van Aswegen H, Roos R, Fabian J, Bebington B. The association between lifestyle-related risk factors and survival, and the role of physiotherapy in patients with colorectal cancer in an urban South African cohort.

Session format: Oral presentation

South African Society of Physiotherapy Congress, 2022 (Stellenbosch, South Africa)

Whelan M, van Aswegen H, Roos R, Fabian J, Bebington B. Preoperative physical activity and functional performance levels are predictors of acute postoperative outcomes in a private South African colorectal cancer cohort.

Session format: Oral presentation

South African Society of Physiotherapy Congress, 2022 (Stellenbosch, South Africa)

Whelan M, van Aswegen H, Roos R. Recommendations on preoperative education content provided by physiotherapists to patients undergoing abdominal surgery for colorectal cancer: an international Delphi study.

Session format: Oral presentation

CONTRIBUTIONS OF AUTHORS TO THIS PROJECT

As part of my declaration for this thesis, I hereby acknowledge the contribution by the following authors as outlined below:

The planning and design of this project including the various methods of data collection and statistical analysis was devised by myself and my two supervisors Professor Heleen van Aswegen[1] and Associate Professor Ronel Roos[1].

Dr Brendan Bebington[2] and Dr June Fabian[3] assisted with the study design of Paper 1 and Paper 2. The data used for Paper 1 and Paper 2 forms part of the Colorectal Cancer South Africa (CRCSA) longitudinal cohort study of which Dr Brendan Bebington and Dr June Fabian are involved. The retrospective database review was performed by myself with data extraction from REDCap being performed by the staff in the research unit at the Wits Donald Gordon Medical Centre, Johannesburg, South Africa.

Systematic database searches were carried out by myself for the narrative review which formed part of Paper 3. Marelee Fourie[1] took the role of research assistant for the narrative review and assisted with the database searches for that paper.

I facilitated the nominal group technique focus group session assisted by Associate Professor Ronel Roos[1] who took computerised notes during the session. I was responsible for the data collection for the focus group session. This formed part of Paper 3.

I was responsible for the design of the REDCap electronic survey questionnaires in preparation for the Delphi study (Paper 4) but the respective authors reviewed the survey documents prior to circulation. Collection of the survey data were handled by myself.

Physiotherapy clinicians from Carr and Associates Physiotherapy Practice, Johannesburg, were the research assistants for the randomised pilot study (Paper 5). They were responsible for administering the preoperative education and for performing the pre-and-postoperative assessments of the patients recruited. I was responsible for collecting retrospective data (such as postoperative complications, length of stay and cancer staging scores) for patients recruited into the pilot study.

I was responsible for the data analysis for the whole project with assistance from Professor Heleen van Aswegen[1] and Associate Professor Ronel Roos [1].

I was responsible for drafting of the literature review, the content and resubmissions of all the papers submitted for publication linked with this project. All authors assisted with editing and reviewing of their respective papers.

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ABSTRACT

The global burden of cancer has increased over the past few decades. Colorectal cancer is one of the most frequently reported cancer types globally. There are a number of lifestyle-related factors described in the literaure linked to risk of colorectal cancer and survival. Surgery remains the top treatment choice (when appropriate) for patients diagnosed with colorectal cancer. Furthermore, patients who have undergone a variety of different cancer treatment methods may experience fatigue and muscle weakness resulting in reduced physical function. There is literature describing the use of preoperative physiotherapy interventions (rehabilitation and education strategies) for patients undergoing abdominal surgery for various pathologies. However, there is a paucity of literature describing the use of preoperative education by physiotherapists for patients undergoing abdominal surgery for coloretal cancer specifically. This thesis describes the profile of patients with colorectal cancer in urban Johannesburg South Africa and further describes those who underwent surgical resection. Secondly, a physiotherapy preoperative education programme was developed using a variety of research methods. Finally the impact and feasibility of the programme was tested in a randomised pilot study for patients who underwent colorectal cancer resection at a private hospital in Johannesburg South Africa.

Paper 1 (Chapter 3) includes a secondary analysis and retrospective review of a database of patients who were diagnosed with colorectal cancer at institutions forming part of the University of the Witwatersrand Academic Teaching Complex. The aim was to determine the demographic, functional and clinical profile of the patients included in the database. The review further aimed to identify modifiable factors linked with colorectal cancer and to determine the relationship between these risk factors and survival. Data from the public sector was compared with data from the private sector. The results showed that patients in the private sector cohort were older, had earlier stages of cancer, had a higher percentage of alcohol consumption and had higher survival rates than the public sector cohort. Furthermore, waist circumfrence was shown to have a large-strength effect on survival across the whole cohort.

Paper 2 (Chapter 4) aimed to further investigate the patients included in the database who had surgical resection for their colorectal cancer in the private sector cohort. The surgical and functional profiles of the patients were identified. Predictors of post-surgical outcomes were determined using regression analysis statistics. One hundred and twenty five patients were included in the review. Postoperative paralytic ileus and surgical site infections accounted for the most postoperative complications that were reported. Preoperative vigorous-intensity

exercise and functional performance status were the significant predictors of hospital length of stay and incidence of postoperative complications in patients who underwent abdominal surgery for colorectal cancer at one private hospital in Johanesburg, South Africa.

Paper 3 (Chapter 5) describes the start of the development of a physiotherapy preoperative education programme framework for patients undergoing abdominal surgery for colorectal cancer. Firstly, five databases were screened and a narrative review was performed to determine the evidence available regarding the timing, content, mode of delivery and setting of preoperative education delivered by physiotherapists for patients who underwent abdominal surgery for various pathologies. Seventeen studies were included in the review. The content included in the programmes described in the literature inclues breathing exercises, coughing techniques, verbal advice, physical exercises, surgical information, postoperative pain management, nutritional support, relaxation techniques and information about postoperative complications. Secondly, physiotherapists working in surgical intensive care units and high care units in Johannesburg were purposively sampled to participate in a focus group session. The nominal group technique was used with the goal to reach consensus on the proposed content of a preoperative education programme for patients undergoing abdominal surgery for colorectal resection. The author used the results of the narrative review and the focus group session to develop a famework for preoperative physiotherapy education for this patient population.

Paper 4 (Chapter 6) describes the use of a modified Delphi study to obtain expert insight into the content of peoperative education that could be provided to patients undergoing colorectal cancer resection. A panel consisting of international physiotherapy clinicians and academics working in the field of surgery, oncology or a combination of both were invited to participate in a two-round Delphi study. The survey developed was based on information gathered from the retrospective database review, narrative review and the focus group session. Consensus was set at 70%. The initial survey consisted on 36 statements. Statements not achieving consensus after the first round were modified and new statements added to the second round survey depending on patient feedback. Seventeen experts were invited to participate. Eight responded to the first round survey and seven responded to the second round survey. Thirty one statements reached consensus after both rounds which fell under the following categories: wound/pain, rehabilitation, respiratory considerations, cancer considerations, medical and surgical journey, and other consideratons.

Paper 5 (Chapter 7) describes the use of a pilot study to test the impact and feasibility of a preoperative physiotherapy education programme for patients undergoing abdominal surgery

for colorectal cancer. Firstly, a reliability study was perfomed to establish interrater reliability of the research assistants who were to assist with data collection in the pilot study. Three research assistants performed assessments using two outcome measures on five healthy control participants. Interrater reliability was measured using the intraclass correlation coefficient using Cronbach's alpha. The results showed that two of the three research assistants demonstrated excellent interrater reliability using the Six minute walk test and the Short Physical Performance Battery. Secondly, a randomised pilot study was perfomed on patients who underwent open abdominal surgery at a private hospital in Johannesburg. Participants who met the inclusion criteria were randomised into one of three groups: a control group, intervention group one (patients received a written education pamphlet) and intervention group two (patients received a written educaton pamphlet as well as a face-to-face education session). Assessments were performed preoperatively, at discharge from the intensive care unit and at hospital discharge. Outcomes measured were hospital length of stay and postoperative complications that developed. Due to very low recruitment rates over the five-month study period, only one patient was included in the pilot study. The patient was randomised into the control group which meant that the impact of the education programme could not be assessed. However, the feasibility of the programme was assessed addressing the practicality and integration aspects.

A number of limitations of the various studies were identified and described in the relevant chapters in the thesis. In conclusion, the profile of South African patients with colorectal cancer described in this thesis highlighted risk factors associated with survival and poor postoperative outcomes. A preoperative physiotherapy education programme was developed and tested. Issues were identified regarding the feasibility of implementing the programme in patients undergoing colorectal cancer resection at a private academic hospital in Johannesburg, South Africa.

Keywords: Colorectal cancer, preoperative education, physiotherapy, physical activity

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LIST OF ABBREVIATIONS

AJCC – American Joint Committee on Cancer
ASA – American Society of Anaesthesiologists Physical Status Classification
BMI – Body mass index
Ca – Cancer
CAUTI – Cather Induced Urinary Tract Infection
CECRC – Common Epithelial Cancer Research Centre
cm – Centimetres
CPAx – Chelsea Critical Care Physical Assessment
CRCSA – Colorectal Cancer South Africa
DVT – Deep Vein Thrombosis
ECOG – Eastern Cooperative Oncology Group
ERAS – Enhanced Recovery after Surgery
GLM – General Linear Model
GPAQ – Global Physical Activity Questionnaire
ICC – Intraclass Correlation Coefficient
ICU – Intensive Care Unit
IQR – Interquartile Range
Kg – Kilogram
Kg/m^2 – Kilogram per meter squared
KPS – Karnofsky Performance
LMIC – Low-and-Middle-Income Countries
LOS – Length of Stay
m – Meters
m^2 – Metres Squared
Mins – Minutes
MRCSS – Medical Research Council Sum Score
MSHOP – Michigan Surgical and Health Optimization Programme
NGT – Nominal Group Technique
NRS – Numerical Rating Scale
PAVS – Physical Activity Vital Sign
POI – Postoperative Paralytic Ileus
PPS – Palliative Performance Status
PTE – Pulmonary Thromboembolism
REDCap – Research Electronic Data Capture

SAMRC – South African Medical Research Council
SD – Standard Deviation
SMOG – Simple Measure of Gobbledygook
6MWT – Six Minute Walk Test
SPPB – Short Physical Performance Battery
TNM – Tumour-Nodes-Metastasis
WDGMC – Wits Donald Gordon Medical Centre
WHO – World Health Organisation

CHAPTER 1

1. INTRODUCTION

1.1 PREFACE

The burden of cancer is increasing globally at a rapid rate. Patients with colorectal cancer present with unique difficulties when compared to patients undergoing abdominal surgery for other pathologies. There is an increasing trend of utilising preoperative strategies for patients undergoing general abdominal surgery.

1.2 PROBLEM STATEMENT

There is some literature supporting the use of preoperative exercise therapy in patients who are undergoing abdominal surgery in order to improve post-operative outcomes (Boereboom et al., 2015; Hijazi et al., 2017; West et al., 2015). However, there is limited evidence supporting the use of preoperative physiotherapy education interventions in patients who have undergone abdominal surgery (Boden et al., 2018). There is currently no evidence in Sub-Saharan Africa or worldwide to support or negate the use of preoperative physiotherapy education interventions for patients undergoing abdominal surgery specifically in the colorectal cancer population.

1.3 RESEARCH QUESTIONS

1.3.1 Paper 1

What is the association between lifestyle-related risk factors and survival in patients with colorectal cancer?

1.3.2 Paper 2

What lifestyle-related risk factors are predictors of acute postoperative outcomes in patients undergoing surgical resection for colorectal cancer in a private South African cohort?

1.3.3 Papers 3 and 4

What could be included in the content of a physiotherapy preoperative education programme for patients undergoing open abdominal surgery for colorectal cancer?

1.3.4 Paper 5

What is the impact of pre-operative education on post-operative outcomes in patients with colorectal cancer in Johannesburg, South Africa?

1.4 RESEARCH AIM

To determine the impact of pre-operative education on post-operative outcomes in patients with colorectal cancer in Johannesburg, South Africa.

1.5 RESEARCH OBJECTIVES

1.5.1 Paper 1

To describe the demographic, clinical and physical activity profiles of patients who had surgery for colorectal cancer.

1.5.2 Paper 2

To determine the factors that influenced post-operative hospital length of stay, complications that developed post-operatively and survival outcomes at hospital discharge for these patients.

1.5.3 Paper 3

To review the available evidence related to physiotherapy pre-operative education interventions for patients undergoing abdominal surgery due to colorectal cancer.

1.5.4 Papers 3 and 4

To develop and validate a formalised physiotherapy pre-operative education tool for patients undergoing abdominal surgery due to colorectal cancer.

1.5.5 Paper 5 and Overall Outcome

To test the effect of a formalised physiotherapy preoperative education tool on the postoperative outcomes of patients undergoing abdominal surgery for colorectal cancer

1.6 SIGNIFICANCE OF THE RESEARCH

This is the first study of its kind in the colorectal cancer population in Sub-Saharan Africa. There is also no evidence of a study of this kind having been performed globally. The retrospective component will paint a picture of the current colorectal population as well as identify factors influencing postoperative outcomes. The narrative review, focus group and Delphi study components will be used to determine the possible content of a physiotherapy preoperative education programme for patients undergoing abdominal surgery for colorectal cancer. Patient outcomes from the retrospective database review will be compared with outcomes from the randomised pilot study in order to determine which preoperative education intervention (if any) is associated with reduced

occurrence of postoperative complications. This study will assist physiotherapy clinicians to choose the most appropriate preoperative intervention for patients undergoing open abdominal surgery for colorectal cancer.

1.7 ETHICAL CONSIDERATIONS FOR THE ENTIRE THESIS

This project was registered with the Pan African Clinical Trials Registry (PACTR201908916815403) (Appendix 1). Ethical clearance to perform all components of this project was granted by the University of the Witwatersrand Human Research Ethics Committee (M181075) (Appendix 2). Approval of the title of the project was obtained from the Faculty of Health Sciences of the University of the Witwatersrand (Appendix 3). Permission to perform the study at the Wits Donald Gordon Medical Centre (WDGMC) was granted by the chief executive officer (Appendix 4), the director of the intensive care unit (Appendix 5) and the allied health representative of the Medical Executive Committee (Appendix 6). The University of the Witwatersrand's rules regarding plagiarism were observed throughout.

1.7.1 Papers 1 and 2

These studies arise from a database linked to the Colorectal Cancer South Africa (CRCSA) longitudinal cohort study. Permission to access and use the information saved in the database was granted by the head of the colorectal unit at the WDGMC. The identity of all research participants remained anonymous.

1.7.2 Paper 3

All physiotherapy clinicians who participated in the focus group session using the nominal group technique were provided with an information sheet (Appendix 6) and consent forms to sign (Appendix 7). Specific and separate signed consent was also obtained for the session to be audio recorded (Appendix 8). The identity of participants remained anonymous during analysis of results and write-up.

1.7.3 Paper 4

All participants signed informed consent to participate in the Delphi study (Appendix 9). The identity of participants remained anonymous throughout. Results of the two survey rounds are stored securely on the REDCap database and the researcher is the only person who has access to this database.

1.7.4 **Paper 5**

An information sheet was issued (Appendix 10) and signed informed consent was obtained for all participants recruited into the mini study of healthy controls as well as the randomised pilot study (Appendix 10). The data obtained from all participants were assigned a study code which was used throughout the data analysis process in order to maintain participant anonymity.

1.8 **OUTLINE OF THE THESIS**

This thesis aims to gain more information regarding the demographic profile and lifestyle-related risk factors of South African patients with colorectal cancer as well as to determine their association with survival and impact on acute postoperative outcomes. Secondly, with the use of a narrative review, focus group and a Delphi study, a preoperative education programme for patients undergoing colorectal cancer resection is developed. Finally, the programme's feasibility and impact is tested in a randomised pilot study.

The outline of each chapter is described below:

Chapter 1 contains a preface to the thesis, a problem statement, research questions, research aims and objectives, ethical considerations and a general outline.

Chapter 2 includes a literature review of the following: lifestyle-related risk factors linked with colorectal cancer, surgery for colorectal cancer, postoperative outcomes and survival, preoperative education for patients undergoing surgery for colorectal cancer and, outcome measures.

Chapter 3 includes a published manuscript that examines the association between lifestyle related risk factors and survival in patients with colorectal cancer living in Johannesburg, South Africa.

Chapter 4 includes a published manuscript which investigates postoperative outcomes (postoperative complications and length of stay) following colorectal cancer resection as well as the risk factors associated with these outcomes.

Chapter 5 contains the start of the development of a framework of physiotherapy preoperative education programme based on a narrative review of the literature as well as a focus group session using the nominal group technique with experienced South

African physiotherapy clinicians practicing in Johannesburg. This manuscript has been accepted for publication.

Chapter 6 contains a manuscript currently under review which includes the results of an international two-round Delphi study to establish some degree of consensus on the content of physiotherapy preoperative education for patients undergoing open abdominal surgery for colorectal cancer.

Chapter 7 contains the results of a randomised pilot study of patients who underwent open abdominal surgery for colorectal cancer. The purpose of this was to determine the feasibility of the preoperative education programme (devised from Chapters 5 and 6) for patients undergoing surgical resection as well as to examine its impact on acute postoperative outcomes.

Chapter 8 contains the discussion and limitations of the thesis.

Chapter 9 includes the overall conclusions of the thesis and recommendations for future research in the field.

Chapter 10 includes all appendices.

CHAPTER 2

2.1 LITERATURE REVIEW

In this literature review, colorectal cancer epidemiology will be discussed as well as a basic explanation of the pathology associated with it. Following this modifiable risk factors linked with colorectal cancer will be unpacked. One has to consider the effects of cancer and cancer-related treatments on the musculoskeletal system as this pertains to physiotherapy interventions that could be provided. Sarcopenia, cachexia cancer-related fatigue and other relevant pathophysiology will be discussed in this section. Because this thesis is focused on preoperative management, surgical management will be addressed including surgical procedures, postoperative outcomes as well as the relationship between modifiable lifestyle factors and postoperative outcomes. Due to the fact that this research project took place during Covid-19 pandemic, one cannot exclude the effects of the pandemic on patients with colorectal cancer. Survival is an important overall outcome that is also addressed in this chapter as well as the impact of lifestyle factors on survival. This sets the scene for physiotherapy management of patients undergoing colorectal cancer resection including prehabilitation, preoperative education strategies, outcomes associated with preoperative education as well as appropriate outcome measures that can be utilised by physiotherapists.

Physiotherapy management has been defined as a profession centred on physical function and movement (South African Society of Physiotherapy, 2023). In the context of this thesis, it involves recognising and maximising quality of life and movement potential in patients with colorectal cancer through health promotion, prevention and physical treatment including prehabilitation and rehabilitation.

2.2 INTRODUCTION

In 2018, colorectal cancer was responsible for 10.2% of all cancers diagnosed worldwide in both males and females. In the same year, the global mortality rate linked with colorectal cancer was 9.2% (Bray et al., 2018). The global disease burden of colorectal cancer is severe (N. Li et al., 2021) and is strongly linked with socioeconomic status (Doubeni et al., 2012). The prevalence of colorectal cancer amongst young adults (<50 years of age) is rising rapidly (N. Li et al., 2021). There is a higher incidence of colorectal cancer reported in males when compared to females (Bray et al., 2018). In South Africa, the crude incidence of colorectal cancer is 5.80/100 000 and 7.17/100

000 in females and males respectively (Cancer Association of South Africa, 2012). Furthermore, the collective lifetime risk for developing colorectal cancer in South Africa is 0.74 for females and 1.24 in males (Cancer Association of South Africa, 2012).

The majority of colorectal cancers arise from the growth of a polyp which is a neoplastic precursor lesion (Dekker et al., 2019). Over a prolonged period of up to 15 years, the polyp eventually progresses to a colorectal cancer tumour (Dekker et al., 2019). It is hypothesized that the cancer progenitor cells are the originating cells within a heterogeneous tumour that have characteristics similar to those of stem cells (Dekker et al., 2019; Du et al., 2021). This in turn results in the ability of these cells to self-renew and differentiate (Tang, 2012). There are two main precursor lesion pathways described in the literature: the adenocarcinoma pathway which is responsible for 70-90% of colorectal cancers, and, the less common serrated neoplasia pathway (Dekker et al., 2019; Keum & Giovannucci, 2019). A third carcinogenic pathway has been described which is linked to unresolved or chronic inflammation contributing to epithelial dysplasia which has been linked to the pathogenesis of various cancers including colorectal cancer (Allavena et al., 2008; Cheng et al., 2021; Keum & Giovannucci, 2019).

2.3 MODIFIABLE RISK FACTORS ASSOCIATED WITH COLORECTAL CANCER

Both environmental and hereditary risk factors seem to play a part in the development of colorectal cancer (Dekker et al., 2019). The rise in incidence of colorectal cancer over the last few decades could be attributed to an increasing ageing global population as well as a group of factors associated with westernisation including unfavourable modern dietary behaviours, smoking, obesity and low physical activity levels (Keum & Giovannucci, 2019; Kuipers et al., 2015). Furthermore, the burden of colorectal cancer is shifting towards lower-and-middle-income countries as they transition economically (Keum & Giovannucci, 2019).

2.3.1 Cigarette Smoking

Some evidence suggests that smoking is not a risk factor for colorectal cancer (Imperiale et al., 2008; Peppone et al., 2009; Schumacher et al., 2021). In contrast, other studies have shown that cigarette smoking is associated with a variety of cancers including colorectal cancer (Puzzono et al. 2021; Wei, Lin & Chang 2011; Sasco, Secretan & Straif 2004). Results of a meta-analysis of prospective cohort studies found that smoking is associated with a higher risk for colorectal cancer which was greater in men than women and more common in rectal cancers than colon cancers (Tsoi et

al., 2009). There is evidence that cigarette smoking contributes to the development of adenomatous polyps which are the precursor lesions for colorectal cancer (Botteri et al., 2008). Furthermore, cigarette smoking contributes to the growth and aggressiveness of adenomas (Botteri et al., 2008).

2.3.2 **Anthropometric Profile**

Insulin resistance, hyperinsulinemia and Type II Diabetes have all been linked to increased risk for colorectal cancer amongst others (McTiernan, 2008). Furthermore, perturbations in glucose control have also been associated with increased risk of colorectal cancer (Saydah et al., 2003; McTeirnan, 2008). As a result of hyperglycaemia, the involvement of reactive oxidative species resulting in low-grade inflammation and the accumulation of advanced glycation end products have been suggested to stimulate carcinogenic pathways (van Guilder et al., 2006; Vulcan et al., 2017;Yu et al., 2022).

Hyperinsulinemia may play a part in carcinogenesis by promoting abnormal stimulation of various cellular signalling cascades, increasing growth factor-dependent cell proliferation as well as by directly affecting metabolism of cells (Arcidiacono et al., 2012). A state of chronic inflammation has been described as one of the links between diabetes and certain cancers (Giovannucci et al., 2010). Diabetes is the most common form of insulin resistance and has been recognized as a low-grade inflammatory condition where the overproduction of specific molecules occurs. These include interleukin-6, free fatty acids, leptin, tumour necrosis factor alpha, adiponectin, plasminogen activator inhibitor-1 and monocyte chemoattractant protein (Giovannucci et al., 2010). This can result in malignant transformation and/or progression of cancer (Giovannucci et al., 2010).

General obesity is a well-researched modifiable factor linked with increased risk for colorectal cancer (especially rectal cancers) (Keum & Giovannucci, 2019; N. Li et al., 2021; Renehan et al., 2008). There are many types of hormones and pro-inflammatory cytokines produced by adipose tissue. This pro-inflammatory environment produces an ideal setting for cancerous cells (Tilg & Moschen, 2006). Although there are others, interleukin-6 and tumour necrosis factor-alpha remain the model pro-tumourigenic cytokines and can influence all stages of tumour production (Becker et al., 2005; Grivennikov & Karin, 2011).

Soltani et al., (2019) found that patients in the colorectal adenoma group had significantly higher incidences of obesity (measured with body mass index) and diabetes when compared to healthy controls. However, there was no significant association between obesity and diabetes in the adenoma group (Soltani et al., 2019). Another study examined the association between visceral obesity (measured by waist circumference) and risk for early onset colorectal cancer. The results showed that visceral obesity is not a risk factor for early onset colorectal adenocarcinoma (Choe et al., 2013). A more recent systematic review and meta-analysis of prospective studies showed that abdominal obesity could be linked the development of colorectal cancer (Dong et al., 2017). Results of an emerging German population-based, case-controlled study showed that early adulthood obesity is associated with greater risk of early-onset colorectal cancer (H. Li et al., 2021).

2.3.3 **Physical Activity**

Physical activity is defined as any body movement produced by the skeletal muscles that results in the expenditure of energy (Casperson et al., 1985). Exercise is a form of physical activity that is planned and structured with the objective of improving physical fitness (Casperson et al, 1985). Physical inactivity is defined as not meeting physical activity guidelines for moderate-to-vigorous physical activity (Bull et al. 2020; Sedentary Behaviour Research Network 2012). The World Health Organisation recently published new guidelines for physical activity for adults as well as specific recommendations for those who are living with a chronic condition of which cancer is specifically mentioned (Bull et al., 2020). The guidelines suggest that some physical activity is better than none at all. The updated guidelines target “150-300 minutes of moderate intensity aerobic physical activity and 75-150 minutes of aerobic vigorous intensity physical activity” per week (Bull et al., 2020, p. 1456). Resistance training is also an important component of physical activity and exercise. Resistance training has been shown to preserve lean muscle mass, metabolic regulation, improved bone density and mineral health, functional benefits, improved health-related quality of life and better cardiovascular health (Westcott, 2012). Similar metabolic equivalents can be achieved with both aerobic and resistance training (Schram et al, 2019).

There are several mechanisms that have been suggested to explain the association between colorectal cancer and physical activity (Samad et al., 2004). One of the mechanisms by which physical inactivity may be detrimental is by gut dysbiosis (Sobhani et al., 2011). Intestinal microbiota is considered mostly beneficial by mechanisms of residual food fermentation, gut immune system modulation and

disease protection (Codella et al., 2018; Sobhani et al., 2011). The mucosal barrier in the colon ensures a healthy condition and ensures luminal confinement of bacteria (Genua et al., 2021).

Physical inactivity amongst other lifestyle factors, could aggravate an impairment in the colonic mucosal barrier resulting in a shift in the microbiota composition (Genua et al., 2021; Vieira et al., 2017). Physical activity may encourage intestinal microbial diversity through a number of mechanisms including the promotion of an anti-inflammatory state (Codella et al., 2018). In a study by Sobhani et al (2011) which showed a composition change in the microbiota of patients with colorectal cancer, the authors concluded that this may impact on the mucosal immune response in these patients.

Another concept to explore is the idea that physical activity decreases gut transit time (Shaw et al., 2018). Bingham & Cummings (1989) investigated the effect of exercise on large intestinal function in sedentary, but otherwise healthy, men and women. The results of the study were inconsistent and the authors concluded that physical activity without changes in diet, does not appear to have an effect on faecal weight and transit time (Bingham & Cummings, 1989).

Furthermore, physical activity has been shown to decreases insulin resistance (Nelson et al., 2013) and reduce hyperinsulinemia (McTiernan, 2008). Insulin is an important growth factor for colonic mucosal cells and is therefore mitogenic to carcinogenesis (Samad et al, 2004). Another factor to consider is the relationship between physical activity and prostaglandin E_2. Patients with colorectal polyps have higher levels of colonic mucosal prostaglandin E_2 (Samad et al., 2004). Increased physical activity levels have been shown to lower prostaglandin E2 levels which in turn lowers the risk for colon cancer (Martinez et al., 1999).

A population-based prospective study showed that there was no association between physical activity patterns and the risk for colon and rectal cancer in Norwegian women (Oyeyemi et al., 2018).

In contrast to this, Slattery et al (2003) performed a population-based study of 952 individuals with cancer of the rectum and rectosigmoid junction. Results showed that vigorous-intensity physical activity was associated with lower rectal cancer risk in both women and men (Slattery et al., 2003). In this study, vigorous-intensity exercise was

defined as any activity that made participants sweat or feel out of breath (Slattery et al., 2003). The primary mechanisms that could be attributed to the link between physical activity and colorectal cancer have not been well described (Slattery et al., 2003). It is also unclear which of these mechanisms are significant for rectal cancer and which are important for colon cancer (Slattery et al., 2003). Furthermore, results of a recent systematic review and meta-analysis have shown a significant protective association between physical activity and the risk for the development of colorectal cancer (Shaw et al., 2018).

2.3.4 Alcohol Consumption

Results of a meta-analysis of published studies showed that there is strong evidence linking alcohol consumption (of more than one drink per day) with colorectal cancer risk (Fedirko et al., 2011). Similarly, there is other evidence suggesting that heavy drinking is a risk factor for the development of colorectal cancer (Bagnardi et al., 2015; de Menezes et al., 2013). There is even evidence to suggest that light alcohol consumption is also linked with colorectal cancer risk albeit low risk (Choi et al., 2018). Results of a meta-analysis of cohort studies showed that light and very light alcohol consumption (light and very light defined as ≤ 1 and ≤0.5 drink per day respectively) are not associated with risk of most cancers except for a slight increase in risk for colorectal cancer in males (Choi et al., 2018). In contrast to this, results of a meta-analysis of 16 studies reporting the association between colorectal cancer risk and alcohol consumption showed that drinking one to two alcoholic beverages per day was associated with a lower risk for colorectal cancer (McNabb et al., 2020). The same study however, also confirmed the association between heavy alcohol consumption and risk for colorectal cancer (McNabb et al., 2020) which supports many other studies recently published (Bagnardi et al., 2015; de Menezes et al., 2013; Inoue, 2013; N. Li et al., 2021).

Alcohol intake is associated with lower concentration levels of folate which has been studied in detail in relation to colorectal cancer aetiology (Sir Michael et al., 2007). Alcohol can also act as a co-carcinogen agent meaning that alcohol consumption in conjunction with other risk factors (such as cigarette smoking) could promote the onset or accelerate the progression of cancer (Bagnardi et al., 2015; Poschl & Seitz, 2004). According to the International Agency for Research on Cancer, alcohol consumption results in exposure of the consumer to acetaldehyde (Inoue, 2013). Acetaldehyde is both mutagenic and carcinogenic by binding to DNA and protein (Poschl & Seitz, 2004).

2.3.5 **Diet**

Veettil et al (2021) performed an umbrella review on 45 meta-analyses examining the role of diet in the incidence of colorectal cancer risk (Veettil et al., 2021). The results showed convincing associations between reduced risk for colorectal cancer and greater intakes of yoghurt, dietary fibre and calcium. Furthermore, lower intake of red meat and alcohol was found to be associated with reduced incidence of colorectal cancer (Veettil et al., 2021). Lai et al (2017) performed a meta-analysis of observational studies to determine the association between dietary protein intake and colorectal cancer risk. The results showed no association between high dietary protein intake and risk of colorectal cancer (Lai et al., 2017). Another factor to consider is the source of dietary protein and risk for colorectal cancer. Liao et al (2019) found that substituting plant protein for animal protein (specifically red meat) is associated with a lower risk for colorectal cancer. Results of a meta-analysis of six prospective cohort studies found no significant association between colorectal cancer risk and animal protein intake (Alexander et al., 2009). Results of a recent systematic review showed that consumption of both soluble and insoluble fibre appears to have a protective effect against colorectal cancer Arayici et al., 2022). Both were associated with a significant reduction in colorectal cancer risk (Arayici et al., 2022).

An interesting concept is the role of dietary and supplemental antioxidants in the risk of developing colorectal cancer. Antioxidants act by minimising the gentoxic damage caused by accumulation of reactive oxygen species (Carini et al., 2011). Pais & Dumitrascu (2013) performed a meta-analysis of 20 randomised controlled trails to investigate the global effect of antioxidants on the incidence of colorectal cancer, recurrence, overall mortality and cancer-related mortality. The results showed no evidence of a protective role of antioxidant supplementation in the prevention of colorectal cancer (Pais & Dumitrascu, 2013). Similar results were found in another systematic review and meta-analysis (Papaioannou et al, 2011).

Another systematic review and meta-analysis investigated the effects of phytochemically rich dietary components on risk for colorectal cancer. The results showed that higher consumption of cruciferous vegetables, garlic, citrus fruits, and tomatoes is linked with lower incidence of colorectal cancer (Borgas, Gonzalez, Veselkov & Mirnezami, 2021).

Moving away from risk factors linked with colorectal cancer, the next section explores the effects that cancer and cancer-related treatments (such as chemotherapy, hormone therapy and radiotherapy) have on the musculoskeletal system.

2.4 Effects of Cancer and Cancer-Treatments on the Musculoskeletal System

Cancer and cancer therapies can have a detrimental effect on the musculoskeletal system namely bone loss, muscle loss and associated muscle weakness (Sturgeon et al., 2019). As a result, weakness, loss of mobility and increased risk for falls can occur (Sturgeon et al., 2019).

There are multiple mechanisms that appear to be responsible for muscle wasting in patients with cancer (Schneider et al, 2007). Cytokines, fatty acid-derived eicosanoids and proteolysis-inducing factor appear to contribute to muscle wasting in this population (Todorov et al., 1996; Tisdale, 2002). Proteolysis-inducing factor activates a proteolytic pathway resulting in the breakdown of skeletal muscle. The interaction of hormones, inflammatory mediators and tumour products promotes gluconeogenesis, enhances catabolism and reduces anabolism (Todorov et al., 1996; Tisdale, 2002). The resultant loss of lean muscle mass occurs due to a reduction in protein synthesis in combination with increased protein catabolism (Todorov et al., 1996; Tisdale, 2002). This in turn results in muscle weakness and functional decline (Schneider et al, 2007).

Sarcopenia has been defined as “a loss of skeletal mass and function” (Fielding et al., 2011). It is a complex syndrome whereby the reduced skeletal muscle mass can occur in isolation or in combination with an increase in fat mass (Fielding et al., 2011). Sarcopenia can be primary where the mechanism of loss of muscle mass is age-associated or secondary where the muscle mass loss has occurred due to pathological mechanisms such as cancer (Vergara-Fernandez et al., 2020). In many cases, patients present with a combination of primary and secondary sarcopenia (Takiguchi et al., 2021). The molecular mechanisms involved with the pathology of muscle wasting seen in sarcopenia include: reduced protein synthesis, protein degradation, mitochondrial abnormalities, inflammation, impaired satellite cell activation and oxidative stress (Bowen et al., 2015). The prevalence of sarcopenia in patients with solid malignant tumours is 35.3% (Surov & Wienke, 2022). Research has shown that reduced muscle mass in patients with colorectal cancer is associated with a higher post-surgical inflammatory response which could contribute to a higher incidence of complications after surgery (Reisinger et al., 2016). Furthermore, Hu et al (2021) found that sarcopenia combined with the expression of the inflammatory marker interleukin-23

significantly predicted poor survival in patients with colorectal cancer (Hu et al., 2021a). Sarcopenia is an important factor linked with physical function, muscle strength and muscle quantity (Reisinger et al., 2015; Vergara-Fernandez et al., 2020). Functional compromise as a result of sarcopenia in patients undergoing surgery for colorectal cancer is associated with poor postoperative outcomes (Reisinger et al., 2015; Vergara-Fernandez et al., 2020). Sarcopenia can have negative implications for treatment options and outcomes (Broughman et al., 2015).

Patients with cancer also commonly present with cachexia (Vergara-Fernandez et al., 2020). Cachexia is a complex metabolic condition portraying severe uncontrolled loss of muscle with or without wasting of fat mass (Bowen et al., 2015). Muscle cachexia involves a combination of malnutrition and abnormal metabolism which leaves the patient's body in a state of hyper catabolism (Siff et al., 2021). The molecular mechanisms responsible for muscle mass loss in cachexia include an increased stimulation of the ubiquitin-proteasome system, autophagy of skeletal muscle cells, oxidative stress, inflammation, low testosterone levels and elevated myostatin expression (Bowen et al., 2015). The resultant effect is an imbalance between muscle proteolysis and protein synthesis which in turn causes the reduction in muscle mass and strength as well as lower physical function (Siff et al., 2021). The loss of muscle mass seen in cancer cachexia occurs at a more rapid rate than the cachexia seen in other diseases (Giordano et al., 2003). Results of a study by Mason et al (2016) showed that the incidence of cancer cachexia was 16.6% in 253 patients awaiting elective surgery (Mason et al., 2016). Fukuta et al (2019) investigated the effect of preoperative cachexia on post-surgical hospital length of stay in older patients undergoing surgery for gastrointestinal cancers. Results of the study showed that preoperative cachexia prolonged patients' postoperative hospital length of stay (Fukuta et al., 2019). Results of another study showed that the diagnosis of cachexia itself was a predictor for haematological and gastrointestinal toxicities during chemotherapy in patients with gastrointestinal cancer (da Rocha et al., 2019). In contrast to this, several common chemotherapeutic agents are themselves known to degrade muscle mass resulting in a vicious cycle (Damrauer et al., 2008; Gilliam et al., 2011). Both muscle mass loss and muscle weakness have been associated with chemotherapy, radiation and hormone-therapy treatments for patients with cancer (Sturgeon et al., 2019).

Although there is an overlap in the definition and molecular mechanisms of the pathology of sarcopenia and cachexia, they are two separate conditions that often

occur together in patients with cancer (Vergara-Fernandez et al., 2020). The combination of both cachexia and sarcopenia results in a reduced quality of life (Bowen et al., 2015). Additionally, the disuse that occurs from inactivity in these patients further compounds the loss of muscle mass (Bowen et al., 2015). Additional measures should be taken to assess and optimize deconditioned patients preoperatively to improve their muscle quality and quantity (Fukuta et al., 2019; Reisinger et al., 2016).

Fatigue related to cancer is a common cause of anguish in cancer survivors (Akechi et al., 1999; Bower, 2014). Cancer-related fatigue is different from everyday fatigue as it is disproportional to exertion levels and is not alleviated by rest (Glaus et al., 1996). Cancer-related fatigue is persistent – it may be present at the time of initial diagnosis, increase during treatment and continue for months or even years after treatment has been completed (Ryan et al., 2007). In many cases, the patients have a reduced quality of life and their ability to perform basic activities of daily living is affected (Ryan et al, 2007). Wang et al (2014) investigated the prevalence and characteristics of fatigue in 2177 patients with cancer. The results showed that 45% of the patients who were undergoing active oncological treatment reported moderate-severe cancer-related fatigue (Wang et al., 2014). The underlying mechanisms of cancer-related fatigue include central and peripheral mechanisms. It is not well defined; however, the pathophysiology is likely linked to muscular, neuroendocrine, cytokine and neurotransmitter changes (Bower, 2014;O'Higgins et al., 2018).

Progressive cancer directly affects several organ systems and can cause neurophysiological deficits in skeletal muscle (Wang, 2008). Dysregulated proinflammatory cytokines may inhibit metabolism and affect normal muscle function. Furthermore, there may be decreased availability of metabolic substrates (Wang, 2008). Cachexia-related muscle catabolism is reported to be linked to proinflammatory cytokines (Argiles et al., 2006). Increased inflammation is also the main culprit for the mechanism behind treatment-induced symptoms (chemotherapy and radiation) (Wang, 2008). Molecules such as C-reactive protein and albumin which are downregulated by cytokines show a high correlation with cancer-related fatigue (Brown et al., 2005).

There is a hypothesis that cancer or cancer-treatments indirectly or directly cause alterations in the hypothalamic-pituitary-adrenal axis which is the central system regulating cortisol (Bakheit et al., 1992; Wang, 2008). This can result in symptoms of fatigue (Bakheit et al., 1992). There are studies that have examined the relationship

between circadian rhythm and cancer-related fatigue as a result of cortisol levels and rest-activity patterns (Wang, 2008). Alterations in fatigue between chemotherapy cycles have also been associated with rest-activity patterns (Roscoe et al., 2002). It is plausible that serotonin dysregulation and upregulation of 5-HT receptors could play a part in the pathophysiology behind cancer-related fatigue (Newsholme & Blomstrand, 1995; Andrews et al., 2005). This can result in reduced somatomotor drive and a subsequent sensation of the lack of ability to perform physical activities (Newsholme & Blomstrand, 1995; Andrews et al., 2005). Furthermore, feelings of weakness and lack of energy leading to fatigue may occur as a result of adenosine triphosphate dysfunction. Cancer and cancer treatments may cause a defect in the adenosine triphosphate regeneration as well as a build up of metabolic biproducts in skeletal muscle and neuromuscular junctions (Dimeo et al., 1997). This could result in peripheral fatigue due to lack of energy (Ryan et al., 2007).

Cancer-related anaemia has a significant impact on patients resulting in dizziness and fatigue amongst other symptoms (Wang, 2008). Anaemia results in reduced delivery of oxygenated blood which may cause fatigue as a result of compromised organ function (Ryan et al., 2007).

Post-surgical fatigue is a common complication and is often attributed to the body's physiological response to the surgery (Wang, 2008). This can further compound cancer-related fatigue in certain patients.

Chemotherapy-induced peripheral neuropathy has been reported in up to 68% of patients in the first month after completing their treatment (Seretny et al., 2014). Although the prevalence reduces over time, 30% of patients are likely to continue to struggle with symptoms related to peripheral neuropathy six months later (Seretny et al., 2014). Neuropathies can occur as a result of nerve damage from the cytotoxic effects of certain chemotherapy drugs (Winters-Stone et al., 2017). Symptoms include pain, paraesthesia, loss of sensation and reduced proprioception leading to muscle weakness, poor mobility, impaired balance and subsequently, increased risk of falls (Winters-Stone et al., 2017).

When looking at the musculoskeletal system, one cannot exclude the muscles of the pelvic floor when discussing pelvic cancers including colorectal cancer (Bernard et al., 2016). The superficial layer of muscles in the pelvic floor plays a role in sexual function (bulbospongiosus and ischiocavernosus), minor support (transverse perineal muscles

and perineum body) as well as faecal continence (external anal sphincter muscle). Urinary continence is maintained by the intermediate layer of muscles namely compressor urethra muscle and external urinary sphincter (Bernard et al., 2016; Rossetti, 2016). Lastly, the deep layer of muscles includes those that make up the levator ani muscle which are responsible for supporting the organs of the pelvis and maintaining overall continence during times whereby the intra-abdominal pressure is increased (Bernard et al., 2016; Rossetti, 2016). The anus and urethra each also have an internal sphincter making up the intrinsic layer responsible for continence (Bernard et al., 2016). A recent systematic review revealed that radiotherapy as a treatment for pelvic cancers has detrimental effects on the function of the pelvic floor musculature (Bernard et al., 2016).

While common in cases of cancers of the prostate, lung and breast; bony metastases do not occur frequently in patients with colorectal cancer. Results of a recent systematic review have shown that bony metastases occur in three to seven percent of patients with colorectal cancer (Christensen et al., 2018). Aside from bony metastases, osteoporosis has been linked with cancer and certain cancer therapies (Sturgeon et al., 2019). Men diagnosed with colorectal cancer have been shown to be less likely to have osteoporosis than women (Barzi et al., 2019). Osteoporosis further results in increased fracture risk, low bone strength, increased skeletal fragility and disruption of the micro-architecture of the bone (Sturgeon et al., 2019).

2.5 SURGERY FOR COLORECTAL CANCER

There are various types of surgical procedures for colorectal cancer resection including anterior resection, left and right hemicolectomies, sigmoid colectomy and, abdominoperineal resection (Guillou et al., 2005). Laparoscopic surgery is becoming increasingly more popular as the surgical option for patients with colorectal cancer as it is generally associated with fewer postoperative complications and a reduced hospital length of stay (Guillou et al., 2005; Hewett et al., 2008; Lee et al., 2017; Moug et al., 2015). Laparoscopic-assisted surgery takes place when the surgeon is able to laparoscopically mobilise the diseased segment of bowel but a slightly larger incision is required to remove the resected segment (Guillou et al., 2005). In some cases, patients may be planned for laparoscopic surgery and the procedure is then changed to open laparotomy intraoperatively. Reasons for conversion from laparoscopic to open laparotomy procedures include the inability to visualise critical structures, advanced disease, adhesions, inability to mobilise the colon, insufficient surgical

margins, advanced disease and intraoperative complications (Hewett et al., 2008). The postoperative length of stay for both laparoscopic and open procedures described in the literature varies from five to 12 days (Lee et al., 2017; Moug et al., 2015; Oodit et al., 2021).

A randomised controlled trial investigated short term outcomes in patients who underwent laparoscopic and open surgery for treatment of colorectal cancer (Hewett et al., 2008). The results showed that there were considerably more cases of recurrent postoperative ileus in those who had open surgery when compared to those who had laparoscopic procedures. There was a one-day variance in postoperative length of stay between the open (9 days) and laparoscopic groups (8 days) (Hewett et al. 2008).

Moug et al (2015) performed a systematic review of randomised controlled trials examining open versus laparoscopic surgery for older persons diagnosed with colorectal cancer. 'Older people' were defined as being 65 years or older (Moug et al., 2015). The results showed that both open and laparoscopic surgical options can be utilised for older people (Moug et al., 2015).

2.6 POSTOPERATIVE OUTCOMES FOLLOWING COLORECTAL CANCER RESECTION

2.6.1 Postoperative Complications and Length of Stay

An emerging multicentre prospective cohort study examined postoperative complications and mortality following surgery for various cancers in 82 different countries (Knight et al., 2021). The results showed that major postoperative complications following colorectal cancer resection were reported in 19.1% of cases in low-income and middle-income countries (LMIC) when compared to 14.4% across all income groups (Knight et al., 2021). Major complications were defined as a Clavien Dindo score of grades three or more. Furthermore, results also showed a mortality rate of 7% and 3.3% in LMIC and across all income groups respectively following surgery for colorectal cancer (Knight et al., 2021). Major postoperative complications after elective surgery for colorectal cancer are linked with reduced long-term survival (Odermatt et al., 2015).

Commonly reported postoperative surgical complications that occur following colorectal cancer surgical resection include anastomotic leakage, bleeding, ileus,

abscess, bowel perforation, adhesions, wound infection, fascial dehiscence, hernia, stoma complications and urethral/bladder perforation (Pallan et al., 2021; Warps et al., 2021). Non-surgical postoperative complications that can occur following colorectal cancer surgery include cardiac, pulmonary, thromboembolic, neurological and infectious complications (Warps et al., 2021).

Results of a recent South African study on 457 patients who underwent elective colorectal surgery showed that 44% of patients developed postoperative complications of which 61% were considered minor (Oodit et al., 2021). In the above-mentioned study wound infections (11.8%), anastomotic leaks (8.5%) and paralytic ileus (8.3%) were the most commonly reported post-surgical complications (Oodit et al., 2021). The median length of stay was five days (Oodit et al., 2021).

Increased hospital length of stay and subsequent increased cost of healthcare often occurs due to surgical site infections. A study in Ghana showed that surgical site infections resulted in an increased hospital length of stay of up to 16 additional days in patients who had undergone rectal surgery (Fenny et al., 2020). Surgical site infections can be categorised as superficial incisional, deep incisional or space/organ (Lee et al., 1999).

Anastomotic leakage is a commonly reported complication following colorectal cancer surgery. According to the 'International Study Group of Rectal Cancer', anastomotic leakage can be defined as a fault of the wall of the intestine at the surgical anastomosis leading to a direct passage between the intra-and-extra-luminal compartments (Rahbari et al., 2010). Following colorectal cancer resection, anastomotic leakage has been shown to occur more often in patients who have lower muscle density (Margadant et al., 2016). This is relevant to our research project as it emphasises the potential for preoperative physiotherapy interventions to improve patients' physical condition before surgery in order to improve muscle mass. Anastomotic leakage is associated with significant mortality and morbidity (Daams et al., 2013). An increase in the body's inflammatory response may be partially responsible for an increased wound healing time (Reisinger et al., 2016). This is significant as it could affect the external surgical incision site, as well as healing of the gut leading to manifestations of anastomotic leakages (Reisinger et al., 2016).

Postoperative paralytic ileus can be defined as a transient inhibition of gastrointestinal motility after surgery due to non-mechanical causes and results in delayed oral intake

(Gero et al., 2017). Results of a Delphi study, which aimed to achieve international agreement on the definition, diagnosis and management of postoperative paralytic ileus, showed that stimulation of ambulation or mobilisation had the highest percentage of consensus (96%) in the treatment of postoperative ileus (Gero et al., 2017). However, there is a paucity of literature on the effect of early mobilisation or postoperative exercise therapy for the treatment or prevention of paralytic ileus. Ahn et al (2013) investigated the effects of in-hospital exercise rehabilitation on postoperative outcomes in comparison to usual postoperative care in patients with colorectal cancer (Ahn et al., 2013). The exercise therapy consisted of stretching, core training, facilitation of balance and low-intensity resistance training (Ahn et al., 2013). The results showed that low-to-moderate intensity postoperative exercise training reduced hospital length of stay and improved bowel motility (Ahn et al., 2013). In contrast to this, results of an older study showed that early postoperative ambulation had no effect on recovery of gut motility when compared to normal postoperative care (Waldhausen & Schirmer, 1990).

Despite being one of the main reasons for postoperative physiotherapy management, postoperative pulmonary complication incidence after colorectal cancer surgery remain fairly low when compared to other complications such as surgical site infections. Oodit et al (2021) reported an incidence of 1.3% and 0.9% of lobar atelectasis and pneumonia respectively in South African patients who had undergone colorectal surgery (Oodit et al., 2021). However, non-surgical complications such as pulmonary complications have a greater impact on long-term survival than surgical complications (Warps et al., 2021). It is also plausible that any patient who has undergone major abdominal surgery is at risk for postoperative pulmonary complications (Tegegne et al., 2021).

Bellini et al (2016) reported a 2% incidence rate of venous thromboembolism after colectomy for colon cancer (Bellini et al., 2016). Immobilisation remains a key risk factor for thromboembolic events and education remains a key factor in risk reduction (Hillegass et al., 2016). Cancer is also a risk factor for increased risk of thromboembolic events such as deep vein thrombosis and pulmonary embolism (Heit et al., 2000). There are various mechanisms that could explain the increased risk linked to cancer including vascular injury, blood stasis, and blood hypercoagulability (Heit et al., 2000). Furthermore, surgery also increases the risk for thromboembolic events (van Hemelrijck et al., 2013). However, the absolute incidence of postoperative thromboembolic events remains low but it is still responsible for significant mortality

and morbidity (Bellini et al., 2016). Results of a retrospective cohort study showed that the incidence of postoperative thrombotic events in patients with ovarian cancer is low (Kim et al., 2022). Nonetheless, physiotherapists are vital in the initiation of early mobilisation in high risk patients (Hillegass et al., 2016).

Despite the implementation of programmes encouraging early mobilisation, there remains a sharp decrease in functional capacity in patients follow surgery which is exacerbated further by immobilisation (Scharm et al., 2019). Schram et al (2019) investigated the feasibility of a resistance-based exercise programme to promote early mobilisation following colorectal cancer surgery. In this study, patients met with an exercise specialist before surgery to address the resistance programme, personalise any exercises if required and review the postoperative period (Schram et al., 2019). Participants were provided with an information booklet containing all the exercises as well as an exercise log. Participants were seen again in the immediate postoperative period and the resistance programme was initiated. Results showed that this type of exercise programme is safe and feasible and could assist clinicians to help patients prepare for and recover from colorectal cancer surgery (Schram et al., 2019).

Timely and appropriate wound healing is imperative for patients' postoperative recovery and rehabilitation (Sandy-Hodgetts et al., 2015). Surgical wound dehiscence is the splitting open or rupture of a surgical wound or incision site (Sandy-Hodgetts et al., 2015). Results of a literature review show that it is most commonly reported after cardiothoracic, orthopaedic, vascular or abdominal surgery (Sandy-Hodgetts et al., 2015). Preoperative modifiable risk factors for surgical wound dehiscence include both smoking and increased BMI (Sandy-Hodgetts et al., 2015). Results of a study that examined risk factors influencing wound dehiscence after midline laparotomy showed that postoperative increases in intra-abdominal pressure are associated with wound dehiscence (Mäkelä et al., 1995). Risk factors involved in increased intra-abdominal pressure include coughing, vomiting, intestinal paralysis and repeated urinary catheterisation (Mäkelä et al., 1995). Furthermore, poor glycaemic control is significantly associated with poor outcomes related to surgical wound closure in high-risk patients (Endara et al., 2013). An increase in the body's inflammatory response may be partially responsible for an increased wound healing time (Reisinger et al., 2016). This is significant as it could affect the external surgical incision site, as well as healing of the gut leading to manifestations of anastomotic leakages (Reisinger et al., 2016).

Many patients have bowel symptoms including faecal incontinence following colorectal cancer surgery (Lin et al., 2018). Varpe et al (2011) investigated the quality of life outcomes especially pelvic floor dysfunction in patients who received surgical resection for rectal cancer. Results showed problems with physical functioning of the pelvic floor including anal dysfunction, urinary incontinence and dysuria as well as sexual dysfunction in male patients (Varpe et al., 2011).

2.7 LIFESTYLE FACTORS AND POSTOPERATIVE OUTCOMES

Lifestyle factors can play a role in determining the outcome of a surgical intervention. These include but are not limited to factors such as muscle mass, physical activity, smoking, alcohol consumption and BMI. One study investigated the prognostic value of muscle density in predicting poor post-surgical outcomes in older patients undergoing surgery for colorectal cancer. The results showed that low muscle density is associated with major postoperative complications (Margadant et al., 2016). Similarly, Onerup et al (2021) found that self-assessed preoperative levels of usual physical activity predicted complications after colorectal cancer resection (Onerup et al., 2019). The prospective observational cohort study utilised the Saltin-Grimby physical activity level scale (Onerup et al., 2019). Postoperative complications were measured using the Clavien Dindo scale and the Comprehensive Complications Index (Onerup et al., 2019). Van Der Hulst et al (2021) concluded that physical prehabilitation may be beneficial in preventing postoperative complications in frail older patients who are undergoing surgery for colorectal cancer (van der Hulst et al., 2021). In addition, low preoperative physical activity levels have been associated with a longer hospital length of stay (Yang et al., 2021). Another study showed that preoperative physical activity (moderate-to-vigorous intensity activity of >1000 minutes per week) was associated with fewer postoperative complications (Loogman et al., 2021). It is of note though that the patients in the above-mentioned group were already high risk as they all had American Society of Anesthesiology (ASA) scores of III and IV (Loogman et al., 2021).

Alcohol use has been linked with increased risk of anastomotic leakage (van Kooten et al., 2021). In contrast, in a retrospective review of a Dutch colorectal cancer cohort, there was no association between alcohol consumption and the risk of postoperative complications (Loogman et al., 2021). Results of a systematic review and meta-

analysis showed that preoperative consumption of more than two units of alcohol per day is associated with increased risk of non-surgical site infections (Shabanzadeh & Sørensen, 2015). The authors of the above-mentioned study admitted that the impact of lesser alcohol consumption on postoperative outcomes remains unknown (Shabanzadeh & Sørensen, 2015).

Research has also shown that increased BMI is associated with higher risk of postoperative complications such as surgical site infections (Almasaudi et al., 2018; Huh et al., 2019) and venous thromboembolism (Bellini et al., 2016). Almasaudi et al (2018) performed a systematic review and meta-analysis of observational studies to investigate the relationship between BMI and outcomes following curative colorectal cancer surgery. The results showed that higher BMI was associated with increased incidence of surgical site infections regardless of the geographical location of the studies (Almasaudi et al., 2018). However, another study showed that there isn't an association between BMI and post-surgical complications (Loogman et al., 2021).

Results of a retrospective cohort study of patients who had surgery for colorectal cancer in Johannesburg, South Africa found that patients with a smoking history were at greater risk of developing postoperative ileus when compared to lifetime non-smokers (Watkins et al., 2021). A study performed in the Netherlands also found smoking to be associated with more postoperative complications (Loogman et al., 2021). Furthermore, another study supported preoperative smoking cessation to limit pulmonary complications after surgery (Singh et al., 2013). In contrast, Graybill et al (2012) found that smoking was not associated with a greater incidence of postoperative pulmonary complications following laparoscopic surgery (Graybill et al., 2012). The time frame between smoking cessation and surgical time may play a part in the occurrence of postoperative pulmonary complications (Davies et al., 2017). Following smoking cessation, there is a temporary increase in mucus production which could increase the likelihood of developing postoperative pulmonary complications for a short period (Davies et al., 2017). Smoking has also been associated with a higher incidence of anastomotic leakage after surgery. This is believed to be due to the microvascular damage caused by smoking resulting in reduced healing of the surgical anastomosis (Parthasarathy et al., 2017).

Furthermore, there is evidence that various lifestyle factors are associated with survival rates in patients with cancer. These will be discussed in the next section.

2.8 LIFESTYLE FACTORS AND SURVIVAL

A study done in Ethiopia examined the survival pattern and prognostic determinants in patients with colorectal cancer. Results showed that survival rate varies depending on tumour-node-metastasis (TNM) stage at diagnosis of cancer (Teka et al., 2021). Patients with stage I and II cancer showed better survival rates than those with more advanced disease (Teka et al., 2021). Similarly, those with evidence of metastatic disease have poorer survival rates. Also, patients who underwent surgery had better survival outcomes than those who didn't. The two, three and five-year colorectal cancer survival rates were 46.8%, 39.5% and 28.7% respectively (Teka et al., 2021).

One author highlighted the obesity paradox in a retrospective review investigating the impact of preoperative obesity and weight changes during post-surgical chemotherapy treatment on survival. Results showed that both weight loss and excessive weight are harmful in these patients (Hu et al., 2021).

Two systematic reviews and meta-analyses that examined the association between smoking and colorectal cancer prognosis found that current and previous smoking behaviour was linked with poorer overall survival (Ordóñez-Mena et al., 2018; Walter et al., 2014). One systematic review and meta-analysis of randomised controlled trials showed that high preoperative alcohol consumption does not increase mortality (Shabanzadeh & Sørensen, 2015).

Wu et al (2016) performed a meta-analysis of 11 studies showed that physical activity before or after the diagnosis of colorectal cancer is associated with reduced overall and cancer-specific mortality (Wu et al., 2016). Similarly, greater levels of physical activity have been linked with increased progression-free survival in patients with metastatic colorectal cancer (Guercio et al., 2019). However, one study showed that the relationship between physical activity and overall survival was not statistically significant in those with metastatic disease (Guercio et al., 2019). Results of a recent systematic review and meta-analysis showed that exercise can improve cancer-related fatigue (Kessels et al., 2018). More specifically, aerobic exercise appears to have the best effect on combatting cancer-related fatigue (Kessels et al., 2018).

2.9 COVID-19 PANDEMIC

The Covid-19 pandemic has affected management of patients awaiting treatment for various cancers worldwide (Lesi et al., 2022). The pandemic has affected regular public health interventions such as cancer screening interventions (Li et al. 2021). Locally, the pandemic affected surgical schedules at both private and public hospitals

especially affecting those patients undergoing elective surgeries. Many patients experienced a preoperative delay as a result of enforced lockdowns. In a study performed in the United Kingdom, 53.3% of patients with colorectal cancer experienced a delay in their treatment (Lesi et al., 2022).

An international, prospective cohort study was performed to determine the effects of the pandemic lockdowns on planned surgery for cancer types including colorectal cancer (Glasbey et al., 2021). There were 20 006 patients included in the study. The results showed that 10% of patients did not receive surgery for their cancers after a median follow up time of 23 weeks. In all the above-mentioned cases, the reasons were linked to the Covid-19 pandemic. In 9.1% of cases, surgery only took place beyond 12 weeks from cancer diagnosis. One in seven patients who were in areas experiencing full lockdowns experienced longer preoperative delays. The authors emphasised that even though short-term outcomes were not affected in those who were to undergo surgery, the patients should be closely monitored for reduced long term outcomes such as reduced survival and metastatic disease (Glasbey et al., 2021).

It is a possibility that we will witness a surge in pandemic-related surgical morbidity and mortality even in those patients who did not contract Covid-19 (Silver, 2020). This could be addressed with prehabilitation strategies which will help rehabilitation professionals to determine a reference point, recognise impairments and provide various interventions to improve patients' physical and psychological health to limit the incidence of future impairments (Silver, 2020).

2.10 PREHABILITATION

Past management of surgical patients has traditionally focused on care in the postoperative period; however, there has been a shift towards targeted preoperative management (Carli et al., 2017; Gillis et al., 2014). "Prehabilitation can be described as the continuum of care between the time of cancer diagnosis and the beginning of acute treatments" (Silver & Baima, 2013, p. 2). This includes but is not limited to a baseline physical assessment and targeted interventions to limit the occurrence of both current and potential impairments (Silver & Baima, 2013). Gillis et al (2014) performed a randomised controlled trial which showed that patients who had received prehabilitation had a significantly greater walking distance in six minutes compared to those who had not been non-prehabilitated two months after colorectal cancer resection surgery (Gillis et al., 2014). Furthermore, patients with a reduced baseline functional walking capacity are most likely to advance their physical function with a

targeted prehabilitation programme (Minnella et al., 2016). Prehabilitation programmes for patients undergoing surgery for abdominal cancers described in the literature remain heterogeneous but often comprises of exercise therapy, psychological interventions and nutritional education (Hijazi et al., 2017). The mode of delivery of prehabilitation programmes also varies across the different studies described (Hijazi et al., 2017). Results of a systematic review showed that prehabilitation prior to abdominal oncological surgery showed changes in outcomes such as six minute walk test distance, anaerobic threshold, VO_2 max as well as health-related quality of life (Hijazi et al., 2017). Cancer prehabilitation increases the prospect of improved health-related and financial outcomes following diagnosis as well as to limit future impairments (Silver, 2015). Although the financial ramifications linked with prehabilitation provide a positive outlook for patients in Sub-Saharan Africa, unfortunately, prehabilitation for surgical patients in these countries is a need that is largely unmet at this time (Fernandes et al., 2020).

A review by Jensen et al (2018) investigated whether prehabilitation for patients undergoing major abdominal urological oncology surgery reduces postoperative morbidity and impairments in the survivorship phase (Jensen et al., 2018). The results showed that short-term, home-based prehabilitation improves early mobilisation postoperatively, time to perform activities of daily living as well as improved health-related quality of life (Jensen et al., 2018). No effect on hospital length of stay or postoperative complications was found (Jensen et al., 2018).

From a physiotherapy perspective, prehabilitation generally comprises of a combination of education and exercise therapy. However, there is a paucity of literature describing physiotherapy education strategies in isolation as a means to preparing patients for surgery.

2.11 PREOPERATIVE EDUCATION FOR PATIENTS UNDERGOING ABDOMINAL SURGERY

Devine and Cook (1986) described pre-operative teaching as “providing the patient with health related information, psycho-social support and the opportunity to learn selected skills in preparation for surgery” (cited by Shuldham,1999). Patient education is vital in order to ensure that compliance with behavioural change is achieved and maintained (Levett *et al.*, 2016).

The Enhanced Recovery After Surgery (ERAS) programme is a patient-centred, multidisciplinary approach used to optimise perioperative care in order to improve outcomes (Oodit et al., 2018). One of the important elements of the ERAS guidelines includes pre-admission counselling. A study by Oodit et al (2021) demonstrated that it is possible to implement and follow the ERAS guidelines in private South African hospitals and, that a significant reduction in length of stay can be accomplished without increasing the risk of postoperative complications (Oodit et al., 2021).

Patient education can be delivered in a variety of ways, perhaps most commonly in the form of face-to-face interface with providers (Rooney et al., 2021). Unfortunately, patients often receive their education after their surgeries and not during the vital preoperative period (Ünver et al., 2018). Preoperative education has been shown to enhance patient postoperative experiences as well as improve postoperative outcomes in a general surgical population (Scott, 2004; Kruzik, 2009). Patients awaiting surgical procedures may have high anxiety levels due to fears, worries and uncertainty about the surgery they will undergo (Gallagher & Mckinley., 2007). The provision of preoperative education could help to alleviate this anxiety (Scott, 2004). Furthermore, postoperative cognitive dysfunction that sometimes occurs after anaesthesia and surgery could limit patients' abilities to absorb new information in the early postoperative period (Rundshagen, 2014). Therefore, the education of patents in the preoperative period appears to be more appropriate.

Baima et al (2017) found no difference in outcomes when comparing two groups: one of which had received face to face education, a written brochure and a link to an online video whereas the other group simply received the written brochure and video link (Baima et al., 2017). It must be noted that this study was performed in patients undergoing surgery for breast cancer and not abdominal surgery (Baima et al., 2017).

2.11.1 **Mode of Delivery of Education**

Several studies examining patients undergoing abdominal surgery for various conditions describe written, digital and pictorial instructions provided to patients before their surgical procedures (Beck et al., 2021; Boden, Skinner, et al., 2018a; Gillis et al., 2014, 2014; Howard et al., 2019; C. Li et al., 2013; Rodrigues et al., 2018; Samnani et al., 2014). Other studies utilized face-to-face and physical demonstration education sessions (Boden, Skinner, et al., 2018a; Dronkers et al., 2010; C. Li et al., 2013). Other authors employed instructional demonstration as the mode of delivery of preoperative information (Berthelsen et al., 2020; Raj & Kathyayani, 2016). Some papers did not

specify the mode of delivery of preoperative educational material provided to the patients (Al-Reda & Rajha, 2020; Tejedor et al., 2018; van Beijsterveld et al., 2019). One study utilized a two-way information system where patients were educated verbally and then they were asked to recall and retell what they had heard (Berthelsen et al., 2020).

2.11.2 Language for Delivery of Education

Some studies had education available in more than one language (written or verbal) (Li et al., 2013; Samnani et al., 2014). One study only included patients who were able to read and write in a specific language (Raj & Kathyayani, 2016). Most studies did not clarify the language in which the education was provided or whether a translator was required.

2.11.3 Setting

Most studies provided education as part of a preoperative outpatient clinic service for patients undergoing abdominal surgery for various pathologies (Beck et al., 2021; Berthelsen et al., 2020; Boden et al., 2018, 2020; Boden, Skinner, et al., 2018a; Dronkers et al., 2010, 2013; Gillis et al., 2014; Li et al., 2013; Rodrigues et al., 2018; Samnani et al., 2014) or education was provided in the hospital or emergency department (Klaiber et al., 2018; Samnani et al., 2014; Tripathi & Sharma, 2017). Conversely, other studies used methods where the patients were educated at home (Howard et al., 2019).

2.11.4 Timing and Content Provided During Education to Patients

The preoperative education described in the literature for patients undergoing abdominal surgeries was provided anywhere between one day and several weeks before surgery (Berthelsen et al., 2020; Boden et al., 2018, 2020; Boden, Skinner, et al., 2018a; Dronkers et al., 2010; Gillis et al., 2014; Howard et al., 2019; Klaiber et al., 2018; Li et al., 2013; Rodrigues et al., 2018; Tripathi & Sharma, 2017). However, some authors did not describe the time frame for provision of preoperative education (Al-Reda & Rajha, 2020; Beck et al., 2021; Raj & Kathyayani, 2016; Samnani et al., 2014; Tejedor et al., 2018; Ünver et al., 2018; van Beijsterveld et al., 2019). Many studies made use of education as part of a physical prehabilitation programme; however, few aimed to investigate the use of preoperative education in isolation (Al-Reda & Rajha, 2020; Beck et al., 2021; Boden et al., 2018, 2020; Boden, Skinner, et al., 2018a; Raj & Kathyayani, 2016; Samnani et al., 2014; Ünver et al., 2018).

In a pre-and-post-test intervention study by Li et al (2013), participants received nutritional support, exercise prehabilitation as well as a session with a trained psychologist to educate them on breathing and relaxation techniques as well as to reinforce and enhance their motivation to comply with their home exercise program before their abdominal surgery for colorectal cancer (Li et al., 2013). The patients were recruited approximately one week before surgery (Li et al., 2013). In a randomized controlled trial by Gillis et al (2014), the authors compared prehabilitation four weeks before surgery with immediate post-surgical rehabilitation in patients undergoing colorectal cancer resection. Patients in both groups received nutritional education and relaxation exercises alongside home-based aerobic and resistance exercises (Gillis et al., 2014). Rodrigues et al (2018) compared preoperative breathing exercise training (paired with written educational instructions) with no pre-operative intervention. This education was provided one week before surgery (Rodrigues et al., 2018).

The Michigan surgical and health optimization programme (MSHOP) is a structured prehabilitation program given to patients at least two weeks before abdominal surgery (Howard et al., 2019). As part of the program, patients are engaged in four preoperative domains: walking, breathing exercises, nutrition, and stress management as well as smoking cessation when applicable (Howard et al., 2019). The patients are also issued with a written brochure and educational DVD to use at home before their surgery (Howard et al., 2019).

Tejedor et al (2018) investigated the use of ERAS protocols in elderly patients undergoing elective colorectal surgery when compared to retrospective case-matched controls. As part of the ERAS protocol, patients in the intervention group received preoperative information regarding the complete process however, the authors did not specify any further details of the information supplied to the patients (Tejedor et al., 2018).

In a randomized controlled trial by Boden et al (2018), physiotherapists provided their patients with a booklet containing written and illustrative information on postoperative pulmonary complications and their prevention with early postoperative ambulation and breathing exercises. In the same study, patients in the intervention group also received 30 minutes of face-to-face education as well as a booklet of information provided to the control group (Boden, Skinner, et al., 2018a). This education was provided within six weeks of surgery (Boden, Skinner, et al., 2018a).

Another study that investigated preoperative counselling as the primary intervention was one by Samnani et al (2014). The authors utilized a randomized controlled trial to compare the intervention group who received education on the surgical procedure and counselling on the importance of postoperative mobilization to improve postoperative outcomes with another group of patients who received the surgical information only (Samnani et al., 2014). Both groups received face-to-face and written education (Samnani et al., 2014).

In a study by Beck et al (2020), patients undergoing abdominal surgery for colorectal and ovarian cancer were issued with an educational leaflet preoperatively. The leaflet contained six multidisciplinary recommendations about the surgery and the postoperative period (Beck et al., 2021). The six recommendations included “education about exercise, nutrition, relaxation, smoking cessation, alcohol cessation, and ‘other preparation” (Beck et al., 2021, p. 3).

Klaiber et al (2018) performed a cluster randomized controlled trial that investigated the impact of preoperative education on postoperative complications in patients undergoing elective major abdominal surgery. Patients in the experimental group attended a patient education seminar the day before their scheduled surgery. The content of the seminar included postoperative complications, principles of acute pain therapy, and other coping strategies. The patients were also educated on postoperative breathing exercises, ambulation, and exercises to prevent thrombosis and burst abdomen. They also received a written informative brochure. The control group received the brochure as well as standard preoperative interactions with the surgeon and ward nurses (Klaiber et al., 2018).

Berthlesen et al (2020) described verbal information provided to patients between one and several weeks preoperatively. Such information included early bed mobility and ambulation techniques, breathing exercises and physical activity, and restrictions post-discharge (Berthelsen et al., 2020).

One study employed preoperative education but this was not the primary intervention investigated and the education was used in the control/sham group only (Dronkers et al., 2010). Dronkers et al (2010) examined the use of a two to four-week-long preoperative therapeutic program for elderly patients undergoing abdominal surgery for oncologic cancers. In this study, patients in the experimental group underwent an intensive therapeutic exercise program whereas patients in the control group were

given home-based exercise advice and were educated on the importance of their physical condition before surgery and encouraged to be active for at least 30 minutes per day before their hospital admission (Dronkers et al., 2010). Patients in both groups were coached on diaphragmatic breathing, deep breathing exercises, incentive spirometry, forced expiratory techniques and, coughing (Dronkers et al., 2010).

Other authors have investigated the impact of preoperative education on breathing exercises and subsequent practice of these exercises in isolation in patients undergoing abdominal surgery (Al-Reda & Rajha, 2020; Raj & Kathyayani, 2016; Tripathi & Sharma, 2017).

2.11.5 Outcomes of Preoperative Education for Patients Undergoing Abdominal Surgery

Beck et al (2020) found that patients prepared for surgery in various ways which was not limited to the information provided to patients in a multimodal prehabilitation educational leaflet (Beck et al., 2021).

One study found that patients who received preoperative education on early postoperative mobilisation following abdominal surgery mobilised out of bed significantly earlier than those who received standard preoperative care (Samnani et al., 2014). The results also showed that the group who was counselled on early mobilisation had fewer postoperative pulmonary complications (Samnani et al., 2014). A pre-and-post-test-study reported a four percent incidence of postoperative pulmonary complications following preoperative education and practice of breathing exercises (Raj & Kathyayani, 2016). Al-Reda et al reported improvements in all lung function parameters for the experimental group who received a preoperative breathing exercise programme when compared to the control group (Al-Reda & Rajha, 2020). Results of another study found that implementing preoperative breathing exercises enhanced lung capacity and prevented postoperative complications (Tripathi & Sharma, 2017). However, results of another showed that preoperative respiratory physiotherapy (including education) had no impact on spirometry measures in patients undergoing abdominoplasty procedures (Rodrigues et al., 2018).

The results of the study by Boden et al showed that the group who received preoperative face-to-face and written education before abdominal surgery had half the number of postoperative pulmonary complications when compared to the control group

who just received written education (Boden, Skinner, et al., 2018a). Furthermore, when investigating the memorability and treatment fidelity of preoperative education, the results showed that those who received face-to-face education were six-times more likely to remember their breathing exercises and 11-times more likely to report physiotherapy as the most notable part of the preoperative clinic (Boden et al., 2018).

In contrast, Berthelsen et al (2020) found that the patients recalled no more than 27% of preoperative physiotherapy education and, that there was no difference between those who received traditional education when compared to those who were educated using the teach-back-method. This method required patients to repeat the educational content that they had heard and any incorrect information was corrected (Berthelsen et al., 2020). Klaiber et al (2018) performed a cluster-randomized controlled trial investigating the effects of a preoperative education lecture compared to standard care in patients undergoing major visceral surgery. The results showed no significant differences in postoperative outcomes between the two groups (Klaiber et al., 2018).

2.11.6 **Financial Implications of Preoperative Education**

Boden et al (2020) investigated whether preoperative physiotherapy education is cost effective in reducing postoperative pulmonary complications. The results showed that for each postoperative pulmonary complication, preoperative physiotherapy education is likely to cost the hospitals less than the estimated cost of treatment for the postoperative complication (Boden et al., 2020).

2.11.7 **Medical Literacy**

The creation of accurate and easily understandable written educational material creates an opportunity for patients to make informed medical decisions (Rooney et al., 2021). Low health literacy is associated with the reduced ability of patients to understand and follow medical advice as well as poor health outcomes (Berkman et al., 2011). Strategies to improve patients' understanding of educational material include avoidance of medical language, the use of pictures, limiting the amount of information given at one time, and, using a "teach back" method to confirm their understanding (Williams et al, 2002; Safeer & Keenan, 2005).

2.12 **OUTCOME MEASURES**

Outcome measures are an important part of the research process as they assist investigators to answer the research question posed (Khun, 2016). In the context of this thesis, the outcome measures presented are vital in determining clinical outcomes

and assist in identifying which treatment strategies will be the most effective for the management of patients with colorectal cancer (Khun, 2016). The outcome measures included below are linked to the chapters that follow in the remainder of the thesis.

2.12.1 **Cancer Staging**

Staging of cancer can be classified using the American Joint Committee on Cancer (AJCC) TNM staging model (Egner, 2010). The tool has been shown to be valid in patients with colorectal cancer (Kim et al., 2011)

2.12.2 **Physical Function**

Performance status is an important tool to assess oncology patients for their physical fitness to withstand various anticancer therapies as well as to assist with determination of prognosis (Azam et al., 2019). Abnormalities in physical function are becoming more common even in those patients who are deemed fit for various cancer treatments (Hsu et al., 2015). In patients with poor performance status, the risk associated with systemic anticancer therapies often outweighs the benefit (Azam et al., 2019). Patients with reduced performance status have shown poorer outcomes when compared to those with increased performance status (Kelly & Shahrokni, 2016). The Karnofsky Performance Status scale (KPS), the Palliative Performance Status (PPS) scale and the Eastern Cooperative Oncology Group (ECOG) score are three commonly used performance status scales in this population (Azam et al., 2019; Zimmermann et al., 2010).

The ECOG score consists of five grades ranging from grade one (where patients are fully active) to grade five where the patient is dead (Oken et al., 1982). The ECOG score has been found to be a useful and reliable tool to measure performance status in patients with cancer (Azam et al., 2019).

The KPS scale consists of an 11-point rating ranging from patients who are functioning normally (100) to those who are dead (0) (Mor et al., 1984). The KPS scale has proved to be both valid and reliable in a research setting (Mor et al., 1984). The PSS was designed as an adaptation of the KPS. There is evidence that the PSS is a reliable measure (Ho et al., 2008). When comparing the KPS, ECOG and the PSS scores, the KPS may provide greater consistency of performance status rating in both research and clinical settings (Zimmermann et al., 2010).

The 6MWT is an objective modality used to assess functional exercise capacity and functional status (Crapo et al., 2002). It has also been used as predictor of morbidity and mortality in patients with heart failure, chronic obstructive pulmonary disease and primary pulmonary hypertension (Crapo et al., 2002). The 6MWT is easy to administer, reliable, well tolerated by patients and more reflective of daily activities when compared to other functional walking tests (Solway et al., 2001). Furthermore, the test is valid for use in patients with cancer (Schmidt et al., 2013).

Use of hand grip strength and the Short Physical Performance Battery (SPPB) is becoming more popular in a clinical oncology setting (Almugbel et al., 2022). The SPPB measures lower extremity function using three domains namely gait speed, chair stands and balance (Almugbel et al., 2022). One study examined the association between the SPPB and falls amongst older patients (Veronese et al., 2014). The results showed that the gait speed component of the SPPB was strongly associated with fall risk (Veronese et al., 2014). The test has been shown to be a valid means to recognizing patients with poor physical conditioning who would benefit from preventative interventions such as rehabilitation (Vasunilashorn et al., 2009). There is evidence that hand grip strength is independently associated with survival (Kilgour et al., 2013). One systematic review and meta-analysis investigated whether physical function predicts mortality in patients with cancer (Nakano et al., 2021). The results showed that low hand grip strength scores and low SPPB scores were significantly associated with mortality risk (Nakano et al., 2021). Furthermore, the SPPB and hand grip strength scores have shown excellent predictive abilities for functional decline in patients with breast cancer (Owusu et al., 2017).

The Chelsea Critical Care Physical Assessment Tool (CPAx) is a scoring system designed to measure physical morbidity in critically ill patients (Corner et al., 2013). The tool consists of 10 domains namely respiratory function, cough effort, bed mobility, supine to sitting on the edge of the bed, dynamic sitting, sit to stand, standing balance, bed-to-chair transfers, stepping and grip strength (Corner et al., 2013). Each domain is scored from zero to five giving patients the opportunity to score a maximum of 50 points (Corner et al., 2014). The CPAx is valid and reliable and has a limited floor and ceiling effect (Corner et al., 2013, 2014).

2.12.3 **Muscle Strength**

The Medical Research Council Sum Score (MRC-SS) is an outcome measure used to assess peripheral muscle strength (Stevens et al., 2009). The MRC-SS ranges from

zero (complete paralysis) to sixty (normal strength) and tests six upper-and-lower limb muscle groups bilaterally (Kleyweg et al., 1991). It is quick to administer, simple to use and has demonstrated good inter-observer agreement (Connolly et al., 2013; Hermans et al., 2012). Patients who are critically ill may acquire a low score or be unable to perform the test due to low levels of consciousness, poor motivation or impaired cognition (Connolly et al., 2013).

2.12.4 **Physical Activity**

The physical activity vital sign (PAVS) is used to measure physical activity as well as to get an idea of a patient's cardiovascular fitness (Sallis et al., 2016). The PAVS uses two self-reported questions to assess the average number of minutes that a patient spends exercising each week (Kuntz et al., 2021). The tool has shown to be valid and can be used to identify patients who do and do not meet weekly physical activity guideline requirements (Kuntz et al., 2021).

The global physical activity questionnaire (GPAQ) was developed by the World Health Organisation to assess moderate-vigorous physical activity as well as sedentary behaviour (WHO, 2012). The tool consists of three domains linked with physical activity (work, leisure and transport) as well as time spent in sedentary behaviour (Bull et al. 2020). The GPAQ has been shown to be a valid measure of moderate-vigorous physical activity (Cleland et al., 2014), Furthermore, the GPAQ has demonstrated good short-term and long-term test-retest reliability (Keating et al., 2019). The concurrent validity of the GPAQ using accelerometers, pedometers and a physical activity log is poor to fair (Keating et al., 2019). The GPAQ is an appropriate tool to measure current and change in moderate-vigorous physical activity (Cleland et al., 2014). However, the tool appears to be less valid in measuring current and change in sedentary behaviour (Cleland et al., 2014).

2.12.5 **Preoperative Risk Assessment**

The American Society of Anaesthesiologists (ASA) Physical Status Classification System is used to determine a patient's preoperative comorbid status (ASA Physical Status Classification System, 2020). The system is used to predict postoperative risk in conjunction with other factors such as frailty and the type of surgery to be performed (ASA Physical Status Classification System, 2020; Wolters et al., 1996). The ASA score has been shown to predict postoperative outcomes (Wolters et al., 1996).

2.12.6 **Postoperative Complications**

The Clavien-Dindo classification system was designed to classify surgical complications (Dindo et al., 2004). The system allows medical personnel to rate the single most severe postoperative complication from Grade I (any deviation from the normal post-surgical course) to Grade V (death of the patient) according to management required to treat the complication (Dindo et al., 2004; Dumitra et al., 2019). The Clavien-Dindo classification system is valid and globally applicable in various fields of surgery (Clavien et al., 2009).

2.12.7 **Readability of Patient Education Material**

Tools that measure readability assess textual parameters such as sentence length and the use of polysyllabic words (Rooney et al., 2021). Rooney et al (2021) performed a 20-year analysis of educational material published in high-impact journals. The results showed very few of these published materials are published at a grade level that could be understood by the general population (Rooney et al., 2021).The Simple Measure of Gobbledygook (SMOG) grade is a simple to use, valid measure of readability (McLaughlin, 1969). The tool determines how many years of education the average person requires to understand a text (McLaughlin, 1969).

2.13 **CONCLUSION**

There are a variety of modifiable risk factors linked with colorectal cancer risk as well as those associated with postoperative outcomes and survival. Unfortunately, there is a paucity of literature on risk factors in the South African population. The effects of cancer and cancer treatments on the musculoskeletal system play a role in patients' physical condition and general level of functioning.

International research has shown great success of prehabilitation and preoperative education for patients undergoing abdominal surgery. However, preoperative physiotherapy education for patients with colorectal cancer undergoing surgical resection specifically is yet to be adequately investigated or described especially in South Africa.

This remainder of this thesis explores the profile of South African patients with colorectal cancer, identifies postoperative outcomes in this patient population as well as their associated modifiable risk factors. Furthermore, a preoperative education programme to be delivered to patients with colorectal cancer is developed using

various research methodologies. Finally, the feasibility of implementing such a programme is also discussed.

2.14 **REFERENCES**

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CHAPTER 3

This chapter includes the bibliographical details and full text of Paper 1.

3.1 PAPER 1

Title: The association between lifestyle-related risk factors and survival in patients with colorectal cancer in an urban South African cohort

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3.1.2 Journal

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3.1.3 Journal Details

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The association between lifestyle-related risk factors and survival in patients with colorectal cancer in an urban South African cohort

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Abstract

Background: Lifestyle-related factors have been linked with risk for colorectal cancer. Data describing the relationship between lifestyle factors of South African patients who present with colorectal cancer and their survival is sparse.

Objectives: The objectives were to describe the profile of patients with colorectal cancer; to determine the association between lifestyle-related factors and survival, and to compare results of patients in the private and public sectors.

Methods: A retrospective review and secondary analysis of information of patients with colorectal cancer were conducted. The independent samples t-test and Mann Whitney U test were administered to determine differences in the clinical presentation. Pearson's Chi-Squared and Eta (η) tests were used to determine the association between survival and lifestyle-related factors.

Results: Data of 441 patients were included. When compared to the public sector cohort, patients in the private sector cohort were older ($p=0.0110$), had earlier stages of cancer at the time of diagnosis ($p<0.001$), had a higher percentage of current alcohol consumption ($p<0.001$) and had higher survival rates ($p<0.001$). Waist circumference was shown to have a large-strength effect on survival ($\eta 2=0.266$).

Conclusion: Emphasis should be placed on anthropometric screening and education to effect long-term behaviour change. Physiotherapists are well placed to provide screening and non-pharmacological interventions for patients with colorectal cancer.

Keywords: Cancer survival; risk factors; physiotherapy.

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Introduction

In South Africa, colorectal cancer is the fourth most prevalent type of cancer[1]. According to the 2014 National Cancer Registry, the crude incidence of colorectal cancer for men and women in South Africa is 7.34/100 000 and 5.86/100 000 respectively[2].

Colorectal carcinogenesis involves several complex biological pathways[3]. Lifestyle-related risk factors include

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cigarette smoking, heavy alcohol consumption, nutrition-related practices, obesity, and lack of physical activity[4,5]. Furthermore, research shows that physical inactivity, body mass index (BMI), and smoking may influence survival after a colorectal cancer diagnosis[6,7].

Smoking and alcohol consumption are both associated with colorectal cancer. Tobacco carcinogens may damage or alter the expression of important cancer-related genes[8]. The carcinogens in tobacco have also been linked with the development and growth of adenomatous polyps, the precursor lesions for colorectal cancer[9]. There are several possible biological mechanisms to explain the higher mortality rates in individuals who smoke at the time of and following the diagnosis of colorectal cancer. Smoking may result in impaired tobacco carcinogen detoxification which could promote residual tumour cell growth either by angiogenesis promotion or by chemotherapy resistance[10]. Secondly, smoking may contribute to abnormal promoter methylation which results in regulatory gene silencing in tumour progression[11]. Relating to alcohol, there are several mechanisms of alcohol-associated carcinogenesis including nutritional deficienies, modulation of cellular regeneration, and the carcinogenic effects of acetaldehyde which is the main metabolite of ethanol[12]. Long term alcohol consumption induces cytochrome P-4502E1 in the liver and gastrointestinal mucosal cells, which increases reactive oxidative species generation, leading to activation of various carcinogens – similar to those in cigarette smoke[12]. Even low daily doses of alcohol can enhance carcinogenesis[12]. Smoking, but not alcohol consumption, has been associated with an increased risk of mortality following colorectal cancer diagnosis[7,13].

The relationship between BMI and colorectal cancer outcomes is complex[14,15]. Central and general obesity have been shown to have a dose-dependent relationship with risk for colorectal cancer[16,17]. Overweight individuals with colorectal cancer have shown better overall survival outcomes[7,14,18].

Evidence suggests that physical activity exerts an independent effect on risk for colorectal cancer[5,19]. Physical activity increases gut motility which in turn reduces faecal transit time[20]. Beyond risk, physical activity has also been linked with survival in patients with colorectal cancer[7,21,22]. Results of a large-scale European prospective study showed that prediagnosis leisure time activity was associated with improved survival in patients with colorectal cancer[22]. Physical activity may reduce tissue insulin and insulin-like growth factor levels as well as play a role in anti-inflammatory actions and immune modulation[23]. Activity-induced body changes may increase cancer treatment efficacy and could support counteracting cancer progression[22].

The objectives of this study were to describe the profile of patients with colorectal cancer; to determine the association between lifestyle-related factors and survival; and to compare results of patients presenting with colorectal cancer at private sector hospitals to those presenting at public sector hospitals within a University teaching complex.

To our knowledge, data describing the relationship between lifestyle-related risk factors of South African patients who present with colorectal cancer and their survival is sparse. This information is vital to determine the need for management of modifiable risk factors in this patient population. As far as we know, this is the first study of this nature in a South African group of patients with colorectal cancer.

Methods

Approval to conduct this study was obtained from the University of the Witwatersrand Human Research Ethics (Medical) committee (M181075). A retrospective review and secondary analysis of information captured on Research Electronic Data Capture (REDCap) hosted at the University of the Witwatersrand were conducted[24,25].

Patient sample and database information

The database includes patient information collected from the study sites based in the Academic Teaching Complex of the University of the Witwatersrand in Johannesburg. These sites included one private hospital (private university referral centre) and three public hospitals (two of which are tertiary referral centres and one is a secondary care facility)[26]. Inclusion criteria comprised patients 18 years or older, a confirmed histological diagnosis of primary colon or rectal adenocarcinoma, diagnosed within the last 12 months, and written informed consent. The records of a convenience sample of patients enrolled between 1 January 2016 and 30 June 2018, with at least six months follow-up data were included.

Information was collected for the following variables: demographics (age, gender, and self-reported race), anthropometrics (weight, height, and waist circumference), lifestyle factors (physical activity, smoking, and alcohol use) and cancer staging. Outcome was reported as survival - disease or disease-free. Overall survival was determined from the date of recruitment to date of death or date of last contact session.

Three trained data capturers entered data onto the REDCap system. Patients were referred by specialists and from relevant departments such as chemotherapy, radiotherapy, and from multidisciplinary meetings hosted at the various study sites. At the time of data capturing, specialists were available to answer any questions and queries regarding the data. The data capturers assisted with data extraction from REDCap onto excel spreadsheets.

Outcome measures

The staging of cancer was measured using the American Joint Committee on Cancer (AJCC) Tumor-Node-Metastasis (TNM) staging model[27]. The AJCC tool (7th edition) categorises the malignancy from stage 0 (presence of a primary tumour) to stage IVB (distant metastases in more than one site)[28]. The tool demonstrates good prognostic validity[28].

Physical performance was measured using the Eastern Cooperative Oncology Group Scale of Performance Status (ECOG)29. The ECOG is a scale that measures patients' functional status including self-care ability and daily activity. The scale was designed to measure the impact of a patient's disease on their ability to perform various activities of daily living and was created specifically to be used in the field of cancer research . The ECOG score is often used to prognosticate for outcomes following cancer treatment. The scale grades patients according to their abilities (grade 0 - patients who are fully active and have no restrictions; grade 5 - patients who have died)[30]. The scale is known for its intraobserver reliability and simplicity[31].

The Global Physical Activity Questionnaire (GPAQ) was used to measure physical activity. The questionnaire was designed to collect information on physical activity participation across three domains namely work activity, travel to and from work, and recreation32. The World Health Organisation (WHO) recommends that an individual should achieve 150 minutes of weekly moderate-intensity aerobic physical activity or 75 minutes of weekly vigorous-intensity aerobic physical activity or 600 met-minutes of combined weekly moderate-and-vigorous-intensity physical activity[33]. The GPAQ scoring is based on these recommendations and is a reliable and valid measure of changes in moderate-to-vigorous physical activity [34,35]. Data was not collected for one sub-domain which resulted in incomplete overall GPAQ scores. This resulted in complete GPAQ data being available only for vigorous-intensity physical activity.

Data analysis

Data obtained were analysed using IBM SPSS (version 25) software[36]. Data describing the profiles and clinical presentations of patients with colorectal cancer were summarised using descriptive analysis and reported as frequencies (%), means and standard deviation (SD) and median and interquartile range (IQR). The normality of distribution of continuous data was measured using the Shapiro Wilk test. The independent samples t-test and Mann Whitney U test were administered to determine differences in the presentation of those presenting at private versus public sector hospitals. The Kaplan-Meier method was used to plot survival data and the log rank test was used to compare survival between the two groups.

Pearson's Chi-Squared test was used to determine the association between survival and nominal variables (smoking and alcohol consumption). The strength of association was measured using the Cramer's V test: a value of 0 indicated no relationship existed, 0.05-0.10 represented a weak relationship, 0.10-0.15 represented a moderate relationship, 0.15-0.25 represented a strong relationship, and >0.25 suggested a very strong relationship[37]. Eta (η) test was administered to determine the associationetween survival and ratio variables (BMI, waist circumference, and vigorous-intensity weekly minutes). Eta-squared ($\eta 2$) was used to determine the effect size. The following guidelines were used to interpret the strength of association for $\eta 2$: 0.02-0.13 represented a small effect size, 0.13-0.26 represented a medium effect size, and >0.26 represented a large effect size38. The significance of findings was set at an alpha level of ≤ 0.05. Missing data that couldn't be recovered was coded and recorded as 'missing'.

Results

Overall, 441 patients met the eligibility criteria for inclu-

sion in the study sample. Of those recruited, 152 (34.5%) were in the private sector and 289 (65.5%) were in the public sector.

Demographic profile

The profile of this cohort is summarised in Table 1.

Table 1: Demographic profile of South African urban cohort presenting with colorectal cancer

	Private sector cohort (n=152)	**Public sector cohort (n=289)**	**p-value**
Gender			0.967
Male	77 (50.7)	147 (50.9)	
Female	75 (49.3)	142 (49.1)	
Age (yrs)	60 (51-67.75)	56 (46-65)	0.011
Self-reported race			<0.001 (overall)
Caucasian	98 (64.5)	41 (14.2)	
Black	26 (17.1)	212 (73.4)	
Mixed race	4 (2.6)	25 (8.7)	
Indian	23 (15.1)	9 (3.1)	
East Asian	0 (0)	2 (0.7)	
Other	1 (0.7)	0 (0)	

Gender (n, %), age (median, IQR), self-reported race (n, %).
IQR (interquartile range), n (number), yrs (years).
The term 'other' refers to patients that felt that their race did not fall under any of the given options.

Those with colorectal cancer in the private sector were significantly older (p=0.011) and predominantly from the Caucasian population group (p<0.001) when compared to the profile of patients with colorectal cancer from state hospitals.

Cancer staging

The stage of cancer for both groups is represented in Table 2.

Table 2: Staging of colorectal cancer of South African urban cohort using AJCC

	Private sector cohort (n=152)	**Public sector cohort (n=289)**	**p-value**
AJCC			<0.001 (overall)
Stage 1	17 (12.4)	11 (4.6)	
Stage IIa	32 (23.4)	25 (10.4)	
Stage IIb	5 (3.6)	8 (3.3)	
Stage IIc	2 (1.5)	7 (2.9)	
Stage IIIa	2 (1.5)	1 (0.4)	
Stage IIIb	31 (22.6)	29 (12)	
Stage IIIc	16 (11.7)	59 (24.5)	
Stage IVa	25 (18.2)	57 (23.7)	
Stage IVb	7 (5.1)	44 (18.3)	
Missing	15	48	

AJCC (n, %)

The cancer staging data are distributed in a bimodal manner. The majority of patients in the private cohort presented with Stage IIa and Stage IIIb colorectal cancer according to the AJCC whereas the greatest percentage of patients in the public cohort presented with Stage IIIc and Stage IVa colorectal cancer. The difference between the two groups was significant ($p<0.001$).

Lifestyle profile

The ECOG scores (physical performance), modified GPAQ scores (physical activity), anthropometric measures, smoking, and alcohol consumption of both cohorts are summarized in Table 3.

Table 3: Anthropometric and lifestyle profiles of the study cohort

	Private sector cohort (n=152)	Public sector cohort (n=289)	p-value
Anthropometric data			
Weight (kg)	65 (56.4-79)	67.9 (56-	0.364
Height (m)	1.67 (1.59-	80.63)	0.567
Waist circumference (cm)	1.73)	1.65 (1.58-	0.108
BMI (kg/m^a	89.5 (83-99)	1.73)	0.212
	24 (21-28)	92 (85-102)	
		25 (21-29)	
Alcohol consumption			<0.001
Current alcohol consumer	86 (57)	83 (28.7)	(overall)
Previous alcohol consumer	19 (12.6)	84 (29.1)	
Never consumed alcohol	46 (30.5)	122 (42.2)	
Missing	1	0	
Smoking			0.021
Current smoker	16 (10.5)	45 (15.6)	(overall)
Previous smoker	52 (34.2)	65 (22.5)	
Never smoked	84 (55.3)	179 (61.9)	
ECOG score			0.341
Grade 0	36 (30.5)	73 (35.3)	(overall)
Grade 1	47 (39.8)	84 (40.6)	
Grade 2	23 (19.5)	31 (15)	
Grade 3	9 (7.6)	18 (8.7)	
Grade 4	3 (2.5)	1 (0.5)	
Missing	34	82	
GPAQ score			
Vigorous-intensity physical activity			0.191
weekly minutes	67.5 (193.6)	92.38 (387.9)	
Vigorous-intensity minutes achieved			0.116
Yes	22 (19)	26 (12.5)	
No	94 (81)	182 (87.5)	
Missing (n)	36	81	

Anthropometric data (median, IQR), alcohol consumption (n, %), smoking (n, %), ECOG score (n, %), GPAQ score vigorous-intensity physical activity weekly minutes (mean, SD), vigorous-intensity minutes achieved (n, %).
SD (standard deviation), kg (kilogram), m (meters), m^2(meters squared), cm (centimetres).

There was no significant difference in anthropometric profiles between the two groups. There was a significant difference in smoking ($p=0.021$) and alcohol consumption ($p<0.001$) between the private and public sector cohorts. The largest percentage of patients in the private and public cohorts had never smoked whereas more than half of the private cohort were current alcohol consumers.

Survival

Table 4 summarises the survival rates and Figure 1 shows the Kaplan-Meier survival plot.

Association between lifestyle factors and survival:

For the combined cohort, there were weak, non-significant, inverse associations between survival and smoking ($x2=2.34$, Cramer's $V=0.052$, $p=0.886$) and between survival and alcohol consumption ($x2=9.58$, Cramer's $V=0.086$, $p=0.386$).

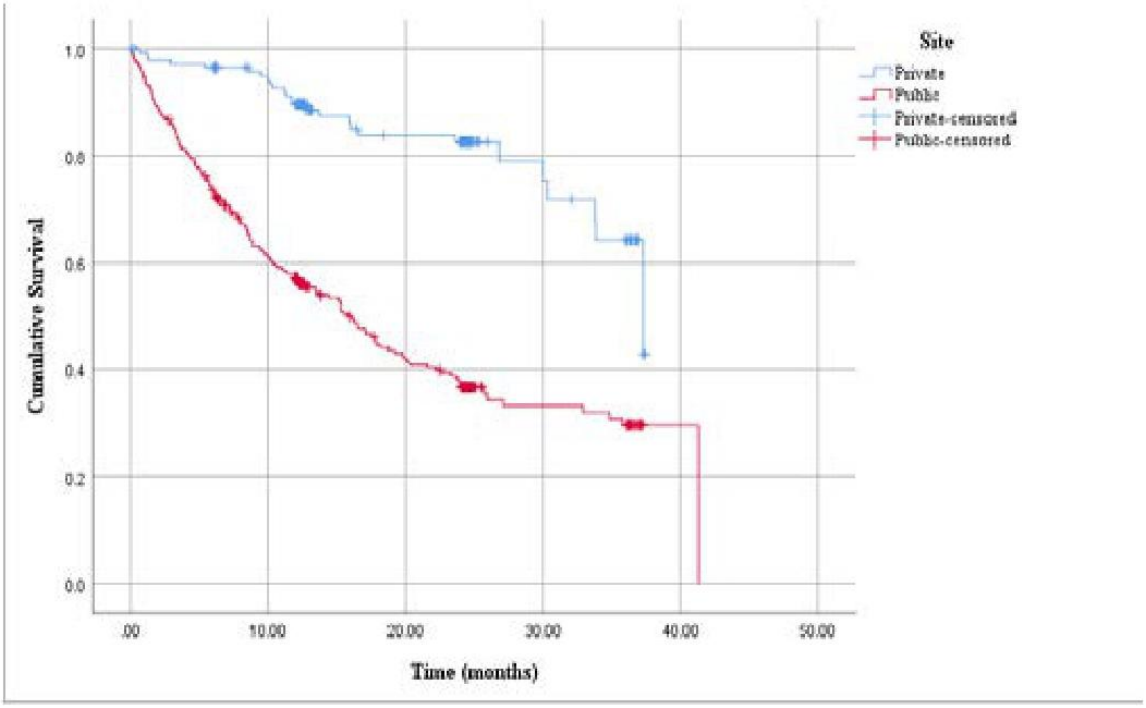


Figure 1: Differences in survival between the private and public sector cohorts

There was a non-significant, weak positive association between the frequency of achievement of vigorous-intensity weekly minutes and survival (x2=2.542, Cramer's V=0.090, p=0.468). There was a small-strength effect of the number of weekly vigorous-intensity minutes achieved on survival in patients with colorectal cancer (η=0.222, η2=0.049).

There was a medium-strength effect of BMI on survival (η=0.325, η2=0.106) and a large-strength effect of waist circumference on survival (η=0.0.516, η2=0.266).

Discussion

To our knowledge, this is the first paper describing clinical profiles, lifestyle-related risk factors, and survival of an urban South African cohort with colorectal cancer. In this cohort, patients in the public sector were younger and mostly Black-African, whereas those in the private cohort were older and more frequently Caucasian. In concordance with our findings, previous epidemiological studies have shown Black individuals develop colorectal cancer earlier than Caucasian individuals[39]. Although there may be genetic and cultural factors, the differences in cancer incidence may be linked to socioeconomic status[40].

The AJCC scores presented in the results showed a significant difference in cancer staging between those presenting in the private and public sectors. A potential explanation for this might be patient-related or linked to barriers to accessing appropriate care. Healthcare in South Africa is comprised of public and private sectors with vast differences separating the two. The public healthcare system serves approximately 80 percent of the South African population; with limited capacity to manage complicated conditions like colorectal cancer, which often requires highly specialised services in multiple disciplines[41]. The difference in cancer staging may in turn also explain the significant difference in survival between the two cohorts. Authors of an American study who analysed data collected from 1981 to 2013 showed younger age and the African race were significant risk factors for advanced staging of colorectal cancer[42].

Evidence suggests that moderate-intensity exercise may have a biological effect in reducing colorectal cancer risk[43]. Patients undergoing cancer treatments may find non-vigorous intensity exercise more tolerable than vigorous-intensity exercise. Examples of moderate-intensity physical activity include brisk walking and dancing whereas running and aerobics are classified as vigorous-intensity physical activity[33]. Due to missing data, we only had access to the vigorous-intensity weekly exercise achieved by the patients in this cohort. Research to date has shown that vigorous-intensity exercise is not associated with improved survival outcomes[21,22]. Our findings support this, as we found only a small-strength effect of the vigorous-intensity weekly minutes achieved on survival. Unfortunately without data for moderate-intensity exercise, conclusions are difficult to make on patients' physical activity profiles.

Our results showed that BMI and waist circumference had moderate-and-large-strength effects respectively on survival. These findings support research which suggests that patients with increased BMI have better survival outcomes[7,14,18]. Patients with advanced-stage colorectal cancer experience weight loss, sarcopenia, and cachexia which may have a greater impct on patients who have a low BMI[14]. Therefore, being overweight may be protective in patients with advanced colorectal cancer[14]. Screening for ideal waist circumference and BMI may be essential in managing patients undergoing various treatments for colorectal cancer. Waist circumference is a simple, inexpensive measure used to determine central adiposity in men and women[44]. However, waist circumference cut-off points for determining colorectal cancer risk and survival are yet to be established in sub-Saharan Africa.

Physiotherapists can provide non-pharmacologic interventions to assist patients with their physical health needs during cancer treatments and pre-and-post-operatively45. As rehabilitation specialists, they are well trained to manage modifiable risk factors such as physical inactivity and can offer education on health behaviours like smoking, alcohol consumption, and basic nutritional practices46. Furthermore, physiotherapists have the resources and clinical reasoning to screen and refer patients to other healthcare providers as needed[45]. The data presented in this paper highlight the need for anthropometric screening and lifestyle education in this cohort presenting with colorectal cancer. Management of modifiable risk factors could influence colorectal cancer incidence and outcomes in South Africa.

Future research is required to determine the incidence of sarcopenia in South African patients with colorectal cancer and to determine its association with survival. This will assist us to re-define and streamline the role of physiotherapists in the management of these patients.

Limitations to the study

Certain variables were considered for inclusion into the REDCap database after the start of data collection. This resulted in missing data for variables such as the ECOG score. Missing data was a limitation in calculating GPAQ scores.

The between-group differences demonstrated in the results of this study should be interpreted with caution due to the large difference in sample size between the two groups.

This cohort only represents a sample of the South African urban population of patients with colorectal cancer. Patients living in rural areas may present with a different profile. This could be due to several factors including access to healthcare which may affect the staging of cancer on the first presentation as well as the comorbidities diagnosed. Another limitation is that the cohort in this study is not a population-based sample.

Conclusion

In this urban South African cohort, lifestyle factors known to be associated with colorectal cancer risk were found. Patients in the private sector cohort were older, had earlier stages of cancer staging, and had a higher percentage of current alcohol consumption when compared to the public cohort. There were significantly higher survival rates in the private sector cohort in comparison to the public sector cohort. Waist circumference and BMI were shown to have large-and-medium-strength positive effects respectively on survival.

Emphasis should be placed on screening for anthropometric data and education on maintaining an ideal waist circumference and BMI should be prioritised. As established healthcare professionals, physiotherapists are

well-positioned to provide such screening and education to effect long-term lifestyle behaviour change and improve outcomes.

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CHAPTER 4

This chapter includes the bibliographical details and full text of Paper 2.

4.1 PAPER 2

Title: Preoperative physical activity and functional performance levels are predictors of acute postoperative outcomes in a private South African colorectal cancer cohort

Whelan, M., van Aswegen, H., Roos, R., Fabian, J., & Bebington, B. (2021). Preoperative physical activity and functional performance levels are predictors of acute postoperative outcomes in a private South African colorectal cancer cohort. *South African Journal of Physiotherapy*, *77*(1). https://doi.org/10.4102/sajp.v77i1.1526

4.1.1 Bibliographical Details of Original Paper 2 (Appendix 13)

Authors: Megan Whelan, Heleen van Aswegen, Ronel Roos, June Fabian, Brendan Bebington

4.1.2 Journal

South African Journal of Physiotherapy

4.1.3 Journal Details

The *South African Journal of Physiotherapy* is the official journal of the South African Society of Physiotherapy. The journal has a double-blind peer revew process and is open-access.

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Preoperative physical activity and functional performance levels are predictors of acute postoperative outcomes in a private South African colorectal cancer cohort

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Background: For patients with colorectal cancer, surgical resection of the primary tumour remains the best treatment option. Surgery for colorectal cancer is being performed on patients who would previously not have been considered as suitable candidates. It remains to be seen which factors influence hospital length of stay (LOS) and the development of acute postoperative complications in South African patients.

Objectives: The objectives of our study were to determine the modifiable factors that influence patients' development of postoperative complications and hospital LOS and, to identify the types of postoperative complications that develop.

Method: A retrospective review and secondary analysis of information in an existing database of patients with colorectal cancer were conducted. Regression analysis statistics were used to determine the predictors of postoperative outcomes. The level of significance at which testing was performed was set at 5% ($p \leq 0.05$).

Results: Data of 125 patients were included. Surgical site infections and postoperative paralytic ileus were the most frequently reported postoperative complications. Preoperative vigorous-intensity physical activity ($p = 0.048$, $\beta = -0.000$) and functional performance status ($p = 0.05$, $\beta = 0.926$) significantly predicted hospital LOS and the incidence of postoperative complications, respectively.

Conclusion: Preoperative physical activity and functional performance levels are predictors of acute postoperative outcomes in a private South African cohort of patients with colorectal cancer. Future research which includes other modifiable factors is required to make informed suggestions for changes in clinical practice.

Clinical implications: Patients requiring surgery for colorectal cancer should be screened for signs of physical deconditioning and referred for physiotherapy intervention before elective surgery to optimise their recovery.

Keywords: physical activity; functional performance; colorectal cancer; predictors; postoperative outcomes.

Introduction

By the end of the 21st century, cancer (Ca) is expected to globally rank as the leading cause of death (Bray et al. 2018). Colorectal Ca is one of the top five most commonly reported Ca types in both men and women worldwide and this is similar to reported incidences in South Africa where colorectal Ca is the fourth most common type of Ca in females and males (Brand, Gaylard & Ramos 2018).

Where indicated, surgical resection of the primary colorectal tumour and its metastases remains the best treatment option for these patients (Van Cutsem et al. 2014). Patients with Ca present with higher perioperative risk because of immune system disturbances, reduced physiologic reserves and longer surgical procedure duration (Simões et al. 2018). As a result of advancements in oncological treatment over the past 50 years, surgery for colorectal Ca is being performed on patients who would previously not have been considered suitable candidates (Boereboom et al.

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2015). A rising number of patients with advanced age, a population at high risk for postoperative complications, are presenting for colorectal Ca surgery (Grosso et al. 2012).

Short-term postoperative outcomes include postoperative complications, increased hospital length of stay (LOS), higher re-admission rates and reduced survival (Aravani et al. 2016; Kelly et al. 2012). Length of stay is an important contributor towards the use of hospital resources (Aravani et al. 2016; Kelly et al. 2012) and has been shown to predict patient re-admission rates to hospital (Chiu et al. 2017; Kelly et al. 2012). There is also evidence to describe a strong link between postoperative complications and a prolonged postoperative hospital LOS (Chiu et al. 2017). Potential complications after colorectal surgery are similar to those reported for other types of abdominal surgery (Kirchhoff, Clavien & Hahnloser 2010). Surgical site infection is one of the most commonly reported hospital-acquired infections described in the literature and is associated with significant morbidity (Badia et al. 2017). Gomila et al. (2018) examined the predictors of early-and-late-onset surgical site infections, with results indicating that previous chemotherapy was the strongest risk factor for the development of late-onset surgical site infections (Gomila et al. 2018). Therapies such as chemotherapy lead to chronic non-resolving inflammation and reduced immune function (Khosravi et al. 2019). As a result of the positive effects of exercise on the immune system functioning in patients with Ca (Khosravi et al. 2019), patients with increased pre-and-postoperative physical activity levels are likely to be less at risk for the development of surgical site infections.

Postoperative paralytic ileus (POI) has long been considered to be an unavoidable complication following any gastrointestinal surgery (Kirchhoff et al. 2010). The factors associated with POI are multifactorial and include humoral, neural, inflammatory and physical components (Millan et al. 2012). Physical causes of POI include manipulation of the bowel during surgery and peritoneal irritation (Lluis & Biondo 2018). Neural causes include postoperative sympathetic hypersensitivity whereas humoral factors include increasing levels of circulating catecholamines and changes in gastrointestinal hormones (Lluis & Biondo 2018; Millan et al. 2012). The inflammatory component includes inflammatory cell activation (Lluis & Biondo 2018). The common final pathway results in impaired gut motility and relative intestinal ischaemia (Vather & Bissett 2018). Opiate use has also been widely described as a causative factor of POI (Millan et al. 2012; Waldhausen & Schirmer 1990). Other commonly reported postoperative complications following abdominal surgery include respiratory (e.g. atelectasis), renal (e.g. acute kidney injury), neurological (e.g. stroke), wound-related problems (e.g. dehiscence) and in some cases even death (Isik et al. 2015; Khan, Khan & Afshan 2017; Moran et al. 2016; Simões et al. 2018).

Various postoperative strategies are used by physiotherapists to reduce the incidence of and manage postoperative complications following abdominal surgery. The 'Enhanced Recovery After Surgery' (ERAS) recommendations emphasise the use of early postoperative mobilisation strategies to improve postoperative outcomes (Gustafsson et al. 2013). Although widely utilised in a clinical setting, research regarding the perioperative role of physiotherapists for patients who have had abdominal surgery is inadequate and equivocal (Reeve & Boden 2016). However, supporting literature is available for the use of prehabilitation for patients undergoing abdominal surgery to improve postoperative outcomes (Boden et al. 2018; Boereboom et al. 2015; West et al. 2015). The composition of prehabilitation programmes is variable; however, many take on a multimodal approach comprising exercise training, nutritional care and anxiety-coping strategies (Hijazi, Gondal & Aziz 2017). Preoperative education is also considered as an essential part of the ERAS guidelines (Melnyk et al. 2011).

Studies performed internationally have reported sarcopenia as an independent predictor of poor postoperative outcomes (Nakanishi et al. 2018; Reisinger et al. 2015). Body mass index (BMI) and waist circumference are associated with survival outcomes in patients with colorectal Ca in South Africa (Whelan et al. 2021). However, it remains to be seen whether modifiable factors influence postoperative outcomes, namely hospital LOS and the development of acute postoperative complications in South African patients. Such information may be used to implement changes in the approach to patients' preoperative care. If given access to patients preoperatively, health professionals such as physiotherapists could screen patients to determine whether they are at risk for poor postoperative outcomes and assist them to manage modifiable factors before surgery (Patman et al. 2017).

The objectives of our study were to determine the modifiable factors that influence patients' postoperative hospital LOS to identify the types of acute complications that develop and which modifiable factors influence the development of these complications following surgical resection for colorectal Ca in a South African private sector cohort.

Method

Our study was a retrospective analysis of an existing database captured using Research Electronic Data Capture REDCap electronic data capture tools (Harris et al. 2009, 2019).

Database information

The database includes patient information collected from one private university specialist referral centre and three public sector hospitals (two tertiary referral centres and one secondary care facility) situated in urban Johannesburg. These facilities form part of the Academic Teaching Complex of the University of the Witwatersrand (Bebington et al. 2018).

Our study arises from the Colorectal Cancer South Africa (CRCSA) longitudinal cohort study (Bebington et al. 2018) for which the REDCap database was specifically created, and was funded by the South African Medical Research Council. Three trained data capturers were responsible for data entry onto the REDCap system. Patients were referred by specialists and from relevant departments such as chemotherapy, radiotherapy and multidisciplinary meetings at the various sites. All patients on the database had been seen by the relevant specialists and information for the database was obtained from the patients' files and supporting reports. At the time of data capture, these specialists were available to answer any questions and queries regarding the data and for aspects such as the American Joint Committee on Cancer (AJCC) staging and surgical information including Clavien Dindo Classification scores of surgical complications.

Patients 18 years and older who were recruited at the above-mentioned private university specialist referral centre, had a confirmed histological diagnosis of primary colon or rectal adenocarcinoma, were diagnosed within the last 12 months, had surgery for colorectal Ca resection and provided written informed consent were included for our retrospective review. Consent was obtained at the time that patients were recruited for the CRCSA cohort study. Patients who did not provide consent were not included in the database. The records of a convenience sample of patients recruited into the database between January 2016 and June 2018 were included for our retrospective review. Some patients may have received chemotherapy or radiotherapy and surgical resection, however, they still met the inclusion criteria and were included in our study sample. Patients who were diagnosed with colorectal Ca but did not receive surgical intervention as part of their management were excluded. Patients recruited from the three public sector hospitals within the teaching complex were also excluded. The reason for this exclusion is that our study forms part of a larger single centre project, which will be conducted at the private university specialist referral centre described here. This retrospective record review aims to establish a clinical profile of patients specifically managed at the private university specialist referral centre.

Information anonymously extracted from the database included the following: demographic profile (age, population group and sex), preoperative clinical profile (Ca site, stage of Ca at presentation, level of physical activity, physical performance, BMI, waist circumference, smoking history and alcohol consumption) and surgical profile (surgical urgency, treatment intent, surgical access, postoperative complications and presence of a stoma). Variables forming part of the clinical profile were once-off measures recorded before surgery. The time-lapse between the measurement of variables and surgery was variable depending on each patient's management plan. Some patients underwent chemotherapy and/or radiation in addition to surgery. Outcomes measured included hospital LOS and the incidence of postoperative complications before hospital discharge.

Outcome measures

The AJCC tumour-node-metastasis (TNM) staging model was used to classify the staging of colorectal Ca (Hari et al. 2013). The AJCC tool (7th edition) categorises the malignancy from stage 0 (presence of a primary tumour) to stage IVb (distant metastases in more than one site) (Hari et al. 2013).

Functional status before surgery consists of a variety of elements but is often evaluated using certain scoring systems. The Eastern Cooperative Oncology Group (ECOG) Scale of Performance status was used to measure preoperative physical performance and to prognosticate disease progression (Oken, Creech & Davis 1982). The scale describes a patient's functional status according to activities of daily living. The ECOG score grades patients according to their abilities from zero (fully active and able to carry out all self-care activities) to five (the patient has died) (Dobbins et al. 2015). Physical health status was measured using the American Society of Anesthesiologists (ASA) grading (Isik et al. 2015). The ASA grading was measured at the time of the first consultation to assess each patient's overall physical health in preparation for surgery (Owens, Felts & Spitznagel 1978). The scoring system ranges from ASA I (a patient who is normal and healthy) to ASA VI (a patient who has been declared brain-dead and is undergoing surgery for organ donation purposes) (Owens et al. 1978).

The Global Physical Activity Questionnaire (GPAQ) was used to measure physical activity. The GPAQ, designed by the World Health Organization, records physical activity across three different domains, namely work, travel to-and-from places and recreational activities (World Health Organization 2010). The questionnaire measures moderate-intensity and vigorous-intensity physical activity and sedentary time (World Health Organization 2010). Some data were missing for the moderate-intensity physical activity section of the GPAQ scores because of an error in the data-collection sheet prepared on REDCap. This resulted in information being available only on patients' vigorous-intensity physical activity.

The Clavien Dindo classification was used to define operative morbidity (Clavien et al. 2009). The classification system rates postoperative complications on an ordinal scale. The single most severe complication is rated on a score ranging from I (any deviation from the normal postoperative course) to V (death of the patient) (Dindo, Demartines & Clavien 2004; Dumitra et al. 2019).

Data analysis

Statistical analysis was performed using IBM SPSS version 25 (IBM Corp. 2017). The first author was responsible for data analysis with assistance from a statistician. The normality of distribution of continuous data was measured using the Shapiro–Wilk test. Descriptive statistics were used to describe the demographic patient profile, treatment intent, surgical

intervention, postoperative complications and hospital LOS. Categorical data are presented as frequencies and percentages. Continuous data are presented as means and standard deviation (s.d.) or median and interquartile range (IQR) (if data were not normally distributed). Simple general linear model (GLM) analysis was used to test the effect of various modifiable factors on hospital LOS and stepwise binary logistic regression analysis was performed to determine the effect of modifiable factors on the development of postoperative complications. The level of significance at which testing was performed was set at 5% ($p \leq 0.05$). Missing data that could not be recovered was coded and recorded as 'missing'.

Modifiable factors from the database included in the GLM and binary logistic regression analysis were BMI, waist circumference, smoking history, alcohol consumption, ECOG scores and weekly vigorous-intensity physical activity minutes (obtained from GPAQ).

Ethical consideration

Permission to conduct our study was obtained from the University of the Witwatersrand Human Research (Medical) Ethics Committee (M181075).

Results

The total number of patients in the cohort during the study period was 441. There were 152 patients from the private sector. A total of 125 patients (82.2%) had surgical resection and the remaining 27 patients were excluded (Figure 1). One of the 27 patients who was excluded was scheduled for surgery but refused the procedure.

Preoperative demographic, clinical and functional profile

The demographic and clinical profile of the cohort is displayed in Table 1.

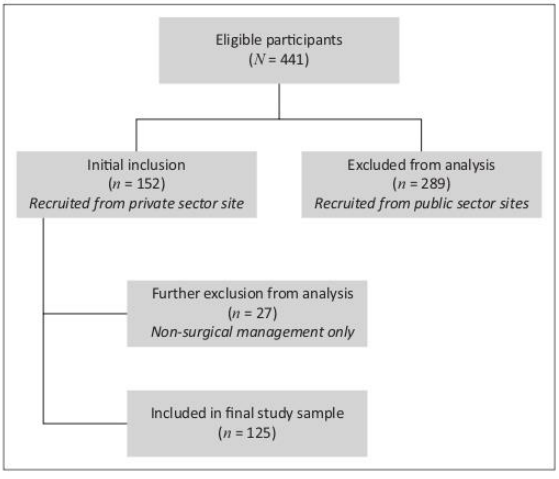


FIGURE 1: Flow chart of participant enrolment.

The majority of patients in the cohort presented with Stage IIa and Stage IIIb colorectal Ca according to the AJCC. The functional and physical activity profile of the cohort are displayed in Table 2.

The ECOG scores suggest that most patients were restricted only for physically strenuous activities but were still ambulatory. The mean weekly vigorous-intensity minutes of physical activity achieved is appropriate when referring to the World Health Organization's physical activity guidelines of 75–150 min per week (Bull et al. 2020).

TABLE 1: Demographic and clinical profile of South African urban cohort presenting with colorectal Ca at a large private university specialist referral centre ($n = 125$).

Profile characteristic	*n*	%
Sex		
Male	61	48.8
Female	64	51.2
Age (mean, s.d.), yrs	59.8	14.1
Self-reported population group		
White	85	68
Black	19	15.2
Mixed race	4	3.2
Indian	16	12.8
Other	1	0.8
AJCC		
Stage 1	17	13.6
Stage IIa	26	20.8
Stage IIb	5	4
Stage IIc	0	0
Stage IIIa	2	1.6
Stage IIIb	29	23.2
Stage IIIc	14	11.2
Stage IVa	16	12.8
Stage IVb	4	3.2
Missing	12	9.6
Ca site		
Colon	62	49.6
Rectum	63	50.4
Anthropometrics		
Waist circumference (median, IQR), cm	96	89.8–107
BMI (median, IQR), kg/m^2	26	23–30
Alcohol consumption		
Current alcohol consumer	72	57.6
Previous alcohol consumer	14	11.2
Never consumed alcohol	38	30.4
Missing	1	0.8
Smoking		
Current smoker	12	9.6
Previous smoker	43	34.4
Never smoked	70	56
ASA score		
Grade I	33	26.4
Grade II	41	32.8
Grade III	2	1.6
Missing	49	39.2

AJCC, American Joint Committee on Cancer; ASA, American Society of Anesthesiologists; BMI, body mass index; cm, centimetres; kg, kilogram; m, meters; m^2, meters squared; *n*, number; s.d., standard deviation, yrs, years.

The term 'other' refers to patients who felt that their race did not fall under any of the given options.

Surgery and postoperative outcomes

The surgical information for the study cohort is presented in Table 3.

Most patients in this cohort had elective surgery (93.6%) for curative purposes (92%) and the surgical access used was mostly through open laparotomy (60%) or laparoscopic (33.6%) procedures. Clavien Dindo scores suggest that the majority of patients presented with postoperative complications that required pharmacological intervention (grade II – 55.9%). Some patients presented with more than one postoperative complication. The frequency of postoperative complications is displayed in Table 4.

TABLE 2: Functional and physical activity profile of a South African urban cohort presenting with colorectal Ca at a private university specialist referral centre (n = 125).

Profile characteristic	*n*	%
ECOG score		
Grade 0	25	20
Grade I	36	28.8
Grade II	19	15.2
Grade III	13	10.4
Grade IV	1	0.8
Missing	31	24.8
GPAQ score		
Vigorous-intensity physical activity (mean, s.d.), weekly minutes	79.9	210.8
Missing	30	24

ECOG, Eastern Cooperative Oncology Group; GPAQ, Global Physical Activity Questionnaire.

TABLE 3: Surgical information for the study cohort (n = 125).

Variable	*n* = 125	%
Surgical urgency		
Elective	117	93.6
Urgent	5	4
Emergent	2	1.6
Missing	1	0.8
Treatment intent		
Curative	115	92
Palliative	5	4
Missing	5	4
Surgical access		
Open laparotomy	75	60
Laparoscopic-assisted	4	3.2
Laparoscopic converted to open	4	3.2
Laparoscopic	42	33.6
Stoma creation		
Yes	74	59.2
No	51	40.8
Postoperative complications		
Yes	76	60.8
No	49	39.2
Clavien Dindo score		
Grade I	6	8.8
Grade II	38	55.9
Grade IIIa	5	7.4
Grade IIIb	16	23.5
Grade IVa	2	2.9
Grade IVb	1	1.5
Grade V	0	0
Hospital length of stay (median, IQR) days	11	7–15

IQR, interquartile range; n, number

Factors associated with postoperative complications

Results of the stepwise (backward) binary logistic regression model analysis showed that high ECOG scores significantly (p = 0.05, β = 0.926) explained the variance of development of postoperative complications noted in this cohort. Although BMI, waist circumference, smoking history, alcohol consumption and weekly vigorous-intensity physical activity minutes were also included in the regression model they were not significant predictors of postoperative complications. The final step of the stepwise

TABLE 4: Frequency of postoperative complications (n = 125).

Complication	*n* = 101	%
Bleed	3	3
Obstruction	5	4.9
Ileus	26	25.7
Surgical site infection (deep and superficial)	43	42.5
High stoma output	4	3.9
CAUTI	2	2
DVT PTE	3	3
Renal failure	2	2
Pneumonia	2	2
Urinary tract infection	1	1
Urinary retention	1	1
Neuropathy in both radial nerves	1	1
Mild stroke	1	1
Anal fistula	1	1
Sepsis of unidentified origin	1	1
Anastomotic stricture	1	1
Colostomy retraction	1	1
Clostridium difficile	1	1
Mid-line abdominal fistula	1	1
Instrument-induced injury during laparoscopy	1	1

CAUTI, catheter-associated urinary tract infection; DVT, deep vein thrombosis; PTE, pulmonary thromboembolism.

TABLE 5: Factors associated with postoperative complications.

Variable	*p*-value	*β*-value
ECOG	0.050	0.926
-2 Log Likelihood = 43.190[a], Nagelkerke R Square=0.173, p = 0.026		

ECOG, Eastern Cooperative Oncology Group.

TABLE 6: Factors associated with increased hospital length of stay.

Variables	*p*-value	*β*-value
Low BMI	0.091	-0.018
Large waist circumference	0.076	0.008
Smoking	**0.169**	-
Current smoker	0.919	-0.016
Previous smoker	0.088	0.134
Alcohol consumption	**0.165**	-
Current alcohol consumer	0.489	-0.062
Previous alcohol consumer	0.061	-0.207
Low weekly vigorous-intensity physical activity minutes	0.048*	-0.000448
ECOG scores	**0.400**	-
Grade 0	0.348	-0.199
Grade I	0.143	-0.297
Grade II	0.290	-0.226
Grade III	0.844	-0.055

BMI, body mass index; ECOG, Eastern Cooperative Oncology Group; F change, 1.980; R Square, 0.476.
p = 0.078; *p < 0.05.

(backward) binary regression model analysis is presented in Table 5.

Factors associated with increased hospital stay

Results of the GLM analysis showed that low total weekly vigorous-intensity physical activity minutes significantly explained the variance observed for increased hospital LOS. The results are presented in Table 6.

Discussion

The majority of patients in this cohort presented with postoperative complications of which preoperative performance status was a significant predictor. Low weekly vigorous-intensity physical activity was a significant predictor of a prolonged hospital LOS. Patients stayed longer in hospital as a result of postoperative complications. However, this cannot be confirmed based on the specific design of this retrospective review.

A study conducted in an Asian lower-middle-income country showed a 36.2% rate of overall postoperative complications following surgery for colorectal Ca (Khan et al. 2011). Complications in the above-mentioned study were classified as either surgical (wound infection, anastomotic leak, abdominal sepsis, paralytic ileus and intestinal obstruction) or systemic (postoperative urinary tract infection, difficulty in voiding, pneumonia, pleural effusion, myocardial infarction, atrial fibrillation, systemic sepsis and stroke) (Khan et al. 2011). However, this study did not classify complications according to the Clavien Dindo system, so making assumptions regarding the severity of the complications described is challenging. A possible reason for the higher rates of complications observed in our cohort (60.8%) firstly may be linked to the fact that the private hospital from which patients were recruited is a university specialist referral centre that may attract more complicated medical cases. Secondly, the patients present late for surgery which is demonstrated with the distribution of AJCC scores shown in the results. Lastly, there is no formal ERAS programme in place at the hospital. However, the complication rate in our study is an unexpected finding and needs to be investigated in future projects.

Gastrointestinal motility problems and infections (wound and organ space infections) are the most frequently reported postoperative complications following colorectal surgery (Tevis & Kennedy 2016). Results from our study support this statement as surgical site infections and POI were the postoperative complications with the highest and second-highest reported incidences, respectively. One study reported that tumour staging and open surgical procedures are risk factors for the development of surgical wound infections after elective rectal Ca resection (Biondo et al. 2012). Increasing the use of laparoscopic procedures may reduce the risk of surgical site infections (Gomila et al. 2018) and limit manipulation of the bowel intraoperatively, which could lead to POI. There is also evidence supporting the link between regular physical activity and the reduction of bacterial and viral infections (Campbell & Turner 2018; Warburton & Bredin 2017). Taking this and our results into account, one could suggest that by improving patients' preoperative physical activity levels and encouraging early activity immediately after surgery, the incidence of surgical site infections may be reduced because of improved immunity.

Perioperative factors that predict prolonged POI in patients undergoing major abdominal surgery were recently reported (Sugawara et al. 2018). The results showed that open abdominal surgery, colorectal surgery, when compared with other types of surgery, as well as smoking history were significant independent predictors of prolonged POI (Sugawara et al. 2018). There is a widespread belief that postoperative early mobilisation reduces the incidence of POI by increasing gut motility; however, there is currently no research to support this theory (Story & Chamberlain 2009; Waldhausen & Schirmer 1990). As a result of the high incidence of POI in our cohort, future research should be carried out to investigate the impact of preoperative and early postoperative physical activity levels on the incidence of POI specifically.

Reduced preoperative performance status negatively influences a patient's ability to cope with surgical interventions and hospitalisation (Lipsitz 2002) and impaired preoperative functional capacity has been shown to adversely affect surgical outcomes (Banugo & Amoako 2017). Our data support this notion as physical activity and performance status significantly predicted acute postoperative outcomes. Both of the above-mentioned factors are modifiable and can be addressed by rehabilitation specialists before surgery, leading to the continuation of rehabilitative care immediately after surgery to optimise recovery. Findings of one study showed that multimodal prehabilitation results in a greater improvement in walking capacity throughout the whole postoperative period when compared with those who only started rehabilitation after surgery for colorectal Ca (Minnella et al. 2017). Based on the findings of our cohort, it is reasonable to assume that patients who are more functional preoperatively may better avoid the adverse effects of bed rest postoperatively and may be at less risk of the development of postoperative complications.

There is a growing interest in investigating preoperative physical activity levels and their association with postoperative recovery (Onerup et al. 2016). Data suggest that the use of preoperative physical activity questionnaires contributes to the prediction of postoperative outcomes in patients undergoing major abdominal surgery procedures (Dronkers et al. 2013). Our results support this as vigorous-intensity physical activity (obtained using the GPAQ) was found to be the only significant modifiable predictor of hospital LOS. Another study showed that there was no

significant association between preoperative physical activity levels and postoperative hospital LOS for patients with colorectal Ca (Onerup et al. 2016). The authors of this study used the four-level Saltin–Grimby Physical Activity Level Scale to describe physical activity. The scale categories range from 'physically inactive' to 'regular hard physical training for competition sports' which would represent vigorous-intensity physical activity (Onerup et al. 2016).

Patients with Ca often experience a decline in functional performance because of the cumulative effects of the various Ca treatments that patients undergo or because of the effect on the body of the Ca itself (West & Jin 2015). Fatigue is experienced by 80% – 100% of patients diagnosed with Ca (Stone et al. 2000). Furthermore, these patients often present with sarcopenia (low muscle mass) and cachexia leading to frailty (Vigano et al. 2017). Sarcopenia is associated with multiple poor outcomes including survival, infection, length of hospital stay, treatment toxicity and physical disability (Lieffers et al. 2012). Although sarcopenia was not measured in our cohort, results of a recent systematic review and meta-analysis report a significant relationship between sarcopenia and physical activity (Steffl et al. 2017).

In conditions such as Ca, the combination of disuse, sarcopenia and cachexia results in muscle wasting (Bowen, Schuler & Adams 2015). Physical activity that includes resistance training has been shown to attenuate signalling pathways associated with protein degradation whilst stimulating protein synthesis in patients with sarcopenia and cachexia (Bowen et al. 2015; Gould et al. 2013). Aerobic training programmes are specifically designed to improve objective functional capacity (Levett et al. 2016). The World Health Organization recommends that adults should perform 150–300 weekly minutes of moderate-intensity aerobic physical activity or 75–150 weekly minutes of vigorous-intensity aerobic physical activity or an equivalent combination of the two (Bull et al. 2020). Prehabilitation programmes for patients with Ca described in the literature are heterogeneous (Levett et al. 2016; Minnella et al. 2017). A recent systematic review concluded that combined aerobic and resistance training should be prescribed for people diagnosed with Ca to combat cancer-related fatigue (Meneses-Echávez, González-Jiménez & Ramírez-Vélez 2015).

Our results highlight the need for the identification of patients with poor functional performance status and low physical activity levels to begin exercise rehabilitation before curative surgery for colorectal Ca. As most of the cases in our cohort were elective and not urgent/emergent procedures, there could be a window period for rehabilitation before surgery. However, this would be dependent on the time between the identification of the need for surgery and the surgical procedure itself. If there is no time for rehabilitation before surgery, high-risk patients could be identified as such and managed appropriately following surgery.

Future research is needed to establish the level of sarcopenia present in our patient cohort and to determine its impact on the development of acute postoperative outcomes. Emphasis should also be placed on further investigating the impact of preoperative rehabilitation and educational strategies on postoperative outcomes for patients undergoing various types of abdominal surgery.

Limitations

Our sample is relatively small which limits the power of prediction that it provides and needs to be taken into account when interpreting the results. Some variables were considered for inclusion into the REDCap database after the start of data collection. This resulted in missing data for variables such as performance status (ECOG) and physical health status (ASA) for some participants. The substantial amount of missing data limits the conclusions that can be drawn from the results of our study. Furthermore, our study represents a private urban cohort of South African patients and therefore the results cannot be used to make assumptions about postoperative outcomes in patients with colorectal Ca from the public sector or rural populations. Moderate-intensity exercise data were missing for this cohort and this is a potentially modifiable risk factor for the development of postoperative complications that would need to be explored in future trials.

It is also important to highlight the fact that the database was not designed to answer the objectives of our study. As a result, the modifiable factors described in the patients' preoperative clinical profile are incomplete. Other factors such as nutrition and anxiety levels would be important to consider for inclusion in a predictive model for acute postoperative outcomes.

Conclusion

Vigorous-intensity physical activity and functional performance status significantly predicted hospital LOS and incidence of postoperative complications, respectively, in this South African private sector cohort of patients with colorectal Ca. Preoperative patient screening and education on physical activity may influence postoperative outcomes for those who require surgical resection for curative management of colorectal Ca.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this research article.

Authors' contributions

M.W., H.v.A. and R.R. contributed to the design of the research. M.W. analysed the data and wrote the manuscript. H.v.A., R.R., J.F. and B.B. contributed to the manuscript.

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Data availability

The data that support the findings of this study are available on request from the corresponding author, M.W.

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The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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CHAPTER 5

This chapter includes the full text of an original narrative review and results of a focus group session which were used to develop a framework for the content of a preoperative education programme. This paper has been published in the journal *South African Family Practice.*

5.1 PAPER 3

Preoperative physiotherapy education for patients undergoing colorectal cancer resection

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Preoperative physiotherapy education for patients undergoing colorectal cancer resection

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Background: Surgical resection is a common treatment for patients with colorectal cancer. Patients undergoing surgery are at risk of functional deterioration as a response to surgical stress. Furthermore, patients with cancer often present with systemic problems as well as a functional decline. The study aimed to create a framework for preoperative education for patients undergoing colorectal cancer resection.

Methods: Five databases were utilised to find intervention-based studies describing the content, mode, setting and timing of delivery of preoperative education for patients undergoing abdominal surgery. Physiotherapists were purposively sampled to participate in a focus group session using a seven-step nominal group technique (NGT) with the goal to reach consensus on the proposed content of a preoperative patient education programme.

Results: Seventeen studies were reviewed. Results indicate that the mode and timing of the education provided are heterogenous. Content included in the education programs described were breathing exercises, coughing techniques, verbal advice, physical exercises, surgical information, postoperative pain management, nutritional support, relaxation techniques and information about postoperative complications. Six physiotherapists participated in the focus group discussion. Ideas generated in the focus group were similar to those described in the literature.

Conclusion: Results from both the narrative review and the focus group session assisted the authors to develop a framework for the content, timing, setting and mode of delivery of physiotherapy preoperative education for patients undergoing surgical resection for colorectal cancer.

Contribution: The framework can be used to inform a physiotherapy preoperative education programme for patients undergoing surgery for colorectal cancer.

Keywords: preoperative education; framework; colorectal cancer; abdominal surgery; physiotherapy.

Introduction

Colorectal cancer is the fourth most common type of cancer in South Africa.[1] Treatment strategies for colorectal cancer are broad and include surgical resection, chemotherapy and radiation therapy.[2] Patients with cancer often present with systemic problems as well as a functional decline because of the effects of the various treatments or as a result of cancer itself.[3] Furthermore, patients undergoing major surgery are also at risk of functional deterioration because of impairment of muscular, cardiorespiratory and neurological function as a response to surgical stress.[4] Emerging data from a cohort of patients from a private South African hospital have shown that surgical site infection and postoperative paralytic ileus were the most frequently reported postoperative complications in patients who underwent surgical resection for colorectal cancer.[5]

Prehabilitation has been defined as the process of improving an individual's functional capacity to better withstand a stressful event such as surgery.[6] There is research supporting the use of preoperative exercise strategies to optimise overall health and improve postoperative outcomes in patients undergoing surgery for various forms of abdominal cancers.[7] In addition to this, psychological support and nutritional input have also been included to create a multimodal prehabilitation approach.[8]

Evidence suggests that educating patients on what to expect before surgery is beneficial by reducing postoperative anxiety, increasing patient satisfaction and improving postoperative outcomes such as length of stay in the hospital.[9] Preoperative education is considered an essential

part of the 'Enhanced Recovery After Surgery' (ERAS) recommendations.[10] Effective management of patients with colorectal cancer requires input from various members of the multidisciplinary team. Surgeons and nurses usually provide preoperative education and counselling for this patient population.[11] This is the current preoperative management of patients with colorectal cancer in a private hospital in South Africa. Typically, this comprises information about the nature of the surgical procedure, what to expect in the pre- and postoperative phases of their surgery, postoperative targets the patient is expected to meet (e.g. the instruction to exercise) and the proposed discharge date.[11]

The traditional 'prehabilitation' role of physiotherapists could be broadened to include educational input for patients undergoing surgery for colorectal cancer. Physiotherapy preoperative education is the process of providing targeted preparatory information to patients regarding their expected postoperative journey and associated participation in various exercises and activities of daily living.[12]

Current evidence supports the use of preoperative physiotherapy to reduce the risk of postoperative pulmonary complications in patients undergoing upper abdominal surgery.[13] Preoperative physiotherapy interventions for patients in sub-Saharan Africa is a need that is largely unmet.[14] The reason for this is unknown. Education (which can be considered prophylactic) is included in the scope of practice of South African physiotherapists, which is described in the *Health Professions Act 56 of 1974*.[15] Before surgery, physiotherapists could assist patients with managing activity-related expectations after surgery, explaining postoperative physiotherapy treatment procedures, assisting with controlling preoperative lifestyle-related risk factors and providing other support as required by patients. If patients are only receiving postoperative physiotherapy and nothing during the vital preoperative period, one could surmise that they are missing out on an element of their care. The educational content that physiotherapists could deliver to patients undergoing surgery for colorectal cancer specifically is yet to be established.

This study aimed to create a framework for physiotherapy-specific preoperative education for patients undergoing abdominal surgery for colorectal cancer. Firstly, the framework was informed by a narrative review of published literature describing the mode of delivery, timing, setting and content of preoperative education material provided by physiotherapists to patients undergoing abdominal surgery. Secondly, a focus group conducted with experienced physiotherapists strengthened the content component of the framework as they reflected on essential components of such a program.

Narrative review

A narrative review was performed to describe the content, timing, setting and mode of delivery of physiotherapy preoperative education for patients undergoing abdominal surgery for colorectal cancer described in the literature.

Materials and methods

Two of the authors independently searched for articles to be included in the narrative review. Inclusion criteria were intervention studies (both randomised controlled clinical trials and quasi-experimental studies), papers published in English and studies investigating patients undergoing abdominal surgery who received preoperative education at any stage before their surgical procedure. Articles were excluded if patients were under the age of 18 years; patients did not undergo abdominal surgery; preoperative education was not included in the preoperative management; or if the authors felt that the preoperative education provided was not appropriate to be administered by a physiotherapist (i.e. outside of scope of practice).[15] Papers that were narrative reviews, scoping reviews or systematic reviews on the topic were excluded. Because of the wide range of information required for patients undergoing abdominal surgery, we decided not to exclude articles where the study participants underwent abdominal surgery for causes other than colorectal cancer if it was still related to preoperative education.

Search terms included 'preoperative education', 'physiotherapy', 'abdominal surgery' and 'cancer'. The databases utilised for the search included Cumulative Index to Nursing and Allied Health Literature (CINAHL), ScienceDirect, Google Scholar, PubMed and Physiotherapy Evidence Database (PEDro). Duplicate articles were removed. Both authors independently reviewed the content of the articles using a simple data extraction table. The reference lists of the articles included were manually searched for more articles to be included in the review. Data were extracted from the studies meeting the inclusion criteria. Information extracted included: author, year of publication, country of origin, aim or purpose, study sample, methodology, intervention type or mode, intervention content, duration of intervention, measurement of outcomes and key findings (Appendix 1). The first author proceeded to use the Joanna Briggs Institute Critical Appraisal Checklists for randomised controlled trials and quasi-experimental studies.

Data analysis

For the narrative review, pertinent information for each paper considered for inclusion was extracted by two authors and recorded on study-specific data extraction forms.

Results

Seventeen papers were included in the narrative review. A flow diagram describing the process of article selection for the review is displayed in Figure 1. Table 1 summarises the type of study, patient population, timing and mode of delivery, content, language and setting of preoperative education delivered to the patients.

Health professionals involved in the delivery of preoperative education

There are data to suggest that nurses and nursing students are often responsible for the delivery of preoperative

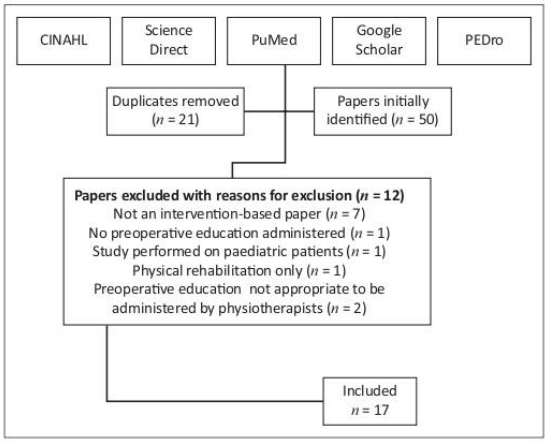


FIGURE 1: Flow diagram of article selection.

education on breathing exercises to patients before abdominal surgery.[16,17,18] In some cases, physiotherapists are responsible for the delivery of preoperative education to patients undergoing abdominal surgery;[19,20,21] however, in most studies, various members of the multidisciplinary team, including physiotherapists, nurses, physicians, surgeons, dietitians and psychologists, contribute to the content of preoperative education provided because of the wide variety of information required.[7,13,22,23,24,25]

The outcome of preoperative education

Because many studies utilised preoperative education as part of a larger prehabilitation program, one often cannot determine the impact of preoperative education alone. However, studies by Ünver, Kıvanç and Alptekin,[16] Boden (2017, 2018, 2020)[12,22,30], Raj and Kathyayani,[26] Al-Reda and Rajha,[27] Beck et al. (2020)[31] and Samnani et al.,[28] which employed preoperative education as the primary intervention, can be used to discuss the impact of such education on postoperative outcomes for patients who had abdominal surgery.

One study showed that preoperative education in the form of 30 min of face-to-face interaction and an instructional booklet reduced the incidence of postoperative pulmonary complications.[29] Their findings suggest that preoperative education is likely to be a cost-saving strategy.[30] Similarly, another study showed that there was only a 4% incidence of postoperative complications where preoperative teaching of breathing exercises was used for patients undergoing elective abdominal surgery.[26] Furthermore, a third study showed that patients who were exposed to an educational breathing exercise program before their abdominal surgery showed greater improvements in postoperative lung function tests compared with patients who received standard preoperative care.[27] In contrast, Klaiber et al.[18] found a similar incidence of postoperative complications in patients who received an informative brochure compared with those who attended a training seminar and received the brochure. There were no significant differences between the groups regarding pain perception, anxiety, quality of life or depression.[18]

Recall and/or revision of information provided

One study found that face-to-face education is highly memorable and has high treatment fidelity for patients undergoing upper abdominal surgery.[22] Another study found a strong correlation between those patients who actually received the education on breathing exercises and those patients who performed the exercises postoperatively.[16] Berthelsen et al. found that patients recalled no more than 27% of the preoperative information that was provided to them when asked questions a few days later. There were small, nonsignificant differences between the control group (who received written information) and the experimental group (who received the information utilising the teach-back method.[25] Results of another study showed that patients prepared for cancer-related abdominal surgery in various ways, which were not limited to the written recommendations provided by the multidisciplinary team.[31]

Focus group discussion

Various methods are used in research for problem-solving and idea generation.[32] The nominal group technique (NGT) is a form of consensus-seeking designed to achieve general agreement around a particular topic.[33] The benefits of an NGT focus group are that all participants are allowed to voice their opinions, and the results are obtained quickly.[33]

Participant information and inclusion criteria

Physiotherapists known to the authors and working in surgical intensive care and high-care units in Johannesburg, South Africa, were purposively sampled to participate in a focus group session using the NGT. Physiotherapists were invited to participate in our study if they had at least five years of experience working in acute care or a surgical ward setting with patients who had abdominal surgery for various conditions or those specifically working in a surgical or oncology setting. Twelve physiotherapy clinicians from 10 different hospitals in both the private and public sectors, who were working in the Gauteng province and met the inclusion criteria, were invited to participate. Furthermore, two patients known to the authors who had undergone surgical colorectal cancer resection were invited to join the session.

Procedure

Eligible participants were invited to attend a focus group session at the Physiotherapy Department at the University of the Witwatersrand in Johannesburg in October 2019. Participants completed a demographic questionnaire before the start of the session. The one session was audio-recorded with written informed consent from all participants. A transcription of the recording was not made and therefore not verified by participants. The identity of all participants is stored in a secure password-protected folder to which only the main author has access. A seven-step NGT was used to answer the following stimulus question: 'What information should be included in preoperative physiotherapy education for patients undergoing abdominal surgery for colorectal cancer to minimise the development of postoperative complications?'

TABLE 1: Synopsis of studies included in the narrative review on preoperative patient education.

Paper	Type of study	Patient population	Timing	Mode	Setting for education	Language	Content of education
Dronkers et al.[19]	Single-blind pilot randomised controlled trial	Elective abdominal oncological surgery	2–4 weeks preoperatively	Face-to-face counselling	Outpatient clinic	Not specified	Home-based exercise advice; importance of physical conditioning; breathing exercises; coughing
Li et al.[24]	Prospective pre- and postintervention study	Elective colorectal cancer resection	Variable depending on surgery wait time	Face-to-face counselling, digital	Outpatient clinic	English, French	Nutrition and modifiable dietary behaviour advice; anxiety reduction; home-based exercise advice (aerobic and resistance)
Gillis et al.[7]	Parallel-arm single-blind superiority randomised controlled trial	Colorectal cancer resection	Approximately 6 weeks preoperatively	Face-to-face counselling, written or pictorial	Outpatient clinic	Not specified	Home-based exercise advice (aerobic and resistance); nutrition advice; anxiety reduction
Samnani et al.[28]	Randomised control trial	Abdominal surgery	Not specified	Face-to-face counselling	Outpatient clinic, hospital emergency department	English, Urdu	Surgical information; early mobilisation information (intervention group only)
Boden et al.[29]	Prospective, pragmatic, multicentre, patient- and assessor-blinded, parallel group, randomised placebo-controlled superiority trial	Major upper abdominal surgery	Within 6 weeks preoperatively	Written or pictorial, face-to-face counselling (intervention group only)	Outpatient clinic	English	Postoperative pulmonary complications; breathing exercises; postoperative ambulation information
Rodrigues et al.[21]	Prospective, interventional, single-centre controlled clinical trial	Abdominoplasty	One week before surgery	Face-to-face counselling, written or pictorial	Outpatient clinic	Not specified	Breathing exercises
Howard et al.[23]	Propensity-matched retrospective chart review	Major abdominal and thoracic surgery	At least 2 weeks preoperatively	Digital, written or pictorial	Outpatient clinic	Not specified	Walking information; breathing exercises; nutrition; stress management; smoking cessation
Beck et al.[30]	Convergent design	Elective abdominal oncological surgery (ovarian and colorectal cancer)	Not specified	Written or pictorial	Outpatient clinic	Not specified	Exercise, nutrition, relaxation techniques, smoking cessation, alcohol cessation; other preparation
Raj and Kathyayani[26]	Pre-experimental one group pretest–post-test design	Elective abdominal surgery	Not specified	Face-to-face counselling	Not specified	Kannada	Breathing exercises
Al-Reda and Rajha[27]	Quantitative quasi-experimental, pre-test and post-test design.	Abdominal surgery	More than 1 day preoperatively	Face-to-face counselling	Not specified	Arabic	Breathing exercises
Berthelsen et al.[25]	Randomised single-blinded controlled trial	Abdominal surgery	One to several weeks preoperatively	Face-to-face counselling	Outpatient	Swedish	Early ambulation; breathing exercises; physical activity and activity restrictions after discharge
Tejedor et al.[20]	Retrospective nonrandomised cohort study	Elective colorectal cancer resection	Not specified	Not specified	Not specified	Not specified	Surgical information; nutrition
Ünver, Kıvanç and Alptekin[16]	Descriptive cross-sectional study	Abdominal surgery	Not specified	Not specified	Hospital ward	Not specified	Breathing exercises
Tripathi and Sharma[41]	Quasi-experimental pilot study	Abdominal surgery	Not specified	Face-to-face counselling, written or pictorial	Not specified	Not specified	Breathing exercises
Klaiber et al.[18]	Cluster randomised controlled trial	Major elective visceral surgery	One day before surgery	Group seminar, written or pictorial	Inpatient	Not specified	Postoperative complication prevention; acute pain therapy and coping strategies; postoperative ambulation; wound support
Boden et al.[22]	Nested mixed-methods randomised-controlled study	Upper abdominal surgery	Within 6 weeks preoperatively	Written or pictorial, face-to-face counselling (intervention group only)	Outpatient clinic	English	Postoperative pulmonary complications; breathing exercises; postoperative ambulation information
Boden et al.[30]	Multicentre randomised controlled trial	Upper abdominal surgery	Within 6 weeks preoperatively	Written or pictorial, face-to-face counselling (intervention group only)	Outpatient clinic	English	Postoperative pulmonary complications; breathing exercises; postoperative ambulation information

The session was facilitated by the authors, one of whom was experienced in NGT methodology. One author led the session and the other took computerised notes throughout the session. The author who led the session was responsible for inviting the participants, analysing the results and communicating with participants after the session to finalise consensus on the final ranking.

Participants were asked to formulate ideas according to 'respiratory system considerations', 'wound considerations',

'cancer-related considerations' and 'other considerations'. Participants were given time to formulate their individual ideas and write each idea onto a coloured self-adhesive paper. Ideas were then shared among the group where clinicians were invited to paste their ideas on the wall for everyone to see. Following this, clarification and clustering of ideas ensued through a group discussion where similar ideas were grouped and duplicate ideas were discarded. Participants were then asked to rank their ideas in order of importance on individual ranking sheets. General ranking of ideas was done rather than ranking for 'respiratory system considerations', 'wound considerations', 'cancer-related considerations' and 'other considerations' specifically. Participants were asked to rank the categories of ideas according to the 10 they felt to be most important. During the session, notations were kept on a laptop to ensure that the ideas shared were not lost. Notes and ideas were captured in a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, Washington, United States). After completion of the session, content from the self-adhesive papers was compared with the information captured in the Excel spreadsheet to ensure that all findings aligned. Results of the category rankings were tallied by the author who led the session. Categories that received the most votes were ranked first, and those that received the least were ranked last. The final collective ranking of ideas was determined and sent to each participant via e-mail after the session. Participants were given one week to give feedback on the final ranking to achieve overall consensus.[34] One hundred percent consensus was considered achieved if all six participants agreed (partially or fully) with the final ranking tally. Table 2 displays a summary of the NGT methodology used in the focus group session.

Data analysis

Statistical analysis for the focus group was performed using the Statistical Package for the Social Sciences (SPSS) version 25 (IBM Corporation, Armonk, New York, United States). Descriptive statistics were used to summarise the data. Demographic data were analysed using mean (standard deviation [s.d.]) or numbers (percentages).

Results

Demographics

Twelve physiotherapists were invited to participate in the focus group. Six physiotherapists responded to the invitation and agreed to participate in the session. The remaining six did not respond to the invitation; the reason for this was unknown. Two patients were invited: one could not attend because of prior commitments and the second had initially agreed to participate but was unable to attend on the day because of a family emergency. The mean age of participants was 36 years (s.d. = 8.5). There were five female (83%) and one male participants. One participant reported having a master's degree in cardiopulmonary physiotherapy, four had undergraduate physiotherapy degrees and one had an undergraduate degree with a postgraduate diploma in cardiopulmonary rehabilitation. Two participants reported having more than 10 years of overall experience working in acute care or a surgical ward setting, and the remaining four (67%) reported having between 5 and 10 years of experience. All six participants worked in the private sector. Table 3 shows the physiotherapy areas of interest of the participants. Three participants reported having more than one area of interest.

Focus group results

There were 108 ideas generated by the participants across the four domains. Twenty-eight percent of the ideas (n = 30) were generated in the 'respiratory system considerations' domain, 21% (n = 23) in the 'wound considerations' domain, 15% (n = 16) in the 'cancer-related considerations' domain and 36% (n = 39) in the 'other considerations' domain. Figure 2 displays the ideas suggested in each of the domains once duplicates were

TABLE 3: Areas of interest expressed by participants of the focus group session.

Area of interest	Percentage
Cardiopulmonary	46
Pain	15
Women's health	23
Oncology	8
Neurology	8

TABLE 2: Summary of the nominal group technique methodology used in the focus group session.

Step	Duration	Description
Step 1: Stimulus question posed	10 min	Following the introduction, a detailed explanation of the methodology and expectations was given; written consent was obtained; and the stimulus question was posed by the researcher to the participants.
Step 2: Brainstorming	15 min	The participants were asked to individually formulate ideas according to 'respiratory considerations', 'wound considerations', 'cancer considerations' and 'other considerations'. Each participant documented their ideas on separate colour-coded self-adhesive notes.
Step 3: Sharing of ideas	45 min	Ideas were then verbally shared among the group, and each idea was stuck on the wall in the various categories for all participants to observe. Each participant was given a chance to share one idea at a time until all the ideas had been shared.
Step 4: Clarification and clustering	65 min	A group discussion ensued, led by the researcher. The researcher numbered and read each idea aloud, and participants guided the placement of the ideas on the wall. Similar ideas were clustered together, and duplicate ideas were discarded. Participants were invited to interrogate any ideas that were displayed, as well as question how the clusters of ideas were being developed. During this process, there was no onus on the participant whose idea was under discussion to take ownership of the idea.
Step 5: Ranking of ideas	20 min	A final list of ideas for each category was displayed on the wall. A ranking list was provided for each participant. Each participant was asked to rank the ideas in terms of their importance across all categories. This step was completed individually by all participants in silence. Participants handed in their ranking sheets to the researcher at the end of the session.
Step 6: Final tally	24 h	Votes were captured in a self-designed Excel database. The ideas were ranked based on the votes received. These results were e-mailed to participants within 24 h of the focus group meeting.
Step 7: Final ranking and consensus	1 week	The participants were invited to give feedback on the final ranking to achieve overall consensus on the ideas generated around the stimulus question posed.

Respiratory system considerations	Wound considerations
Coughing – technique including wound support Education on the reason for use, choice of and how to perform each active respiratory treatment technique to be used postoperatively Demonstrate how to use adjunctive respiratory devices Preoperative respiratory muscle training and mobilisation Effects of anaesthetic on the respiratory system Education on why manual chest techniques may be used and the benefits thereof Importance of mobilisation Possibility of mechanical ventilation Possible postoperative respiratory complications Importance of postoperative mobilisation Positioning	Possible size of the wound – what to expect post surgery Possible surgical attachments and impact on mobility Education on healing phases and scar management Potential wound site and relevant anatomy Wound care after discharge Infection control Wound support with mobility Pain related to the wound Mobilisation protocol after surgery, e.g. when it is safe to start lifting objects, etc. What to expect regarding dressings and stoma care Wound management related to stoma and mobility Long-term stiffness when healing has taken place
Cancer-related considerations	**Other considerations**
Pain related to the cancer condition Importance of exercise postoperatively and following discharge Understanding of cancer and its treatment, e.g. chemotherapy Side effects of cancer treatments Type of cancer Importance of exercise for cancer (to improve outcomes and to manage cancer-related fatigue) Endurance, strength and balance following surgery Peripheral neuropathy as a cancer treatment side effect and how it influences mobility Possible prognosis Cancer support groups Impact on body condition and how it influences exercise tolerance Family history regarding cancer Possibility of metastasis	Nutritional support and dietary considerations Importance of early mobilisation and expected mobilisation program Emotional status of patient and family support Risk of further surgical procedures Support systems Outcome measure education Drains and intravenous lines post surgery Having realistic expectations Psychological effects of cancer and surgery Likely length of stay and the recovery pathway Education of possible postoperative complications and how to prevent them Intensive care unit (ICU) and theatre environment, including mechanical ventilation Estimated ICU and length of hospital stay Protocol regarding the amount of weight allowed to be lifted post surgery Why physiotherapy is important pre- and postoperatively Medication and potential side effects Long-term expectations and follow-up treatment Protocol of exercise allowed post surgery, e.g. running, cycling How can the family be involved? Details of the surgical procedure Why is exercise important? Communication strategies if mechanically ventilated post surgery Management and integration back into family and community The psychological impact of cancer and surgery Stoma care Incontinence, bowel function and retraining

FIGURE 2: Ideas suggested by focus group participants related to the 'respiratory system considerations', 'wound considerations', 'cancer-related considerations' and 'other considerations' domains.

TABLE 4: Final ranking of categories for inclusion in preoperative education for patients with colorectal cancer.

No.	Description of category
1	Education on active breathing techniques and why they are important
2	Education on the development of possible respiratory complications
3	Wound support with activity – how and why?
4	Positioning to optimise respiratory function
5	Education on how to perform active breathing techniques
6	Pain – cancer, wound, medication
7	Importance of mobilisation – education, complications and outcome measures
8	Passive physiotherapy techniques to assist with sputum clearance
9	Medical and surgical journey and surgical expectations
10	Wound care and infection control
11	Scar management during the phases of healing
12	The rehabilitation protocol – short-term, long-term, including post discharge (pathway of care)
13	Side effects of chemotherapy and radiation
14	Importance of the multidisciplinary team (support, family, dietician, stoma nurse, etc.)
15	Cancer – types, prognosis and outcomes
16	Exercise and cancer
17	Other complications – bladder and bowel

removed, and some ideas were combined as they were found in more than one domain. Following the group discussion where ideas were clustered together, 17 clusters of ideas remained. Concerns were raised about excluding certain categories that led to the ranking of all 17 categories instead of just 10. Verbal consensus was reached by all six participants during the session to include all 17 categories in the final ranking. Each individual then voted on the final ranking of the 17 categories. None of the participants had the same individual ranking of the 17 categories. A final combined ranking list was developed as described in the methodology and e-mailed to participants after the session was concluded. All participants confirmed via e-mail that they agreed with the final ranking results. The authors considered this to confirm 100% consensus with the final ranking. Table 4 summarises the categories in order of importance following the final ranking tally.

The first author used the summary of the narrative review and results of the focus group session to develop a combined framework for physiotherapy preoperative education. The other two authors reviewed the framework developed and gave feedback, following which changes were made as necessary (Figure 3).

Discussion

Various studies were identified that utilised preoperative education strategies for patients undergoing abdominal surgery. The timing of preoperative education delivery described in the literature appears to be variable. Preoperative education is provided by various members of the multidisciplinary team.[7,13,22,23,24,25] There is evidence that preoperative physiotherapy education prior to abdominal surgery has shown high treatment fidelity, is highly memorable, leads to lower hospital costs and reduces postoperative pulmonary complications.[22,26] However, it appears that physiotherapists are often underutilised when it comes to the provision of preoperative education for patients undergoing abdominal surgery. For example, the

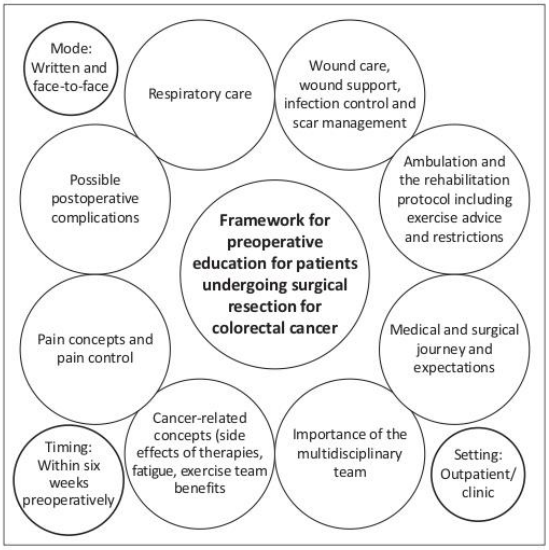


FIGURE 3: Framework for preoperative education for patients undergoing surgical resection for colorectal cancer.

provision of education regarding breathing exercises falls within the scope of physiotherapy practice,[15] although currently breathing exercise education is being provided by nurses in multiple settings.[16,26] Although nurses are able to provide general advice regarding breathing exercises, physiotherapists would educate patients in more detail.[15,35]

Content included in the education programs included breathing exercises, coughing, verbal advice on trunk and pelvic mobility exercises and leg mobility exercises, surgical information, postoperative pain management, nutritional support, relaxation techniques and information about postoperative pulmonary complications and their prevention with early postoperative ambulation. The question remains whether the content of preoperative educational information provided to patients undergoing abdominal surgery by physiotherapists could be expanded upon to include other concepts and whether this could have any impact on their postoperative outcomes.

Many of the ideas presented in the final NGT ranking by the participating physiotherapists were similar to those described in the education program provided to patients in the studies by Boden et al.[13,30] Our results had more information related to cancer, which is appropriate given that the clinicians were tasked with determining the information that should be included in preoperative physiotherapy education for patients undergoing abdominal surgery for colorectal cancer specifically. Categories such as treatment side effects (chemotherapy and radiation) and cancer (type, prognosis, etc.) were ranked outside the top 10 items in our study. This could be because some of the participants verbalised during the session that although these concepts are important, discussion of these matters could be outside the scope of physiotherapy practice.

Based on the opinion of the clinicians who attended the focus group, concepts such as the postoperative rehabilitation journey and physiotherapy management of incontinence could also be included in a physiotherapy preoperative education program. For patients undergoing surgery for colorectal cancer specifically, preoperative education on cancer-related fatigue and the associated benefits of exercise and the impact of lifestyle-related risk factors on postoperative outcomes could be beneficial for patients undergoing abdominal surgery for the tumour resection.

Results of a systematic review and meta-analysis showed that multimodal exercise interventions are effective in the management of cancer-related fatigue.[36] Preoperative functional performance levels and physical activity are predictors of acute postoperative outcomes in South African patients undergoing colorectal cancer resection.[5] This supports the decision to include physical activity and information regarding other lifestyle-related factors to effect changes in acute and long-term outcomes in this patient group.

'Early Recovery After Surgery' protocols are multidimensional and consider aspects of preoperative, perioperative and postoperative care aimed at enhancing recovery following surgery.[10] The ERAS pathway helps reduce the incidence of postoperative complications and hospital length of stay in patients undergoing major open abdominal surgery for colorectal cancer. Because of the fact that ERAS guidelines encourage a multidisciplinary approach, it is important that patients are aware of the other members of their care team. Over the past few years, there has been a rise in multidisciplinary management of patients with cancer. An important component of ERAS principles is postoperative analgesia.[10] Although the optimal modality for postoperative analgesia control is still up for debate, poorly controlled analgesia is associated with impaired mobility and poor postoperative outcomes.[10] Physiotherapists are able to advocate for their patients to receive appropriate pain control, which has the potential to improve acute postoperative outcomes such as hospital length of stay. Another component of the ERAS pathway is preoperative counselling where patients are given information about their medical and surgical journey, which would support the addition of this component to our framework.[10]

Evidence supporting the effectiveness of breathing exercises to prevent postoperative pulmonary complications is inconclusive. On the one hand, results of a recent randomised controlled trial found that the active cycle of breathing technique is more effective than autogenic drainage in improving thoracic expansion, peak expiratory flow rate and inspiratory capacity in patients who underwent abdominal surgery.[37] Alternatively, results of a cluster randomised controlled trial showed that the addition of deep breathing exercises to physiotherapy-directed early mobilisation following abdominal surgery had no impact on the incidence of postoperative pulmonary complications when compared with early ambulation in isolation.[38] However, given the fact

that active breathing techniques were at the top of the final ranking after the NGT, and were included in several of the studies reviewed, the authors retained it as part of 'respiratory care' in the framework.

Early ambulation after surgery is one of the components of the ERAS guidelines.[10] Browning et al.[39] performed a study to determine how much uptime is performed in the first four days following upper abdominal surgery. Results showed that the quantity of upright mobilisation is low in these patients.[39] Less uptime was a predictor of longer hospital length of stay.[39] Similarly, results from a more recent prospective cohort study in older patients who underwent emergency abdominal surgery found that delayed mobilisation was associated with poor postoperative outcomes.[40] This highlights the need to educate patients on the benefits of early upright positioning and mobilisation following surgery.

The time period between diagnosis and commencement of treatment in South African patients with colorectal cancer remains heterogenous. However, if referred timeously to physiotherapists, many patients could benefit from preoperative interventions such as physiotherapy education. Doctors and other primary care practitioners could play a vital role in the referral of patients for various rehabilitation services at the time of diagnosis.

Limitations

Although 17 studies were identified and included in the narrative review, only eight were randomised controlled trials.[7,18,19,22,25,28,29,30] The remaining nine studies utilised a variety of other interventional study designs. Because of the varying strengths of the designs of research papers included, it is difficult to accurately draw solid conclusions for this review. Rather, the information gathered regarding content, timing and method of delivery of preoperative education can be used to guide future studies.

Because the clinicians were purposively sampled to participate in the focus group session, selection bias cannot be ruled out. Furthermore, because the focus group session was facilitated by the authors, there was also a risk of bias during the session that cannot be ignored. There were a small number of participants who took part in the NGT; however, the sample still fell within the recommended sample size for an NGT session.[33] Our study only included physiotherapy clinicians who work in the private sector, despite the invitation being extended to clinicians working in the public sector. Clinicians working in the public sector may have presented different ideas during the NGT session. Furthermore, although two patients were invited to participate in the session, we only had physiotherapy clinicians in attendance.

The study populations described in the narrative review were heterogenous and not limited to patients with colorectal cancer. However, because the framework was also based on the results of the focus group, the framework presented could be considered useful for patients with colorectal cancer. However, further validation and testing will be required before this can be used in clinical practice. The framework developed was not reviewed by members of the focus group, and consensus was only achieved by the authors of this paper.

Conclusion

Preoperative physiotherapy education reduces the incidence of postoperative pulmonary complications, is memorable and has high treatment fidelity for patients undergoing abdominal surgery. Several authors investigated the use of physiotherapy preoperative education for patients undergoing abdominal surgery. Various modes of delivery are described, and the timing of education interventions is heterogenous and case dependent. The preliminary framework developed for preoperative physiotherapy education delivery to patients undergoing surgical resection for colorectal cancer provides the content, timing, setting and mode of delivery. Further research is needed to investigate the impact of a comprehensive physiotherapy preoperative education program on postoperative outcomes in South African patients undergoing colorectal cancer resection.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

M.J.W. was involved in the conceptualisation of the study, methodology, analysis of the data and writing of the first draft of the manuscript. R.R. was involved in the conceptualisation of the study, supervision and review and editing of the manuscript. M.F. was involved in the methodology of the study and review and editing of the manuscript. H.v.A. was involved in the conceptualisation of the study, supervision and review and editing of the manuscript.

Ethical considerations

Approval to conduct our study was obtained from the University of the Witwatersrand Human Research Ethics (Medical) Committee (ref. no. M181075). Written informed consent was obtained from all clinicians who participated in the focus group session.

Funding information

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Data availability

The authors confirm that the data supporting the findings of this study are available within the article.

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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Appendix starts on next page →

Appendix 1

A	Author(s)
B	Year of publication
C	Source origin or Country of origin
D	Aims and purpose
E	Study participation or sample size (if applicable)
F	Methodology
G	Intervention type
H	Concept
I	Duration of the intervention
J	How outcomes are measured
K	Key findings that relate to the review question

FIGURE 1-A1: Extraction form for narrative review.

CHAPTER 6

This chapter includes original research with the results of a Delphi study with an international panel of physiotherapy experts. This manuscript is currently under review with the *Journal of Acute Care Physical Therapy.*

6.1 PAPER 4

Title: Preoperative education content provided by physiotherapists to patients undergoing open abdominal surgery for colorectal cancer: a Delphi study

Whelan M, van Aswegen H, Roos R. Preoperative education content provided by physiotherapists to patients undergoing open abdominal surgery for colorectal cancer: a Delphi study. *Journal of Acute Care Physical Therapy (under review)*

6.1.1 Bibliographical Details of Original Paper 4

Authors: Megan Whelan, Heleen van Aswegen, Ronel Roos

6.1.2 Journal

Journal of Acute Care Physical Therapy

6.1.3 Journal Details

The *Journal of Acute Care Physical Therapy* is the only peer-reviewed journal dedicated to physiotherapy in an acute care setting. It is the official journal of the Academy of Acute Care Physical Therapy of the American Physical Therapy Association.

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The formatting of the content of this paper is in line with the requirements of the specific journal it has been submitted to.

6.1.4 ABSTRACT

Introduction:

Reduced preoperative physical condition predicts poor postoperative outcomes in patients undergoing colorectal cancer resection.

Review of literature:

There is a paucity of literature on the content of preoperative physical therapy education that could be administered to patients undergoing colorectal cancer resection. The purpose was to obtain insight on the content of preoperative education that could be provided by physiotherapists for patients undergoing surgical resection for colorectal cancer.

Subjects and design:

A panel consisting of international physical therapy clinicians and/or researchers with more than five years of experience working in the field of oncology, surgery or a combination of both participated in a two-round online modified Delphi survey.

Methods:

The initial survey that consisted of 36 statements was circulated. Consensus threshold was set at 70%. Statements not achieving consensus in round one were modified and new statements were added to the second round dependent on participant feedback. Descriptive data analysis was done.

Results:

Seventeen experts were invited to participate of which eight (47%) responded in round one and seven (41%) in round two. Thirty-one statements reached 70% consensus after both rounds which fell under the following categories: wound/pain (16.1%), rehabilitation (29%), respiratory considerations (22.6%), cancer considerations (6.5%), medical/surgical journey (16.1%) and other (9.7%).

Conclusion:

The statements agreed upon by the participants represent the insight of an international physical therapy panel on the proposed content of a physical therapy preoperative education programme for patients undergoing colorectal cancer surgery. The content includes preoperative exercise advice, postoperative respiratory techniques and ambulation, wound care, medical/surgical information, cancer considerations and return to physical activity guidelines.

6.1.5 Keywords

Preoperative education, physiotherapy, colorectal cancer

6.2 FULL TEXT

6.2.1 BACKGROUND

Pre-operative cardiopulmonary functional capacity, management of pre-existing risk factors and assessment of a patient's surgical risk all influence postoperative outcomes [1]. Results of a recent study showed that low preoperative physical activity and functional performance levels are predictors of acute postoperative outcomes (increased hospital length of stay and incidence of postoperative complications) in South African patients undergoing abdominal surgery for colorectal cancer [2].

Patients with colorectal cancer will likely experience muscle weakness with a decline in their functional and physical capacity after receiving treatments such as chemotherapy, radiotherapy and surgery [3, 4]. The period between diagnosis and surgical intervention could be utilised to improve or re-establish physical function [4]. It is likely that patients with cancer who have experienced loss of muscle mass will benefit from prehabilitation [5].

Research has shown that physiotherapists play a significant role in the preoperative management of patients undergoing abdominal surgery for various diagnoses [6–9]. Preoperative physical therapy programmes implemented by others for patients undergoing abdominal surgery included exercise therapy (to improve muscle strength; functional and aerobic capacity) [10] and education (related to lifestyle-related risk factors, postoperative ambulation, postoperative breathing exercises etc.) [6,10–15] and resulted in improved postoperative respiratory outcomes [6,16,17]. Prehabilitation for major abdominal surgery reduces postoperative morbidity [18]. Furthermore, results of a randomised-controlled study showed that preoperative physical therapy education before abdominal surgery is memorable and has high treatment fidelity [19] .

There is a paucity of evidence on the use of preoperative education delivery by physiotherapists to patients scheduled for abdominal surgery specifically for colorectal cancer resection. The purpose of this study was to use a modified Delphi technique with an international panel to gain insight on the proposed content of preoperative education that could be provided by physiotherapists for patients undergoing surgical resection for colorectal cancer.

6.2.2 METHODOLOGY

Approval to conduct this study was obtained from the University of the Witwatersrand Human Research Ethics (Medical) committee (M181075). A two-round modified Delphi study was performed. Study data were collected and managed using REDCap electronic data capture tools hosted at the University of "X" [20,21]. The study was performed during the period July to October 2021.

Participants were considered for inclusion in the Delphi panel according to the following criteria: international and South African physical therapy clinicians and/or researchers with more than five years of experience working in the field of oncology, surgery or a combination of both. Potential participants were identified by the authors based on recent publications and work in the field of oncology and surgery. Potential participants were purposively sampled by the authors. Furthermore, a snowball sampling strategy was employed whereby panel members who agreed to participate were asked to suggest other relevant stakeholders who were then contacted by the authors [22].

The Delphi technique is a consensus method used in research to solve problems, generate ideas and determine priorities [23]. This research method makes use of a multistage self-completed questionnaire with feedback from individuals to determine consensus from a larger group of experts [23]. The number of rounds used in published studies varies due to a predetermined criteria (for example two or three rounds planned and set as stopping criteria) or because consensus was achieved [24]. A systematic review of 100 Delphi studies showed that 48% had two rounds, 42% had three rounds [24]. Results of a recent study, which analysed 12 systematic reviews, showed that the number of experts included in published Delphi studies is variable [25]. Although there is no set standard for the size of a Delphi panel, it is assumed that the larger the panel, the more reliable the judgement of the group [26].

The content of our Delphi survey was developed based on information extracted from a retrospective secondary analysis of an existing database of South African patients with colorectal cancer who underwent surgical resection [2], a focus group session with expert South African physical therapy clinicians held in Johannesburg in 2019 using the nominal group technique (NGT), and, a narrative review of the current literature regarding preoperative education of patients undergoing abdominal surgery. Although we set consensus for each of the statements included in the content at 70%, we planned a two-round modified Delphi survey and used this as the stopping criteria for the study[24]. Any statements that did not reach 70% consensus after two rounds were

ultimately excluded. The objective was to determine which of the statements included in round one would reach consensus at the end of the second round [24]. The predetermined time frame for each round was set at three weeks [24]. Three experts reviewed the survey before it was circulated to study participants. Individuals were invited to participate in the study and those who agreed were sent an email with a link to the REDCap survey.

6.2.2.1 **Delphi Round One**

Participants were given a timeframe of three weeks to complete round one of the surveys and one reminder was sent out to those who had not completed the survey after 10 days.

The survey consisted of seven sections: “demographic information”, “medical and surgical journey”, “respiratory considerations”, “pain and wound considerations”, “rehabilitation considerations”, “cancer considerations” and “other considerations”. Demographic information collected from participants included their age, gender, country of residence, work environment and work experience. Within the survey, there were 36 statements and participants were asked to rate each statement using a five-point Likert scale. The Likert scale consisted of the following options: “strongly agree”, “agree”, “neutral”, “disagree” and “strongly disagree”. Participants were given the option to add comments or suggestions at the end of the survey. The statements included in the first round of the survey are displayed in Table 1.

The five-point Likert scale was collapsed into three categories for data analysis namely “agree”, “neutral” and “disagree”. All responses “strongly agree” and “agree” were collapsed into one category “agree”. All responses “disagree” and “strongly disagree” were collapsed into one category “disagree”. The percentage of agreement was calculated for each statement. Consensus on each statement was considered if 70% was achieved [23]. All the statements that reached 70% were set aside to be included in the preoperative education programme. The remaining statements were altered and additional statements were created according to suggestions from the participants.

6.2.2.2 **Delphi Round Two**

The remaining statements were included in the survey for round two. The new survey was sent to all participants who were given three weeks to complete it. A reminder was sent out after 10 days to those who had not yet responded.

Once again, the five-point Likert scale was collapsed into three categories for data analysis namely “agree”, “neutral” and “disagree”. The percentage of agreement was calculated for each statement. All the statements that reached 70% consensus in round two were set aside to be included in the preoperative education programme along with the statements from round one that also reached consensus.

6.2.3 **RESULTS**:

6.2.3.1 **Delphi Round One**

Seventeen physiotherapists were invited to participate in the study and eight (47%) responded to the survey in round one. The mean age of participants was 44.1 years (SD = 11.43) with seven female (87.5%) and one male (12.5%) participants. Sixty two percent of participants resided in Australia, 13% in the United Kingdom and 25% in South Africa. Seven participants (87.5%) reported having more than 10 years of overall experience working in their current environment and the remaining participant (12.5%) reported having between five and 10 years of experience. The participants’ characterization is displayed in Table 2. After round one, 25 of the 36 statements (69.4%) presented in the survey reached 70% consensus and were put aside. The remaining 11 statements were included in the survey for round two.

6.2.3.2 **Delphi Round Two**

The survey for round two comprised of 11 statements from round one that did not reach 70% consensus and an additional four statements were developed based on suggestions from the participants during round one. The statements included in the second round are displayed in Table 3.

Seven (87.5%) out of the eight participants from round one responded to the second-round survey. After round two, six of the 15 statements (40%) presented reached 70% consensus. There was a total of 31 statements that reached 70% consensus after two rounds which included: wound/pain (16.1%), rehabilitation (29%), respiratory considerations (22.6%), cancer considerations (6.5%), medical/surgical journey (16.1%) and other considerations (9.7%). Table 4 displays the statements that reached 70% consensus after both rounds of the Delphi study. Nine statements did not reach 70% consensus after two rounds of the Delphi survey.

6.2.4 **DISCUSSION**

Research suggests that educating patients on what to expect before surgery is valuable [27,28]. Preoperative education is an important part of the 'Enhanced Recovery After Surgery (ERAS)' guidelines for patients with colorectal cancer undergoing surgical procedures [29]. It is important that patients are prepared for the surgical procedure as well as the medical and rehabilitative journey that they will be undertaking. Available research shows that preoperative education for patients undergoing abdominal surgery reduced the incidence of postoperative pulmonary complications [7].

Content of preoperative education programmes for patients undergoing abdominal surgery described in the literature includes breathing exercises [6,11,14,16,17,30–32], coughing with support [11,14], verbal advice on preoperative walking, trunk, leg and pelvic mobility exercises [10,12,15], surgical information [33], nutritional support [10,12,15,30], lifestyle-related risk factors [10,15], relaxation techniques [10,12,15], principles of pain therapy [14] and, information about postoperative complications and early postoperative ambulation [6,11,14,31,33].

Given the unique challenges that patients with cancer face, it is worth considering an education programme that includes oncology-related content. Two studies utilised preoperative education specifically for patients undergoing abdominal surgery for various cancers [11,15]. The study by Dronkers et al used education for the sham/control group in the form of face-to-face education [11]. The education included advice on physical activity as well as instructions on how to perform respiratory techniques that would be required postoperatively [11]. The study by Beck et al utilised a preoperative education pamphlet containing six multidisciplinary recommendations pertaining to exercise, nutrition, relaxation, alcohol cessation, smoking cessation and other preparation [15]. For the exercise recommendations, patients were advised to exercise daily at an intensity higher than that of normal daily activities [15]. Examples of exercise options were listed [15].

The statements that reached consensus in this study spanned across multiple categories including "medical and surgical journey", "respiratory considerations", "pain and wound considerations", "rehabilitation considerations", "cancer considerations" and "other considerations". There were some similarities between our content and the education content described by Beck et al and Dronkers et al [11,15] however our content included additional information such as how to get in and out of bed after surgery, long

term return to activity after surgery as well as contact information for cancer support groups to name a few. The proposed content of the preoperative education programme encourages patients to have an active and independent approach to rehabilitation after their surgical procedure. The information obtained from this study could potentially be used in clinical practice once further research has been done to test and validate the proposed content of such a preoperative education programme delivered by physiotherapists.

The majority of Delphi participants who took part in this study reside outside the African context. A point to highlight from this study is the difference in context between South Africa and other first-world countries such as Australia and the United Kingdom. In many first-world countries, preoperative physical therapy interventions are considered standard practice. In contrast to this, prehabilitation for surgical patients in Sub-Saharan African countries is currently poorly implemented [1]. At a specialised colorectal unit within a private hospital in an urban part of South Africa, patients are seen preoperatively by the colorectal surgeon, colorectal clinical associate, physician and, a wound/stoma nurse but, not by a physiotherapist. Furthermore, preoperative physical therapy is often not considered part of the bundle of care for patients undergoing surgical resection for colorectal cancer. Not all patients who present for healthcare services in South Africa have access to medical insurance. If they do not have medical insurance, they are required to fund their own medical expenses or seek care in the public sector which has its own set of challenges. A recent study found that preoperative physical therapy education aimed at the prevention of postoperative pulmonary complications in patients undergoing major abdominal surgery is likely to be cost effective from the perspective of the hospital [34]. Therefore, it is plausible that one preoperative physical therapy education session could better prepare patients with colorectal cancer for their surgeries compared to receiving nothing at all in contexts where the uptake of preoperative physical therapy education is lacking. On a more global scale, preoperative education may play an important role in oncology healthcare service delivery in low-and-middle-income countries as well as those with fewer physiotherapists available to provide services.

In this study, the primary goal was to educate patients to improve acute postoperative outcomes. However, the secondary goal was also to improve long-term functional outcomes and survival. We thought that this was appropriate given the fact that most South African patients (even in the private sector) do not receive preoperative physiotherapy and many don’t receive post-discharge follow up either.

6.2.4.1 **Limitations**

There were a number of limitations identified in this study. Although the expert panel presented in this study represented an international physical therapy population, participants from Asia and America did not take part. Only 25% of participants resided in South Africa. Therefore, the geographical scope of the participants could limit the applicability of the results in a South African setting. Furthermore, the heterogeneity of the background/scope of participants in the panel raises limitations regarding the validity of the results. Only one participant reported working in the field of oncology which could question the remaining participants' expert knowledge in the management of patients with cancer specifically. This may have affected the cancer-related concepts that didn't reach consensus after both rounds.

Approximately 50% of the reviewer pool who initially agreed to participate did not complete the first or second round surveys. However, out of the eight participants who completed the first round survey, 87.5% (n=7) of them went on to complete the second round survey. Due to the low number of panel members who participated in this study, the validity and reliability of the results are questionable [25]. However, on the other hand, results of one study showed that smaller panels are generally associated with higher second round response rates [35].

The results should be interpreted with caution as there are flaws in the Delphi technique as it shows no evidence of reliability and the consensus achieved simply represents an agreement from the group on the topic presented to them.

6.2.5 **CONCLUSION**

The statements agreed upon by the participants in this study represent the insight of an international physical therapy panel on the proposed content of a physical therapy preoperative education programme for patients undergoing colorectal cancer surgery. The content includes preoperative exercise advice, postoperative respiratory techniques and ambulation, wound care, medical/surgical information, cancer considerations and return to physical activity guidelines. The programme requires further validation and testing before being applied in a clinical setting.

Ethical approval:

Approval to conduct this study was obtained from the University of the Witwatersrand Human Research Ethics (Medical) committee (M181075).

Conflicts of Interest:

The authors declare that they have no conflicts of interest.

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Figure legends:

Table 1: Statements included in round one of the Delphi survey
Table 2: Characterization of participants
Table 3: Statements included in round two of the Delphi survey
Table 4: Statements that reached 70% consensus after both rounds

Table 1: Statements Included in Round One of the Delphi Survey

Category A: Medical and Surgical Journey

The intensive care unit (ICU) environment should be described to the patient (NGT, 2019).
Patients should be informed of the possibility of waking up on a mechanical ventilator and educated on what it is used for (NGT, 2019).
Options for communication strategies should be discussed with the patients in case they are intubated postoperatively (NGT, 2019).
The projected stay in the hospital should be described to the patient (e.g. first ICU then high care then the ward then discharge home) (NGT, 2019).
Patients should be informed of the most common postoperative complications namely pulmonary complications, thromboembolic events, ileus, wound sepsis and infections, wound dehiscence, catheter-associated urinary tract infection and renal failure [2,6,14].

Category B: Respiratory Considerations

Patients should be educated on the effects of anaesthesia on the respiratory system (NGT, 2019).
Patients should be educated on active breathing techniques and their importance in preventing postoperative pulmonary complications (NGT, 2019) [6,14,16,17]
Patients should be taught how to perform active breathing techniques to improve lung volumes and to assist with sputum clearance (NGT, 2019)[6,10,11,13,14,16,17,30–32].
Patients should be made aware of the possibility of the need for passive physical therapy chest clearance techniques (should the need arise) and the different types of techniques that may be used (NGT, 2019).
Patients should be educated on various respiratory devices that may be administered to them to assist with sputum clearance and improvement of lung volumes (NGT, 2019). [11]
Patients should be educated on the benefit of postoperative upright positioning to optimise respiratory function (NGT, 2019).
Patients should be educated on the benefit of early postoperative ambulation to optimise respiratory function [6,14].

Category C: Pain and Wound Considerations

Patients should be educated on the different types of pain they may experience (from the cancer itself, from the surgical site or, due to other causes such as chemotherapy-induced peripheral neuropathy) (NGT, 2019) [14] .
Patients should be educated on the various forms of delivery of acute pain therapy (oral versus intravenous versus epidural etc.) and the importance of adequate postoperative pain control (NGT, 2019) [14].
Patients should be informed of the surgical procedure, potential wound site and the relevant surrounding anatomy (NGT, 2019) [33].
Patients should be taught how to support their laparotomy wound during activities that increase abdominal pressure (e.g. coughing, sneezing) (NGT, 2019) [11,14].
Patients should be taught how to protect their laparotomy wound during mobilisation activities such as getting in and out of the bed (NGT, 2019) [14,31].
Patients should be given basic education on stoma bags (for colostomy or ileostomy) and they should be assured that it is safe to mobilise with a stoma bag (NGT, 2019).
Patients should be advised to keep their wounds (and wound dressing) clean and dry (NGT, 2019).
Patients should be educated on the signs and symptoms of infection of the surgical wound site (NGT, 2019).
Patients should be educated on the management of the wound and later the scar during the various phases of healing (NGT, 2019).

Category D: Rehabilitation Considerations

Patients should be encouraged to remain active during the preoperative period as recent research has shown that preoperative physical activity levels and functional performance status are predictors of acute postoperative outcomes in patients undergoing surgical resection for colorectal cancer [2,10,11,15].
Patients should be educated on the importance of postoperative ambulation mobilisation to improve gut motility and, prevent thromboembolic events as well as postoperative pulmonary complications (NGT, 2019) [33].
Patients should be taught basic circulatory exercises to be performed after their surgery to prevent thromboembolic complications [14].
Patients should be educated on the basic surgical attachments that may be in situ postoperatively and how to mobilise with them (NGT, 2019).
Patients should be advised that they will be expected to mobilise in and out of the bed on the first day following their surgery (NGT 2019) [31].
Patients should be educated on the long-term return to physical activity protocol (including restrictions) that they can expect to follow in the postoperative period (e.g. driving, running, lifting heavy objects etc.) (NGT, 2019) [31].

Category E: Cancer-Related Concepts

Cancer-related fatigue and its causes should be described to the patients (NGT, 2019).
Patients should be educated about peripheral neuropathy as a cancer-treatment side effect and how it influences mobility (NGT, 2019).
Patients should be educated on the benefit of exercise to combat cancer-related fatigue (NGT, 2019).
Patients should be referred to local cancer support groups (NGT, 2019)

Category F: Other Considerations

Patients should be taught how to perform relaxation and other stress management techniques [12,15,30].
Patients should be advised about the possibility of acquiring bladder-and-bowel-related complications associated with colorectal cancer surgery (NGT, 2019).
Patients should be advised about the role of physical therapy to assist with urinary and faecal incontinence (NGT, 2019).
Patients should be educated on the association between lifestyle-related risk factors (smoking, alcohol consumption, body mass index etc.) with survival in patients with colorectal cancer [10,15,36].
Patients should be educated on the importance of basic nutrition and referred to a dietitian if not already (NGT, 2019) [10,12,15,30].

Table 2: Characterization of Participants

Age (mean, SD)	44.1 (11.43)
Gender (n, %) Male Female	 1 (12.5) 7 (87.5)
Work experience (n, %) 5-10 years >10 years	 1 (12.5) 7 (87.5)
Work environment* (n, %) Acute care – oncology Acute care – surgery Academic/researcher	 1 (12.5) 5 (62.5) 8 (100)

* When asked about their work environment, participants were able to select more than one option

Table 3: Statements Included in Round Two of the Delphi Survey

Round Two

1. Options for basic communication strategies should be discussed with the patients in case they are intubated postoperatively (e.g. patients may ask for a pen and paper)

2. Patients should be informed on the frequency of physical therapy treatment sessions to be expected following their surgery (Round 1 Delphi).

3. Patients should be educated that they should start practising their breathing exercises immediately after awakening from their surgery (Round 1 Delphi).

4. The patients should be given memory cues to remind them to do their breathing exercises regularly (e.g. while the nurses do their hourly observations) (Round 1 Delphi).

5. Patients should be made aware of the possibility of the need for passive physical therapy chest clearance techniques (should the need arise) to assist with the clearance of retained secretions postoperatively and the different types of techniques that may be used (e.g. percussions and vibrations etc.).

6. Patients should be educated on various respiratory devices that may be administered to them to assist with sputum clearance and improvement of lung volumes (e.g. incentive spirometer, flutter device etc.)

7. Depending on the time frame leading up to their surgery, the patients should be advised that they should see a physiotherapist for prehabilitation if they have access to one (Round 1 Delphi).

8. Patients should be educated on the benefit of postoperative upright positioning to optimise respiratory function.

9. Patients should be reminded about the signs and symptoms of infection of the surgical wound site.

10. Patients should be educated on the management of the wound and later the scar during the various phases of healing.

11. Patients should be taught basic circulatory exercises to be performed after their surgery to prevent thromboembolic complications in the case that they are unable to mobilise out of bed for whatever reason.

12. Patients who are undergoing chemotherapy should be educated about peripheral neuropathy as a cancer-treatment side effect and how it influences mobility.

13. Cancer-related fatigue and its causes should be described to the patients.

14. Patients should be taught how to perform relaxation and other stress management techniques.

15. Patients should be advised about the possibility of acquiring bladder-and-bowel-related complications associated with surgery (especially in those with rectal tumours) or from the urinary catheter.

Table 4: Statements that Reached 70% Consensus after Both Rounds

	Statement	% Consensus
1	The projected stay in the hospital should be described to the patient (e.g. first ICU then high care then the ward then discharge home)	100
2	Patients should be informed of the most common postoperative complications namely pulmonary complications, thromboembolic events, ileus, wound sepsis and infections, wound dehiscence, catheter-associated urinary tract infection and renal failure	100
3	Patients should be educated on the effects of anaesthesia on the respiratory system	100
4	Patients should be educated on active breathing techniques and their importance in preventing postoperative pulmonary complications	100
5	Patients should be taught how to perform active breathing techniques to improve lung volumes and to assist with sputum clearance	100
6	Patients should be educated that they should start practising their breathing exercises immediately after awakening from their surgery	100
7	Patients should be educated on the benefit of early postoperative ambulation to optimise respiratory function	100
8	Patients should be educated on the benefit of postoperative upright positioning to optimise respiratory function	100
9	Patients should be educated on the various forms of delivery of acute pain therapy (oral versus intravenous versus epidural etc.) and the importance of adequate postoperative pain control	100
10	Patients should be taught how to support their laparotomy wound during activities that increase abdominal pressure (e.g. coughing, sneezing)	100
11	Patients should be encouraged to remain active during the preoperative period as recent research has shown that preoperative physical activity levels and functional performance status are predictors of acute postoperative outcomes in patients undergoing surgical resection for colorectal cancer	100

CHAPTER 7

This chapter includes a reliability study on five healthy controls followed by a pilot study to determine the feasibility and impact of a preoperative physiotherapy education programme on acute postoperative outcomes in patients undergoing open surgical colorectal cancer resection.

Paper 5:

Title: The impact and feasibility of a physiotherapy preoperative education programme for patients undergoing open abdominal surgery for colorectal cancer: a pilot study

7.1 INTRODUCTION

Colorectal cancer is one of the most commonly reported cancers in South Africa (Brand et al., 2018) and is most often managed with surgical resection (van Cutsem et al., 2014). Laparoscopic surgery is becoming increasingly more popular in the management of these patients and is generally associated with better postoperative outcomes (Lee et al., 2017; Moug et al., 2015). The stress of cancer itself combined with that brought on by surgery often leaves patients suffering from fatigue, reductions in appetite and concentration as well as reduced functional capacity during the postoperative period (Carli et al., 2017). This creates an ideal opportunity for preoperative interventions to be used to improve patients' overall physical and mental preparation for surgery (Carli et al., 2017).

Unfortunately, although ERAS programmes are widely used in surgical patients, the reality is that preoperative interventions have been given little attention when compared to care in the postoperative period (Carli et al., 2017). Prehabilitation for surgical patients in Sub-Saharan Africa is currently an unmet need (Fernandes et al., 2020). Several studies have investigated the use of preoperative physiotherapy education and rehabilitation interventions specifically in oncological surgical patients outside the borders of South Africa (Beck et al., 2021; Carli et al., 2017; Curtis et al., 2018; Hijazi et al., 2017; Jensen et al., 2018; Silver & Baima, 2013; Treanor et al., 2018; van der Hulst et al., 2021; van Rooijen et al., 2017).

Curtis et al (2018) investigated whether the time between diagnosis of colorectal cancer and surgical resection allows for the safe implementation of prehabilitation interventions. The results showed that the time from colorectal cancer diagnosis to curative laparoscopic surgery did not impact five-year survival (Curtis et al., 2018). The

authors concluded that this may allow for an altered preoperative pathway to include prehabilitation and other important interventions (Curtis et al., 2018). It is important to note that this study was based on patients undergoing laparoscopic and not open abdominal surgical procedures.

Therefore, the primary objective of the study was to determine the impact of preoperative education on acute postoperative outcomes (postoperative complications and hospital LOS) in patients undergoing open abdominal surgery for colorectal cancer. The secondary objective was to assess the feasibility of a preoperative physiotherapy education programme specifically concerning practicality and integration (Bowen et al., 2009). Feasibility studies are used to determine whether interventions can be used for further evaluation and testing (Bowen et al., 2009).

7.2 RELIABILITY STUDY

7.2.1 Background

Before the main pilot study, a smaller study on healthy control participants was performed. The purpose was to determine the inter-rater reliability of the three research assistants who would later be performing the assessments of participants during the main pilot study.

7.2.2 Study Design

An inter-rater reliability study was done using two outcome measures which are not part of standard physiotherapy care at WDGMC. However, these outcome measures are specific to the main pilot study which will be discussed later in this chapter.

7.2.3 Study Sample

A convenience sample size of five participants was decided upon for the reliability study.

7.2.4 Inclusion Criteria

The inclusion criteria for this reliability study were male or female participants deemed to be healthy between the ages of 40 and 70. Participants were purposively sampled from the staff at WDGMC. Healthy controls were used as the participants had to perform multiple physical function tests for different testers in one day and this may have caused unnecessary fatigue in patients with cancer. The age range for inclusion was chosen based on the mean age of participants who previously underwent surgery for colorectal cancer at the WDGMC (described in the retrospective review Paper 2).

7.2.5 **Methodology**

The research assistants for this study were three physiotherapy clinicians working with surgical patients in acute care at the clinical site. A copy of the study protocol and information pertaining the two outcome measures to be used were circulated amongst the research assistants to enable them to familiarise themselves with the material. Virtual training was provided by the main researcher for the research assistants on the use of the six minute walk test (6MWT) and the Short Physical Performance Battery (SPPB) five days beforehand. This consisted of an online education session via Zoom®. The CPAx tool, hand-grip strength, and the Medical Research Council sum score (MRCSS) are part of standard care in the ICU at the WDGMC and therefore were not included in the reliability study.

Written informed consent was obtained from the participants (Appendix 12). Each participant was assessed three times with one hour between assessments. Assessments took place in an empty room within the hospital. Before any functional assessments were performed, vital signs were taken for each participant at each assessment as a safety measure to ensure that the patients were fit to continue. These included heart rate, oxygen saturation and blood pressure. Respiratory rate was not measured. Participants sat quietly for five minute before vitals were assessed. For each participant, a single assessment included the 6MWT and the SPPB and was performed by a different research assistant each time. The 6MWT was performed first followed by a five minute rest, then the SPPB.

7.2.6 **Outcome Measures**

7.2.6.1 The 6MWT is a tool used to measure submaximal functional exercise capacity (Crapo et al., 2002). There is evidence for construct validity and sensitivity to change of the 6MWT as a measure of physical recovery after elective colorectal surgery (Moriello et al., 2008). One study found that the minimal clinically important difference in 6MWT distance is 14m in patients who have undergone abdominal surgery (Antonescu et al., 2014).

The 6MWT was performed according to guidelines described by the American Thoracic Society (Crapo et al., 2002). This included using the script described in the guidelines document (Crapo et al, 2002). The test was performed in a long corridor inside the hospital at WDGMC. A cone was set to measure 30m in the corridor. After vital signs were taken and the participant was deemed fit for the test, the tester explained the procedure to the participant. Participants were instructed to walk as far

as possible during the six minutes up and down the 30m stretch of corridor. Participants were instructed not to talk to anyone during the test. The tester called out the remaining time to the participants every two minutes. The testers used a mechanical lap counter to record the number of laps walked during the 6MWT. A tape measure was used to measure the distance achieved. Vital signs were taken immediately after the test and again two minutes later. The score for the 6MWT was determined as the total distance achieved by the participants for each attempt.

7.2.6.2 The SPPB is a well-established tool used to assess lower limb physical performance status in older patients (Guralnik et al., 1994). Results of a systematic review of instruments used to assess performance-based physical function in older adults showed that the SPPB is valid and reliable and, is responsive to change over time (Freiberger et al., 2012). Furthermore, the tool has also been shown useful in predicting all-cause mortality (Pavasini et al., 2016). For older dwelling adults, the minimal clinically important difference in SPPB scores is one point (Perera et al., 2006).

The SPPB is comprised of a balance component, sit-to-stand test and a gait speed test. For the balance component, the participants' ability to stand in three different positions was assessed. The researcher stood close by to assist in case the participants lost their balance. First, participants were instructed to stand with their feet together, side-by-side for 10 seconds. If this was performed successfully, the participants were then asked to maintain a semi-tandem position for 10 seconds. If successful, participants were then asked to stand in a full tandem stance for 10 seconds. Following this, the participants were instructed to move on to the gait speed test. If a participant could not maintain any of the three positions for 10 seconds, they were instructed to move straight on to the gait speed test. Participants could score a maximum of four points for the balance component. For the gait speed test, a cone was used to mark out a four meter course in the corridor. Participants were asked to walk as quickly as they could across the course. The tester walked behind/to the side of the participant. Participants were then asked to perform the gait speed test a second time. A stop watch was used to measure the time. The best speed achieved during the two was recorded for scoring purposes. Participants could score a maximum of four points for the gait speed test depending on the time taken to complete the four meter lap. For the chair stand test, participants were asked to perform a single chair stand with arms folded across the chest. If participants achieved this, they were then instructed to perform the repeated chair stand test where they were required to stand up from the chair five times in quick succession. The testers used a stopwatch to record

the total time taken to complete all five chair stands. Participants could score a maximum of four points for the chair stand test. A copy of the score sheet for the SPPB can be found in Appendix 17. Scores for each of the three domains of the SPPB were added to form a total score out of 12 for each assessment.

7.2.7 Data Analysis

Descriptive statistics were used to describe the demographic profile of the participants. Data for the 6MWT and SPPB were presented as means and standard deviation (SD). An overall score of 10-12 using the SPPB was considered to be normal (Pavasini et al., 2016). Reliability analysis was performed between testers A and B, A and C, and B and C to determine the degree of agreement between these testers for the outcome variables of 6MWT distance walked and the total SPPB scores measured for the five participants. This was done using IBM® SPSS® version 28 software.

Inter-rater reliability was determined by the intraclass correlation coefficient (ICC) using Cronbach's alpha. Inter-rater reliability was considered acceptable if the ICC>0.75.

7.2.8 Results

Five healthy controls were used to test the inter-rater reliability of the research assistants. The mean age was 44.8 years and 40% (n=2) were male and 60% (n=3) were female. Figure 7.1 below shows the gender of participants.

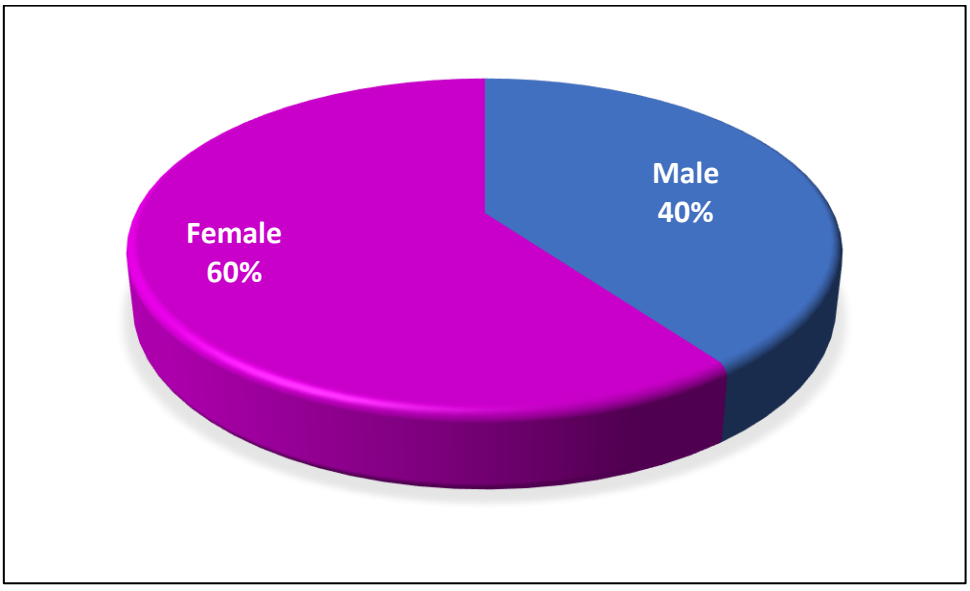


Figure 7.1: Gender of Participants

Table 7.1 below shows the vital signs of each participant before the first assessment was performed.

Table 7.1: Vital Signs of Participants

Participant	Blood Pressure (mmHg)	Heart Rate (bpm)	Oxygen Saturation (%)
1	119/78	65	96
2	124/72	53	96
3	142/94	65	98
4	101/68	59	96
5	127/88	82	97
Normal value (Collins et al., 2015; Sapra, Malik & Bhandari, 2020)	>140/90	60-100	96-98

The mean distance walked by all five participants during the 6MWT was 531.8m (n=5, SD=106.42) Table 7.2 displays the results of the testing using the 6MWT.

Table 7.2: Distance Achieved during 6MWT

Participant	Tester A 6MWT (m)	Tester B 6MWT (m)	Tester C 6MWT (m)	Mean (metres)
1	530.6	385	485.5	467
2	770.2	660	727.3	719.2
3	480	505	495.5	493.5
4	504	506.3	476.1	495.5
5	493.3	479.9	496.2	489.8

6MWT, Six Minute Walk Test; m, meters

The mean SPPB score was 10.87 (n=5 SD=1.19). Table 7.3 displays the results of the testing using the SPPB.

Table 7.3: SPPB Scores

Participant	Tester A SPPB	Tester B SPPB	Tester C SPPB	Mean	Normal value
1	8	10	9	9	10-12
2	12	12	12	12	10-12
3	11	11	11	11	10-12
4	11	11	10	10.7	10-12
5	12	11	12	11.7	10-12

SPPB - Short Physical Performance Battery

The level of agreement between the three testers when administering the 6MWT and SPPB was determined using intraclass correlation, 95% confidence interval and level of significance (p-value), as reported in Table 7.4.

Table 7.4: Reliability Analysis between Testers A, B and C

Testers	6MWT Distance	SPPB Score
A vs B	ICC = 0.734 95% CI = [-0.007, 0.967] p-value = 0.036	ICC = 0.667 95% CI = [-0.445, 0.960] p-value = 0.092
A vs C	ICC = 0.963 95% CI = [0.713, 0.996[p-value < 0.001	ICC = 0.907 95% CI = [0.313, 0.990] p-value = 0.009
B vs C	ICC = 0.852 95% CI = [0.271, 0.983] p-value = 0.014	ICC = 0.714 95% CI = [-0.282, 0.966] p-value = 0.068

The research assistants A and C demonstrated excellent inter-rater reliability using both the 6MWT (ICC=0.963) and the SPPB (ICC=0.907). Testers B and C demonstrated good inter-rater reliability using the 6MWT (ICC=0.852) but only moderate agreement using the SPPB (ICC=0.714). Testers A and B demonstrated moderate agreement using both the 6MWT (ICC=0.734) and SPPB (ICC=0.667).

7.2.9 Discussion

Although all participants were considered to be healthy prior to the assessment, one participant scored lower than 10 on the SPPB which suggests that she is at higher risk for all-cause mortality (Pavasini et al., 2016).

An ICC value of less than 0.5 is considered poor whereas values between 0.5 and 0.75 suggests moderate reliability (Koo & Li, 2016). Values between 0.75 and 0.9 indicate good reliability and those above 0.9 indicate excellent reliability (Koo & Li, 2016). The ICC score between testers A and C demonstrates an excellent degree of agreement when using both the SPPB and the 6MWT which suggests that no further training is required before commencing with the next phase of the study. Testers A and C were selected to commence with the outcomes assessment for the pilot study to follow.

One limitation to the study is the short time frame between assessments. Each participant underwent three 6MWT and SPPB assessments in one day. Muscle fatigue could have affected their physical performance on the day as well as the overall outcome of the tests.

7.2.10 Conclusion

Two of the three research assistants demonstrated excellent inter-rater reliability when using the 6MWT and the SPPB outcome measures.

7.3 PILOT STUDY

7.3.1 Background

Currently, at the WDGMC, preoperative care for patients undergoing surgery for colorectal cancer includes an assessment with the colorectal surgeon and a specialist physician, as well as a preoperative education session with a clinical associate from the colorectal unit and a wound/stoma nurse (if appropriate). The education programme provided by the clinical associate includes written information regarding the preoperative period such as the necessary bowel preparation and timely stopping of anticoagulant medication prior to surgery. The patients are encouraged to stop smoking and drinking excessive amounts of alcohol as well as to exercise for up to 15 minutes daily. The patients are given information regarding the specific surgical procedure that they will undergo and are given an approximate duration of surgical time. The patients are informed that they will spend some time in the intensive care unit postoperatively and are encouraged to mobilise as soon as possible. The patients are given an estimate on their hospital LOS and given basic wound care advice as well as information on basic complications to watch out for at home. Hospital LOS was defined as the number of days of a single hospital admission. The patients are advised on when they can return to driving, exercise and work. The patients are given basic instructions on a postoperative diet and are encouraged to visit a dietitian.

Patients do not receive any standard preoperative physiotherapy care but receive physiotherapy intervention following surgery in hospital. The results of the retrospective database review (described in Chapter 4 of this thesis) showed that more open laparotomies (60%) were being performed at WDGMC compared to laparoscopic procedures during the recruitment period (January 2016 to June 2018). The database review also revealed that the median hospital LOS for patients undergoing both laparoscopic and open surgical procedures was 11 days.

7.3.2 Study Design and Sample Size

The study design used was a single-blind randomised pilot study and a sample size of 15 patients was chosen. The study design was based on a recent study that investigated the use of a preoperative physiotherapy education programme for the

prevention of postoperative pulmonary complications following upper abdominal surgery (Boden et al., 2018).

7.3.3 Inclusion Criteria

Inclusion criteria included: 1) all adult patients (classified as 18 years or older) with colorectal cancer who were to be admitted at WDGMC through the colorectal unit, who were scheduled or open abdominal surgery 2) Patients who are independently mobile with or without an assistive device.

7.3.4 Methodology

Participants who met the inclusion criteria were referred to the physiotherapy outpatient clinic for a preoperative assessment by the clinical associates at the WDGMC Colorectal Unit. Patients who were due to undergo laparoscopic surgery and those unable to undergo exercise testing as a result of cardiac or physical impairments were excluded from the study.

The patients were given an information sheet and written informed consent for each patient was obtained before commencing the assessment. The preoperative assessment included a subjective component (demographic information, medical and surgical history, chemotherapy treatment, radiation treatment, and lifestyle information specifically physical activity, smoking and alcohol consumption) and a physical objective component (anthropometric data, hand grip strength, peripheral muscle strength, lower limb function and submaximal exercise tolerance). The assessments were performed by the two research assistants (Testers A and C) who took part in the reliability study on healthy controls.

Following their assessment, patients were randomised into one of three groups using a stratified method: 1) a control group who received no preoperative physiotherapy intervention, 2) intervention group one who received a written pamphlet containing preoperative physiotherapy information, and, 3) intervention group two who received the written pamphlet as well as a face-to-face education session with a physiotherapist (see Figure 7.2 below).

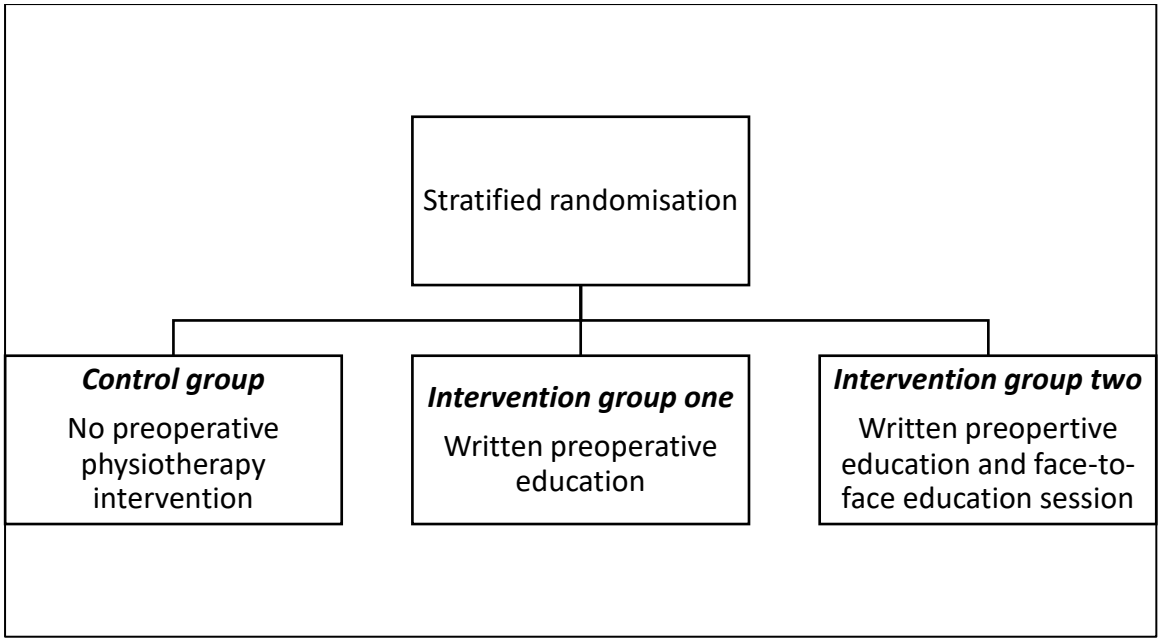


Figure 7.2: Diagram Depicting the Control and Intervention Groups

Participants were stratified according to age category, a recent history of chemotherapy and/or radiation for their current cancer and, lastly, the presence of comorbidities. The assessing physiotherapist issued the participants with a sealed envelope containing the intervention to be administered. A separate research assistant opened the envelope and provided the intervention that was described in the envelope. The research assistants who were assigned to administer the assessments to the participants were blinded to the intervention administered.

The content of the education pamphlet was developed based on results of the retrospective review (paper 1 and paper 2), a focus group using the nominal group technique (paper 3), a narrative review of the literature (paper 3), and, a Delphi study with an international panel of physiotherapy experts (paper 4). The researcher used the Simple Measure of Gobbledygook (SMOG) score to check the readability of the pamphlet. The pamphlet was also given to two patients who had undergone recent colorectal cancer resection at WDGMC and feedback was requested with the intent to make changes to the pamphlet as required. No suggestions were given by the patients.

The education pamphlet given to the patients in intervention groups one and two respectively included information about medical/surgical information, preoperative exercise advice, postoperative respiratory techniques and ambulation, wound care, return to physical activity guidelines, cancer considerations including contact details for cancer support groups and other members of the multidisciplinary team (Appendix

13). The face-to-face education consisted of a verbal explanation (with demonstration where appropriate) of the information provided in the pamphlet.

Once admitted after their surgery, participants received standard postoperative physiotherapy care in the intensive care unit (ICU) and the surgical ward. Standard postoperative care included early progressive mobilisation and respiratory interventions were administered as required. On discharge from the ICU, participants were reassessed using the Numerical Rating Scale for pain, the Chelsea Critical Care Physical Assessment (CPAx) tool, hand grip strength and MRC Sum Score. On discharge from the hospital, participants were reassessed using the Numerical Rating Scale for pain, the CPAx tool, the SPPB, hand grip strength, 6MWT and MRCSS. The physiotherapy clinician who administered the preoperative intervention to the participants was not involved with the postoperative management of the patients to avoid potential bias. The assessment forms used in the pilot study can be found in Appendices 14-16. The impact of preoperative education was defined as hospital LOS and postoperative complications as the primary outcomes.

7.3.5 **Outcome Measures**

Hand grip strength is a simple, cost-effective tool that can be used to measure patients' overall condition. Results of a prospective study showed that weak hand-grip strength was associated with increased postoperative complications and higher mortality in patients undergoing surgery for oesophageal cancer (Chen et al., 2011).

The CPAx tool is a bedside scoring system that was developed to grade physical morbidity of patients in an acute-care setting (Corner et al., 2013). The tool consists of 10 domains including respiratory function, cough, moving within bed, moving from lying to sitting on the edge of the bed, dynamic sitting, sit-to-stand ability, standing balance and stepping (Corner et al., 2013). The CPAx has demonstrated content validity (Corner et al., 2013) and construct validity (Corner et al., 2014).

The SPPB and 6MWT were also used during the pilot study. These are described in more detail in the reliability study above.

7.3.6 **Data Analysis**

Data analysis was performed using IBM SPSS version 28 (IBM Corp. Released, 2017). Descriptive statistics were used to describe the demographic patient profile. Categorical data are presented as frequencies and percentages. Continuous data are

presented as means and SD or median and interquartile range (IQR). Reference equations were used to calculate the predicted 6MWT distance at each assessment according to age, gender, height and weight (Enright & Sherrill, 1998).

7.3.7 **Results**

Recruitment of patients for the main pilot study commenced on 1 March 2022. Due to the slow recruitment of patients, data collection was stopped after five months. Only one patient met all the inclusion criteria and was recruited into the pilot study. Figure 7.3 is a flow diagram representing the patient recruitment process.

The integration and practicality aspects of a feasibility study were considered which will be unpacked later in the discussion portion of this chapter. Before the pilot study commenced, a virtual presentation was performed for the colorectal surgeons involved at WDGMC informing them of the study purpose and the inclusion and exclusion criteria for participants. In-person meetings were also organised with the head of the colorectal unit and the clinical associates to discuss the logistics of the study. In order to encourage referral of patients by the doctors for inclusion in the study, frequent email and text message reminders were sent to the colorectal surgeons and the clinical associates throughout the recruitment period. Despite this, patient recruitment rates were very low suggesting that currently it is not feasible to implement a preoperative physiotherapy programme at the WDGMC.

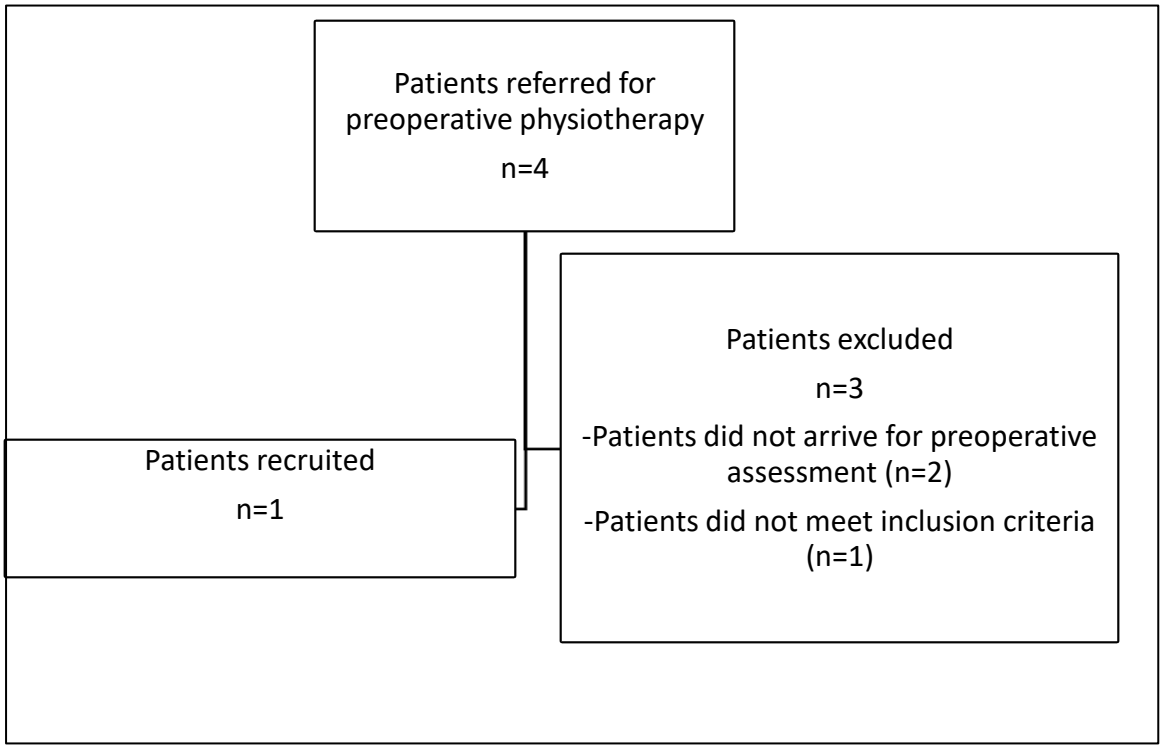


Figure 7.3: Flow Diagram of Patient Recruitment

The patient recruited presented with no comorbidities and received both chemotherapy and radiation before surgical resection and had been diagnosed with peripheral neuropathy. She was randomised into the control group. Table 7.5 represents the patient's demographic data. Table 7.6 represents the patient's physical function during the preoperative assessment, at ICU discharge and hospital discharge.

Table 7.5: Socio-Demographic Information

Demographic Variable	Results	Normal Values (where applicable)
Gender	Female	
Age (years)	56	
Smoking history	Previous smoker	
Alcohol consumption	Previous social alcohol consumer	
Physical activity vital sign (mins)	0	>150 minutes/week
Height (cm)	165	
Weight (Kg)	93	
BMI (Kg/m^2)	34.2	18.50–24.99
Waist circumference (cm)	111	<80

Mins - minutes; Kg - kilograms; cm - centimetres; Kg - kilograms; Kg/m^2 – kilogram per meter squared

Although she was not a current smoker or alcohol consumer, the patient's anthropometric profile showed that she has a high BMI and waist circumference that

puts her at risk for all-cause mortality. She also did not report doing any type of physical activity.

Table 7.6: Physical Function Assessment

Physical Function Variable	Preoperative	ICU Discharge	Hospital Discharge	Normal/Predicted (where applicable)
Hand grip strength (kg)	44	25.8	23.7	24.2
SPPB (overall)	10	n/a	8	10-12
SPPB balance test score	4	n/a	4	
SPPB gait speed score	4	n/a	3	
SPPB repeated chair stand score	2	n/a	1	
6MWT distance (m)	493	n/a	226	478.38
Percentage of predicted distance (%)	103.1	n/a	47.24	
MRCSS	60	44	60	>48
CPAx	n/a	39	42	
Pain NRS (rest)	n/a	0/10	0/10	
Pain NRS (with activity)	n/a	3/10	1/10	

Kg - kilograms; SPPB - Short Physical Performance Battery; 6MWT - Six Minute Walk Test; m - metres; MRCSS - Medical Research Council Sum Score (muscle strength), CPAx - Cheslea Critical Care Physical Assessment, NRS - numerical rating scale (pain)

The patient's SPPB score improved from ICU discharge to hospital discharge however it was still below her preoperative baseline when she went home. Her hand grip strength and SPPB scores were lower at hospital discharge when compared to the baseline preoperative assessment values. Her preoperative handgrip strength was significantly higher than that predicted for her age. The reason for this is unknown. On discharge from the ICU, her 6MWT distance achieved was well below her predicted distance.

The patient underwent open abdominal surgery in the form of a low anterior resection with pelvic sidewall lymph node dissection. An ileostomy was created in surgery. Her pain was managed with rectus sheath catheters. She scored a grade II according to the Clavien Dindo classification. She spent seven days in the ICU followed by a further four days in the ward before being discharged home.

7.3.8 **Discussion**

This study was conducted to assess the impact and feasibility of a physiotherapy preoperative education programme on patients undergoing open surgical resection for colorectal cancer in a private hospital in Johannesburg.

Unfortunately, due to the low recruitment rates experienced during the five months, only one patient was enlisted into this pilot study and she was randomised into the control group. Therefore, we were unable to determine the impact of preoperative education administered by a physiotherapist on acute postoperative outcomes such as hospital length of stay and the incidence of postoperative complications.

At her baseline assessment, this patient was obese according to her BMI and her waist circumference was also higher than that predicted for a female ("Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation.," 2000). Studies have shown that obesity is a risk factor for the development of colorectal cancer (Keum & Giovannucci, 2019; Li et al., 2021; Renehan et al., 2008) and is also associated with poor postoperative outcomes in this specific patient population (Almasaudi et al., 2018).

At hospital discharge, the patient presented with 6MWT distance that was significantly less than that predicted for her age group (Enright & Sherrill, 1998). As described by Carli et al (2017) she still had some functional difficulties when she was sent home from the hospital (Carli et al., 2017) which is shown in her discharge CPAx and SPPB scores. Her Clavien Dindo score was grade II which means that her postoperative complications could be managed with pharmacological treatment and did not require further surgery. Her hospital length of stay was 11 days which is in keeping with the median LOS described in the retrospective database review. Acute hospitalization can result in significant stress on older patients which further results in periods of immobility. (Falvey, Mangione & Stevens-Lapsley, 2015). One study investigated the proportion of time spent in lying, sitting and standing/walking in a cohort of 45 hospitalised older patients (Brown et al., 2009). The results showed that patients spent 83% of the time in bed and 12% in the chair despite being able to walk independtly (Brown et al., 2009). Prolonged immobility in the hospital results in reduced protein synthesis, muscle strength, muscle mass and physical function (Gill, Allore & Guo, 2004; Drummond et al., 2012; Bodilsen et al., 2013; Vigano et al., 2017). Surgical stress can cause inflammation leading to reduced muscular endurance (Bautmans et al., 2010). Furthermore, cancer often results in sarcopenia and cachexia leading to frailty and reduced functional performance (Vigano et al., 2017). All of the above could have contributed to the deconditioning experienced by the patient presented in this pilot study.

When considering the practicality of a study, one needs to determine whether an intervention can be implemented when resources, time commitments or other factors are restricted (Bowen et al., 2009). As found in similar studies described in the literature, our study demonstrated low recruitment rates (Karlsson et al., 2019; Northgraves et al., 2020). One of the main challenges faced was the small window period between the decision to do surgery and the surgery itself. In many cases, the surgical wait time was as short as one day which meant that the patients could not be recruited into the pilot study. Comparable challenges were described in a recent study that aimed to investigate the feasibility of a novel exercise prehabilitation programme for patients undergoing elective colorectal cancer surgery as well as its effect on hospital LOS (Northgraves et al., 2020). Thirdly, 50% of the patients referred for recruitment into our trial did not arrive at the physiotherapy clinic. The reason for this was unknown. Karlsson et al reported similar challenges in their study which was performed in Sweden on a group of elderly patients with colorectal cancer (Karlsson et al., 2019).

With regards to the integration component of feasibility studies, one attempts to implement a new process or programme into an infrastructure that has already been established (Bowen et al., 2009). We attempted to implement a preoperative physiotherapy education intervention into an existing colorectal service (Bowen et al., 2009). Changing the culture of surgical management of patients to incorporate physiotherapy as part of preoperative management proved to be more difficult than originally thought. Recruitment rates specifically in terms of referral of patients to physiotherapy services were low. Perhaps, preoperative physiotherapy education should be initiated when the patients first present to their general practitioners or oncologists rather than at the time of their first preoperative surgical consultations.

The majority of patients that were undergoing surgery at WDGMC during the recruitment period underwent laparoscopic surgery and not open abdominal surgery which meant that they did not meet the inclusion criteria. This suggests a change in the colorectal unit's surgical trends since the start of this study. Furthermore, quite a few patients who were on the surgical list for open abdominal surgery during the pilot study recruitment period had undergone laparoscopic procedures during the same hospital admission.

7.3.8.1 **Limitations**

The major limitation of this study was the small sample size due to extremely low recruitment rates. Since the only patient recruited was randomised into the control group, the preoperative education programme was not implemented at all. This means that no conclusion can be drawn regarding the impact of the programme on the patient's acute postoperative outcomes.

Secondly, flaws in the design of the study were exposed during the recruitment period. It could be suggested that attempting a preoperative education programme at the time of the first visit to the colorectal surgeon could create a window too small to initiate physiotherapy interventions before surgery in many cases. Rather, perhaps patients should be referred to physiotherapists by their primary care doctors or oncologists at the same time that they are referred to colorectal surgeons for surgical intervention.

Due to the fact that only one patient was recruited, the data could be presented in a case study format rather than maintaining the project as a pilot study.

7.3.9 **Conclusion**

This study has highlighted issues regarding the practicality and integration aspects of the feasibility of implementing a preoperative physiotherapy education intervention for patients undergoing open abdominal surgery for colorectal cancer at a private hospital in Johannesburg, South Africa.

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CHAPTER 8

8.1 DISCUSSION

This chapter includes a discussion summarising the results and limitations of all the phases of this research project presented in the previous sections of this thesis. The relevant links between each of the studies presented will be described.

8.1.1 Introduction

Chapter 3 investigated the clinical and demographic profile and lifestyle-related risk factors of patients with colorectal cancer in an urban South African cohort. This was required to determine which modifiable lifestyle factors may have led to the development of colorectal cancer. Furthermore, the study aimed to determine which modifiable lifestyle factors were linked with survival in these patients. Once identified, modifiable risk factors can be addressed and patients can be educated with the goal of encouraging changes in lifestyle behaviours to improve outcomes. Chapter 4 investigated a sub-group of the larger cohort consisting of patients who had undergone colorectal cancer surgical resection in the private sector.

The objectives of Chapters 5 and 6 were to ascertain and validate the content of a preoperative education programme that could be provided to patients undergoing open abdominal surgery for colorectal cancer. Chapter 7 aimed to investigate the impact and feasibility of the preoperative education programme that was developed.

8.2 DEMOGRAPHIC PROFILE OF PATIENTS DIAGNOSED WITH COLORECTAL CANCER IN AN URBAN AREA OF SOUTH AFRICA

To the author's knowledge, this is the first study of its kind in a South African context. Studies performed in other low-and-middle-income countries have shown a higher burden of younger patients with colorectal cancer and a higher incidence of males when compared to females (Deo et al. 2021). In our cohort, patients in the public sector were younger and mostly Black-African compared to the older and more frequently White cohort in the private sector. Results of an epidemiological study showed that Black individuals develop colorectal cancer earlier than White individuals which is in keeping with our findings (Agrawal et al. 2005). The differences in incidence between the public and private sector patients that we presented may be linked to

socioeconomic status however genetic and cultural factors could also be relevant (Parker, Davis, Wingo, Ries & Heath 1998).

Within our cohort, those in the public sector presented with later stages of cancer at the time of diagnosis when compared to those in the private sector. This could be patient-linked or it could be related to barriers in accessing healthcare services for patients in the public sector. Patient-linked factors could be reduced knowledge regarding the early signs and symptoms of colorectal cancer such as altered bowel habits, rectal bleeding and pain in the abdomen (Majumdar, Fletcher & Evans 1999). Patients may not be aware of the early signs and symptoms or may be embarrassed to discuss this with anyone including healthcare professionals. On the other hand, late presentation of patients with cancer to healthcare facilities may be due to the fact that many South Africans have lost trust in the public healthcare system. This could be as a result of factors such as failure to meet basic standards of care and the expectations of the general population (Maphumulo & Bhengu 2019; South African Department of Health Strategic Plan 2014). A feature of vulnerable populations is reduced access to healthcare with poorer health outcomes when compared to the general population (World Health Organization 2004). Roughly 80 percent of the South African population makes use of public healthcare services which has reduced capacity to cope with complex conditions (Young 2016). Furthermore, the differences in cancer staging could also impact the differences in survival between the two sectors as shown in our results.

8.3 LIFESTYLE-RELATED RISK FACTORS AND THEIR IMPACT ON SURVIVAL

As presented in the literature review, various lifestyle-related factors have been linked with increased risk for development of colorectal cancer. Physical inactivity as well as excessive body weight account for a quarter to a third of colorectal cancers (Haggar & Boushey 2009; Stein & Colditz 2004). Research has shown that moderate-intensity physical activity may have a biological effect in limiting colorectal cancer risk (Campbell & McTiernan 2007).

Unfortunately, due to missing data, we could only provide the vigorous-intensity weekly exercise data achieved by the patients in this cohort. Patients undergoing cancer treatments may better tolerate non-vigorous intensity exercise when compared to more vigorous activities. Therefore, the physical activity profile of our patients needs to be interpreted with caution. It is possible that should their moderate-intensity exercise data be available, they may be a lot more active than what is shown in our results.

Some studies have shown that there is no association between survival outcome and vigorous-intensity physical activity (Guercio et al. 2019; Walter et al. 2017). Our findings are in keeping with this as we found tha vigorous-intensity physical activity had a minimal effect on survival outcome.

Our results showed that both waist circumference ($\eta 2=0.266$) and BMI ($\eta 2=0.106$) had an effect on patients' survival (Chapter 3). There is evidence that patients with higher BMI have better chances of survival (Shahjehan et al. 2018; van Zutphen, Kampman, Giovannucci & van Duijnhoven 2017; Kroenke et al. 2016). Patients who have a low BMI may be more negatively affected by weight loss, cachexia and sarcopenia which are commonly seen symptoms experienced by patients with advanced-stages of colorectal cancer (Shahjehan et al. 2018). Therefore, it is plausible that being overweight may be beneficial in patients with advanced stages of the disease.

Screening for anthropometric data could be vital in managing patients who are undergoing cancer treatments. This is important to ensure early identification of those at risk and commence management through education to encourage behavioural changes such as exercise and diet modification. This could easily be included in the physical preoperative assessment for patients diagnosed with colorectal cancer. However, the cut-off points for waist circumference in determining risk for colorectal cancer as well as survival in Sub-Saharan Africa have not yet been identified.

Physiotherapists are equipped to manage lifestyle-related risk factors such as physical inactivity and can offer advice on various health behaviours such as exercise, alcohol consumption, basic dietary information and smoking cessation. (Shahjehan et al. 2018; Dean et al. 2011). It is possible that the management of lifestyle-related risk factors could impact South African colorectal cancer incidence and outcomes.

As the cohort of patients presented in Chapter 3 include those who did not undergo surgical resection, it was important to isolate those who had undergone surgery in order to examine their demographic and clinical profiles. Furthermore, this enabled us to determine which modifiable factors predicted acute postoperative outcomes.

8.4 MODIFIABLE FACTORS AS PREDICTORS OF ACUTE POSTOPERATIVE OUTCOMES

The majority of patients presented in Chapter 4 had postoperative complications of which preoperative performance status was a significant predictor ($p = 0.05$, $\beta = 0.926$). Our results also showed that low weekly vigorous-intensity physical activity was a significant predictor of a prolonged hospital LOS ($p = 0.048$, $\beta = -0.000$). This emphasises the importance of physical activity on acute postoperative outcomes.

Our results showed a higher rate of postoperative complications than what has been described in the literature for similar studies performed in low-and-middle-income countries (Khan, Bari, Zafar & Raza 2011). However, not all studies make use of the Clavien Dindo classification system which makes it difficult to classify the complications described in terms of severity. However, the complex patients presenting to WDGMC may play a part in the increased incidence of postoperative complications. The hospital is a university specialist referral centre where patients are transferred in from other hospitals. This often results in more complicated medical cases. Secondly, the AJCC scores showed that the patients presented late for surgery. However, the high rate of complications was unexpected and warrants further investigation in future studies.

The types of postoperative complications described in the database review of surgical patients at WDGMC are similar to those described in the literature (Tevis & Kennedy 2016). Gastrointestinal motility problems and surgical site infections are the most frequently described post-surgical complications (Tevis & Kennedy, 2016). Similarly, our study showed that POI and surgical site infections had the highest incidence in our patient cohort.

One study reported that open laparotomies and tumour staging are risk factors for the development of surgical site infections after elective rectal cancer surgery (Biondo et al., 2012). Laparoscopic surgeries may limit the risk of infections at the surgical site in these patients (Gomila et al., 2018). Our database review showed that most patients underwent open laparotomies and not laparoscopic procedures during the data collection period (2016-2018). Furthermore, there is evidence suggesting that regular exercise is linked with a reduction in bacterial/viral infections (Campbell & Turner 2018; Warburton & Bredin 2017). So, bearing this in mind, it is plausible that a combination of increased preoperative exercise levels and facilitating early postoperative

mobilisation could reduce the incidence of surgical site infections due to improved immunity.

The high incidence of POI is an interesting finding following the retrospective database review. Open abdominal surgical procedurs, colorectal surgery (when compared to other types of surgery) as well as a history of smoking have been shown to predict the incidence of POI in patients undergoing major abdominal surgery (Sugawara et al., 2018). Increased manipulation of the bowel during surgery could lead to increased incidence of POI due to promotion of a postoperative cellular inflammatory response in the intestinal smooth muscle layer (Kalff, Schraut, Simmons & Bauer 1998). It is widely believed that early postoperative ambulation limits the incidence of POI by increasing gut motility; however, there is currently no research supporting this notion (Waldhausen & Schirmer, 1990; Story & Chamberlain, 2009). Postoperative ileus is the single largest factor responsible for an increased hospital length of stay following bowel resection procedures (Weledji 2020). Interestingly, POI has also been shown to favour intestinal bacterial growth which can lead to infections.

Our results showed that functional performance status and physical activity levels predicted acute postoperative outcomes. Research has shown that reduced preoperative physical performance reduces a patient's ability to adequately manage surgery and hospitalisation (Lipsitz, 2002). Secondly, surgical outcomes are adversely affected by low preoperative functional performance levels (Banugo & Amoako, 2017). Preoperative performance status and physical activity are both modifiable factors and can be addressed by physiotherapists before surgery with further rehabilitative care immediately following surgery to enhance recovery. One study showed that patients who underwent prehabilitation programmes had a better postoperative walking capacity when compared to those who started rehabilitation postoperatively (Minnella et al., 2017). Based on the findings for our cohort, it is reasonable to assume that those patients with better preoperative functional abilities will be more functional postoperatively which in turn will limit the harmful effects of bed rest and immobility.

Reduced functional performance is prevalent in patients with cancer as a combined result of the treatments that patients have undergone or as a result of the cancer itself (West & Jin, 2015). Fatigue is experienced by the majority of patients with cancer (Stone et al., 2000). The results of a recent systematic review showed that a combination of aerobic and resistance training is effective in combatting cancer-related fatigue (Meneses-Echávez, González-Jiménez & Ramírez-Vélez, 2015). One could

simply start with encouraging patients to adhere to the guidelines described by the World Health Organisation regarding physical activity (Bull et al. 2020). Other modifiable factors were not included in the database but may have impacted on the results. Sleep disturbances in oncology patients is estimated to be double that of the general population (Mark et al. 2017). Poor nutrition practices have also been linked with increased risk of poor postoperative outcomes in surgical oncology patients (Kathiresan, Brookfield, Schuman & Lucci 2011).

Our results have highlighted the need to identify patients with low preoperative levels of function and reduced physical activity. This could enable rehabilitation professionals such as physiotherapists to intervene before surgery. However, other studies have identified problems with the feasibility of implementing preoperative interventions due to the narrow window period between diagnosis and surgery (Northgraves et al. 2020; Karlsson et al. 2019). If preoperative rehabilitation interventions cannot be implemented, high-risk patients could be identified provided with at least one education session before surgery and/or managed appropriately following surgery.

Given the fact that laparoscopic surgery is known to be associated with better postoperative outcomes compared to open abdominal surgery (Lee et al. 2017; Moug, McCarthy, Coode-Bate, Stechman & Hewitt 2015; Hewett et al. 2008; Guillou et al. 2005) and, that more patients underwent open procedures as shown in the retrospective review, we chose to target our preoperative education programme at those undergoing open laparotomies. Chapter 5 was aimed at developing the proposed content of a preoperative education programme and will be described below.

8.5 DEVELOPMENT OF A PREOPERATIVE PHYSIOTHERAPY EDUCATION PROGRAMME FOR PATIENTS UNDERGOING OPEN ABDOMINAL SURGERY

Currently, at the WDGMC, preoperative care for patients undergoing surgery for colorectal cancer includes an assessment with the colorectal surgeon and a specialist physician, as well as a preoperative education session with a clinical associate from the colorectal unit and a wound/stoma nurse (if appropriate). The education programme provided by the clinical associate includes written information regarding the preoperative period. The patients are encouraged to stop smoking and drinking excessive amounts of alcohol as well as to exercise for up to 15 minutes daily however no specific exercises are suggested. Patients are informed of the specific surgical procedure that they will receive and are given an approximate duration of surgical time.

The patients are informed that they will spend some time in the intensive care unit postoperatively and are encouraged to mobilise as soon as possible. The patients are given an estimate on their hospital LOS and given basic wound care advice as well as information on basic complications to watch out for at home. The patients are advised on when they can return to driving, exercise and work and given basic instructions on a postoperative diet and are encouraged to visit a dietitian. Physiotherapists do not see the patients preoperatively.

During the narrative review, we identified various studies that used preoperative education programmes for patients undergoing abdominal surgery for various pathologies. The timing of preoperative education delivery described in the literature appears to be variable. Preoperative education is provided by various members of the multidisciplinary team (Berthelsen, Wiklund, Säthil, Samulowitz & Fagevik Olsén 2020; Howard et al. 2019; Boden et al. 2018, 2018a; Gillis et al. 2014; Li et al. 2013). There is evidence that preoperative physiotherapy education prior to abdominal surgery has shown high treatment fidelity, is highly memorable, leads to lower hospital costs and reduces postoperative pulmonary complications (Boden et al. 2018, 2018a). Physiotherapists appear to be underutilised when it comes to the provision of preoperative education for patients undergoing abdominal surgery. For example, the provision of education regarding breathing exercises falls within the scope of physiotherapy practice, however many studies describe breathing exercise education provided by nurses (Mehta & Patil 2020; Ünver, Kıvanç & Alptekin 2018; Raj & Kathyayani 2016).

Content included in the education programs reviewed included breathing exercises, coughing, verbal advice on trunk and pelvic mobility exercises and leg mobility exercises, surgical information, postoperative pain management, nutritional support, relaxation techniques and, information about postoperative pulmonary complications and their prevention with early postoperative ambulation.

Preoperative functional performance levels and physical activity are predictors of acute postoperative outcomes in South African patients undergoing colorectal cancer resection as described in Chapter 4 (Whelan, van Aswegen, Roos, Fabian & Bebington 2021). This supports the decision to include physical activity and information regarding other lifestyle related factors to effect changes in acute and long-term outcomes in this patient group.

‘Early Recovery After Surgery’ (ERAS) protocols are multidimensional and consider aspects of preoperative, perioperative and postoperative care aimed at enhancing recovery following surgery (Fearon et al. 2005). The ERAS pathway helps reduce the incidence of postoperative complications and hospital length of stay in patients undergoing major open abdominal surgery for colorectal cancer. Due to the fact that ERAS guidelines encourage a multidisciplinary approach, it is important that patients are aware of the other members of their care team. Over the past few years, there has been a rise in multidisciplinary management of patients with cancer (Brar, Hong & Wright 2014). An important component of ERAS principles is postoperative analgesia (Hughes, Ventham, McNally, Harrison & Wigmore 2014). Although the optimal modality for postoperative analgesia control is still up for debate, poorly controlled analgesia is associated with impaired mobility and poor postoperative outcomes (Wu & Fleisher 2000). Physiotherapists are able to advocate for their patients to receive appropriate pain control which has the potential to improve acute postoperative outcomes such as hospital length of stay. Another component of the ERAS pathway is preoperative counselling where patients are given information about their medical and surgical journey, which would support the addition of this component to our framework (Varadhan et al. 2010).

Early ambulation after surgery is one of the components of the ERAS guidelines (Varadhan et al. 2010). Browning et al (2007) performed a study to determine how much uptime is performed in the first four days following upper abdominal surgery. Results showed that quantity of upright mobilisation is low in these patients (Browning, Denehy & Scholes 2007). Less uptime was a predictor of longer hospital length of stay (Browning et al. 2007). Similarly, results from a more recent prospective cohort study in older patients who underwent emergency abdominal surgery found that delayed mobilisation was associated with poor postoperative outcomes (Pederson et al. 2020). This highlights the need to educate patients on the benefits of early upright positioning and mobilisation following surgery.

Evidence supporting the effectiveness of breathing exercises to prevent postoperative pulmonary complications is inconclusive. On the one hand, results of a recent randomised controlled trial found that the active cycle of breathing technique is more effective than autogenic drainage in improving thoracic expansion, peak expiratory flow rate and inspiratory capacity in patients who underwent abdominal surgery (Shingavi, Kazi, Gunjal & Lamuvel 2017). Alternatively, results of a cluster randomised controlled trial showed that the addition of deep breathing exercises to physiotherapy-

directed early mobilisation following abdominal surgery had no impact on the incidence of postoperative pulmonary complications when compared to early ambulation in isolation (Silva, Li & Rickard 2013). However, given the fact that active breathing techniques was at the top of the final ranking after the NGT, and was included in several of the studies reviewed, the authors retained it as part of 'respiratory care' in the framework.

The diagnosis of cancer is a shock and many patients may feel overwhelmed during the preoperative period (Stinesen Kollberg et al. 2017). In a study which investigated the feasibility of a supervised home-exercise programme in patients undergoing colorectal cancer surgery, many participants declined participation due to feeling too stressed before surgery and felt that a preoperative programme would be 'too much' (Karlsson et al. 2019).

The question remains whether the content of preoperative educational information provided by physiotherapists to patients undergoing abdominal surgery could be expanded upon to include other concepts and whether this could have any impact on their postoperative outcomes? However, on the other hand, perhaps it would be wise to make the programme concise and not overwhelm patients with information that could be provided to them at a later stage. Perhaps a staggered approach to preoperative education could be undertaken in this patient group. If given the opportunity, physiotherapists could do a brief preoperative education session, followed by discharge advice at the end of their hospital stay and then post-discharge follow up care as required. This may be beneficial to limit escalation of patients' anxiety levels.

8.6 PREOPERATIVE PHYSIOTHERAPY EDUCATION CONTENT AS DESCRIBED BY PARTICIPANTS OF THE NGT FOCUS GROUP

Many of the ideas presented in the final NGT ranking were similar to those described in the education program provided to patients in the studies by Boden et al (Boden et al. 2018a, 2020). There were ideas linked to cancer specifically which is appropriate for the stimulus question that the participants were given. Some ideas linked to cancer were ranked outside the top 10 possibly due to the fact that they could be considered to be outside of the physiotherapy scope of practice.

Based on the opinion of the clinicians who attended the focus group, concepts such as the postoperative rehabilitation journey, and physiotherapy management of

incontinence could also be included in a physiotherapy preoperative education program. For patients undergoing surgery for colorectal cancer specifically, preoperative education on cancer-related fatigue and the associated benefits of exercise, and the impact of lifestyle-related risk factors on postoperative outcomes could be beneficial for patients undergoing abdominal surgery for tumour resection.

However, it is possible that the views of South African therapists on the proposed content of a preoperative education programme could be very different to those of therapists working in different settings and in different countries. Preoperative interventions such as prehabilitation are considered to be standard care in many countries whereas in South Africa and other Sub-Saharan countries, it is an unmet need (Fernandes et al. 2020).

The framework developed in Chapter 5 gives us an idea of the possible content of a physiotherapy education programme, however further testing and validation is necessary before this content can be used in clinical practice.

8.7 CONSENSUS ON THE CONTENT OF A PHYSIOTHERAPY PREOPERATIVE EDUCATION PROGRAMME

In Chapter 6, we utilised an international Delphi panel to determine consensus as to what should be included in a physiotherapy preoperative education programme for patients undergoing open abdominal surgery for colorectal cancer.

Preoperative education is an important part of the ERAS guidelines for patients with colorectal cancer undergoing surgical procedures (Gustafsson et al. 2013). It is important that patients are prepared for the surgical procedure as well as the medical and rehabilitative journey that they will be undertaking. Other studies have showed that preoperative education for patients undergoing abdominal surgery is effective in reducing the incidence of postoperative pulmonary complications (Boden et al. 2018a).

Given the unique challenges that patients with cancer face, it is worth considering an education programme that includes oncology-related content. Two other studies utilised preoperative education specifically for patients undergoing abdominal surgery for various cancers (Beck, Vind Thaysen, Hasselholt Soegaard, Blaakaer & Seibaek 2021; Dronkers et al. 2010).

The statements that reached consensus in this study spanned across multiple categories including “medical and surgical journey”, “respiratory considerations”, “pain and wound considerations”, “rehabilitation considerations”, “cancer considerations” and “other considerations”. These were carried over from the framework developed in Chapter 5. There were some similarities between our content and the education content described by other authors (Beck et al. 2021; Dronkers et al. 2010) however, our content included additional information.

The difference in context with regards to delivery of healthcare services was highlighted in the Delphi study. Given the fact that the majority of the Delphi panel members reside outside Africa, many concepts that the members of the South African NGT focus group considered to be important did not reach consensus in the Delphi study. In many first-world countries, preoperative physiotherapy interventions are considered standard practice. In Chapter 7, the impact and feasibility of the physiotherapy preoperative programme was tested in the form of a randomised pilot study.

In this study, the primary goal was to educate patients to improve acute postoperative outcomes. However, the secondary goal was also to improve long-term functional outcomes and survival. We thought that this was appropriate given the fact that most South African patients (even in the private sector) do not receive preoperative physiotherapy and many don’t receive post-discharge follow up either.

8.8 IMPLEMENTATION OF A PREOPERATIVE EDUCATION PROGRAMME PILOT STUDY: TESTING THE IMPACT

The primary aim of the study described in Chapter 7 was to test the impact of a physiotherapy preoperative education programme on acute postoperative outcomes namely incidence of postoperative complications and hospital length of stay. Unfortunately, low recruitment rates over the 5-month recruitment period resulted in only one patient being enlisted. The patient was recruited into the control group. Therefore, the impact of the programme could not be tested at all.

However, when looking at the demographic and clinical profile of the patient who was recruited, one can see where implementing the programme could have been beneficial. The patient presented with significant risk factors for colorectal cancer including increased waist circumference and BMI and extremely low physical activity

levels (Shaw et al. 2018; Dong et al. 2017). Furthermore, research has shown that obesity is associated with poor postoperative outcomes in patients with colorectal cancer (Almasaudi, McSorley, Edwards & McMillan 2018). At hospital discharge, the patient's 6MWT was below the distance predicted according to her age (Enright & Sherrill 1998). In addition to this, her CPAx and SPPB scores were lower when compared to her baseline assessment suggesting that she had reduced physical function at hospital discharge. Although her hospital LOS (11 days) was in keeping with the LOS described in the retrospective review in Chapter 4, she reported not doing any physical activity leading up to the surgery. The results of Chapter 4 showed that preoperative vigorous-intensity physical activity predicts hospital length of stay in this patient population (Whelan et al. 2021). Therefore, it is plausible that educating her to be more active in the time leading up to her surgery, could have contributed to a change in her postoperative outcomes.

8.9 IMPLEMENTATION OF A PREOPERATIVE EDUCATION PROGRAMME PILOT STUDY: TESTING THE FEASIBILITY

The low recruitment rates experienced during the data collection period for the pilot study speak to the feasibility of implementing a preoperative physiotherapy programme at the particular institution where the study took place.

We addressed practicality and integration when assessing the feasibility of our study (Bowen et al. 2009). Regarding practicality, the small window period between the decision to surgery and the surgery itself was one of the biggest challenges faced. Secondly, not all patients who were referred presented to the clinic for their physiotherapy assessments (Northgraves et al. 2020; Karlsson et al. 2019).

The low recruitment rates also speak to the integration component of feasibility (Bowen et al. 2009). Changing the culture of surgical management of patients to incorporate physiotherapy as part of preoperative management proved to be more difficult than originally thought. The rate of referral of patients to physiotherapy services was extremely low.

In order to address the practicality and integration, perhaps, preoperative physiotherapy education should be initiated when the patients first present to their general practitioners or oncologists rather than at the time of their first preoperative surgical consultations.

There was a change noted in the surgical trend of the colorectal unit at WDGMC during the course of the studies performed in this thesis. During the retrospective review described in Chapter 4, most patients underwent open abdominal surgical procedures. In contrast to this, when investigating the reason for poor patient recruitment for the pilot study, it was reported to the main researcher that majority of patients undergoing surgery at WDGMC during the recruitment period underwent laparoscopic surgery and not open abdominal surgery which meant that they did not meet the inclusion criteria.

On the other hand, not all patients who present for healthcare services in South Africa have access to medical insurance. If they do not have medical insurance, they are required to fund their own medical expenses or seek care in the public sector which has its own set of challenges. This means that patients may have to fund their own preoperative education sessions.

A recent study found that preoperative physiotherapy education aimed at the prevention of postoperative pulmonary complications in patients undergoing major abdominal surgery is likely to be cost effective from the perspective of the hospital (Boden et al. 2020). Therefore, it is plausible that one preoperative physiotherapy education session could better prepare patients with colorectal cancer for their surgeries compared to receiving nothing at all in contexts where the uptake of preoperative physiotherapy education is lacking.

8.10 LIMITATIONS

A number of limitations were identified in the studies presented in this thesis.

8.10.1 Chapters 3 and 4

Regarding the retrospective database review presented in Chapters 3 and 4, certain variables were considered for inclusion into the REDCap database after the start of data collection which resulted in missing data for variables such as the ECOG score, ASA score and the GPAQ score. Secondly, missing data was a limitation in calculating GPAQ scores and the result was no data on moderate-intensity physical activity. This in turn means that the patients' full physical activity profiles were not complete. The substantial amount of missing data limits the conclusions that can be drawn from the results.

There were also limitations regarding the patient sample. The cohort represents patients from urban areas of Johannesburg. Patients from rural areas may present with different demographic and clinical profiles. Another limitation is that the cohort in this study is not a population-based sample.

Lastly, this database was not designed to answer the objectives proposed in Chapters 3 and 4. This meant that other modifiable factors that could have been considered for inclusion were not part of the database. Examples of other modifiable lifestyle factors include but are not limited to sleep and diet.

8.10.2 Chapter 5

The number of participants that took part in the focus group was small however, the sample still fell within the recommended sample size for a NGT session (McMillan et al. 2016). Our study only included physiotherapy clinicians who work in the private sector despite the invitation being extended to clinicians working in the public sector. Clinicians working in the public sector may have presented different ideas during the session. Furthermore, due to the fact that there were no patients who attended the focus group session, the ideas generated were limited to the opinion of clinicians only and not the end-users (i.e., the patients and caregivers).

Because the clinicians were purposively sampled to participate in the focus group session, selection bias cannot be ruled out. Furthermore, because the focus group session was facilitated by the authors, there was also a risk of bias during the session which cannot be ignored.

Using a narrative review was one way to demonstrate the recent evidence available on preoperative education for patients undergoing abdominal surgery. However, a systematic review may have been superior as systematic reviews are more methodologically explicit and generally present less bias (Greenhalgh, Thorne & Malterud 2018; Faggion, Bakas & Wasiak 2017).

The study populations described in the narrative review were heterogenous and not limited to patients with colorectal cancer. However, because the framework was also based on the results of the focus group, the framework presented could be considered useful for patients with colorectal cancer. However, further validation and testing will be required before this can be used in clinical practice. The framework developed in

this chapter was not reviewed by members of the focus group and consensus was only achieved by the authors of this paper.

8.10.3 **Chapter 6**

There were a number of limitations identified in this study. Although the expert panel presented in this study represented an international physical therapy population, participants from Asia and America did not take part. Only 25% of participants resided in South Africa. Therefore, the geographical scope of the participants could limit the applicability of the results in a South African setting. Furthermore, the heterogeneity of the background/scope of participants in the panel raises limitations regarding the validity of the results. Only one participant reported working in the field of oncology which could question the remaining participants' expert knowledge in the management of patients with cancer specifically. This may have affected the cancer-related concepts that didn't reach consensus after both rounds.

Approximately 50% of the reviewer pool who initially agreed to participate did not complete the first or second round surveys. However, out of the eight participants who completed the first-round survey, 87.5% (n=7) of them went on to complete the second-round survey. Due to the low number of panel members who participated in this study, the validity and reliability of the results are questionable.

The results should be interpreted with caution as there are flaws in the Delphi technique as it shows no evidence of reliability and the consensus achieved simply represents an agreement from the group on the topic presented to them.

8.10.4 **Chapter 7**

The major limitation of this study was the small sample size for the randomised controlled trial due to extremely low participant recruitment rates. Since the only patient recruited was randomised into the control group, the preoperative education programme was not implemented at all. This means that no conclusion can be drawn regarding the impact of the programme on the patient's acute postoperative outcomes.

Secondly, flaws in the design of the study were exposed during the recruitment period. It could be suggested that attempting a preoperative education programme at the time of the first visit to the colorectal surgeon could create a window too small to initiate physiotherapy interventions before surgery in many cases. Rather, perhaps patients

should be referred to physiotherapists by their primary care doctors or oncologists at the same time that they are referred to colorectal surgeons for surgical intervention.

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CHAPTER 9

This chapter contains the conclusion of all the components of this thesis as well as recommendations for future research.

9.1 CONCLUSION

The urban cohort of patients presented in the retrospective review presented with various risk factors associated with colorectal cancer. Patients in the private sector were older, had earlier staging of cancer and a higher percentage of alcohol consumption when compared to those in the public sector. Survival rates in the private sector were significantly better than those in the public sector. Waist circumference and BMI were shown to have positive large-and-medium strength effects respectively on survival. Anthropometric screening and preoperative education on lifestyle risk factors could be provided by physiotherapists to effect long-term behaviour changes in patients with colorectal cancer.

In patients who previously had surgery for colorectal cancer at WDGMC, preoperative vigorous-intensity exercise and functional performance status significantly predicted hospital LOS and incidence of postoperative complications. Surgical site infections (deep and superficial) and POI were the most frequently reported postoperative complications in this cohort.

As presented in the narrative review, preoperative physiotherapy education reduces the incidence of postoperative pulmonary complications, improves postoperative lung function, is memorable and, has high treatment fidelity for patients undergoing abdominal surgery. Several authors investigated the use of physiotherapy preoperative education for patients undergoing abdominal surgery. Various modes of delivery are described and, the timing of education interventions is heterogeneous and case-dependent. Based on the opinion of the clinicians who attended the focus group, concepts such as the postoperative rehabilitation journey, and physiotherapy management of incontinence could also be included in a physiotherapy preoperative education program. The preliminary framework developed provides the content, timing, setting and mode of delivery of physiotherapy preoperative education for patients undergoing colorectal cancer resection.

The statements agreed upon by the participants in the Delphi study represent the insight of an international expert physiotherapy panel on the proposed content of a

physiotherapy preoperative education programme for patients undergoing colorectal cancer surgery. The content includes preoperative exercise advice, postoperative respiratory techniques and ambulation, wound care, medical/surgical information, cancer considerations and return to physical activity guidelines. The programme requires further validation and testing before being applied in a clinical setting.

The physical activity and anthropometric profile of the patient who participated in the pilot study emphasises the need for physiotherapy preoperative education for patients undergoing open abdominal surgery for colorectal cancer. The study highlighted issues regarding the feasibility of implementing a preoperative physiotherapy education intervention for patients undergoing open abdominal surgery for colorectal cancer at a private hospital in Johannesburg, South Africa.

9.2 RECOMMENDATIONS FOR FUTURE RESEARCH

Significant challenges in implementing preoperative physiotherapy interventions were experienced in this patient cohort. However, future research is also needed to determine the need for postoperative physiotherapy follow up care in South African patients undergoing colorectal cancer resection.

Future research is required to determine the incidence of sarcopenia in South African patients with colorectal cancer and to determine its association with survival. This will assist us to re-define and streamline the role of physiotherapists in the management of these patients.

Moderate-intensity exercise data were missing for retrospective review in this thesis and is a potentially modifiable risk factor for the development of postoperative complications that would need to be explored in future trials.

Due to the high incidence of POI in our surgical cohort, future research should be done to investigate the impact of preoperative and early postoperative physical activity levels on the incidence of POI specifically.

Offsite platforms for doing the preoperative care should be investigated. Screening and assessments with questionnaires could be done online with education and patients can ask questions as needed. This could also serve as a risk stratification to determine who needs to be seen face-to-face for further management.

Patient-centred research could be performed to determine the impact of the preoperative physiotherapy education programme on the quality of life of patients undergoing surgery for colorectal cancer. Furthermore, studies could be performed to determine whether the preoperative education programme has any financial benefit for patients and the hospitals at which the surgeries are performed.

APPENDIX 1

- **PAN AFRICAN CLINICAL TRIAL REGISTRATION**

14 August 2019

To Whom It May Concern:

RE: The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer in Johannesburg, South Africa

As project manager for the Pan African Clinical Trial Registry (www.pactr.org) database, it is my pleasure to inform you that your application to our registry has been accepted. Your unique identification number for the registry is **PACTR201908916815403**.

Please be advised that you are responsible for updating your trial, or for informing us of changes to your trial.

Additionally, please provide us with copies of your ethical clearance letters as we must have these on file (via email or post or by uploading online) at your earliest convenience if you have not already done so.

Please do not hesitate to contact us at +27 21 938 0835 or email epienaar@mrc.ac.za should you have any questions.

Yours faithfully,

Elizabeth D Pienaar
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APPENDIX 2

- **ETHICS APPROVAL**

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/49 Ms M Whelan

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M181075

NAME: (Principal Investigator)	Ms M Whelan
DEPARTMENT:	School of Therapeutic Sciences Department of Physiotherapy Medical School University
PROJECT TITLE:	The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer
DATE CONSIDERED:	26/10/2016
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Professor H van Aswegen
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	11/12/2016

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on 3rd floor, Phillip V Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report.** When a funder requires annual re-certification, the application date will be one year after the date of the meeting when the study was initially reviewed. In this case, the study was initially reviewed in **October** and will therefore reports and re-certification will be due early in the month of **October** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature — Date: 12/12/2018

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX 3

- **APPROVAL OF TITLE**

UNIVERSITY OF THE
WITWATERSRAND
JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

03 January 2022
Person No: 0702224G
PAG

Mrs MJ Whelan

Dear Mrs Megan Whelan

Doctor of Philosophy: Approval of Title

We have pleasure in advising that your proposal entitled *The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer in Johannesburg, South Africa* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

APPENDIX 4

- **PERMISSION FROM CHIEF EXECUTIVE OFFICER**

Wits University
Donald Gordon
Medical Centre

MEDICLINIC

21 June 2018

To whom it may concern

Re: Permission to conduct research at Wits Donald Gordon Medical Centre

This letter serves to confirm that permission is granted from the CEO, Dr Susan Tager at WDGMC for Megan Whelan, to conduct her PhD study titled:

"The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer", at the Wits Donald Gordon Medical Centre.

No data collection may start at WDGMC until a Clearance Certificate has been obtained to do the study from the Wits Human Research Ethics Committee (Medical).

Yours faithfully,

Dr Sue Tager
CEO
Wits Donald Gordon Medical Centre
Tel: (+27) 011 356 6302
Mobile: 082 457 7134
Email: sue.tager@mediclinic.co.za

Wits University Donald Gordon Medical Centre (Proprietary) Limited
Upper level, St Joseph Wing, 24 Eton Road, Parktown, Johannesburg, 2193, South Africa
P.O. Box 2872, Houghton, 2041, South Africa, Tel +27 11 356 6302 Fax +27 11 356 6301

APPENDIX 5

PERMISSION FROM THE DIRECTOR OF THE ICU

Dr Gunter K Schleicher

MBBCh(WITS), DTM&H, FCP(SA), FCCP, M.Med, Cert Pulmonology(SA)

Specialist Physician/Pulmonologist

Director, Wits DGMC ICU

Pr No 0180C50156256

ROOMS: Wits University Donald Gordon Medical Centre, Eton Road, Parktown
Tel: (011) 726-7403/4

POSTAL ADDRESS: PO Box 98218, Sloane Park, 2152, SOUTH AFRICA

Email: schleicher@worldonline.co.za

FAX: (011) 728-7407

1 June 2018

To whom it may concern

Re: Megan Whelan

I, Dr GK Schleicher Director of the Wits Donald Gordon Medical Centre ICU, give Megan Whelan permission to conduct her PhD research project entitled "The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer" at the WDGMC ICU. The study will have no financial implications for the patients enrolled or to the Hospital. No interventions with potential harmful effects are performed, and there is no increased risk to the patients' standard level of medical care.

Yours faithfully

Gunter Schleicher

APPENDIX 6

- **PERMISSION FROM THE ALLIED HEALTH REPRESENTATIVE OF THE MEDICAL EXECUTIVE COMMITTEE**

1 June 2018

Dear Megan

PERMISSION TO PERFORM STUDY

Thank you for your protocol for your study for your PhD.

I give you permission to perform your study both in my capacity as Allied Health Representative of the Medical Executive Committee of the Wits Donald Gordon Medical Centre as well as owner of Carr and Associates which is the Practice that will be treating these patients.

Yours sincerely



Michele Carr
082 378 8919

APPENDIX 7

- **INFORMATION SHEET FOR PARTICIPATION IN NOMINAL GROUP TECHNIQUE**

The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer

Dear potential participant,

My name is Megan Whelan. I am a physiotherapy clinician working at the Wits Donald Gordon Medical Centre. I am performing a research study entitled '*The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer*'. The purpose of my study is to develop a pre-operative physiotherapy education programme for patients undergoing surgery for colorectal cancer. This will be achieved using the nominal group technique in a focus group session.

What does the study involve?

I will send questions to you in advance regarding the use of pre-operative physiotherapy education for patients who will be undergoing abdominal surgery as well as the content of a formalised programme that could be used to educate patients pre-operatively.

On the day of the focus group session and prior to the discussion, you will be given a period of 'silent generation' to reflect on and/or record your responses to the questions posed.

I will facilitate face-to-face discussions in small groups with all the physiotherapists included. You will all be given a chance to verbalise your ideas in a 'round robin' fashion with each person giving only one idea at a time. You will then be given the opportunity to work together to group certain ideas together. Some ideas will be included and others excluded. Group themes will then be generated.

You will be asked to select your top preferences from the ideas generated and then record them on a ranking sheet that will be provided to you. The scores for each idea will then be added and then presented to the group for discussion. Ideas recorded on the ranking sheets by participants will be ranked in order of importance and scored accordingly. Results from the focus group session will be emailed back to you within 24 hours after completion of the session.

The ideas from the group session will be used to create a formalised tool to be used for pre-operative education for patients undergoing abdominal surgery specifically for colorectal cancer. The completed programme will be sent back to you and the other physiotherapists included for you to review in order to validate the content of the programme.

The session will be recorded with a cellphone or a dictaphone and is estimated to be one to two hours in duration.

What are the risks?
There are no known risks to participating in the study.

What is the cost?
Your travel costs to attend the focus group session will be reimbursed according to the South African Government Gazette of 2018.

Confidentiality and Anonymity:
All voice recordings will be transferred to a secure, password-protected folder as soon as possible after the interview and permanently deleted from the voice recorder. The recording only will be used for analysis and as examples in conference presentations, lectures and publications. Written permission will be requested prior to the recordings being used for anything else. Once transcription is complete, you will be given the opportunity to review the transcription documents prior to further commencement of the study.

Your anonymity cannot be guaranteed during the focus group session as you will meet and engage with the other participants taking part in the study. However, each participant will be given a code and during analysis all participants' identity documentation will remain anonymous and information obtained from the study will be used for statistical purposes only.

What are your rights?
You may withdraw your consent for participating in the study at any stage. No questions will be asked regarding your decision.

Contact details:
This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg. A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research. If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet

APPENDIX 8

- **CONSENT FORM FOR PARTICIPATION IN NOMINAL GROUP TECHNIQUE**

The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer

Informed Consent:

I _____ hereby acknowledge that I have received, read and understood the information sheet pertaining to the study.

I _____ hereby acknowledge that I have been given the opportunity to ask questions related to the study and acknowledge that the researchers have answered my questions adequately.

I _____ understand that I, without prejudice, may withdraw my consent and participation from the study at any time.

Signed:

Participant's name : _____

Signature : _____

Date : _____

Researcher's name : _____

Signature : _____

Date : _____

APPENDIX 9

- **CONSENT FORM FOR AUDIO RECORDING DURING NOMINAL GROUP TECHNIQUE**

The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer

I _____ (Physiotherapists' name) hereby give my consent willingly to audiotape recording of the group interview sessions.
I have understood the content in the information sheet and the researcher has clarified verbally the purpose of the audio taping of the group interview session and my freedom to withdraw from the audiotape recording at any given time.

Participants Signature: _____
Witness : _____
Date : _____

APPENDIX 10

- **CONSENT FOR PARTICIPATION IN THE DELPHI STUDY**

Content development of preoperative physiotherapy education for patients undergoing open abdominal surgery for colorectal cancer: a Delphi study (Round 1)

The following statements in the survey below relate to the proposed content of preoperative physiotherapy education to be provided to patients awaiting open abdominal surgery for colorectal cancer.

The survey consists of seven sections:
Demographic information, Medical and Surgical Journey, Respiratory Considerations, Pain and Wound Considerations, Rehabilitation Considerations, Cancer Considerations and Other Considerations.

The content has been developed based on information extracted from a retrospective secondary analysis of an existing database of South African patients with colorectal cancer who underwent surgical resection, a focus group session with expert physiotherapy clinicians using the nominal group technique (NGT), and, a narrative review of the current literature regarding preoperative education of patients undergoing abdominal surgery.

Approval to conduct this study was obtained from the University of the Witwatersrand Human Research Ethics (Medical) committee (M181075).

For any queries, please do not hesitate to contact the researcher, Megan Whelan (meganwhelanphysio@gmail.com).

Thank you for your participation. Please complete the survey below.

By signing below, you have agreed to participate in the study

_____ _____

Signature Date

APPENDIX 11

- **INFORMATION SHEET FOR PARTICIPATION IN THE RANDOMISED PILOT STUDY**

Dear potential participant,

My name is Megan Whelan. I am a physiotherapy clinician working at the Wits Donald Gordon Medical Centre. I am performing a research study entitled '*The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer*'. The purpose of my study is to test the impact of a developed pre-operative physiotherapy education programme on the rehabilitation outcomes of patients undergoing surgery for colorectal cancer.

Why am I being asked to participate?

- You have colorectal cancer and are scheduled for abdominal surgery.
- Your participation in this study is completely voluntary. If you decide not to participate, you will not be penalised in any way and will continue to receive the usual medical, nursing and physiotherapy care provided for any patients in our ICU and high care unit following abdominal surgery for colorectal cancer.

What does the study involve?

In this study, you will be randomly allocated into one of three groups prior to your surgery. Participants in all three groups will be assessed according to functional capacity, grip strength and muscle strength as well as your exercise tolerance with a Six Minute Walk Test. This is a walking test that lasts for six minutes and will be performed prior to your surgery. If you are allocated to the first group, you will not receive any pre-operative physiotherapy. If you are allocated to the second group, you will receive a physiotherapy education programme before you receive your surgery. This will consist of a written handout with information regarding the type of physiotherapy you will receive after your operation and the importance of it. If you are allocated to the third group, you will also receive a pre-operative physiotherapy education programme which will include the same written handout as for group two, as well as 30 minutes of one-on-one contact time with the researcher who will explain the handout to you. While you are in the hospital, you will continue to receive standard physiotherapy care as required. The standard physiotherapy care interventions given to you postoperatively does not form part of this research study. On discharge from the ICU, your physical function, grip strength and muscle strength will be re-assessed. On discharge from the hospital, your exercise tolerance, grip strength, muscle strength, functional capacity and physical function will be re-assessed.

What are the benefits of participation?

Although your participation in this study may not hold any direct benefits to you for your current period of stay, it will assist us to determine what type of preoperative physiotherapy education interventions are associated with the best rehabilitation outcomes for future patients who undergo abdominal surgery for colorectal cancer at the Wits DGMC. Therefore you might receive benefit from your participation now when you return to Wits DGMC for future care related to your diagnosis.

What are the risks?

There are no known risks to participating in the study.

What is the cost?

If you had to come to the hospital for the preoperative assessment on a different day to your appointment with your doctor, your travel costs to attend the pre-operative physiotherapy assessment session will be reimbursed at standard AA rates per kilometre You will not be charged for pre-operative assessments or the repeat assessments at ICU discharge and hospital discharge as these form part of the procedures for this study. You will only be financially liable for any standard physiotherapy treatment received as part of your routine hospital stay which does not form part of this study.

There are no other costs involved.

Confidentiality and anonymity:

All participants' documentation will remain anonymous and information obtained from the study will be used for statistical purposes only. Each participant will get a study code and only the researcher will have access to a password protected document with your personal details linked to your code. These details will not be shared with anyone.

What are your rights?

You may withdraw your consent for participating in the study at any stage. No questions will be asked regarding your decision.

Contact details:

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg. A principal function of this Committee is to safeguard the rights and dignity of all human subjects who agree to participate in a research project and the integrity of the research. If you have any concern over the way the study is being conducted, please contact the Chairperson of this Committee who is Professor Clement Penny, who may be contacted on telephone number 011 717 2301, or by e-mail on Clement.Penny@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za and Rhulani.Mukansi@wits.ac.za

Thank you for reading this Study Information Sheet.

APPENDIX 12

- **CONSENT FOR PARTICIPATION IN THE RANDOMISED PILOT STUDY**

The impact of pre-operative education on post-operative outcomes in patients with colorectal cancer

Consent form for patients

Informed Consent:

I _____ hereby acknowledge that I have received, read and understood the information sheet pertaining to the study.

I _____ hereby acknowledge that I have been given the opportunity to ask questions related to the study and acknowledge that the researchers have answered my questions adequately.

I _____ understand that I, without prejudice, may withdraw my consent and participation from the study at any time.

Signed:

Participant's name : _____

Signature : _____

Date : _____

Researcher/Research assistant's name: _____

Signature : _____

Date : _____

APPENDIX 13

- **PREOPERATIVE EDUCATION PROGRAMME PAMPHLET**

PHYSIOTHERAPY INFORMATION BEFORE YOUR SURGERY

FOR COLORECTAL CANCER

This guide aims to prepare you for your surgery and help you to feel at ease with what is to come.

Before your surgery:

Research has shown that being more active before your surgery may prevent postoperative complications. Exercise can be useful to combat fatigue that you may feel due to your cancer.

Exercise Recommendations:

We suggest that you exercise to condition your body for your surgery. Some exercise ideas are listed below. Aim for both aerobic and strength exercises each week. Do as many repetitions of each exercise as you can to start. Then try to build on those (do more) as you are able. You should exercise to your ability and level of fatigue.

- For aerobic exercise, you can walk, swim or ride for around 30 minutes (3 days of the week). Aim to exercise at a moderate intensity level which means that you are not too short of breath to be able to talk in short phrases. But also, not too light an intensity that you can talk easily with long sentences.



Cycling



Walking

1

- Activities such as sit-to-stand training and step ups can also be done.





Sit-to-stand




Step up

- Strength exercises for your legs such as straight leg raises, bridges, mini squats, heel lifts and hip exercises in standing (2 sets of 8-12 repetitions, 2 days per week)



Mini wall squat



Heel lifts



Hip extension

2



Straight leg raise



Hip abduction



Bridge

- Strength exercises for your arms such as shoulder presses, elbow extensions, shoulder abductions and wall push ups (2 sets of 8-12 repetitions, 2 days per week). You can use weights or a theraband as tolerated.



Shoulder press



Shoulder abduction



Wall push up



Elbow extension

If possible, go see your physiotherapist for further information regarding exercises tailored for you.

3

Nutrition:

Nutrition is a vital part of cancer therapy. Eating a balanced diet is crucial to your general health as well as your recovery following your surgery. In a recent study on South African patients with colorectal cancer, results showed that both body mass index (your weight in relation to your height) and waist circumference (weight distribution around your middle) affect survival. You should consult with your dietitian and follow their instructions about your diet before and after your surgery.

If you would like more dietary information, you can contact:

Madeleine Coetzee

0820632779

Madeleine.coetzee@gmail.com

Adele van der Merwe

0829645145

adele@copingwithcancer.co.za

Your medical and surgical journey

Straight after your surgery, you will spend some time in the intensive care unit (ICU). Within the ICU, there are quite a few beds. You will be connected to a variety of machines to check your overall condition. The ICU can be quite a noisy place as the machines will be beeping and you will be regularly checked on by a nurse allocated to you.

There is a chance that you may wake up on a mechanical ventilator which means you may have a breathing tube in place. This tube will be removed when the doctors are happy that you can breathe safely on your own.

As you start to improve you will be moved from ICU to the main ward which usually happens 2-3 days after your surgery. Once the doctors are happy with your condition, you will be sent home from the main ward. The time that you spend in the hospital will depend on the nature of your operation, the way you respond to your surgery and

whether you encounter any complications. The surgical team will guide you during your stay in the hospital.

Complications that affect the lungs are common after abdominal surgery. These include infections such as pneumonia, reduced ability to take a deep breath, phlegm causing the small airways to block as well as the development of blood clots in the lungs.

Infection at the surgical wound site is another possible complication as well as temporary paralysis of your digestive system which could delay your bowel movements. These complications could prolong your stay in hospital.

General anaesthesia can affect breathing. The respiratory muscles are temporarily weakened meaning there is a smaller amount of air moving in and out of your lungs. This could also make it harder to give a strong cough and clear phlegm from your lungs.

Following your surgery, you will receive physiotherapy daily unless your doctor/physiotherapist decides that you need more than one session per day.

Breathing exercises

Breathing exercises are important after surgery as they help you to activate your breathing muscles, take deep breaths and clear any phlegm that may block your airways. You should start practising your breathing exercises as soon as you wake up after your surgery.

The active cycle of breathing technique (ACBT) is a simple set of breathing exercises that you can do on your own. Please see below:

Breathing control (BC):

- This is normal gentle breathing, using the lower part of your chest (do not do deep breathing)
- To do BC, rest one hand on your stomach (underneath your breast bone)
- Then breathe in gently feeling your hand move outwards as the lower part of your chest expands when your lungs fill with air
- Breathe out slowly while your shoulders are relaxed downwards

- You will feel your hand move back inwards as the air leaves your lungs.
- The breath out should be slow- like a “sigh”
- You should always do BC in between the more active exercises of ACBT because it allows your airways to relax

Deep breathing with thoracic expansion exercises (TEE) – active breathing exercises:

- Place your hands on either side of the bottom of your ribcage so that you can feel your chest expanding
- Breathe in deeply as much as you can and feel the lower part of your chest expand in all directions into your hands
- Keep your neck and shoulders relaxed during breathing
- Gently breathe the air out
- Repeat this step: 3-5 times
- Return to breathing control (BC) until you are ready to do more deep breathing in the next step

Deep breathing with thoracic expansion exercises (TEE) and a 3 second hold:

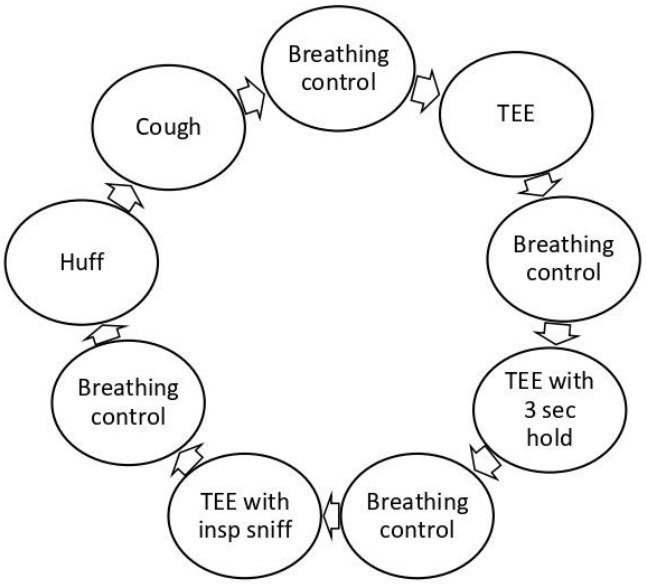
- With your hands placed on the bottom part of your ribcage, breathe in deeply and feel the lower part of your chest expand in all directions.
- Hold the breath for 3 seconds keeping the neck and shoulders relaxed
- Gently breathe the air out
- Repeat this step: 3-5 times
- Return to breathing control (BC) until you are ready to do more deep breathing in the next step

Deep breathing with thoracic expansion exercises (TEE) and inspiratory sniff:

- With your hands placed on the bottom part of your ribcage, breathe in deeply as much as you can and feel the lower part of your chest expand in all directions
- At the top of the breath, take a sniff in through your nose
- Gently breathe the air out
- Repeat this step: 3-5 times
- Return to breathing control (BC) until you are ready to do more deep breathing in the next step

Huff:

- Support your wound as you do this exercise
- A huff is a short sharp breath out through an open mouth
- This helps to force all the secretions (phlegm) from the back of your throat into your mouth
- To perform this, imagine that you are trying to mist up a glass mirror (you can even use a mirror when huffing)
- Remember that the huff must be through an open mouth and use your tummy muscles to help you squeeze the air out (remember huffing is not sighing)
- You may feel the need to cough after performing your huff. Just remember to support your surgical wound so your cough is strong and to ease any pain that you may feel when you cough.



The cycle can be repeated until you feel that you have coughed out any phlegm you can feel in your chest. You should do your breathing exercises multiple times each day. When your nurse writes his/her hourly observations on your ICU chart, you should use this as a cue to do your breathing exercises.

Pain

You should expect to have some pain at the surgical site. You may also have pain from cancer itself or other conditions. Post-surgical pain is usually managed with multiple pain-reducing medications. The right type, delivery and dose of medications for you depend on the type of surgery and expected recovery, as well as your own needs.

For the first day after your surgery, you may have a patient-controlled analgesia (PCA) pump. You can control this yourself by pressing a button when you need extra pain relief. Alternatively, you may have something called a rectus sheath catheter which provides pain medication directly to your abdomen near your surgical incision. Or you may have an injection in your back (epidural) to control pain.



PCA pump

Although mobilising out of bed after your surgery is vital to your recovery, moving around may result in more pain at the wound site. Supporting your wound when moving out of bed and during coughing is an effective strategy to limit pain.

You may also have pain from causes other than the surgery (for example pain in your hands and feet from peripheral neuropathy which is a common side effect of chemotherapy). Tell your nurse if you are in pain right away so that they can change the type or dose of pain relief. It is important to note that your pain should be well controlled at all times, and you should notify your medical team if you feel that your pain is not being managed well enough.

Mobilisation and positioning

Sitting up in bed or a chair and getting out of bed early after your surgery (as guided by your physiotherapist) will help your breathing function. If all goes well, you will be expected to mobilise out of bed **on the first day** after your surgery.

Moving around early after your surgery will help to improve your circulation (thus preventing blood clots), improve the motility of your digestive system and it will encourage you to take deeper breaths.

If you are unable to move out of bed, you must perform circulatory exercises with your legs to prevent blood clots. These exercises include ankle pumps and knee bends. You should do at least 10 repetitions of these exercises every hour while you are awake until you start mobilising out of bed.



Knee bends



Ankle pumps

Wound support and management

During your surgical procedure, the surgeon will make a cut into your abdominal cavity. Some people may need a temporary or permanent stoma bag (colostomy or ileostomy) after surgery depending on the specific procedure. If this is the case, you

will be referred to a wound/stoma nurse who will give you more information on the management of your stoma bag. You can mobilise out of bed with a stoma bag, a catheter and any drip lines that may be attached to you. Your nurse and physiotherapist will assist with these when you need to move.

Wound support will limit the amount of pain felt during certain activities. When coughing, hold a rolled-up towel or pillow against your wound. You can also do this during any other activities that use your tummy muscles (such as when you laugh or sneeze).





When getting out of the bed, turn onto your side, gently move your legs off the side of the bed and then push yourself up into sitting using your arm. Try not to come straight up into sitting from lying on your back as this will put too much pressure on the wound and could delay the healing of your abdominal muscles. When getting back onto the bed, sit down on the edge of the bed, lie down on your side, bring your legs up onto the bed and then turn onto your back with your knees bent.



You need to keep your wound (and wound dressings) clean and dry after your surgery to prevent an infection from occurring.

Return to Activity:

You must follow your physiotherapist's instructions regarding the gradual return to physical activity; however, we have listed below the general guidelines that you can expect to follow (these need to be cleared with your physiotherapist on a case-by-case basis).

Sitting: Unless instructed by your surgeon, you can start sitting in a chair immediately following your surgery. By the end of the 4th week, it is safe for you to spend the entire day sitting in a chair.

Walking: You can start walking immediately following your surgery. Initially, you will need help from your physiotherapist and the nursing staff until you can walk safely by yourself. By the end of your second week, it is safe for you to walk for up to 30 minutes at a time.

Driving: You should not drive for the first 3 weeks following your surgery.

Lifting: Avoid lifting any objects for the first 2 weeks after your surgery.

Avoid lifting anything heavier than 5Kg until 4 weeks after your surgery.

After four weeks, it is safe to lift objects up to 15Kg.

Return to work: Depending on the type of work that you do, you can normally return to work 4-6 weeks after your surgery. Discuss this with your surgeon at your follow-up appointment.

Cycling: After 1 week or once your wound has healed, it is safe for you to start doing some gentle cycling on a stationary bicycle with no resistance.

Abdominal exercises: Do not do any abdominal exercises for at least 6 weeks after your surgery

Support

Contact CANSA on 0800 22 6622 for information regarding local cancer support groups.

Following your surgery, if you are struggling to control your urine or bowel movements, contact your physiotherapist so that they can refer you to a specialised pelvic health physiotherapist for further rehabilitation.

For any questions about the information in this pamphlet, please feel free to contact:

Bianca Swart

0113566045

Megan Whelan

0714822036



APPENDIX 14

- **PREOPERATIVE INDIVIDUAL PARTICIPANT DATA COLLECTION SHEET**

Date : _____

Participant's study code: _____

Age : _____

Gender : _____

Radiation for current cancer: Y/N

Chemotherapy for current cancer: Y/N

If yes, what chemotherapy drugs have you received?_____

_____

Have you been diagnosed with peripheral neuropathy? Y/N

Co-morbidities:_____

_____

Medical and surgical history: _____

_____

_____

History of weight loss and cachexia: _____

Home support:_____

AJCC Colon and rectal staging score: _____

Smoking:		Alcohol:	
Current smoker	□	Current alcohol consumer	□
Previous smoker	□	Previous alcohol consumer	□
Never smoked	□	Never consumed alcohol	□

Physical activity:

1. On average, how many days per week do you engage in moderate to strenuous exercise (like brisk walking)? _____
2. On average how many minutes do you engage in exercise at this level? _____

Total minutes per week (multiply answers of 1 and 2): _____

Physical Assessment

Hand grip strength: Left: _____ Right: _____

Height: _____ **Weight:** _____ **Waist circumference:** _____

SPPB:

Balance test score : _____

Gait speed test score : _____

Repeated chair test score: _____

Six Minute Walk Test (6MWT):

Medication taken before test: _____

Contraindications to 6MWT:

- ☐ Resting heart rate > 120 beats / min after 10 minutes rest (relative contraindication)
- ☐ Systolic blood pressure > 180 mm Hg +/- diastolic blood pressure > 100 mm Hg (relative contraindication)
- ☐ Resting SpO2 < 85% on room air or on prescribed level of supplemental oxygen
- ☐ Physical disability preventing safe performance
- ☐ No contraindications identified

Mobility aid: Y/N					
BP before:					
Time (mins)	SP02	HR	RPE	Distance walked	Rests/Comments
Rest					
1					
2					
3					
4					
5					
6					
1 min post					
2 min post					

6MWT Termination Criteria:

- ☐ Chest pain or angina-like symptoms
- ☐ Heart rate > Predicted HR max.
- ☐ Evolving mental confusion, light-headedness or incoordination
- ☐ Physical or verbal severe fatigue
- ☐ Intolerable dyspnoea, unrelieved by rest
- ☐ Persistent SpO2<85%
- ☐ Abnormal gait pattern: staggering, leg cramps, ataxia
- ☐ Other clinically warranted reason

Medical Research Council Sum Score for Muscle Strength:

	L	R
Shoulder abduction		
Elbow flexion		
Wrist extension		
Hip flexion		
Knee extension		
Dorsiflexion		

Total MRCSS: _____

APPENDIX 15

- **PHYSICAL ASSESSMENT: ICU DISCHARGE**

Participant's study code : _____ Date: _____

Surgical procedure : _____

Pain management postoperatively:

Rectus sheath catheters □

Epidural □

PCA □

Other □ _____

NRS score (pain) at surgical incision site: _____

NRS score (pain) (other) :_____

Hand grip strength : Left: _____ Right: _____

CPAx:

Respiratory function		Sit to stand	
Cough		Standing balance	
Moving within the bed		Transfer (bed to chair)	
Supine to EOB		Stepping	
Dynamic sitting		Grip strength	

CPAx score: _____

Medical Research Council Sum Score for Muscle Strength:

	L	**R**
Shoulder abduction		
Elbow flexion		
Wrist extension		
Hip flexion		
Knee extension		
Dorsiflexion		

Total MRCSS: _____

Date of ICU discharge: _____

Time of ICU discharge: _____

APPENDIX 16

- **PHYSICAL ASSESSMENT: HOSPITAL DISCHARGE**

Participant's study code : _____ Date: _____

Hand grip strength : Left: _____ Right: _____

CPAx:

Respiratory function		Sit to stand		
Cough		Standing balance		
Moving within the bed		Transfer (bed to chair)		CPAx score: _____
Supine to EOB		Stepping		
Dynamic sitting		Grip strength		

Medical Research Council Sum Score for Muscle Strength:

	L	**R**
Shoulder abduction		
Elbow flexion		
Wrist extension		
Hip flexion		
Knee extension		
Dorsiflexion		

Total MRCSS: _____

Six Minute Walk Test (6MWT):

Medication taken before test: _____

Contraindications to 6MWT:

- ☐ Resting heart rate > 120 beats / min after 10 minutes rest (relative contraindication)
- ☐ Systolic blood pressure > 180 mm Hg +/- diastolic blood pressure > 100 mm Hg (relative contraindication)
- ☐ Resting SpO2 < 85% on room air or on prescribed level of supplemental oxygen
- ☐ Physical disability preventing safe performance
- ☐ No contraindications identified

Mobility aid: Y/N					
BP before:					
Time (mins)	SP02	HR	RPE	Distance walked	Rests/Comments
Rest					
1					
2					
3					
4					
5					
6					
1 min post					
2 min post					

6MWT Termination Criteria:

- ☐ Chest pain or angina-like symptoms
- ☐ Heart rate > Predicted HR max.
- ☐ Evolving mental confusion, light-headedness or incoordination
- ☐ Physical or verbal severe fatigue
- ☐ Intolerable dyspnoea, unrelieved by rest
- ☐ Persistent SpO2<85%
- ☐ Abnormal gait pattern: staggering, leg cramps, ataxia
- ☐ Other clinically warranted reason

SPPB:

Balance test score : _____

Gait speed test score : _____

Repeated chair test score : _____

NRS score (pain) at surgical incision site: _____

NRS score (pain) (other) :_____

Date of hospital discharge : _____

Time of hospital discharge : _____

APPENDIX 17

- **SHORT PHYSICAL PERFORMANCE BATTERY SCORING SHEET**

Short Physical Performance Battery Protocol and Score Sheet

Participant Name: _____ Date: _____

All of the tests should be performed in the same order as they are presented in this protocol. Instructions to the participants are shown in bold italic and should be given exactly as they are written in this script.

1. BALANCE TESTS

The participant must be able to stand unassisted without the use of a cane or walker. You may help the participant to get up.

Now let's begin the evaluation. I would now like you to try to move your body in different movements. I will first describe and show each movement to you. Then I'd like you to try to do it. If y
do it, tell me and we'll move on to the next one. Let me emphasize that I do not want you to try to do any exercise that you feel might be unsafe.

Do you have any questions before we begin?

A. Side-by-Side Stand

1. ***Now I will show you the first movement.***
2. (Demonstrate) ***I want you to try to stand with your feet together, side-by-side, for about 10 seconds.***
3. ***You may use your arms, bend your knees, or move your body to maintain your balance, but try not to move your feet. Try to hold this position until I tell you to stop.***
4. Stand next to the participant to help him/her into the side-by-side position.
5. Supply just enough support to the participant's arm to prevent loss of balance.
6. When the participant has his/her feet together, ask ***"Are you ready?"***
7. Then let go and begin timing as you say, ***"Ready, begin."***
8. Stop the stopwatch and say "***Stop***" after 10 seconds or when the participant steps out of position or grabs your arm.
9. If participant is unable to hold the position for 10 seconds, record result and go to the gait speed test.

B. Semi-Tandem Stand

1. ***Now I will show you the second movement***.
2. (Demonstrate) ***Now I want you to try to stand with the side of the heel of one foot touching the big toe of the other foot for about 10 seconds. You may put either foot in front, whichever is more comfortable for you.***
3. ***You may use your arms, bend your knees, or move your body to maintain your balance, but try not to move your feet. Try to hold this position until I tell you to stop.***
4. Stand next to the participant to help him/her into the semi-tandem position
5. Supply just enough support to the participant's arm to prevent loss of balance.
6. When the participant has his/her feet together, ask ***"Are you ready?"***
7. Then let go and begin timing as you say ***"Ready, begin."***
8. Stop the stopwatch and say ***"Stop"*** after 10 seconds or when the participant steps out of position or grabs your arm.
9. If participant is unable to hold the position for 10 seconds, record result and go to the gait speed test.

C. Tandem Stand

1. ***Now I will show you the third movement***.
2. (Demonstrate) ***Now I want you to try to stand with the heel of one foot in front of and touching the toes of the other foot for about 10 seconds. You may put either foot in front, whichever is more comfortable for you.***
3. ***You may use your arms, bend your knees, or move your body to maintain your balance, but try not to move your feet. Try to hold this position until I tell you to stop.***
4. Stand next to the participant to help him/her into the tandem position.
5. Supply just enough support to the participant's arm to prevent loss of balance.
6. When the participant has his/her feet together, ask ***"Are you ready?"***
7. Then let go and begin timing as you say, ***"Ready, begin."***
8. Stop the stopwatch and say ***"Stop"*** after 10 seconds or when the participant steps out of position or grabs your arm.

SCORING:

A. Side-by-Side stand

Held for 10 sec	❒1 point
Not held for 10 sec	❒0 points
Not attempted	❒0 points

If 0 points, end Balance Tests

Number of seconds held if less than 10 sec:

____.___ Sec

If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not hold position unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (specify)	6
Participant refused	7

B. Semi-Tandem Stand

Held for 10 sec	❒1 point
Not held for 10 sec	❒0 points
Not attempted	❒0 points

(circle reason to the right)

If 0 points, end Balance Tests

Number of seconds held if less than 10 sec:

____.___ Sec

If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not hold position unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (specify)	6
Participant refused	7

C. Tandem Stand

Held for 10 sec	❒2 point
Held for 3 to 9.99 sec	❒1 points
Held for < than 3 sec	❒0 points
Not attempted	❒0 points

(circle reason above)

Number of seconds held if less than 10 sec:

____.___Sec

If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not hold position unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (specify)	6
Participant refused	7

D. Total Balance Tests score _____ (sum points)

Comments:_____

_____

_____

_____

2. GAIT SPEED TEST

Now I am going to observe how you normally walk. If you use a cane or other walking aid and you feel you need it to walk a short distance, then you may use it.

A. First Gait Speed Test

1. ***This is our walking course. I want you to walk to the other end of the course at your usual speed, just as if you were walking down the street to go to the store.***
2. Demonstrate the walk for the participant.
3. ***Walk all the way past the other end of the tape before you stop. I will walk with you. Do you feel*** *this would be safe?*
4. Have the participant stand with both feet touching the starting line.
5. ***When I want you to start, I will say: "Ready, begin."*** When the participant acknowledges this instruction say: ***"Ready, begin."***
6. Press the start/stop button to start the stopwatch as the participant begins walking.
7. Walk behind and to the side of the participant.
8. Stop timing when one of the participant's feet is completely across the end line.

B. Second Gait Speed Test

1. ***Now I want you to repeat the walk. Remember to walk at your usual pace, and go all the way past the other end of the course.***
2. Have the participant stand with both feet touching the starting line.
3. ***When I want you to start, I will say: "Ready, begin."*** When the participant acknowledges this instruction say: "Ready, begin."
4. Press the start/stop button to start the stopwatch as the participant begins walking.
5. Walk behind and to the side of the participant.
6. Stop timing when one of the participant's feet is completely across the end line.

GAIT SPEED TEST SCORING:

Length of walk test course: Four meters ❒ Three meters ❒

A. Time for First Gait Speed Test (sec)

1. Time for 3 or 4 meters ____.___ sec
2. If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not walk unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (Specify) _____	6
Participant refused	7
Complete score sheet and go to chair stand test	

3. Aids for first walk..... None ❒ Cane ❒ Other ❒

Comments:_____

_____

_____

B. Time for Second Gait Speed Test (sec)

1. Time for 3 or 4 meters ____.___ sec
2. If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not walk unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (Specify)	6
Participant refused	7

3. Aids for second walk..... None ❒ Cane ❒ Other ❒

What is the time for the faster of the two walks?

Record the shorter of the two times ____.___ sec

[If only 1 walk done, record that time] ____.___ sec

If the participant was unable to do the walk: ❒ 0 points

For 4-Meter Walk:		For 3-Meter Walk:	
If time is more than 8.70 sec:	❒1 point	If time is more than 6.52 sec:	❒1 point
If time is 6.21 to 8.70 sec:	❒2 points	If time is 4.66 to 6.52 sec:	❒2 points
If time is 4.82 to 6.20 sec:	❒3 points	If time is 3.62 to 4.65 sec:	❒3 points
If time is less than 4.82 sec:	❒4 points	If time is less than 3.62 sec:	❒4 points

3. CHAIR STAND TEST

Single Chair Stand

1. ***Let's do the last movement test. Do you think it would be safe for you to try to stand up from a chair without using your arms?***
2. ***The next test measures the strength in your legs.***
3. (Demonstrate and explain the procedure.) ***First, fold your arms across your chest and sit so that your feet are on the floor; then stand up keeping your arms folded across your chest.***
4. Please stand up keeping your arms folded across your chest. (Record result).
5. If participant cannot rise without using arms, say "Okay, try to stand up using your arms." This is the end of their test. Record result and go to the scoring page.

Repeated Chair Stands

1. ***Do you think it would be safe for you to try to stand up from a chair five times without using your arms?***
2. (Demonstrate and explain the procedure): ***Please stand up straight as QUICKLY as you can five times, without stopping in between. After standing up each time, sit down and then stand up again. Keep your arms folded across your chest. I'll be timing you with a stopwatch.***
3. When the participant is properly seated, say: ***"Ready? Stand"*** and begin timing.
4. Count out loud as the participant arises each time, up to five times.
5. Stop if participant becomes tired or short of breath during repeated chair stands.
6. Stop the stopwatch when he/she has straightened up completely for the fifth time.
7. Also stop:
    - If participant uses his/her arms
    - After 1 minute, if participant has not completed rises
    - At your discretion, if concerned for participant's safety
8. If the participant stops and appears to be fatigued before completing the five stands, confirm this by asking ***"Can you continue?"***
9. If participant says "Yes," continue timing. If participant says "No," stop and reset the stopwatch.

SCORING

Single Chair Stand Test

	Yes	No	
A. Safe to stand without help	❒	❒	
B. Results:			
Participant stood without using arms	❒		→ Go to Repeated Chair Stand Test
Participant used arms to stand	❒		→ End test; score as 0 points
Test not completed	❒		→ End test; score as 0 points

C. If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not stand unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (Specify)	6
Participant refused	7

Repeated Chair Stand Test

	Yes	No
A. Safe to stand five times	❒	❒

B. If five stands done successfully, record time in seconds.
Time to complete five stands ____.___ sec

C. If participant did not attempt test or failed, circle why:

Tried but unable	1
Participant could not stand unassisted	2
Not attempted, you felt unsafe	3
Not attempted, participant felt unsafe	4
Participant unable to understand instructions	5
Other (Specify)	6
Participant refused	7

Scoring the Repeated Chair Test

Participant unable to complete 5 chair stands or completes stands in >60 sec:	❒0 points
If chair stand time is 16.70 sec or more:	❒1 points
If chair stand time is 13.70 to 16.69 sec or more:	❒2 points
If chair stand time is 11.20 to 13.69 sec:	❒3 points
If chair stand time is 11.19 sec or less:	❒4 points

Participant ID: _____ Date: _____ Tester Initials: _____

Scoring for Complete Short Physical Performance Battery

Test Scores

Total Balance Test score _____ points

Gait Speed Test score _____ points

Chair Stand Test score _____ points

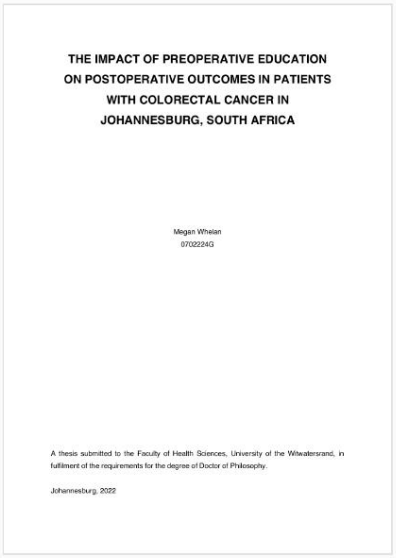
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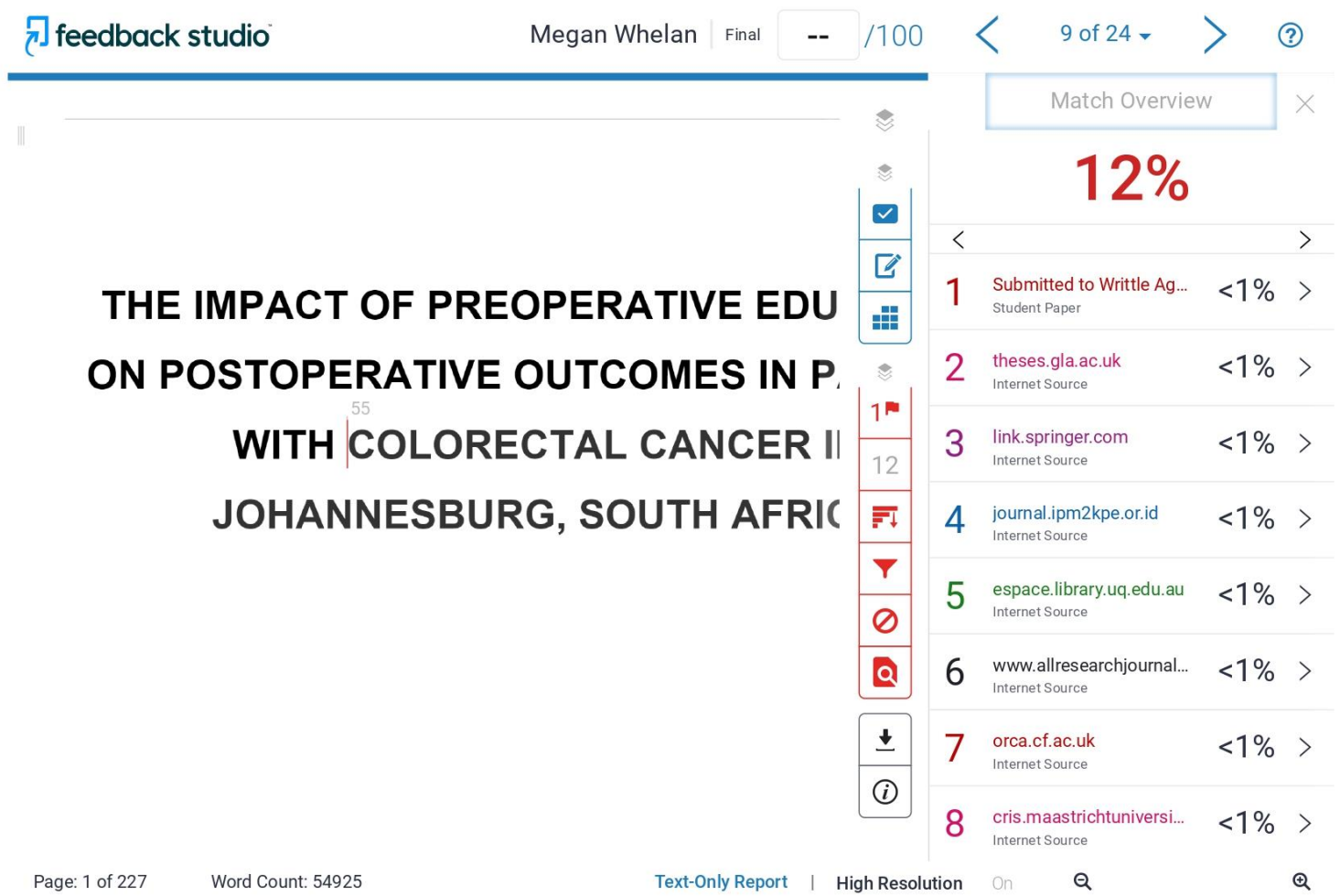
THE IMPACT OF PREOPERATIVE EDUCATION
ON POSTOPERATIVE OUTCOMES IN PATIENTS
WITH COLORECTAL CANCER IN
JOHANNESBURG, SOUTH AFRICA

Megan Whelan
0702224G

A thesis submitted to the Faculty of Health Sciences, University of the Witwatersrand, in fulfilment of the requirements for the degree of Doctor of Philosophy.

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