UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

The effects of pelvic floor rehabilitation in treating post-robotic-assisted laparoscopic prostatectomy urinary incontinence: a systematic review

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Physiotherapy

Johannesburg, 2021

DECLARATION

I Vhahangwele Masutha declare that this Thesis/Dissertation/Research Report is my own, unaided work. It is being submitted for the Degree of Master of Science in Physiotherapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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(Signature of candidate)

5th day of September 2021 in Fourways, Johannesburg.

DEDICATION

Dedicated to my parents, Naledzani and Nkhumeleni Masutha.

ACKNOWLEDGMENT

I would like to thank the following people that if not for their guidance and support, this research project would not have been possible.

Dr Natalie Benjamin-Damons, my main supervisor and a true inspiration. Her wisdom and expertise in the research field has been incredibly appreciated.

Mr Kgantetso Sekome, my co-supervisor, for his encouragement and guidance in refining my research.

Professor Benita Olivier, the postgraduate and research coordinator for physiotherapy students, for her belief in my capabilities and encouraging me to never give up.

Mrs Chichi Ezennwugo, my second assessor and reviewer, for taking the time to read and review articles and for being a sounding board when I needed it the most.

Mr Devind Peter, the Witwatersrand Health Sciences Library Librarian, who assisted me in developing a search string and how to use the different databases to assist me with my research.

Dr Corlia Brandt, for her advice and teachings in the pelvic health field.

The patients and staff at Charlotte Maxeke physiotherapy out-patients department. I was privileged to be able to volunteer, treat and assess patients with urinary incontinence.

Professor Patricia Mc Inerney for her training and expertise in SUMARI of the Joanna Briggs Institute (JBI). The Joanna Briggs Institute and Mrs Judy Palmer, the Administration Officer at the Joanna Briggs Institute, for her help with the registration and renewal process of my JBI subscription.

My family and friends for their continuous support, love and encouragement throughout the entire process of this degree.

Thank God, with Whom ALL things are possible.

ABSTRACT

Background

The death rate for prostate cancer (PCa) is relatively high in men of African descent and is the sixth leading cause of cancer related death (Cassell *et al*., 2019). In Sub-Saharan Africa (SSA), it has been reported that PCa is the number one cancer affecting men (Rebbeck *et al*., 2011). More than 90 % of PCa cases are confined to the organ (Sridhar et al, 2017). Some reasons given by patients who present with advanced stages of PCa include inadequate treatment options, unaffordable medication and lack of screening programmes in their communities which in turn add to the constraints to the effective management of PCa in Africa (Adeloye *et al*., 2016).

Robot-assisted laparoscopic and traditional laparoscopic surgical approaches are becoming the minimally invasive standard of care when it comes to urological and abdomino-pelvic surgery (Kaplan *et al*., 2016). Robotic prostatectomy has had the widest uptake of all procedures that fall under robotic surgeries (Hutchinson *et al*., 2016). According to Arcila-Ruiz, 2018, however, the main complication following this type of surgery is urinary incontinence. During a robot-assisted laparoscopic radical prostatectomy (RARP), the sphincteric mechanism which is made up of the internal and external sphincters that along with the surrounding pelvic structures is altered and leads to urinary incontinence (Sridar *et al*., 2017). This impact to the quality of life following a prostatectomy has resulted in an increase in the number of patients seeking treatment for post-prostatectomy urinary incontinence (PPUI) is increasing (Arcila-Ruiz, 2018).

The physiotherapy management approaches for urinary incontinence include pelvic floor muscle rehabilitation, electrical stimulation, lifestyle changes as well as biofeedback (MacHold *et al.*, 2009).

Aim

The aim of this study was to conduct a review on the effects of pelvic floor muscle rehabilitation in the treatment of urinary incontinence post-robotic-assisted laparoscopic prostatectomy (RALP).

Methods

A three-step search strategy was utilised based on the Joanna Briggs
Institute (JBI) for systematic reviews protocol. An initial search on PubMed was executed

followed by scanning the title, abstract and index terms used to describe the article. A second search was then executed using the identified keywords (pelvic floor, robotic prostatectomy, levator ani, overactive bladder, complications, urinary incontinence, recovery, rehabilitation, physical therapy and physiotherapy) and index terms across all included databases. Thirdly, a reference list of all identified reports and articles was searched for additional studies. This search was limited to studies that were published in English between the years 2000 and 2018.

Results

Out of 261 studies found, 225 studies were excluded from the study due to not meeting the inclusion criteria. Thirty six studies were identified for review. Out of the 36 studies identified, 26 studies were excluded and 10 studies met the inclusion criteria for review. The studies were assessed by two reviewers independent of each other. The quality of the studies were assessed by critical appraisal using the JBI checklist the System for the Unified Management and Review of Information (SUMARI) software.

There were five studies that were in favour of perioperative rehabilitation for treatment of post-RALP urinary incontinence. Perioperative rehabilitation which included education, functional exercise prescription, electrotherapy modalities and guidance showed to have better outcomes in gaining continence post-RALP.

Conclusion

Pelvic floor rehabilitation for post-RALP urinary incontinence supported by biofeedback, functional exercises and Kegel exercises has shown to be effective. This review supports the use of perioperative rehabilitation for better outcomes in the recovery of continence following a RALP.

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List of Abbreviations

±	plus/minus
%	Percent
3D	Three Dimensional
24hr	Twenty-four hours
AIDS	Acquired Immunodeficiency Syndrome
ASR	Age-Standardized Rates
BMI	Body Mass Index
cm	Centimeters
DALYs	Disability Adjusted Life Years
DRE	Digital Rectal Examination
EPIC	Expanded Prostate Cancer Index Composite
FDA	Food and Drug Administration
g	Grams
HREC	Human Research Ethics Committee
EMG	Electromyography
HIV	Human Immunodeficiency Virus
ICIQ-SF	International Consultation of Incontinence Questionnaire Short Form
ICIQ-UI	International Consultation on Incontinence Questionnaire Urinary Incontinence
ICS	The International Continence Society
IIQ	International Impact Questionnaire
IPAQ	International Physical Activity Questionnaire
IPSS	International Prostate Symptom Score
KHQ	King's Health Questionnaire
l	Litres
LRP	Laparoscopic Radical Prostatectomy
ml	milliliters
MUCP	Maximum Urethral Closure Pressure
N	No
N/A	Not Applicable
ng	Nanograms
PCa	Prostate Cancer
PFM	Pelvic Floor Muscles

PFME	Pelvic Floor Muscle Exercises
PFMT	Pelvic Floor Muscle Training
PICO	Population Intervention Comparator Outcome
PPI	Post-Prostatectomy Incontinence
PPUI	Post-Prostatectomy Urinary Incontinence
PSA	Prostate-Specific Antigen
Q	Question
RALP	Robotic-Assisted Laparoscopic Prostatectomy
RARP	Robot-Assisted Laparoscopic Radical Prostatectomy
RP	Radical Prostatectomy
SA	South Africa
SACPS	South African Prostate Cancer Study
SSA	Sub-Saharan Africa
SUI	Stress Urinary Incontinence
TB	Tuberculosis
US	United States
USA	United States of America
VAS	Visual Analogue Scale
WHO	World Health Organization
Y	Yes

Chapter 1 Introduction and scope of the research report

1.1 Introduction

1.1.1 Prevalence of prostate cancer

Prostate cancer (PCa) has been reported as being the most common cancer that affects men in South Africa (SA), across most demographics. This is reflected with the age-standardized rates (ASR) where the PCa rates are higher in Southern Africa (61.8 per 100 000) compared to lower rates in Northern Africa (10.6 per 100 000) (Le Roux *et al.*, 2015). A recent study by Cassell *et al.*, (2019) reported that South Africa had a PCa rate of 61.7 per 100 000. There is little clarity when it comes to the PCa rates among from the African continent (Chu *et al.*, 2011). Due to lack of screening, under-diagnosis as well as limitations in population registry, the rates of PCa incidence in Sub-Saharan Africa (SSA) have been reported to be underestimated (Rebbeck *et al.*, 2011). Less than 40 percent of PCa cases in SSA present with localized PCa (Cassell *et al.*, 2019). One of the reasons for the variations in the rates across the continent could be the limitation of health care access (Chu *et al.*, 2011). From a geographic perspective, the authors also reported that the incidence of PCa among African men had the highest rates in East and South of Africa and then the lowest in the West (Chu *et al.*, 2011).

In developing countries such as South Korea, PCa is in the top five types of cancer affecting men (Park *et al.*, 2018). Early diagnosis is seen as a contributing factor to the higher numbers being recorded in these regions (Park *et al.*, 2018). Early diagnosis of localised PCa has become more accurate because of the prostate-specific antigen (PSA) test (Park *et al.*, 2018). In contrast, in many regions of SSA, screening of the PSA is still relatively uncommon (Chu *et al.*, 2011). A major challenge across African countries is the lack of low cost PCa screening programs (Adeloye *et al.*, 2016). This makes the management of PCa difficult in Africa (Adeloye *et al.*, 2016). Screening practices, availability of pathology services, lifestyle factors, quality of the registry and access to medical care are some of the limiting factors in PCa diagnosis and treatment among African men (Chu *et al.*, 2011).

1.1.2 Surgical interventions

Once PCa is diagnosed, the focus is usually on the patient's survival and removal of the prostate (Nahon *et al.*, 2006). Radical prostatectomy (RP) is a surgical procedure that is performed by removing the entire prostate gland as well as the surrounding malignant tissue (Vernooij *et al.*, 2020). Radical prostatectomy is the most effective treatment in curing early stage PCa (Filocamo *et al.*, 2005). Radical prostatectomy has been the main surgical intervention in most Sub-Saharan nations (Cassell *et al.*, 2019). According to Santa Mina *et al.* (2015), a RP has more than a 90 percent 15-year survival rate for localised PCa. Unfortunately, this method can result in urinary incontinence where the recovery of continence can take up to 2 years (Van Kampen *et al.*, 2000). Robotic-assisted laparoscopic prostatectomy (RALP) can reduce the rate of incontinence by 21.3 percent, as it is a more advanced nerve-sparing technique (Sathianathen *et al.*, 2017). The RALP procedure is a laparoscopic surgical procedure using robotic instruments (Park *et al.*, 2018). Currently, South Africa and Egypt are the only countries utilizing surgical robots in Africa (Oyebamiji, 2020). In Nigeria, a limited health budget, poor leadership as well unreliable electrical power supply are some of the challenges in the implementation of robotic surgery (Oyebamiji, 2020).

1.1.3 Urinary incontinence

Not much is discussed about the long-term effects of the surgery especially when it comes to urinary incontinence (Nahon *et al.*, 2006). Patel *et al*. (2013) reported that urinary incontinence is prevalent in eight to 87 percent of patients at six months and five to 44 percent of patients at 12 months post-operatively. This represents the severity of post-prostatectomy urinary incontinence (PPUI) (Patel *et al.*, 2013). The experience and skill of the surgeon is an important prognostic factor for PPUI (Patel *et al.*, 2013). Other important factors that contribute to urinary incontinence post-operatively include: size of the prostate, type of surgical technique, age of the patient and urodynamic integrity prior to surgery (Dubbelman *et al.*, 2010). It has been reported that the rate of PPUI is one percent for patients with benign PCa, compared to two percent to 66 percent once they have undergone a RP prostatectomy (Aydın Sayılan and Özbaş, 2018). Gaining urinary continence is important for both the clinician and the patient, as it impacts on the economy as well as, quality of life and psychosocial well-being of the individual (Santa Mina *et al.*, 2015).

Stress urinary incontinence (SUI) is the most prevalent type of urinary incontinence worldwide (Irwin *et al.*, 2011). An increased Body Mass Index (BMI) has been associated with increased chances of PCa diagnosis (Aydın Sayılan and Özbaş, 2018). Prostate cancer and obesity increases the risk of SUI because of increased levels of leptin hormone and insulin (Aydın Sayılan and Özbaş, 2018). Irwin *et al.* (2011) estimated that SUI would increase from 5.9 percent to 6.1 percent in women and from 0.49 percent to 0.53 percent in men between 2008 and 2018. The authors report that Africa has the third highest prevalence of urinary incontinence, with an estimated 40 million individuals on the continent affected by 2018. Shamliyan *et al.* (2009) reported that urinary incontinence was prevalent in 16 percent of white American men compared to 21 percent of African American men. They also reported that 11 percent of men with urinary incontinence were between the ages of 60 and 64 years old (Shamliyan *et al.*, 2009). Of these men with urinary incontinence, 30 percent to 47 percent reported daily urinary incontinence and 15 percent to 37 percent only experienced it weekly (Shamliyan *et al.*, 2009). Shamliyan *et al.* (2009) stated that 40 percent of the weekly incontinence reporters remained untreated and frustrated, whereas only 22 percent of the daily incontinence reporters sought medical attention.

1.1.4 Management of urinary incontinence

Sathianathen *et al.* (2017) discusses a study that defines a single pad weighing 72.1g of urine as incontinent. The study went on to discuss that if 72.1g of urine in a pad showed incontinence, then any pad that weighed less than that would be continent. Sathianathen *et al.* (2017) further discussed that another study done in California, defined continence as the use of 0-1 pad over 24 hours. Van Kampen *et al.* (2000), defined continence as less than 2g of urine on both the 1-hour pad test as well as the 24 hour pad test. According to Van Kampen *et al.* (2000), the 24-hour pad test is a better outcome measure compared to the 1-hour pad test. The reasoning is that the 1-hour pad test is not as sensitive to incontinence as the 24-hour pad test (Van Kampen *et al.*, 2000).

Overgård *et al.* (2008) used the patients' self-report on continence or incontinence as their primary outcome measure (Overgård *et al.*, 2008). The patients had to report on if they needed to use a pad or not. In their discussion the definition of continence and incontinence confused some of the patients, and therefore was not completely reliable (Overgård *et al.*, 2008). The definition of continence in various studies can be subject to bias, especially when collecting data via questionnaires (Sathianathen *et al.*, 2017). For the purpose of this study we defined fully continent as the use of zero pads per day (Basto *et al.*, 2014).

Urinary control is dependent on the co-ordination of the pelvic floor muscles (Santa Mina *et al.*, 2015). The male pelvic floor muscles are divided into a deep supportive layer (urogenital diaphragm) and a superficial layer (Dorey, 2005). Urinary incontinence post-prostatectomy is mainly caused by bladder dysfunction or sphincter insufficiency as a result of injury to the internal sphincter causing pressure on the wall of the bladder (Santa Mina *et al.*, 2015). The neurovascular bundle that supplies the bladder and urethral sphincter can also be compromised during any surgical procedure that involves removal of the prostate (Park *et al.*, 2018).

The role of pelvic floor exercises is to increase the strength of the muscles as well as to improve the co-ordination and timing for contraction when the intra-abdominal pressure has increased (Patel *et al.*, 2013). If the pelvic floor exercises are applied in the first six to 12 months of recovery (following prostatectomy surgery), the exercises can improve blood circulation as well as the muscle strength of the external sphincter (Marchiori *et al*., 2010). Kegel exercises are commonly recommended for conservative management of urinary incontinence following a prostatectomy (Park *et al.*, 2018). According to Patel *et al*. (2013) there are many studies that have shown that physiotherapist-guided pelvic floor exercises have been effective if administered correctly and started as early as less than six weeks post-operatively.

Robotic-assisted laparoscopic prostatectomy surgery was first done in May 2000 in Frankfurt, Germany, and since then there has been a steady increase in the number of urologists performing the RALP procedure internationally (Sharma, Shah and Neal, 2009). Evidence reports that the quality of life of patients who have undergone prostatectomy surgery progressively worsened after the first month of recovery, due to urinary incontinence (Marchiori *et al.*, 2010; Laurienzo *et al.*, 2013). This supports why evidence of the effectiveness of a pelvic floor rehabilitation programme for PPUI is necessary.

1.2 Problem Statement

Literature has shown that pelvic muscle floor training improves the function of the external urethral sphincter, especially when this muscle is contracted repeatedly (Nahon *et al.*, 2006).

However, this is not being recommended in practice. Nahon *et al*. (2006) reported that, medical doctors lean towards not asking about their patients' incontinence problems. The authors also reported that patients were also less likely to ask their medical doctors about their incontinence problems. According to Patel *et al*. (2013), urinary incontinence is prevalent in eight to 87 percent of patients at six months and five to 44 percent of patients at 12 months post-prostatectomy. No systematic review exists that focuses on current literature emphasising the role of pelvic floor rehabilitation in gaining continence post-RALP.

1.3 Research Question

Review questions:

- What are the effects of pelvic floor rehabilitation in treating patients with urinary incontinence post-RALP?
- Which pelvic floor rehabilitation is most effective in treating urinary incontinence post-RALP?

The following table represents the PICO (Population, Intervention, Comparator, Outcome) framework. It is used to develop questions for systematic reviews on effectiveness.

Table 1.1 PICO framework

Population	Men who have undergone RALP
Intervention of interest	Studies involving pelvic floor rehabilitation as treatment for post-RALP urinary incontinence.
Comparator	Men who did not have pelvic floor rehabilitation for post-RALP urinary incontinence.
Outcome	The effects of pelvic floor rehabilitation in treating patients with urinary incontinence post-RALP. The types of pelvic floor rehabilitation used for post-RALP urinary incontinence.

1.3.1 Aim of the study

This systematic review aims to review current literature to establish the effectiveness of pelvic floor rehabilitation as a conservative intervention in treating post-RALP incontinence.

1.3.2 Objectives of the study

1.3.2.1 To establish the effects of pelvic floor rehabilitation in treating patients with post-RALP urinary incontinence.

1.3.2.2 To establish the effects of the types of pelvic floor rehabilitation in treating patients with post-RALP incontinence.

1.3.3 Significance of the study

The findings of the review could help support the role and importance of pelvic floor rehabilitation in patients who have had a RALP. The evidence could help to guide clinicians on the need to involve a multidisciplinary team in order to help patients with post-prostatectomy complications and rehabilitation.

The study could contribute to the body of research in the fields of urology and physiotherapy for Africa as well as for other global regions. The findings of the research can help to motivate for courses that tertiary institutions can implement or teach to future clinicians at an early stage.

1.4 Organisation of the research report

Chapter 1: Introduction to the research topic is given in this chapter. This includes urinary incontinence as a result of RALP and the importance of rehabilitation of the pelvic floor. The problem statement is presented. The research questions, aim, objectives as well as the significance of the research report are outlined in this chapter.

Chapter 2: The literature review is presented in this chapter. The literature review includes the anatomy of the prostate and the pelvic floor, prevalence of prostate cancer, post-RALP urinary incontinence as well as pelvic floor rehabilitation.

Chapter 3: The methodology of the research report is outlined in this chapter. The study design, the study setting, participants, sample size and selection, inclusion and exclusion criteria as well as the instrumentation and outcome measures are presented in this chapter.

Chapter 4: The results and findings of the research report are presented in this chapter in a narrative form.

Chapter 5: The discussion of the main findings of the research report is presented here.

Chapter 6: The conclusion as well as recommendations for future research is discussed in this chapter.

Figure 1.1: Flow chart of the research report

Chapter 2 Literature Review

2.1 Introduction

This chapter reviews the current literature on the anatomy of the male pelvis in relation to the prostate and the impact that a prostatectomy has on the surrounding structures. The phenomena of non-invasive surgery, namely robot-assisted surgery, how it is performed, and the benefits of the surgery are also reviewed. Literature on the complication of urinary incontinence post-prostatectomy, as well as the rehabilitation focusing on the pelvic floor muscles in the recovery of continence is also discussed. The literature review also focuses on different types of urinary incontinence as a result of prostate surgery and the impact that urinary incontinence has on general quality of life.

The above evidence and literature were sourced from the following databases: PEDro, Cochrane Library, EBSCO Host Cumulative Index to Nursing and Allied Health Literature (CINAHL), MEDLINE via PubMed, ProQuest Health and Medical Complete, EBSCO Host Masterfile Premier, Science Direct, SCOPUS and SPORTDiscus.
Articles that were published in English and had the following keywords that were searched (between the years 2000 and 2018): male pelvis anatomy, prostate anatomy, pelvic floor, pelvic floor exercises, urinary incontinence, overactive bladder, recovery, rehabilitation, physiotherapy, physical therapy, robot-assisted, robotic surgery, da Vinci robot system, prostatectomy and prostate cancer.

2.2 Anatomy of the prostate

The largest male accessory gland is the human prostate (Lee, Akin-Olugbade and Kirschenbaum, 2011) (Figure 2.1). The prostate gland is important for male fertility and reproduction (Verze, Cai and Lorenzetti, 2016). The prostatic fluid that is contained in the prostate epithelium assists in activating the sperm and ejaculation (Verze, Cai and Lorenzetti, 2016). Two of the most prevalent diseases that affect aging men are benign prostatic hyperplasia and PCa, both of which originate in the prostate gland (Lee, Akin-Olugbade and Kirschenbaum, 2011). More than 90 percent of the cases of men diagnosed with PCa are confined to the organ (Sridhar *et al.*, 2017). With a mass of approximately 20 grams, a length of three centimeters, a depth of two centimeters and a width of four centimeters, a normal prostate gland can vary in size, especially as men get older (Muruve, 2013). The prostate gland is situated below the bladder, above the perineal gland, in front of the rectum and behind the pubic symphysis (Muruve, 2013). It lies in the subperitoneal compartment, that is between the pelvic diaphragm and the peritoneal cavity (Lee, Akin-Olugbade and Kirschenbaum, 2011). The prostate gland ends at the apex and then develops to become the external urethral sphincter. This external sphincter is a tubular sheath than runs vertically and surrounds the prostate and the urethra (Muruve, 2013). Proximal to and surrounding the urethra, the conical "wall-nut" shaped prostate gland is found upon the urethral exit of the bladder (Lee, Akin-Olugbade and Kirschenbaum, 2011).

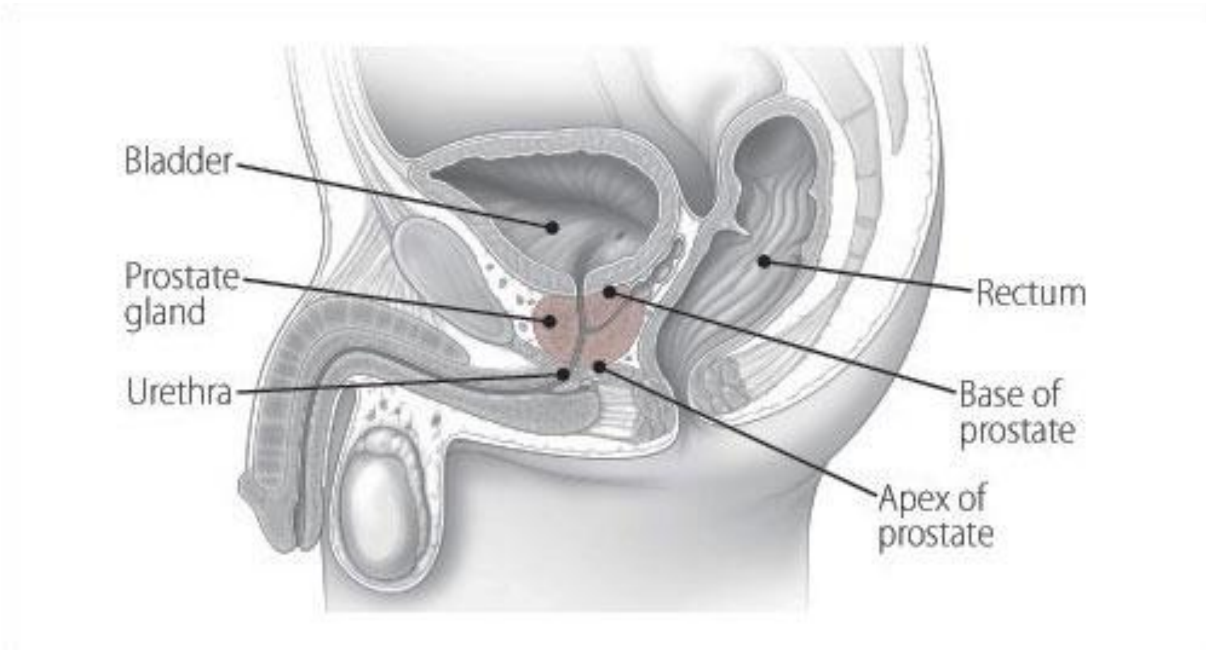

Figure 2.1: Location of the prostate gland (Harvard Health, 2011)

There are three zones (Figure 2.2) that make up and divide the prostate gland: the central zone, the transition zone and the peripheral zone. It has been reported that 70 percent of all prostate cancers arise from the peripheral zone. All of the zones have different origins when it comes to embryology. Any malignancy involves the relationship between its biological behaviour and histology grade 9 (Lee, Akin-Olugbade and Kirschenbaum, 2011). The Gleason grading system is used to grade the cancer by looking at the glandular architecture (Heyns and Van der Merwe, 2008). 10 to 12 tissue samples are collected via a transrectal ultrasound. The tissue samples are presented in a grid-like pattern and examined by a pathologist (Litwin and Tan, 2017). The grade of prostate cancer is dependent on the pattern of the cancer and its architecture as well as the how it is differentiated (Lee, Akin-Olugbade and Kirschenbaum, 2011). A good prognosis is a well differentiated cancer and poor prognosis is a poorly differentiated cancer (Heyns and Van der Merwe, 2008). The three options for treatment for localized PCa are radiation, watchful waiting and surgery (Litwin and Tan, 2017). Watchful waiting happens when the progression of the prostate cancer is monitored without definitive management (Litwin and Tan, 2017). Surgery or radiation is usually indicated when the PSA (Prostate-specific antigen) level is higher than 10ng/ml. If palpable nodules are present on digital rectal examination (DRE), then surgery and or radiation is also indicated (Litwin and Tan, 2017).

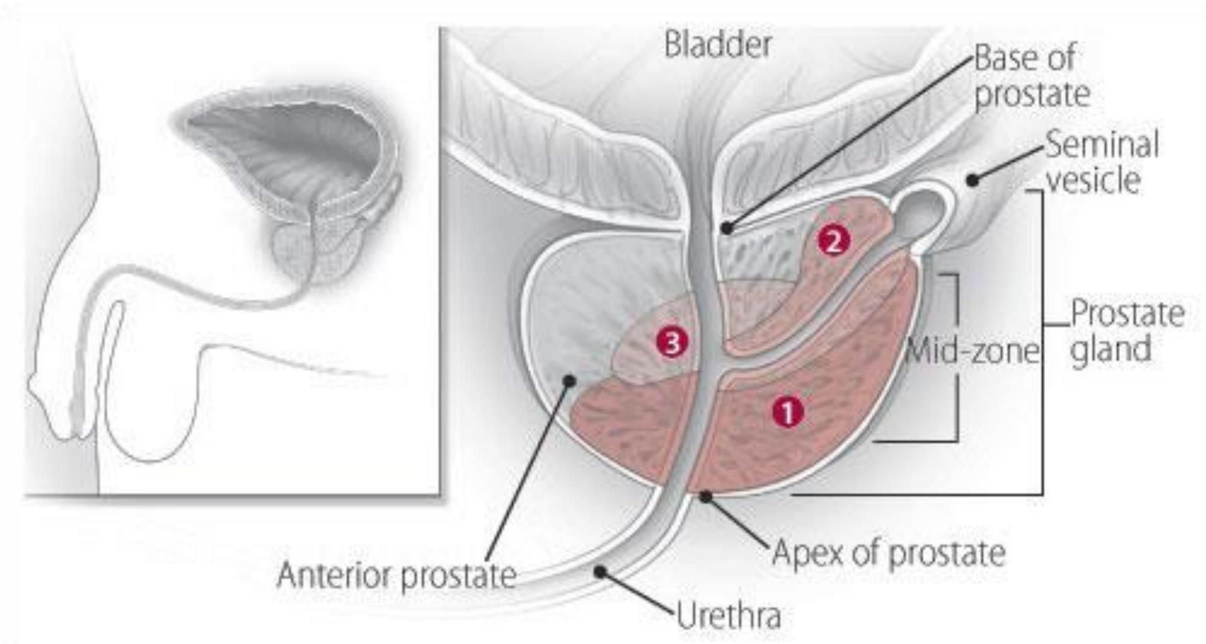

Figure 2.2: Zones of the prostate gland (Harvard Health, 2011)

1: Peripheral Zone

2: Central Zone.

3: Transition zone

Anteriorly, the prostate gland is held up by the puboprostatic ligaments. Inferiorly it is supported by the perineal membrane as well as the external urethral sphincter (Muruve, 2013). The puborectal part of the levator ani muscle, surrounds the prostate gland (Muruve, 2013). The inferior vesicle artery is the primary arterial supply of the prostate gland. It has two main branches, namely the urethral artery and the capsular artery. The former supplies adenomas found in benign prostatic hyperplasia, while the latter supplies glandular tissue (Muruve, 2013). The deep dorsal vein divides into the superficial branch as well as into left and right branches which all form part of the venous drainage system of the prostate gland, which are in communication with the internal iliac vein (Muruve, 2013). The pelvic plexuses give rise to the autonomic innervations of the prostate gland (Figure 2.3). The pelvic plexus is found next to the rectum and it is formed by parasympathetic fibers from levels S2 to S4 of the sacrum and sympathetic fibers that arise from thoracolumbar levels L1 to L2 (Muruve, 2013).

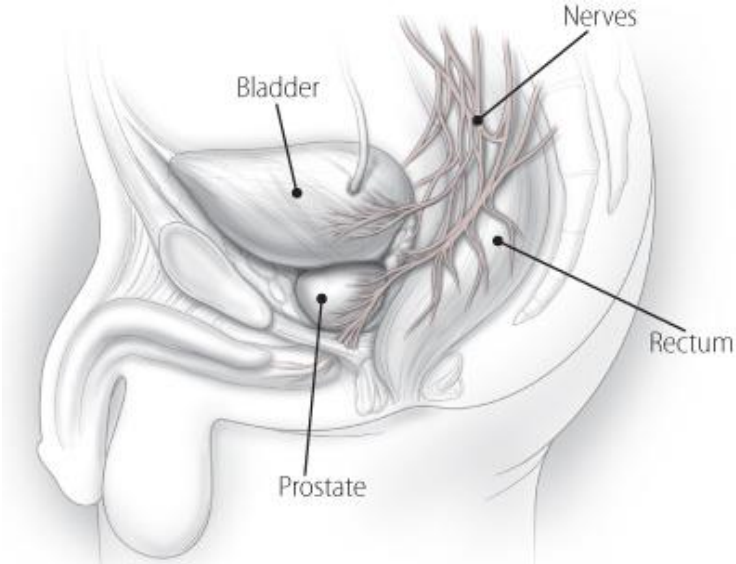

Figure 2.3: Nerve supply of the prostate (Harvard Health, 2009b)

2.3 Anatomy of the pelvic floor

There are two divisions of the pelvic floor muscles (Dorey, 2005) (Figure 2.4). The deep supportive layer is made up of the puborectalis, pubococcygeus, iliococcygeus and ischiococcygeus muscles as well as the external sphincter (Dorey, 2005). This deep layer makes up the pelvic diaphragm. The superficial layer includes the anal sphincter as well as the bulbocavernosus and the ischiocavernosus muscles (Dorey, 2005). One of the roles of the bulbocavernosus muscle is to help eject the remainder drops of urine from the urethra after urination (Dorey, 2005).

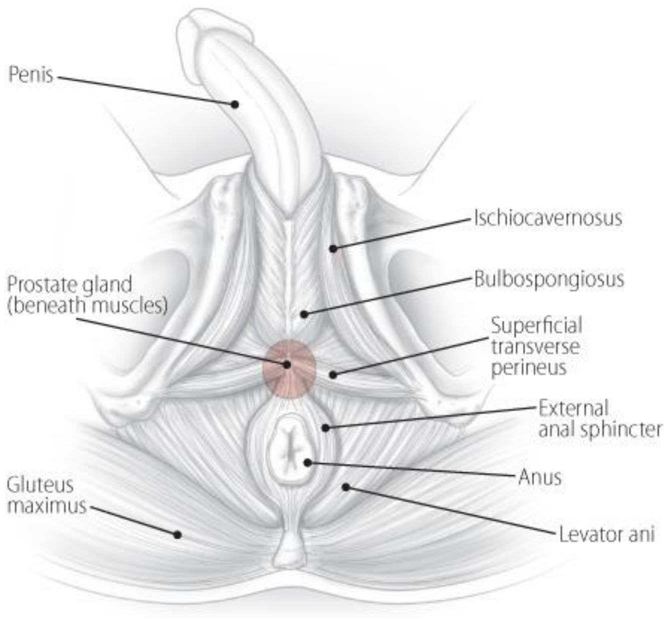

Figure 2.4: Male pelvic floor muscles (Harvard Health, 2009a)

The internal sphincter is important for closing the bladder (Dorey, 2005). It is mostly made up of smooth muscle fibers and its nerve supply is the hypogastric nerves. It assists with passive urinary incontinence, helping to prevent reverse ejaculation and thus closure of the bladder (Dorey, 2005). The external sphincter is made up of the rhabdosphincter (supplied by the pudendal nerve), which is an outer layer of striated muscle. The inferior hypogastric plexus supplies the inner smooth muscle layer. Active urinary continence is controlled by the external sphincter. Both of the sphincters and their nerve supply are at risk for injury during surgery (Sridhar *et al.*, 2017). The major nerve supply that innervates the striated sphincter and the levator ani muscle is the pudendal nerve (Muruve, 2013).

The central nervous system controls the movement of all trunk muscles along with the diaphragm especially when individuals are preforming respiratory and postural tasks (Zachovajevienė *et al.*, 2012). Intra-abdominal pressure is modulated through the coordination of the diaphragm and the abdominal and pelvic floor muscles. The combined function of the levator ani muscle along with the endopelvic fascia work together to maintain continence as well as to support the pelvic organs (Zachovajevienė *et al.*, 2012). The authors reported that pelvic floor muscle contractions include the coordination of the transversus adbominis, rectus adbominis and internal oblique muscles. In addition, elevation of the bladder neck happens when the pelvic floor muscles and the transversus abdominis muscle are contracted at the same time (Zachovajevienė *et al.*, 2012).

The bladder has to stretch in order to accommodate urine(Holroyd, 2015). The role of the bladder is to store urine and the normal capacity of the bladder is approximately 400–600mls in an adult. While the bladder is being filled, the detrusor muscle is at rest until capacity has been reached. At the same time, nerve impulses are sent to the brain in order to begin the phase of emptying the bladder (Holroyd, 2015). The urethra and sphincters remain closed during the phases of filling and storage of urine in the bladder. During these phases, the pelvic floor contracts in order to prevent leakage of urine. The pelvic floor remains contracted when there is increased intra-abdominal pressure when the individual is coughing, laughing, sneezing or performing a physical activity (Holroyd, 2015). When the emptying phase begins, the detrusor muscle begins to contract and at the same time the sphincters and the urethra open and the pelvic floor relaxes. There is intravesical pressure which increases and that results in the bladder emptying (Holroyd, 2015).

2.4 Prostate Cancer

In African American studies, African ancestry has shown to be important in identifying PCa risk (Hayes and Bornman, 2018). It has been reported that aggressive PCa phenotypes have been found within certain populations in Western, Eastern and Southern Africa (Tindall *et al.*, 2014). PCa is reported to be the second highest cause of cancer related death in Ghanaian men (Kyei *et al.*, 2013). The variations in PCa incidence and mortality rates in northern Africa and SSA have been attributed to differences in genetics, diet, infectious diseases as well as poverty (Adeloye *et al.*, 2016).

The prevalence of PCa increases with age and is one of the most common types of cancer affecting men (Aydın Sayılan and Özbaş, 2018). Presently, the three main risk factors of PCa include a positive family history, age and race (Leitzmann and Rohrmann, 2012). In the United States, the rates of PCa are 1.6 times higher in men who are African American compared to men who are Caucasian (Leitzmann and Rohrmann, 2012). In Caribbean and US studies black men have been found to have highest PCa incidence and poorest PCa prognosis (Jalloh, 2013).

Hayes & Bornman (2018) reported that the estimates for PCa incidence in Africa was 22.0 per 100 000. West and West-Central African countries had incidence rates that varied from 0.38 to 182.5 per 100 000. The incidence of PCa for South Africa (SA) is 61.7 per 100 000

(Cassell *et al.*, 2019). This is high compared to other African countries such as Nigeria (23.3 per 100 000). The development of PCa in an individual is slow and may take many years to develop into a disease which is clinically significant (Leitzmann and Rohrmann, 2012). The risk of death caused by PCa is at 3 percent, even though a lifetime risk of PCa development is at 42 percent for men who are 50 years old (Leitzmann and Rohrmann, 2012). Rebbeck *et al.* (2011) reported that the number of PCa related deaths in SSA would double in the next 20 years.

The clinical presentation of PCa is more advanced in SSA due to the lack of an adequate screening program (Jalloh, 2013). In the Western Cape of SA, white patients made up 28 percent of patients with metastatic cancer (Le Roux *et al.*, 2015). The authors reported that black men presented with a higher PSA and a more aggressive cancer than white or coloured men living in the Western Cape province of SA (Le Roux *et al.*, 2015). As a result of other health related challenges in Africa, PCa cases often present late where local invasion has occurred as well as metastasis (Adeloye *et al.*, 2016).

2.5 Screening and Diagnosis of Prostate Cancer

In 1987, the PSA test was introduced in the United States (US) (Hayes and Barry, 2014). It is a blood test which has shown to be affective in diagnosing PCa at an early stage. This could lead to treatment for PCa while it's still at a curative stage (Heidenreich *et al.*, 2001). Unfortunately there are instances where men present with advanced stages of the cancer including metastases and tumors due to non-routine screening of the PSA (Hou *et al.*, 2015). Prostate specific antigen screening as well as prostate biopsy are not easily available in African countries (Heyns *et al.*, 2011). 41 percent to 96 percent of black men in Africa present with locally advanced PCa. 16 percent to 59 percent present with metastatic PCa (Heyns *et al.*, 2011). Fortunately, in SA, screening is routinely practiced in medical care, compared to East and West Africa (Rebbeck *et al.*, 2011). Lack of funds as well as lack of data has resulted in limitations in clinical research on PCa in Africa (Adeloye *et al.*, 2016).

The PSA test has been named controversial as it can either be a beneficial diagnosis for men under the age of 50 years old or a negative diagnosis for men who are 69 years old and older (Hayes and Barry, 2014). 75 percent of men in the USA who were 50 years old and older had been screened for prostate cancer using the PSA test at least once in their lifetime by the year 2001 (Leitzmann and Rohrmann, 2012). In East Africa less men are screened for PCa, compared to the South and West Africa (Rebbeck *et al.*, 2011). Screening practices tend to be limited to men who have urinary symptoms, a family history of PCa and men who are older than 50 years old (Rebbeck *et al.*, 2011).

The PSA screening has shown an increase in diagnosis and treatment in men that are younger than 50 years old (Welch and Albertsen, 2009). In June 2013, a report by the Prostate Cancer Foundation of South Africa suggested that men who were older than 40 years old and had African ancestry needed to have routine PSA screening (Hayes and Bornman, 2018). Black South African men have been reported to present for PSA screening five years later than Americans on average (Hayes and Bornman, 2018). They also present three years earlier within SA, depending if they are part of an urban or rural population (Hayes and Bornman, 2018). Black South African men living in the rural communities of Gauteng and Limpopo province, were found to have higher PSA levels and higher stage and grade of PCa (Le Roux *et al.*, 2015). This was in comparison to African American men, done by the South African Prostate Cancer Study (SACPS) (Le Roux *et al.*, 2015).

A needle biopsy of prostate tissue or a systematic prostate biopsy via a transrectal ultrasound are two methods in which a pathologist obtains and evaluates samples for PCa diagnosis (Litwin and Tan, 2017). Rebbeck *et al*. (2011) reported that Digital Rectal Examination (DRE) is the most commonly used method of PCa detection in West Africa and SA, but less common in East Africa. East Africa commonly used free PSA to detect PCA. Most of the cases of PCa in SA were detected by screening, whereas in East and West Africa most of the PCa cases were detected by patient symptoms (Rebbeck *et al.*, 2011). Diseases such as human immunodeficiency virus and acquired immunodeficiency syndrome (HIV/AIDS), malaria and tuberculosis (TB) often overshadow the management of PCa in SA (Hayes and Bornman, 2018). South Africa, Kenya and Nigeria are the only countries where studies on the presentation of PCa in African countries have been done (Le Roux *et al.*, 2015). Adeloye *et al*. (2016) reported that many African countries do not have a cancer registry that is functional. This is according to the World Health Organisation (WHO), and that the registries that are available mainly focus on urban areas and not rural areas (Adeloye *et al.*, 2016).

The Gleason grading system is the most common system that is used to grade adenocarcinoma of the prostate (Heidenreich *et al.*, 2001). A biopsy and not a blood test, is required in order to assess the Gleason score (Heidenreich *et al.*, 2001). The system grades the growth and pattern of the tumor from grade 1 to grade 5. A grade 1 Gleason grade describes a tumor that has a pattern that is the least aggressive, while a grade 5 describes a tumor that has the most aggressive pattern. Grade 1 tumors are well differentiated, and grade 5 tumors are poorly differentiated. A combined score of the two most common tumor patterns is given. (Heidenreich *et al.*, 2001)

Staging of prostate cancer is based on the Union for International Cancer Control 2002 Tumour Node Metastasis classification: where “T” is the primary tumour, “N” involves the regional lymph nodes and “M” categorizes distant metastasis (Heidenreich *et al.*, 2001).

2.6 Robotic-assisted laparoscopic prostatectomy

Robotic prostatectomy has been the most accepted treatment for men with localized and advanced PCa (Sharma, Shah and Neal, 2009). The progression rates of the PSA over 10 years are around 30% post RP (Sharma, Shah and Neal, 2009). Robot-assisted laparoscopic and traditional laparoscopic surgical approaches are increasingly becoming the minimally invasive standard of care when it comes to urological abdomino-pelvic surgery (Kaplan *et al.*, 2016). The access to the robotic-assisted technology is very limited in Africa (Oyebamiji, 2020). Egypt and South Africa are the only African countries currently using surgical robots in practice (Oyebamiji, 2020).

In the late 1980’s a program in the US was developed in order to perform remote surgery, specifically to use in warzones (Sharma, Shah and Neal, 2009). In 1999, the da Vinci surgical system was launched by Intuitive Surgical (Sharma, Shah and Neal, 2009). In the year 2000, the system was approved for general laparoscopic surgery, after FDA (Food and Drug Administration) approval (Sharma, Shah and Neal, 2009). The da Vinci system robot has three or four operating arms which are connected to different surgical instruments. The system also has a console which is controlled by the surgeon in order to perform the surgery (Sharma, Shah and Neal, 2009). An important benefit of the da Vinci robot system is that it has up to 12 times magnification, seven degrees in the range and freedom of movement and has 3D (three-dimensional) vision (Sharma, Shah and Neal, 2009). In order to have adequate exposure of the pelvis, the Trendelenberg position is used during surgery (Kaplan *et al.*, 2016). The robotic-assisted prostatectomy can range between 6.5 and 9.9 hours long, with the patient in a steep Trendelenburg position (Kaplan *et al.*, 2016). There is a risk of compartment syndrome and peripheral nerve injury in this prolonged position. The da Vinci robot Xi system (Intuitive Surgical, Sunnyvale, CA) keeps the patient in a modified Trendelenberg position by using a boom that can adjust the angle (Kaplan *et al.*, 2016).

In May 2000, the first RALP was performed in Frankfurt, Germany (Sharma, Shah and Neal, 2009). In November 2004, the first RALP in the United Kingdom was performed at St Mary's Hospital in London (Sharma, Shah and Neal, 2009). The authors stated that at the time, there were 14 centres using the da Vinci robotic system and the United States had accounted for 70 percent of all radical prostatectomy cases for RALP. The robotic prostatectomy is a procedure that has had the widest uptake out of all procedures that fall under robotic surgeries (Hutchison, Johnson and Carter, 2016). As a result, the robotic prostatectomy rapidly gained momentum. In the United States of America more that 75 percent of prostatectomies are done robotically (Hutchison, Johnson and Carter, 2016). According to Hutchison *et al.* (2016), the surgeons prefer the RALP because of how it simplifies surgeries which would have been considered as challenging. The benefits include the surgeon being able to directly control the camera and surgical tool, compared to only relying on a surgical assistant (Hutchison, Johnson and Carter, 2016).

Even though the RALP is favourable and popular, many countries outside of North America are still predominantly performing laparoscopic prostatectomies. The high cost of the robotic technology is often a barrier (Willis *et al.*, 2012). In the year 2009, the da Vinci robot system cost £1.5 million with an additional £1300 for disposable instruments (Sharma, Shah and Neal, 2009). Willis *et al*. (2012) reported that there was an estimated 1344 da Vinci robotic systems installed in the USA compared to the 330 da Vinci robotic systems installed in Europe. There were also an estimated 166 robotic systems installed in other countries outside of Europe and USA (Willis *et al.*, 2012). In a recent study by Oyabamiji (2020), the author discussed challenges in having robotic surgery in Nigeria. One of the main challenges was the lack of constant power supply. Like other developing countries, Nigeria's power supply has been described as inadequate and unreliable which may result in damaging surgical robots (Oyabamiji, 2020).

Benefits of minimally invasive surgery include a shorter hospital stay, a shorter recovery period, a decrease in surgical complications and a decrease in the demand for narcotics (Kaplan *et al*., 2016). Often the benefits are as a result of increased surgical costs and the management of complications these non-invasive procedures is of utmost importance to guarantee their success (Kaplan *et al*., 2016). The robotic assistance technology has been described as having a steep learning curve which could give rise to significant consequences that affect the quality of life of a patient (Skolarus *et al*., 2012). Due to late presentation, treatment and management of PCa in Africa has been limited (Adeloye *et al.*, 2016). As more surgical robots are manufactured, the affordability, maintenance as well the acquisition of the surgical robot will gradually become more accessible to countries of low to middle income (Oyebamiji, 2020).

2.7 Post-Prostatectomy Urinary Incontinence

The International Continence Society (ICS), defines urinary incontinence as the loss of urine by accident or without intention (D'Ancona *et al.*, 2019). Stress urinary incontinence is defined as involuntary incontinence which occurs during some sort of physical activity which results in increased abdominal pressure on the bladder (D'Ancona *et al.*, 2019). Examples of activities that result in SUI include sneezing, coughing, laughing, lifting heavy items and running. Stress incontinence is common in men who have had surgery involving the prostate. It has also been reported that stress incontinence is common in patients with chest conditions which are chronic (D'Ancona *et al.*, 2019). Urge incontinence is different from stress incontinence as it is defined as the contraction of the bladder muscle which results in unintentional loss of urine (Holroyd, 2015). A sense of urgency usually accompanies this type of incontinence. Stress incontinence occurs when the nerve pathways involved in the micturition cycle are interrupted (Holroyd, 2015).

Kim *et al.*, (2019) reported that urinary incontinence frequently occurred as a complication in five to 20 percent of men post RP. It has been suggested that a RARP has better results when it comes to the early recovery of PPUI (Manley *et al.*, 2016). The post-surgical complication rates for a robot-assisted prostatectomy are at 7.8 percent (Kaplan *et al.*, 2016). Over time, it has been reported that post-prostatectomy incontinence to be 87 percent at 12 months (Sathianathen *et al.*, 2017). Arcila-Ruiz and Brucker (2018) reported that the rate of post RP incontinence ranges between 2.9 and 87 percent. Incontinence rates are dependent on several factors including the surgeon's experience, the surgical technique and patient specific factors (Arcila-Ruiz and Brucker, 2018). Sathianathen *et al.* (2017), reported that the inner smooth muscle sphincter as well as the outer skeletal muscle both become damaged as a result of a prostatectomy, which leads to PPUI. Arcila-Ruiz and Brucker (2018) reported that up to 88 percent of men who have post-prostatectomy incontinence had dysfunction of the external sphincter.

Post-prostatectomy incontinence can be caused as a result of a combination of both a bladder issue and or a bladder outlet issue (Arcila-Ruiz and Brucker, 2018). In men, the bladder outlet, which includes the internal and external sphincters, helps to maintain urinary continence (Arcila-Ruiz and Brucker, 2018). During surgery and when the prostate gland is removed, the bladder neck as well as the internal sphincter become altered. This results in the patient having an outlet mechanism that is reliant on the external sphincter for maintenance (Arcila-Ruiz and Brucker, 2018). Therefore, the insufficiency of the external sphincter function becomes the main cause of post-prostatectomy incontinence and bladder dysfunction (Arcila-Ruiz and Brucker, 2018). According to Muruve (2013), there are three mechanisms that control urinary continence. An intact bladder neck in coordination with an internal sphincter that is functioning, is the first mechanism. The second mechanism involves the smooth muscle of the urethral wall working together with the external urethral sphincter. Lastly, the levator ani muscle achieves the third mechanism of continence. Voluntary contraction of the levator ani muscle is how active continence is controlled (Muruve, 2013).

The maximum pressure between urethral and intravesical pressure is known as the Maximum urethral closure pressure (MUCP) as defined by the ICS (D'Ancona *et al.*, 2019). The changes that the external sphincter undergo is a result of the changes in MUCP because the closing pressure of the sphincters has been altered (post-prostatectomy), (Arcila-Ruiz and Brucker, 2018). Denervation of the somatic nervous fibers, which is damage to the nerves, can occur during surgery and contributes to the alteration of the function of the sphincters (Arcila-Ruiz and Brucker, 2018). The pelvic floor muscles and the striated urethral sphincter are innervated by the pudendal nerve branches which are very close to the area where the prostate gland is dissected (Arcila-Ruiz and Brucker, 2018).

Other causes of post-prostatectomy incontinence include an underactive detrusor muscle and a decrease in the compliance of the bladder (Arcila-Ruiz and Brucker, 2018). It has been reported that detrusor underactivity occurred in 28.6 percent of incontinent men and a decreased bladder compliance was reported in 18.4 percent of incontinent men post-surgically (Arcila-Ruiz and Brucker, 2018). Respectively, decreased bladder compliance as well as detrusor underactivity was reported in 20 percent of patients as pre-existing conditions (Arcila-Ruiz and Brucker, 2018). Symptoms of an overactive bladder have been reported in 77 percent of patients after RP in the first year (Arcila-Ruiz and Brucker, 2018). These symptoms usually spontaneously recover during the first year, (Arcila-Ruiz and Brucker, 2018). Overactive Urgency incontinence usually resolves with in eight months post-prostatectomy in majority of patients (Arcila-Ruiz and Brucker, 2018). Urge incontinence has little to do with the prostatectomy and is as a result of a bladder outlet obstruction (Arcila-Ruiz and Brucker, 2018).

Frequency of incontinence can be dependent on the quantity of the incontinence as well as the evaluation, whether it be the specialist or the patient who monitors the absence or presence of the incontinence, (MacHold *et al.*, 2009). Most treatments for urinary incontinence are aimed at specifically treating SUI (Arcila-Ruiz and Brucker, 2018). There are different options for therapy depending on the type of incontinence as well as the impact the incontinence has on the individual's quality of life (Arcila-Ruiz and Brucker, 2018). Pelvic floor muscle exercises, lifestyle modifications and medication prescription are considered to be conservative treatments for SUI (Arcila-Ruiz and Brucker, 2018). Surgical intervention is only considered if the conservative treatment fails (Arcila-Ruiz and Brucker, 2018).

2.8 Pelvic floor rehabilitation for urinary incontinence

As a result of injury to the internal sphincter and increased activity of the detrusor muscle, it is up to the pelvic floor muscles to support the external urethral sphincter (Santa Mina *et al.*, 2015). Therefore, it is important that pelvic floor muscles are strengthened in order to assist with activation of the external urethral sphincter (Santa Mina *et al.*, 2015). Pre-operative pelvic floor physiotherapy has shown to predict post-operative recovery of continence and therefore has become an important part of rehabilitation post-prostatectomy (Sathianathen *et al.*, 2017). Physical therapy treatment for pelvic floor muscle training prior to and post prostatectomy has shown to be beneficial in assisting patients to gain continence earlier (Arcila-Ruiz and Brucker, 2018).

The physiotherapy management approaches for urinary incontinence include pelvic floor muscle rehabilitation, electrical stimulation, lifestyle changes as well as biofeedback (MacHold *et al.*, 2009). These have shown excellent results in treating post-prostatectomy urinary incontinence (MacHold *et al.*, 2009). These methods are also beneficial as they are cost-effective and timesaving (MacHold *et al.*, 2009). The physical therapy assists with restoring the function of both the sphincter and the pelvic floor (Arcila-Ruiz and Brucker, 2018). It has been reported that if physical therapy is started between one and 17 years following a RP then there are less episodes of incontinence as a benefit (Arcila-Ruiz and Brucker, 2018).

The integrity of the urethral sphincter complex has been reported to affect the recovery of continence post-RP (Kim *et al.*, 2019). This complex is made up of the urethra and the structures which surround it (Kim *et al.*, 2019). The structures surrounding the urethra include the pelvic diaphragm, the supporting fascia and the rhabdosphincter (Kim *et al.*, 2019). The membranous urethral length and the pelvic diaphragm length have been thought to predict the return of continence (Kim *et al.*, 2019). Pelvic floor muscles work together in order to promote normal urinary control (Santa Mina *et al.*, 2015). Kegel exercises where introduced in the 1940s (Holroyd, 2015). They are pelvic floor exercises and considered as one of the most conservative methods in treating stress urinary incontinence (Holroyd, 2015). Some of the key benefits of pelvic floor exercises are that they are non-invasive, they are not costly, and they are safe to perform (Holroyd, 2015). The male pelvic floor has had less guidance and less evidence for the support of pelvic floor exercises when compared to the female pelvic floor (Holroyd, 2015). There was no reliable method in assessing the male pelvic floor before the year 1996 (Holroyd, 2015).

Holroyd *et al*. (2015) reported that a digital anal assessment tool was recommended in order to assess the male pelvic floor. This assessment ranged from 0-5, where 0 means there is no contraction and 5 means that there is an effective contraction or squeeze. An anal manometry was also advised as a reliable tool to measure pelvic floor muscle strength. Anal manometry is usually reserved and used by specialists (Holroyd, 2015). Nowadays, pelvic floor examination courses are traditionally aimed to equip physiotherapists, nurses and many other specialists who are working in the continence field (Holroyd, 2015). Currently, the recommendation for the physical assessment of the male pelvic floor is to have the individual in a supine position so that the anal wink, scrotal lift as well as penile retraction can be observed (Holroyd, 2015). Previously, the physical examination involved the individual being on their left side or left lateral, (Holroyd, 2015). Holroyd *et al*. (2015) reported that compliance is a common issue when it comes to the patients doing their pelvic floor exercises. The author reported that patients with poor compliance blame the technique and not being able to perform the pelvic floor exercises correctly. It is recommended that an internal DRE is important to assess the correct technique for the individual being able to perform pelvic floor muscle exercises (Holroyd, 2015).

Santa Mina *et al*. 2015 described a typical pelvic floor muscle activation instruction as trying to stop the flow of urine by "lifting up" the pelvic floor. Biofeedback is initially used to identify and correctly activate the pelvic floor muscles, thereafter the cueing, observation techniques and instructions are issued to the patients to perform the exercises routinely (Santa Mina *et al.*, 2015). Zachovajevienė *et al*. (2012) reported that the activation of the pelvic floor muscles involved the following three exercises: drawing in the navel (abdominal hollowing), abdominal bracing as well as abdominal bracing while the individual is holding their breath. Three sets of 10 repetitions per day of pelvic floor muscle exercises may be beneficial in improving continence following a prostatectomy (Arroyo Fernández *et al.*, 2015).

Conservative treatment is the first choice for treatment of urinary incontinence because most men regain continence within a year post-surgically (Arroyo Fernández *et al.*, 2015). When commenced as soon as possible after surgery, pelvic floor muscle exercises have shown to be affective in improving post-prostatectomy continence (Arroyo Fernández *et al.*, 2015).

2.9 Measurement of continence

Continence is considered as the use of one pad per day or defined as no pad use at all (Lee *et al.*, 2010). No pads, using a security pad or zero to one pad per day is a common definition of continence, following a RP (Arcila-Ruiz and Brucker, 2018). It has been reported that if there is a loss of less than two grams of urine in a 24hr pad test, then the individual is continent, as defined by some authors (Arcila-Ruiz and Brucker, 2018). When using no pad definition as a measurement, above 80 percent of men will gain urinary continence within a year postoperatively (Sridhar *et al.*, 2017).

Patient-reported questionnaires as well as physician interviews are some of the many methods that are used to obtain continence-related information from patients (Lee *et al.*, 2010). A subjective measure can be done by the physicians in a clinal setting, but often considered bias. Surgeons may also consider the seriousness of the incontinence to be of less importance than what the patients' feel (Lee *et al.*, 2010). Patient-reported questionnaires give an objective measure as well as reflection on the patients' perspective when it comes to their incontinence, even though the questionnaires rely heavily on patient compliance (Lee *et al.*, 2010).

The International Consultation of Incontinence Questionnaire -Short Form (ICIQ-SF) is a validated assessment tool for self-reported measures of SUI (Karmakar, Mostafa and Abdel-Fattah, 2017). It measures the severity and impact of urinary incontinence on the individual's quality of life, subjectively (Karmakar, Mostafa and Abdel-Fattah, 2017). This tool has been validated in both men and women who have been seeking treatment for SUI. It is widely used and is able to detect changes whether the individual had surgical or conservative treatment for urinary incontinence (Karmakar, Mostafa and Abdel-Fattah, 2017). Due to the effect that urinary incontinence has on a patient's quality of life, self-assessment questionnaires are important in evaluating the symptoms and severity (Karmakar, Mostafa and Abdel-Fattah, 2017). The ICIQ-SF has been awarded a "Grade A" status for the assessment of the quality of life and symptoms by the ICS's Consultation on Incontinence (Kurzawa *et al.*, 2018). The questionnaire fulfilled the evaluation criteria of being sensitive to change as well as valid and reliable (Kurzawa *et al.*, 2018). The ICIQ-SF is one of several questionnaires that measure urinary incontinence subjectively and is defined as a questionnaire that is incontinence specific (Kadono *et al.*, 2016). The ICIQ-SF is made up of six items (Karmakar, Mostafa and Abdel-Fattah, 2017). Four items, out of the six items, rate the urinary incontinence symptoms in the first four weeks (Karmakar, Mostafa and Abdel-Fattah, 2017). The scores of the first three instruments add up to give a total score that ranges from zero to 21 (Kurzawa *et al.*, 2018). The severity of the symptoms is asked in the first two questions, while the third question asks about the interference of the incontinence with the individual's daily life (Kurzawa *et al.*, 2018). The fourth evaluates the individual's perception when it comes to the cause of the incontinence (Kurzawa *et al.*, 2018). A high score in the questionnaire could either mean a high urinary incontinence severity or a low urinary incontinence quality of life (Kurzawa *et al.*, 2018).

Lee *et al*. (2010) confirmed in their study that the ICIQ-SF was affective in assessing urinary incontinence following a RALP. It is the preferred questionnaire by clinicians, as it measures both the frequency and volume of urinary incontinence as well as the impact that the incontinence has on daily life (Lee *et al.*, 2010). A tool that measures the quality of life for patients who have been diagnosed with localized PCa is the Expanded Prostate Cancer Index (EPIC) (Kadono *et al.*, 2016). Compared to the King's Health Questionnaire (KHQ), The Incontinence Impact Questionnaire (IIQ) and the Incontinence Quality of Life Questionnaire, the ICIQ-SF is widely available, and the scoring system is easy to use (Lee *et al.*, 2010).

Currently there is no standard measurement tool, to measure post-prostatectomy incontinence (Kadono *et al.*, 2016). It has been reported that daily count and use of incontinence pads seems to be the most convenient method (Kadono *et al.*, 2016). The 24hr-pad test is more desirable than pad weight test, which is more of an objective measure (Kadono *et al.*, 2016). The following categories have been used by previous authors in order to categorize post-prostatectomy incontinence: <100gm/24 hours as mild, 100-400gm/24 hours as moderate and

>400gm/24 hours as high-grade (Malik *et al.*, 2016). Kadono *et al.* (2016) reported that in their study, two patients leaked more urine in the 24-h pad test using pads daily, compared to those patients who did not use pads daily. The study also required patients to weigh their own pads at home, compared to previous studies that required patients to place their used pads in a sealed bag (to prevent evaporation) and then take it to their prospective clinics for testing and weighing. This seemed a complicated matter, as reported by Kadono *et al.* (2016).

Pad usage per day is often used by practitioners as an estimate of how severe the urinary incontinence is for the patient (Malik *et al.*, 2016). When compared to a variety of pad tests that range from 20-min to 24-hours, the 24-hour pad test has been reported to be superior in objectively measuring the quantity of urine loss (Malik *et al.*, 2016). It has been recommended by the ICS that the 24-hour pad test is completed without an activity that has been standardized (Malik *et al.*, 2016). Malik *et al.* (2016) evaluated 25 patients who had SUI post-RP. The participants had to submit their 24-hour pad weights with a survey that documented their level of activity as well as the number of pads that were used. Results of the study showed that there was a significant difference of the 24-hour pad weight leakage when there were changes in the level of activity of the participants. Therefore, the level of activity can be an important value in predicting the testing of the pad weight.

The cough test is considered as an alternative method of evaluating SUI (Price and Noblett, 2012). The benefit of the cough test is that the results are immediate, and it can be performed in the clinician's office in a single visit (Price and Noblett, 2012). The cough test is performed by the individual giving a forceful cough while having a full bladder and the urethra is watched for any leakage (Price and Noblett, 2012). Compared to the 24hr pad test, the cough test has been researched less and there is a limit when it comes to the effort of the individuals cough as well as the volume in their bladder (Price and Noblett, 2012).

The objective results of a 24-hour pad test can be different from the subjective results of urinary incontinence by interviewing the patient (Lee *et al.*, 2010). It is suggested by Kadono *et al.* (2016) that a combination of both objective and subjective measures of post-prostatectomy urinary incontinence should be evaluated in order to get the most desirable outcomes. The study reported that the ICIQ-SF is convenient, while the 24-h pad test evaluates the volume of incontinence. (Kadono *et al.*, 2016). For the purpose of the study, zero pads per day were defined as continent.

2.10 Conclusion

According to Adeloye *et al*. (2016), in SSA it has been reported that the disability adjusted life years (DALYs) from PCa were estimated to have increased from 100,200 to 219,700 between 1990 and 2010. Over the same period, the PCa mortality rates increased from 5,600 to 12,300 in SSA (Adeloye *et al.*, 2016).

The main complication following a robotic prostatectomy is urinary incontinence (Arcila-Ruiz and Brucker, 2018). Urinary incontinence has a role to play on the quality of life of the patient (Arcila-Ruiz and Brucker, 2018). The problem of losing bladder control is not only physical but can have psychological, economical and emotional impact (Arroyo Fernández *et al.*, 2015). Social distress, increased healthcare expenses as well as poor hygiene are some of the problems that affect people who have urinary incontinence (MacHold *et al.*, 2009). As a result of the negative impact to the quality of life of following a prostatectomy the number of patients seeking treatment for PPUI is increasing (Arcila-Ruiz and Brucker, 2018). According to Geraerts *et al.* (2013), pelvic floor muscle training has proven to be effective in regaining urinary continence sooner.

Currently there is no review that looks at the effectiveness of pelvic floor muscle rehabilitation in treating post-RALP incontinence, which is this aim of this study.

Chapter 3 Methodology

3.1 Introduction

This chapter focuses on the methods that were used to gather the information needed for the review and outlines the procedure used. The review utilized the Joanna Briggs Institute (JBI) protocol for Systematic reviews, which is discussed in more detail (JBI reference: project 15955).

3.2 Study Design

This is a systematic review of effectiveness, based on the JBI, which facilitated the entire systematic review process. This study included both experimental and non-experimental study designs. The reason for a systematic review was to analyze the available literature and to evaluate the effectiveness as expressed in the literature, as explained on the JBI website. JBI was utilized as a guideline in conducting reviews of effectiveness.

3.3 Study Setting

This review included all studies evaluating the effectiveness of pelvic floor rehabilitation on post-robotic-assisted laparoscopic urinary incontinence between the years 2000 and 2018. The studies ranged from a hospital setting, to a clinic setting as well as rehabilitation facilities. The study setting did not have an impact on the selection of articles, as the review had a small sample size.

3.4 Participants

3.4.1 Source of Participants

Studies were sourced from databases between 2000 and 2018. The databases searched are listed in the procedure.

3.4.2 Sample Size

The number of studies that met the inclusion criteria were 10.

3.4.3 Sample Selection

3.4.3.1 Inclusion Criteria

All studies that were published in English, between the year 2000 and 2018 were considered. The participants in the studies were men, older than 18 years of age, with localized prostate cancer, who had undergone a RALP and had received pelvic floor rehabilitation for urinary incontinence. The phenomena of interest included the types of urinary incontinence, types of pelvic floor rehabilitation and the type of prostatectomy specifically a robotic-assisted prostatectomy. Primary sources of literature such as original research articles, were included.

3.4.3.2 Exclusion Criteria

Studies that were excluded were studies that had participants who were younger than 18 years old, studies that had participants who had advanced prostate cancer (participants who did not have localized PCa), studies of men who had previous incontinence issues prior to surgery, studies that were not robotic-assisted laparoscopic radical prostatectomies (RALP or RARP) and studies that were not within the time frame of between 2000 to 2018. Systematic reviews were also excluded from the study because they are secondary sources of literature.

Refer to table of characteristics of included studies (Appendix VI and Appendix VII).

3.4.4 Study Selection

The JBI search strategy was utilised for the study selection. The first step was an initial search on PubMed. Secondly, Physiotherapy Evidence Database (PEDro), Cochrane Library, EBSCO Host Cumulative Index to Nursing and Allied Health Literature (CINAHL), MEDLINE via PubMed, ProQuest Health and Medical Complete, EBSCO Host Masterfile Premier, Science Direct, SCOPUS and SPORTDiscus databases were searched. The following keywords were searched: pelvic floor, robotic prostatectomy, levator ani, overactive bladder, complications, urinary incontinence, recovery, rehabilitation, physical therapy and physiotherapy. Figure 3.1 is a PRISMA flow diagram representing the search strategy and the outcome.

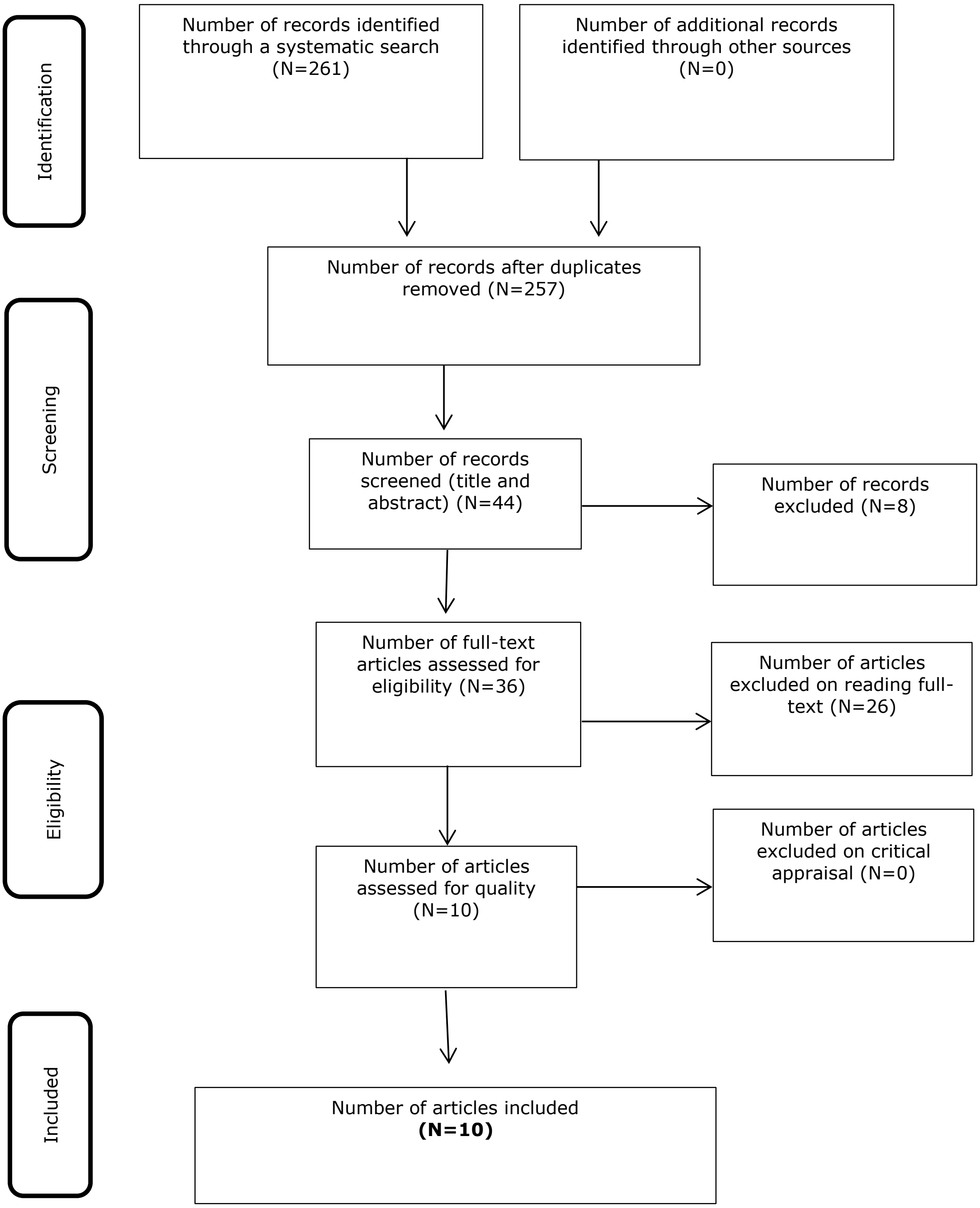

Figure 3.1: Search strategy and outcome. PRISMA flow diagram

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

3.5 Outcomes of interest

3.5.1 Types of outcome measures

The primary outcome of interest was the effectiveness (how quickly urinary continence is gained) of pelvic floor rehabilitation for urinary incontinence following a robotic-assisted laparoscopic prostatectomy (RALP).

The secondary outcome of interest included the types of pelvic floor rehabilitation used as treatment for post-prostatectomy (RALP) incontinence.

3.6 Procedure

3.6.1 Search Strategy

A three-step search strategy was used in this review (Joanna Briggs Institute for Systematic Reviews Protocol).

1. An initial search on PubMed was executed using the following keywords: pelvic floor, robotic prostatectomy, levator ani, overactive bladder, complications, urinary incontinence, recovery, rehabilitation, physical therapy and physiotherapy. This was followed by scanning the title, abstract and index terms used to describe the article.
2. A second search was executed using the identified keywords and index terms across all databases mentioned below.
3. A reference list of all identified reports and articles was searched for additional studies.

Articles that had been published from the year 2000 to 2018 in English were searched. The abstracts were looked at first.

The following databases were used for the search:

- Physiotherapy Evidence Database (PEDro)
- Cochrane Library
- EBSCO Host Cumulative Index to Nursing and Allied Health Literature (CINAHL)
- MEDLINE via PubMed, ProQuest Health and Medical Complete
- EBSCO Host Masterfile Premier
- Science Direct
- SCOPUS

- SPORTDiscus

The full text of the articles identified by the search were reviewed according to their title, abstract and description of the subjects. There were two types of studies that were included. These were cohort studies and randomized controlled trials (RCTs).

3.6.2 Assessment of methodological quality

A total of 36 studies met the inclusion criteria broadly. Out of the 36 studies, 10 studies met the inclusion criteria and were found to be sufficient. All of the 10 identified studies were assessed by two independent reviewers.

Methodological quality was assessed by critical appraisal using a standardized validated tool, namely the Joanna Briggs Institute (JBI) checklist the System for the Unified Management, Assessment and Review of Information (SUMARI) software (www.jbisumari.org). A summary of the software is represented in table 3.1.

Table 3.1: Description of JBI appraisal tool

Appraisal tool	**Description**
Study	The title for each study.
Author	The names of the authors each study.
Review questions	The two main questions of the review: 1. What are the effects of pelvic floor rehabilitation in treating patients with urinary incontinence post-RALP? 2. Which pelvic floor rehabilitation is most effective in treating urinary incontinence post-RALP?
Keywords	The keywords that were searched in the databases: complications; levator ani; overactive bladder; pelvic floor; physical therapy; physiotherapy; recovery; rehabilitation; robotic prostatectomy and urinary incontinence.
Participants	All studies that include men with urinary incontinence who have undergone RALP. Studies on men who are 18 years old and older with a diagnosis of localised prostate cancer.
Interventions	Pelvic floor rehabilitation.
Outcome measures	The objectives are the study: 1. The effectiveness of pelvic floor rehabilitation for post-RALP urinary incontinence.

	2. The types of pelvic floor rehabilitation used for treatment of post-RALP urinary incontinence.
Types of studies	All studies that fell within the inclusion criteria.
Methods	JBI SUMARI software utilised by two independent reviewers.
Search strategy	The JBI three-step search strategy that was used.
Information sources	The databases that were searched and listed.
Assessment of methodological quality	JBI critical appraisal tool that was utilised for the different types of studies that were included.
Data extraction	A standardized extraction tool (JBI SUMARI) that was utilised by two independent reviewers.
Data synthesis	The method in which the data was reported as well as the justification.

3.6.3 Data collection

A standardized extraction tool (JBI SUMARI) was used to minimize the risk of error when extracting data. The data extracted included details about the interventions, populations, study methods and outcomes. The JBI-SUMARI (System for the Unified Management, Assessment and Review of Information) software was utilized to facilitate the entire review process. The data that was extracted would show the similarities and the differences among the studies.

The two independent reviewers reviewed articles which would be included in the study. Each study was initially reviewed using a table (table 3.2) as a guideline to assist the reviewers meet the inclusion criteria.

Table 3.2: Inclusion criteria guideline checklist

Author:		**Reviewer:**		
Inclusion criteria		**Y**	**N**	**U**
Age: ≥ 18 years		☐	☐	☐
Medical diagnosis: Localised prostate cancer		☐	☐	☐
Study design	Randomized Control Trial	☐	☐	☐
	Cohort Study	☐	☐	☐
Surgical Intervention – RALP, RARP		☐	☐	☐
Intervention	Kegel exercises	☐	☐	☐
	Guided exercises	☐	☐	☐
	Biofeedback	☐	☐	☐
	Other	☐	☐	☐
Primary outcome measure – Time frame for recovery				
Secondary outcome measure – Type of pelvic floor exercise				

Once the articles were identified for critical appraisal, the JBI checklist was used to narrow the studies down to the 10 included studies. Depending on the type of study, the JBI checklist was used to assess the quality of each study (appendix I and appendix II). Any disagreements between the two reviewers were resolved through a discussion. Consultation with a third independent reviewer was not required.

3.6.4 Data synthesis

Information including the authors, the year of publication, the country where the study was set, the setting and or the context of the study, the participant characteristics, the groups, the outcome measures as well as the description of the main result was extracted. The studies were heterogenous in their methods and therefore a narrative form was used to represent the results found.

3.6.5 Statistical Analyses

Statistical pooling was not possible, due to the heterogeneity of the studies. The results of the findings of the studies were presented in a narrative form and tables were used to represent the findings. There were two groups of studies found: two randomised controlled trials (table 4.2) and eight cohort studies (table 4.3). These results are discussed in more detail, in chapter 4.

3.7 Ethical Considerations

An ethical clearance waiver was not necessary according to the University of Witwatersrand's Human Research Ethics Committee (HREC) (https://www.wits.ac.za/media/wits-university/research/documents/HREC(Med)ClearanceProcedures.pdf). This was because no human participants were involved in this study. "If no ethics approval (human or animal) is required, this will be recorded at the protocol assessors meeting. In instances where a journal requires an ethics waiver certificate for publication of research, the HREC Chair can be approached to issue an ethics waiver certificate." – University of Witwatersrand's Human Research Ethics Committee.

3.8 Conclusion of methodology

In this chapter this systematic review's study design, study setting, participants, sample selection including the inclusion and exclusion criteria has been presented. The methodology has been discussed which included the procedure, the methodological assessment of the quality of the studies, the data collection and synthesis as well as the statistical analysis. The results are presented in chapter 4.

Chapter 4 Results

4.1 Introduction

The results of the review are represented in this chapter. The results are presented in a narrative form because the studies were heterogenous and statistical pooling was not indicated. Tables and figures have been included to represent the findings. This chapter discusses the setting, sample, participants, outcome measures as well as the quality of the studies that were assessed.

4.2 Description of studies

There was a total of 36 studies that were identified and of which 26 were excluded from the study. The excluded studies are represented in appendix V as well as table 4.1. There were 10 excluded studies that were systematic reviews and meta-analyses. There were six excluded studies that did not include the main surgical intervention which was a robotic prostatectomy. There were six excluded studies that did not include pelvic floor rehabilitation as part of their intervention. There was one excluded study that was a study protocol and another excluded study was as pilot study. There was one study that was excluded because it only measured the receipt of PFMT. There was one study did that not measure urinary incontinence and was therefore also excluded.

Table 4.1: Excluded studies

Authors	Title	Reason for exclusion
Ahmed MT, Mohammed AH, Amansour A. (2012)	Effect of Pelvic Floor Electrical Stimulation and Biofeedback on the Recovery of Urinary Continence after Radical Prostatectomy	Does not include robotic prostatectomies.
Arroyo Fernández R, García-Hermoso A, Solera-Martínez M, Martín Correa MT, Ferri Morales A, Martínez-Vizcaíno V. (2015)	Improvement of Continence Rate with Pelvic Floor Muscle Training Post- Prostatectomy: A Meta-Analysis of Randomized Controlled Trials	A meta-analysis and does not include robotic prostatectomies.
Eaton K. MOJ Yoga & Physical Therapy. (2016)	Benefits of Pelvic Floor Rehabilitation for Urinary Incontinence after Prostatectomy: A Review of the Literature	A literature review.

Garg T, Young AJ, Kost KA, Park AM, Danella JF, Kirchner HL. (2017)	Patient-reported quality of life recovery curves after robotic prostatectomy are similar across body mass index categories	Does not include pelvic floor rehabilitation.
Goonewardene SS, Gillatt D, Persad R. (2018)	A systematic review of PFE pre-prostatectomy	A systematic review.
Haga N, Ogawa S, Yabe M, Akaihata H, Hata J, Sato Y, *et al*. (2015)	Factors Contributing to Early Recovery of Urinary Continence Analyzed by Pre- and Postoperative Pelvic Anatomical Features at Robot-Assisted Laparoscopic Radical Prostatectomy	Does not include pelvic floor rehabilitation.
Hirschhorn AD, Kolt GS, Brooks AJ. (2014)	A multicomponent theory-based intervention improves uptake of pelvic floor muscle training before radical prostatectomy: a 'before and after' cohort study	Measures receipt of PFMT only.
Hou GL, Luo Y, Di JM, Lu L, Yang Y, Pang J, *et al.,* (2015)	Predictors of Urinary Continence Recovery after Modified Radical Prostatectomy for Clinically High-Risk Prostate Cancer	Does not include robotic prostatectomies.
Hsu LF, Liao YM, Lai FC, Tsai PS. (2016)	Beneficial effects of biofeedback-assisted pelvic floor muscle training in patients with urinary incontinence after radical prostatectomy: A systematic review and meta-analysis	A systematic review and meta-analysis.
Jafri SM, Nguyen LN, Sirls LT. (2018)	Recovery of urinary function after robotic-assisted laparoscopic prostatectomy versus radical perineal prostatectomy for early-stage prostate cancer	Does not include pelvic floor rehabilitation.
Kaplan JR, Lee Z, Eun DD, Reese AC. (2016)	Complications of Minimally Invasive Surgery and Their Management	A literature review.
Kim M, Park M, Shim M, Choi SK, Lee SM, Lee ES, *et al*. (2016)	Effect of preoperative urodynamic detrusor overactivity on post-prostatectomy incontinence: a systematic review and meta-analysis	A systematic review.
Lee SR, Kim HW, Lee JW, Jeong WJ, Rha KH, Kim JH. (2010)	Discrepancies in Perception of Urinary Incontinence between Patient and Physician after Robotic Radical Prostatectomy	Does not include pelvic floor rehabilitation.
Lin YH, Yang MS, Chia-Hsiang Lin V, Yu TJ, Chiang PH. (2011)	The effectiveness of pelvic floor exercise on urinary incontinence in radical prostatectomy patients	Does not include robotic prostatectomies.

MacDonald R, Fink HA, Huckabay C, Monga M, Wilt TJ. (2007)	Pelvic floor muscle training to improve urinary incontinence after radical prostatectomy: a systematic review of effectiveness	A systematic review.
Manley L, Gibson L, Papa N, Beharry BK, Johnson L, Lawrentschuk N, *et al.* (2016)	Evaluation of pelvic floor muscle strength before and after robotic-assisted radical prostatectomy and early outcomes on urinary continence	A pilot study.
Milios J, Atkinson C, Naylor L, Millar D, Thijssen D, Ackland T, *et al.* (2018)	Pelvic floor muscle assessment in men post prostatectomy: comparing digital rectal examination and real-time ultrasound approaches	Does not include robotic prostatectomies.
Neumann P, Fuller A, Sutherland P. (2015)	Verbal pelvic floor muscle instructions pre-prostate surgery assessed by transperineal ultrasound: Do men get it?	Does not measure or include urinary incontinence.
Peyromaure M, Ravery V, Boccon-Gibod L. (2002)	The management of stress urinary incontinence after radical prostatectomy	Does not include robotic prostatectomies
Rebuck DA, Haywood S, McDermott K, Perry KT, Nadler RB. (2011)	What is the long-term relevance of clinically detected postoperative anastomotic urine leakage after robotic-assisted laparoscopic prostatectomy?	Does not include pelvic floor rehabilitation.
Santa Mina D, Au D, Alibhai SM., Jamnicky L, Faghani N, Hilton WJ, *et al.* (2015)	A pilot randomized trial of conventional versus advanced pelvic floor exercises to treat urinary incontinence after radical prostatectomy: a study protocol	A study protocol.
Schroeck FR, Krupski TL, Sun L, Albala DM, Price MM, Polascik TJ, *et al.* (2012)	Systematic Review and Meta-analysis of Studies Reporting Urinary Continence Recovery After Robot-assisted Radical Prostatectomy	A systematic review.
Skolarus TA, Weizer AZ, Hedgepeth RC, He C, Wood DP, Hollenbeck BK. (2012)	Understanding Early Functional Recovery After Robotic Prostatectomy	Does not include pelvic floor rehabilitation.
Sridhar AN, Abozaid M, Rajan P, Sooriakumaran P, Shaw G, Nathan S, *et al.* (2017)	Surgical Techniques to Optimize Early Urinary Continence Recovery Post Robot Assisted Radical Prostatectomy for Prostate Cancer	A literature review.
Tienforti D, Sacco E, Marangi F, Addessi AD, Racioppi M, Gulino G, *et al.* (2012)	Efficacy of an assisted low-intensity programme of perioperative pelvic floor	Does not include robotic prostatectomies.

	muscle training in improving the recovery of continence after radical prostatectomy.	
Wang W, Huang QM, Liu FP, Mao QQ. (2014)	Effectiveness of preoperative pelvic floor muscle training for urinary incontinence after radical prostatectomy: a meta-analysis	A meta-analysis

After critical appraisal by two independent reviewers, a total of 10 studies fell within the inclusion criteria. There were two studies that were randomized controlled trials. These were studies where participants had been randomly assigned to a control group or an experimental group. There were eight studies which were cohort studies. Cohort study designs look at similar characteristics over a certain period of time.

Most of the studies were done in a hospital setting. There was one study which occurred in a rehabilitation facility (Palisaar *et al.*, 2015). Another study (Mungovan *et al.*, 2013) did an observational study at a urological cancer centre.

Out of the 10 studies that were included in this review, four were from Australia (Mungovan *et al.*, 2013; Basto *et al.*, 2014; Sathianathen *et al.*, 2017; Neumann and O'Callaghan, 2018), one was from the United States of America (Kumar *et al.*, 2015), one was from Germany (Palisaar *et al.*, 2015), one was from South Korea (Ku *et al.*, 2017), one was from Ireland (Nason *et al.*, 2017), one was from Belguim (Geraerts *et al.*, 2013) and one was from Turkey (Aydın Sayılan and Özbaş, 2018).

Table 4.2: Included studies

Authors	**Title**	**Type of study**	**Country**	**Setting**
Aydın Sayılan A, Özbaş A. 2018.	The Effect of Pelvic Floor Muscle Training On Incontinence Problems After Radical Prostatectomy	Randomized controlled trial	Turkey	Hospital: Dr Sadi Konuk Training and Research Hospital
Geraerts I, Van Poppel H, Devoogdt N, Joniau S, Van Cleynenbreugel B, De Groef A, *et al.* (2013).	Influence of Preoperative and Postoperative Pelvic Floor Muscle Training (PFMT) Compared with	Randomized controlled trial	Belgium	Hospital: University Hospitals Leuven

	Postoperative PFMT on Urinary Incontinence After Radical Prostatectomy: A Randomized Controlled Trial			
Basto MY, Vidyasagar C, Te Marvelde L, Freeborn H, Birch E, Landau A, *et al*. (2014).	Early urinary continence recovery after robot-assisted radical prostatectomy in older Australian men	Cohort study	Australia	Three hospitals: Peter MacCallum Cancer Centre, Epworth Healthcare and Cabrini hospital
Ku JY, Lee CH, Lee JZ, Ha HK. (2017).	Comparison of functional outcomes between laparoscopic radical prostatectomy and robot-assisted laparoscopic radical prostatectomy: a propensity score-matched comparison study	Cohort study	South Korea	Hospital: Pusan National University Hospital
Kumar A, Samavedi S, Bates AS, Coelho RF, Rocco B, Palmer K, *et al*. (2015).	Continence outcomes of robot-assisted radical prostatectomy in patients with adverse urinary continence risk factors	Cohort study	United States of America	Hospital: Global Robotics Institute, Florida Hospital Celebration Health
Mungovan SF, Huijbers BP, Hirschhorn AD, Patel MI. (2013)	Relationships between perioperative physical activity and urinary incontinence after radical prostatectomy: an observational study	Cohort study	Australia	Urological centre
Nason GJ, O'Kelly F, White S, Dunne E, Smyth GP, Power RE. (2017)	Patient reported functional outcomes following robotic-assisted (RARP), laparoscopic (LRP), and open radical prostatectomies (ORP)	Cohort study	Ireland	Hospitals: Beaumont Hospital and Mater Private Hospital
Neumann PB, O'Callaghan M. (2018)	The Role of Preoperative Puborectal Muscle	Cohort study	Australia	Data extracted from South Australian Prostate

	Function Assessed by Transperineal Ultrasound in Urinary Continence Outcomes at 3, 6, and 12 Months After Robotic-Assisted Radical Prostatectomy			Cancer Clinical Outcome Collaborative database.
Palisaar JR, Roghmann F, Brock M, Löppenberg B, Noldus J, von Bodman C. (2015)	Predictors of short-term recovery of urinary continence after radical prostatectomy	Cohort study	Germany	Hospital: Maarien Hospital
Sathianathen NJ, Johnson L, Bolton D, Lawrentschuk NL. (2017)	An objective measurement of urinary continence recovery with pelvic floor physiotherapy following robotic assisted radical prostatectomy	Cohort study	Australia	Peter MacCallum Cancer Centre Olivia Newton-John Cancer Research Institute

4.3 Methodological quality

The quality of the literature was assessed using the JBI SUMARI checklist depending on the type of studies that were found. The studies that were included were: cohort studies and randomized controlled trials (RCTs). Two studies (Geraerts *et al.*, 2013; Aydın Sayılan and Özbaş, 2018) reported on findings of a single randomised controlled trial (Table 4.8). Eight studies were cohort studies (Table 4.9). They were each scored according to the JBI checklist for cohort studies.

Table 4.3 represents the JBI critical appraisal scores for the methodological qualities of RCTs and cohort studies. Geraerts *et al* (2013) scored 12/13 and Aydın Sayılan and Özbaş (2018) scored 8/13. One article (Kumar *et al.*, 2015) scored 11/11. Two studies (Ku *et al.*, 2017; Neumann and O'Callaghan, 2018) scored 10/11. Four cohort studies (Mungovan *et al.*, 2013; Basto *et al.*, 2014; Palisaar *et al.*, 2015; Sathianathen *et al.*, 2017) scored 9/11 on the checklist. One study (Nason *et al.*, 2017) scored 8/11.

Table 4.3: Critical appraisal scores

Authors	**Study type**	**JBI critical appraisal checklist score**
Aydın Sayılan A, Özbaş A. (2018)	Randomized controlled trial	8/13
Geraerts I, Van Poppel H, Devoogdt N, Joniau S, Van Cleynenbreugel B, De Groef A, *et al.*, (2013)	Randomized controlled trial	12/13
Basto MY, Vidyasagar C, Te Marvelde L, Freeborn H, Birch E, Landau A, *et al.,* (2014)	Cohort study	9/11
Ku JY, Lee CH, Lee JZ, Ha HK. (2017)	Cohort study	10/11
Kumar A, Samavedi S, Bates AS, Coelho RF, Rocco B, Palmer K, *et al.,* (2015)	Cohort study	11/11
Mungovan SF, Huijbers BP, Hirschhorn AD, Patel MI. (2013)	Cohort study	9/11
Nason GJ, O'Kelly F, White S, Dunne E, Smyth GP, Power RE. (2017)	Cohort study	8/11
Neumann PB, O'Callaghan M. (2018)	Cohort study	10/11
Palisaar JR, Roghmann F, Brock M, Löppenberg B, Noldus J, von Bodman C. (2015)	Cohort study	9/11
Sathianathen NJ, Johnson L, Bolton D, Lawrentschuk NL. (2017)	Cohort study	9/11

4.4 Sample

The total number of men included in the study was 3423 across all 10 studies. The cohort studies' found their samples through databases that ranged from January 2008 to July 2016. Mungovan *et al.* (2013) recruited their patients at a urological cancer centre in Australia. The randomized control trial of Aydın Sayılan and Özbaş (2018) used Russ G-Power analysis software to calculate the sample size before the experimental study was conducted. Geraerts *et al.* (2013) recruited their participants at an out-patients urology clinic in Belgium.

4.5 Participants

The most important patient characteristic was the patients' surgical procedure. The participants of the studies were men who had either undergone or were undergoing robotic assisted surgery for a prostatectomy for localised PCa. The men were also being treated for urinary incontinence using pelvic floor rehabilitation.

Basto *et al.* (2014) categorized their participants according to their age. The participants were divided into a 70 years old and older group and a 70 years old and younger group. The younger group was assessed because they had no comorbidities and were not having a salvage prostatectomy. Sathianathen *et al.* (2017) had a median age of 63.4 years old.
Nason *et al.* (2017) had a median age of 61.3 years old. Aydın Sayılan and Özbaş (2018) had a mean age of 63 ± 8.61 years old in the experimental group and 59.93 ± 6.98 years old in the control group.

4.6 Interventions

Pelvic floor rehabilitation for urinary incontinence following a robotic-assisted prostatectomy was the main intervention assessed. There were five studies that had pelvic floor muscle rehabilitation perioperatively. The study by Mungovan *et al.* (2013) looked at a pelvic floor muscle training program that was issued and assessed by three men's health physiotherapists. The program began preoperatively at a urological cancer centre. The program included education as well as supervised activation and contraction of the pelvic floor (in functional positions). The patients were guided on the importance of practicing the contractions during activities of daily living. Real time ultrasound was used to supervise the contractions of the pelvic floor. Routine physiotherapy consultations continued post-operatively upon follow-up.

In a study by Santhianathen *et al.* (2017), pre-operative pelvic floor rehabilitation was started two to three weeks pre-RALP. The rehabilitation included education on anatomy of the pelvic floor. Ultrasound was used for demonstration as well as a digital rectal exam for contracting the pelvic floor muscles. Post-RALP included refining the pelvic floor muscles exercises that were given preoperatively as well as re-education if needed.

Geraerts *et al.* (2013) conducted a randomized control trial which included 31 patients in the experimental group and 33 patients in the control group. The experimental group began pelvic floor muscle training (PFMT) three weeks before surgery and continued post-surgically. The control group started PFMT after surgery once the catheter was removed. Electromyography (EMG) biofeedback was used by the therapist to control the exercises of the pelvic floor as part of the PFMT program. The experimental group was also issued with a home exercise program which included up to 60 repetitions of pelvic floor muscle contractions per day while sitting and standing from a chair as well as with coughing. In the study by Kumar *et al.* (2015) the urinary catheter was removed four to five days postoperatively. Kegel exercises were given to the patients to perform preoperatively as well as post-operatively until continence was achieved.

In the study by Aydın Sayılan and Özbaş (2018) the experimental group had to do pelvic floor muscle exercises (PFME) and or Kegel exercises three times a day for six months. No exercises were given to the control group. Training started preoperatively where the men had both supervised and unsupervised contractions of the pelvic floor muscles in various functional positions. The physiotherapy training program included general physical activity as well as PFME. Feedback was given using real-time transabdominal ultrasound imaging. This was performed at approximately one cm above the bladder to assess the strength of the contraction of the pelvic floor muscle. Training began one week before surgery, on the day of hospitalization, one and two days postoperatively and 10 days postoperatively once the urinary catheter was removed.

There were three studies where the participants had only post-operative pelvic floor rehabilitation. Ku *et al.* (2017) had participants which began pelvic floor muscle exercises after the catheter was removed. The pelvic floor exercises where guided by a nurse who was assisted by a physician, they were also individually taught and reviewed once weekly until continence was gained.

In the study by Palisaar *et al.* (2015) all the patients began pelvic floor exercises on day two post-surgically. This was while the individuals were still in hospital and the exercises were supervised by a professional. Upon discharge the participants attended an acute rehabilitation facility for further rehabilitation. Rehabilitation began within two weeks postoperatively and lasted for three weeks. At the facility, they had routine individual pelvic floor rehabilitation guided by a physiotherapist twice daily. For some selected cases, both electrical stimulation as well as biofeedback were offered. Meanwhile in the study by Nason *et al.* (2017) on day one postoperatively, the patients were encouraged to mobilize until they were mobilizing independently upon discharge. Pelvic floor exercises, specifically Kegel exercises, were taught to the patients by both a prostate cancer nurse specialist as well as a pelvic floor physiotherapist. Education was included.

There were two studies which included participants that only had pre-operative pelvic floor muscle rehabilitation. In the study by Neuman and O'Callaghan (2018) bladder neck (BN) displacement was assessed preoperatively during physiotherapy, which included education on the functional anatomy of the pelvic floor. Standard pelvic floor exercises were issued to the men, with the instructions of contacting their pelvic floor muscles in order to stop the flow urine. These exercises where performed in sitting and standing positions. Patients had to maintain their contraction while breathing and were instructed to be aware of the retraction of the penis as well as contraction of the anal sphincter and elevation of the testicles.

In the study by Basto *et al.* (2014), the participants were referred to a physiotherapist who specialized in the pelvic floor. Each man participated in the training prior to surgery.

Table 4.4: Summary of the findings

Authors	**Study type**	**Intervention type**	**Intervention period**	**Outcomes used**
Aydın Sayılan A, Özbaş A. (2018)	Randomized controlled trial	Kegel exercises	6 months.	Incontinence diagnosis questionnaire. Incontinence assessment scale. ICOQ-UI. Self-reports on incontinence. Number of pads used.
Geraerts I, Van Poppel H, Devoogdt N, Joniau S, Van	Randomized controlled trial	PFMT	12 months.	24-h pad test. 1-h pad test. KHQ. IPSS.

Cleynenbreugel B, De Groef A, *et al.* (2013)				
Basto MY, Vidyasagar C, Te Marvelde L, Freeborn H, Birch E, Landau A, *et al.* (2014)	Cohort study	PFMT	May 2008 – September 2012.	Pads/day.
Ku JY, Lee CH, Lee JZ, Ha HK. (2017)	Cohort study	PFME	September 2008 – January 2016.	IPSS. 24-h pad test.
Kumar A, Samavedi S, Bates AS, Coelho RF, Rocco B, Palmer K, *et al.* (2015)	Cohort study	Kegel exercises	January 2008 – November 2012	EPIC. Questionnaires via telephonic interviews.
Mungovan SF, Huijbers BP, Hirschhorn AD, Patel MI. (2013)	Cohort study	Pelvic floor muscle strengthening. Physical activity prescription.	December 2011- May 2012.	IPAQ. SenseWear Pro3 Armband. 24-hour pad test. ICIQ-SF.
Nason GJ, O'Kelly F, White S, Dunne E, Smyth GP, Power RE. (2017)	Cohort study	Kegel exercises Education	3 years	IPSS Self-reported questionnaire on number of pads used per day.
Neumann PB, O'Callaghan M. (2018)	Cohort study	PFMT Education Ultrasound	3 years	Ultrasound EPIC
Palisaar JR, Roghmann F, Brock M, Löppenberg B, Noldus J, von Bodman C. (2015)	Cohort study	PFMT Biofeedback Electrical stimulation	3 – 6 weeks	24-hour pad test
Sathianathen NJ, Johnson L, Bolton D, Lawrentschuk NL. (2017)	Cohort study	PFE Education Ultrasound	January 2013 – July 2016	24-hour pad test. Ultrasound

4.7 Measurement of incontinence

Seven of the studies measured urinary incontinence using pads per day, 24 hour pad test, questionnaires or a combination of both. In the study by Basto *et al.* (2014) pad usage was used for questionnaires in order to measure the incontinence. Urinary continence was measured as pads/day. Fully continent was defined as zero pads per day. Patients were evaluated postoperatively at four to six weeks as well as three months, six months, nine months and at 12 months.

The study by Sathianathan *et al*. (2017) the weight of the pad (four weeks post-operatively) was recorded in a diary over 24-hours. This involved subtracting the dry pads in order to measure the urine weight. The average pad weight was determined by the amount of urine leakage over 24 hours during the week. Continence was defined as zero millilitres of urine on a pad over 24-hours. In the study by Neuman & O'Callaghan (2018) The Urinary Incontinence domain score of the Expanded Prostate Cancer Index Composite (EPIC-26) was used to assess continence at three, six and 12 months preoperatively. Kumar *et al.* (2015) also used Expanded Prostate cancer Index Composite (EPIC) to assess continence. A questionnaire was completed by the patients during their visits and also done via telephonic interviews. Continence was assessed using the data that was collected at one and a half, four, six, nine and 12 months postoperatively. In the study by Palisaar *et al*. (2015) daily pad usage was assessed via interview at the end of the rehabilitation program (after three weeks). Less than one pad over a 24-hour period was defined as continent.

Three studies used the International Prostate Symptom Score (IPSS) questionnaire to evaluate the recovery of continence. Ku *et al*. (2017) used the IPSS as well as counted the number of pads used. Continence was defined as three continuous days of zero grams of urine leakage using the 24-h pad test. The study by Nason *et al*. (2017) also used IPSS as well as a self-reported continence score which included a questionnaire for number pads used per day. In the study by Geraerts *et al*. (2013) used the IPSS to measure secondary outcomes along with the 1-hour pad test, the Visual Analogue Scale (VAS) and the King's Health Questionnaire (KHQ) which measured quality of life. Urine loss was primarily measured by using the 24-hour pad test where continence was defined as zero grams of urine loss for three consecutive days.

The study by Mungovan *et al.* (2013) used the 24-hour pad test as well as the International Consultation on Incontinence Questionnaire - Urinary Incontinence (ICIQ-UI) Short form were used to measure urinary incontinence at three and six weeks postoperatively. Aydın Sayılan and Özbaş (2018) used three different questionnaires to assess the recovery of continence. The Incontinence Diagnosis Questionnaire included 14 questions aimed at the frequency and number of episodes of incontinence. The Incontinence Assessment Scale: ICIQ-SF where continence was defined as an ICIQ-UI score of zero. Thirdly, a self-reported recovery of continence at six months post-prostatectomy which included an incontinence scale and the number of pads that were used weekly.

4.8 Success rate of gaining continence

Five studies showed improvement in incontinence rates within the first month following surgery. (Mungovan *et al.*, 2013) had the fastest recovery of continence with a reduction in the 24-hr pad usage at three weeks. Six studies had results that were in favour of post-operative pelvic floor muscle rehabilitation. Aydın Sayılan and Özbaş (2018) showed that there was a significant difference in the first month and the first six months following surgery. More men in the experimental group used less pads compared to the control group that continued to use several pads per week. Pelvic floor muscle exercises were shown to assist patients who had incontinence problems post robot-assisted radical prostatectomy.

The study by Sathianathan *et al.* (2017) showed a significant improvement in urinary leakage for men who had undergone a RALP and had participated in a structured physiotherapist guided pelvic floor rehabilitation program. At three months post-RALP there was a 75,6 % improvement in leakage. Palisaar *et al.* (2015) reported that 65,4% of the participants were continent after six weeks postoperatively. Meanwhile in the study by Ku *et al.* (2017) patients who had a RARP gained continence earlier than patients who had LRP.

In the study by Kumar *et al.* (2015) adverse risk factors such as an older age, a higher BMI, increased prostate weight and previous bladder neck surgery had lower continence rates compared to patients without those risk factors. This was also reflected in the study by Basto *et al.* (2014) where at four to six weeks post RARP, the number of pads per day was greater the group agreed 70 years old or older. One study showed that the bladder neck could not be affected with pelvic floor rehabilitation. Neuman and O'Callaghan (2018) reported that displacement of the bladder neck is not associated with continence outcomes. The puborectal muscle was not significant in recovery of continence following a RARP.

There were three studies that included preoperative physiotherapy reported that the pelvic floor rehabilitation did not make a significant difference in the duration of incontinence. This included a study by Geraerts *et al.* (2013) where three additional sessions of preoperative pelvic floor muscle training did not make any significant difference in the post-operative duration of urinary incontinence. In the study by Mungovan et al. (2013) found no significant relationship between perioperative level of physical activity and post-prostatectomy urinary incontinence. Nason *et al.* (2017) reported that there was no difference in urinary function at three months, six months, nine months or at 12 months between the three surgeries (RARP, LRP and ORP).

Table 4.5: Time-frame to gaining continence

Authors	Study type	Intervention period	Time to continence
Aydın Sayılan A, Özbaş A. (2018)	Randomized controlled trial	6 months.	1 month post-operatively. Reduction in pads used.
Geraerts I, Van Poppel H, Devoogdt N, Joniau S, Van Cleynenbreugel B, De Groef A, *et al.* (2013)	Randomized controlled trial	12 months.	30 and 31 days (median) post-operatively.
Basto MY, Vidyasagar C, Te Marvelde L, Freeborn H, Birch E, Landau A, *et al.* (2014)	Cohort study	May 2008 – September 2012.	4-6 weeks post-RARP, a decrease in number of pads used per day.
Ku JY, Lee CH, Lee JZ, Ha HK. (2017)	Cohort study	September 2008 – January 2016.	1 month post-operatively for RARP patients.
Kumar A, Samavedi S, Bates AS, Coelho RF, Rocco B, Palmer K, *et al*. (2015)	Cohort study	January 2008 – November 2012	2.4 months post-operatively for group with no risk factors.
Mungovan SF, Huijbers BP, Hirschhorn AD, Patel MI. (2013)	Cohort study	December 2011-May 2012.	Reduced 24-hr pad test at 3 weeks post-RALP.
Nason GJ, O'Kelly F, White S, Dunne E, Smyth GP, Power RE. (2017)	Cohort study	3 years	6 months post-operatively for all surgical procedures.
Neumann PB, O'Callaghan M. (2018)	Cohort study	3 years	3- 12 months post-operatively.
Palisaar JR, Roghmann F, Brock M, Löppenberg B, Noldus J, von Bodman C. (2015)	Cohort study	3 – 6 weeks	6 weeks post-operatively.
Sathianathen NJ, Johnson L, Bolton D, Lawrentschuk NL. (2017)	Cohort study	January 2013 – July 2016	11.3 weeks post-operatively.

4.8.1 Critical Appraisal Results

The JBI critical appraisal checklists for cohort studies and randomized controlled trials are represented in appendix I and appendix II. The links (appendix III and appendix IV) to the questions are found on the tables representing the critical appraisal results.

The following two tables (table 4.6 and table 4.7) represent the critical appraisal results and scoring of the eight included cohort studies, as well as the two included RCTs. This data was extracted using the JBI SUMARI software.

Table 4.6: Critical appraisal of RCTs

Appendix III: JBI critical appraisal checklist questions for RCTs

N: No **N/A:** Not Applicable **Q:** Question **U:** Unclear **Y:** Yes

Citation	**Q1:** Was true randomization used for assignment of participants to treatment groups?	**Q2:** Was allocation to treatment groups concealed?	**Q3:** Were treatment groups similar at baseline?	**Q4:** Were participants blind to treatment assignment?	**Q5:** Were those delivering treatment blind to treatment assignment?	**Q6** Were outcomes assessors blind to treatment assignment?	**Q7** Were treatment groups treated identically other than the intervention of interest?	**Q8:** Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?	**Q9:** Were participants analysed in the groups to which they were randomized?	**Q10:** Were outcomes measured in the same way for treatment groups?	**Q11:** Were outcomes measured in a reliable way?	**Q12:** Was appropriate statistical analysis used?	**Q13:** Was the trial design appropriate , and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?
Geraerts I, Van Poppel H, Devoogdt N, Joniau S, Van Cleynenbreugel B, De Groef A, *et al.* (2013)	Y	Y	Y	U	Y	Y	Y	Y	Y	Y	Y	Y	Y
Aydın Sayılan A, Özbaş A. (2018)	U	U	Y	U	U	U	Y	Y	Y	Y	Y	Y	Y
%	50.0	50.0	100.0	0.0	50.0	50.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 4.7: Critical appraisal of cohort studies

Appendix IV: JBI critical appraisal checklist questions for cohort studies

N: No **N/A:** Not Applicable **Q:** Question **U:** Unclear **Y:** Yes

Citation	**Q1:** Where the two groups similar and recruited from the same population?	**Q2:** Where the exposures measured similarly to assign people to both exposed and unexposed groups?	**Q3:** Was the exposure measured in a valid and reliable way?	**Q4:** Were confounding factors identified?	**Q5:** Were strategies to deal with confounding factors stated?	**Q6:** Were groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	**Q7:** Were outcomes measured in a valid and reliable way?	**Q8:** Was the follow up time reported and sufficient to be long enough for the outcomes to occur?	**Q9:** Was the follow up complete, and if not, were the reasons to loss of follow up described and exposed?	**Q10:** Were strategies to address incomplete follow up utilized?	**Q11:** Was appropriate statistical analysis used?
Basto MY, Vidyasagar C, Te Marvelde L, Freeborn H, Birch E, Landau A, *et al.* (2014)	Y	Y	Y	Y	Y	U	Y	Y	Y	U	Y
Ku JY, Lee CH, Lee JZ, Ha HK. (2017)	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y
Neumann PB, O'Callaghan M. (2018)	Y	Y	Y	Y	Y	Y	Y	Y	Y	U	Y
Sathianathen NJ, Johnson L, Bolton D, Lawrentschuk NL. (2017)	Y	Y	Y	Y	Y	U	Y	Y	Y	U	Y
Mungovan SF, Huijbers BP, Hirschhorn AD, Patel MI. (2013)	Y	Y	Y	Y	Y	U	Y	Y	Y	N	Y
Kumar A, Samavedi S, Bates AS, Coelho RF, Rocco B, Palmer K, *et al.* (2015)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Palisaar JR, Roghmann F, Brock M, Löppenberg B, Noldus J, von Bodman C. (2015)	Y	Y	Y	Y	N	Y	Y	Y	Y	U	Y
Nason GJ, O'Kelly F, White S, Dunne E, Smyth GP, Power RE. (2017)	Y	N	Y	Y	N	Y	Y	Y	Y	N/A	Y
%	100.0	87.5	100.0	100.0	62.5	62.5	100.0	100.0	100.0	25.0	100.0

4.9 Conclusion of results

Most of the studies (26 out of 36) were excluded from this review because they did not meet the inclusion criteria for this review. The results were presented in a narrative as well as tabulated where possible. Statistical pooling was not possible, due to the studies being varied in their methodology and outcome measures.

The results were in favour of perioperative pelvic floor rehabilitation for post-RALP urinary incontinence. Five out of the 10 included studies reported that pelvic floor rehabilitation both preoperatively and postoperatively, showed better results in the recovery of urinary incontinence following a RALP.

Kegel exercises, PFMT, PFME, education on the anatomy of the pelvic floor, biofeedback and electrical stimulation were used as common interventions for rehabilitation of post-RALP urinary incontinence. The 24-hour pad test as well as self-reported questionnaires were used to report and measure the rate of incontinence as well as the recovery of continence.

Chapter 5 Discussion

5.1 Introduction

This systematic review has examined the effectiveness of pelvic floor rehabilitation in treating urinary incontinence post-RALP. There are no recent reviews investigating the role of pelvic floor rehabilitation specifically for post-RALP urinary incontinence. In this chapter the results are discussed, including discussions on the surgical and rehabilitation interventions.

5.2 Robotic prostatectomy surgery

Robotic prostatectomies were first performed in the year 2000 (Sharma, Shah and Neal, 2009). Before 2008, there was minimal published research on the advantages of RARP for the recovery of urinary incontinence (Schroeck *et al.*, 2012). When compared to open and laparoscopic surgical techniques, RALP has shown to be superior in the recovery of urinary continence over 12 months (Basto *et al.*, 2014). According to Mungovan *et al*. (2013) RALP patients benefit from less postoperative pain and the surgery helps to encourage earlier return to physical activity and function.

Some of the participants were being compared to other participants who had had other surgical approaches for treatment of localized prostate cancer. In the study by Ku *et al.* (2017) RARP patients regained continence sooner than LRP patients. After the first month postoperatively, RARP had a urinary incontinence recovery of 65% compared to LRP which had recovery of 31% (Ku *et al.*, 2017). Factors that influence the recovery of continence include the experience of the surgeon and the surgical technique as well as patient specific factors such as BMI, age, symptoms of lower urinary tract and the size and volume of their prostate (Sirdhar *et al*., 2017). As with all surgery there are risks and side-effects involved when a patient decides to have RALP. One of the major side effects of the surgery is postoperative incontinence (Ku *et al.*, 2017).

5.2.1 Urinary incontinence and outcome measures

The mechanism of male continence is complex in its structure and results in PPI when the urethral function is compromised (Neumann and O'Callaghan, 2018). A big negative effect of urinary incontinence following a prostatectomy is the effect on the men's quality of life (Hou *et al.*, 2015). The impact that PPUI has on the general quality of life is the reason why a quick recovery is needed. Santa Mina *et al*., (2015) emphasise the economic burden of the expenses relating to incontinence products and the loss of productivity at work also affecting the patients' quality of life. It is important to help men who have had a RALP gain urinary continence as soon as possible. Rehabilitation of the pelvic floor is a non-invasive, cost-effective and non-surgical method to improve urinary continence. The review included 10 studies on pelvic floor rehabilitation. These studies varied in their methods of rehabilitating the pelvic floor muscles.

Implementation and decentralization of best practices should be considered as one of the approaches for better outcomes of PPUI (Skolarus *et al.*, 2012). This approach involves minimizing the number of hospitals and providers performing robotic prostatectomies (Skolarus *et al.*, 2012). One of the disadvantages of this approach is the elusiveness of robotic prostatectomy, as the technology cannot easily be transferred between surgeons (Skolarus *et al.*, 2012). In the continent of Africa, Egypt and South Africa are the only two countries that have been reported to be performing robotic surgery (Oyebamiji, 2020). This represents the limitations in treating localized prostate cancer using robotic technology for Africa. In the study by Basto *et al*., 2014, the sample size of those having RARP (54) was smaller than the sample size of those having ORP (116).

The definitions of a urinary pad varied amongst the studies. This can be considered a confounding factor as the evaluation of continence does not have a clear definition. In this study, the included studies used both pad usage as well as questionnaires to measure the recovery of continence. Capturing of the questionnaires may also be inaccurate as they vary between the studies. Three studies included self-reported questionnaires for record keeping. Palisaar *et al*. (2015) assessed the recovery of continence via telephonic interviews, which was administered by a professional.

Out of the 10 included studies, nine studies used pads to measure incontinence. The number of pads used per day is a common measurement tool used by practitioners to estimate urinary incontinence severity (Malik *et al.*, 2016). The pad usage and the definition of urinary continence has been reported as a limiting factor as an outcome measure (Basto *et al.*, 2014). Patient recall, pad description as well as the amount of urine loss are also limitations in assessing the recovery of continence (Malik *et al.*, 2016). Urinary continence rates may be underestimated as patients who wear a security pad may still be fully continent (Basto *et al.*, 2014). In this study there were various definitions of the 24-hour pad test. Ku *et al*. (2017) defined continence as three continuous days of zero grams (using the 24h pad test) of urine leakage. As previously mentioned, zero pads per day were defined as continent for the purpose of this study.

Secondary to the 24-hour pad test, self-reported and formal questionnaires were used. Recovery of urinary incontinence was assessed using questionnaires and a count of the number of pads used in the study by Ku *et al*., (2017). The ICIQ-UI-SF is a self-reported questionnaire that does not clearly differentiate between the severity of urinary incontinence and the quality of life of urinary incontinence (Kurzawa *et al.*, 2018). It focuses on how symptoms impact the quality of life (Kurzawa *et al.*, 2018).

5.2.2 Rehabilitation

Protocols in PFMT vary in studies on PPI, resulting in differences in the reported outcomes of continence (Neumann and O'Callaghan, 2018). The results of this study have shown that PFMT plays a significant role in the recovery of continence within the first month post-RALP. Research has shown that PFMT helps to recover urinary continence faster (Geraerts *et al.*, 2013). Pre- and post-surgical pelvic floor evaluation and training has been a standard treatment for men having RARP (Manley *et al.*, 2016). This training is provided by a physiotherapist that specializes in pelvic floor and continence rehabilitation (Manley *et al.*, 2016). PFM exercises have been reported to improve the outcomes of continence when taught preoperatively instead of postoperatively (Neumann, Fuller and Sutherland, 2015). In the study by Geraerts *et al*. (2013) the control group started PFMT after surgery once the catheter was removed. Most literature included in this study was in favour of perioperative pelvic floor rehabilitation. The first three sessions of PFMT only helps to make the patients aware of their pelvic floor (Basto *et al.*, 2014). Therefore, more treatment sessions are necessary for adequate PFMT.

The recovery of continence has mainly been reported and analysed in a short-term period (Palisaar *et al.*, 2015). Early mobilisation is important for recovery postoperatively. In the study by Nason *et al*. (2016), the patients were encouraged to mobilise day one post-surgery, until they were mobilising independently upon discharge from the hospital. Pelvic floor exercises in functional positions such as sitting, and standing were taught to participants. It is important to incorporate functional exercises in a rehabilitation program. In the study by Aydın Sayılan and Özbaş (2018) PFME and general activity was included in their rehabilitation program. Training started preoperatively where the men had both supervised and unsupervised contractions of the pelvic floor muscles in various functional positions.

Mungovan *et al*. (2013) established that patients who are more physically active prior to surgery have reduced or earlier recovery of post-prostatectomy urinary incontinence. The study's results reported that the level of activity pre-operatively was generally high and that the rate of urinary incontinence post-operatively was generally low. Therefore, those who are physically active prior to surgery, have an advantage in gaining early continence. Older men are denied curative surgical treatment because of the perceived risk of incontinence (Basto et al, 2014). The impact on the recovery of urinary incontinence is greater and increases with age (Basto *et al*., 2014). Basto *et al*. (2014) categorized their participants according to their age. One group was 70 years old and older, and the other group was younger than 70 years old. Their study concluded that the recovery for urinary incontinence for men who were 70 years old or older had the same rate of recovery as men who were younger than 70 years old and advocates that older men should not be denied curative treatment for localized PCa. All participants of the study had pelvic floor training guided by a pelvic floor physiotherapy specialist.

In three studies, education was part of the rehabilitation process. The studies by Sathianathan *et al*. (2017), Neuman and O'Callaghan (2018) and Nason *et al.* (2017) included education on anatomy of the pelvic floor. Education was beneficial in helping the patients understand how to correctly activate the right pelvic floor muscles. In the study by Neuman and O'Callaghan (2018), education on the anatomy of the pelvic floor and its function was provided preoperatively. The education in the study included diagrams which represented the pelvic floor as well as a 3D model of the male pelvis which showed the bony landmarks. Self-palpation as well as verbal instructions in functional positions such as sitting, and standing were also beneficial in PFMT (Neumann and O'Callaghan, 2018).

Ultrasound was used in three of the studies to assist with demonstration of pelvic floor muscle activation. In the study by Aydın Sayılan and Özbaş (2018) feedback was given using real-time transabdominal ultrasound imaging to assess the contraction of the pelvic floor muscles. Sathianathan *et al*. (2017) also included ultrasound preoperatively for demonstration and guidance for the muscles of the pelvic floor. Biofeedback was also used to assist with the correct activation of the pelvic floor muscles during training. For some selected cases in the study by Palisaar *et al*. (2015), both electrical stimulation as well as biofeedback was offered. Electromyography (EMG) biofeedback was used by the therapist to control the exercises of the pelvic floor as part of the PFMT program (Geraerts *et al*., 2013). The patients had to use a digital or EMG biofeedback control while performing their exercises at the hospital, post-operatively. Anal biofeedback has been reported to be common in assisting to teach the contraction of PFMs (Neumann, Fuller and Sutherland, 2015). The authors argue that the effect of anal biofeedback and anal EMG might be due to the electrical stimulation of the anal sphincter instead of the control and awareness of the anal sphincter. The resting tone of PFM cannot be assessed by ultrasound (Neumann, Fuller and Sutherland, 2015). Overactive levator ani muscles, weakness and decreased motor control may be interpreted as lack of movement on the ultrasound screen (Neumann, Fuller and Sutherland, 2015). Overactivity of the levator ani muscles need to be addressed prior to strengthening the PFMs (Neumann, Fuller and Sutherland, 2015). Men should to be taught to completely relax their pelvic floor muscles as overactive muscles could impact urinary incontinence post-surgically (Neumann, Fuller and Sutherland, 2015).

Only two RCTs were retrieved for this study. A sample of 33 RCTs from a Cochrane review is described in a study by Hirschorn *et al*. (2014). The study reports that although the review showed the benefits of PFMT in reducing PPUI, there were too many variations in the type, the intensity and the timing of PFMT (Hirschhorn, Kolt and Brooks, 2014). The quality of the RCTs were reported as moderate to poor (Hirschhorn, Kolt and Brooks, 2014). It is important to ensure that men are effectively trained in contracting and allocating their pelvic floor muscles (Neumann, Fuller and Sutherland, 2015). Kegel exercises were taught to participants in the studies by Nason *et al*. (2017), Kumar *et al*. (2015) and Aydın Sayılan and Özbaş (2018). All three studies reported success in using these exercises to gain continence following a RALP. Kegel exercises have shown to be successful in strengthening the pelvic floor of women and men. Aydın Sayılan and Özbaş (2018) evaluated the effect of six month Kegel exercise program that involved three sessions of Kegel exercises per day for six months. The study reported a highly significant difference in the pad usage (decreased) at the first and sixth month post-RP. In a study by Kumar *et al*. (2015), patients who had high risk factors for urinary incontinence also benefitted from Kegel exercises. The results for salvage radical prostatectomies had significantly lower continence rates (Kumar *et al.*, 2015).

All of the included studies used physiotherapists, nurses and physicians to teach and guide the participants for rehabilitation of the pelvic floor. Basto *et al*. (2014) as well as the study by Neuman and O'Callaghan (2018), both had physiotherapists who were specialists in the pelvic floor guide their participants during the rehabilitation process. Mungovan *et al.* (2013) had three men's health physiotherapists teach the participants on the correct contraction of the pelvic floor. The participants had supervised activation and contraction of the pelvic floor (Mungovan *et al.*, 2013). Home exercise programs and compliance diaries were issued to the patients. In the study by Geraerts *et al*. (2013), the participants had to diarize when they had completed their prescribed exercises every day.

Different verbal commands have shown to produce variations in the different interactions of pelvic floor muscles (Neumann and O'Callaghan, 2018). The study argues that verbal commands that focus on activation of anterior pelvic anatomy are more effective than verbal commands focusing on activation of posterior pelvic anatomy (Neumann and O'Callaghan, 2018). Neuman and O'Callaghan focused on the practice of stopping the flow of urine without anal biofeedback. In another study by Neuman, Fuller and Sutherland (2015), men successfully contracted their pelvic floor muscles on verbal commands alone. The participants could not see the physiotherapist's ultrasound screen and a mirror was not used for assistance. This study focused on activation of the urethra. The verbal cues from the physiotherapist to the patient as well as patient feedback played an important role in the success of the study (Neumann, Fuller and Sutherland, 2015).

5.3 Conclusion of discussion

Incontinence rates of RARP have been reported to be 56% compared to the incontinence rates of 60 % post LRP (Ku *et al.*, 2017). As a consequence of RARP, urinary incontinence is still very common (Geraerts *et al.*, 2013). The results of this study were in favour of perioperative pelvic floor rehabilitation. Five out of the 10 studies reported that have pelvic floor rehabilitation both preoperatively and postoperatively, showed better results in the recovery of urinary incontinence following a RALP. The preferred rehabilitation methods included Kegel exercises, PFMT, PFME, education, biofeedback and electrical stimulation. Pelvic floor exercises (Kegel exercises, PFMT, PFME) were used by all ten studies as part of their rehabilitation programs. This shows that these exercises are the methods of choice and more effective in treating post-RALP urinary incontinence, compared to other methods of strengthening the pelvic floor, in this study.

Chapter 6 Conclusion and Recommendations

6.1 Conclusion

Africa is the second largest continent in physical size as in well population in the world. Most of the countries in Africa are still developing and face similar challenges experienced by developing of countries. Robotic surgery is quickly becoming the preferred intervention for non-invasive management of localised prostate cancer. Egypt as well as SA are the only two countries where robot technology has been adopted in surgical practice in Africa (Oyebamiji, 2020). One of the main complications following RALP is urinary incontinence. Perioperative rehabilitation of the pelvic floor including Kegel exercises, PFME, PFMT, electrotherapy, functional exercises as well as education have shown be beneficial in the early recovery of urinary continence, following a RALP.

6.2 Clinical/Practical Recommendations

According to the findings of this study, it can be recommended that education on the early management and treatment of PPUI could be important in the field of urology and physiotherapy in Africa. As more robot technology becomes accessible on the continent, it is vital that holistic management begins at a ground level. A country like SA is more developed in health care, compared to other countries in Africa (Chu *et al.*, 2011). However, there is a racial imbalance when it comes to the incidence of prostate cancer between black and white South African men. Black South African men are suggested to still be at a disadvantage in their access to health care and the rates of underdiagnosis are higher in populations that cannot access adequate health care (Chu *et al.*, 2011). This represents how inaccessible better health care is in many remote regions of Africa.

Urologists usually deal with post-surgical urinary incontinence as patients present for their routine follow up treatment (Manley *et al.*, 2016). Rehabilitation of the pelvic floor for PPUI is cost effective and for a continent like Africa where financial challenges can be a burden, it is recommended that urologists work with physiotherapist in the management of PPUI. Patients should begin with PFME, PFMT, Kegel exercises, biofeedback and education preoperatively and continue postoperatively until continence has been achieved.

6.3 Recommendation for future research

The rates for PCa for Africa are still underreported due to various reasons such as a limited registry and financial constraints. A study by Tindall *et al*. (2014) looked at the clinical presentation of PCa within Black South African men. They recruited over 1000 participants and found that there was a significant difference in the PSA levels (higher) of men with PCa compared to those without. This study was then compared to clinical data of Black American men. South African Black men presented with higher PSA levels and a more aggressive type of PCa when compared to Black American men. This study showed that the lack of routine PSA screening within Black South African men, contributed to the more aggressive PCa disease phenotype going undetected and subsequently treated. As a proper and accurate registry gets developed as well as routine screening is encouraged, it is important to work with a multidisciplinary team that can develop a protocol when it comes to management of PPUI following RALP in Africa.

6.4 Strengths and limitations

The strength of this review was in the methodology based on the JBI protocol for systematic reviews. This helped to refine the research and to assess the quality of the studies in an organised manner. It is the only study that is specific to the effects and benefits of pelvic floor rehabilitation for urinary incontinence as a result of robotic prostatectomy.

The first limitation of the study is that the number of studies included in this review was small. A larger number of studies would have been more beneficial. Research on robotic prostatectomy and PPUI rehabilitation is ongoing and more recently published literature is still needed. The small number of studies also varied in their definitions, methodology and outcome measures. As a result there was insufficient data for statistical pooling and therefore the results were tabulated and presented in a narrative form. The variations in the definitions and measurements of urinary incontinence presented as a limitation in this study. This made it difficult to draw up a definite conclusion in the time to recovery of continence. Pelvic floor rehabilitation also varied between the studies. PFMT and PFME seem to be broad umbrella terms for exercises involving the pelvic floor. None of the studies had a clear definition for PFMT or PFME and the exact exercises that were involved with each.

Publication bias was also not calculated due to the variations in the data of the included studies. Another limitation of the review was that there has not been any research or published articles on robotic prostatectomy surgery in Africa and including the outcomes. Even though surgical robots are being used in SA and Egypt (Oyebamiji, 2020), published studies are still unavailable. As mentioned by many studies on PCa in Africa, the limitations in registry, management practices and finances has been challenging (Chu *et al.*, 2011).

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Appendices

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Appendix I: JBI critical appraisal checklist for randomized controlled trials

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JBI Critical Appraisal Checklist for Randomized Controlled Trials

Reviewer___________________________________Date________________________________

Author ___________________________________Year______________Record Number______

	Yes	No	Unclear	NA
1. Was true randomization used for assignment of participants to treatment groups?	☐	☐	☐	☐
2. Was allocation to treatment groups concealed?	☐	☐	☐	☐
3. Were treatment groups similar at the baseline?	☐	☐	☐	☐
4. Were participants blind to treatment assignment?	☐	☐	☐	☐
5. Were those delivering treatment blind to treatment assignment?	☐	☐	☐	☐
6. Were outcomes assessors blind to treatment assignment?	☐	☐	☐	☐
7. Were treatment groups treated identically other than the intervention of interest?	☐	☐	☐	☐
8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	☐	☐	☐	☐
9. Were participants analyzed in the groups to which they were randomized?	☐	☐	☐	☐
10. Were outcomes measured in the same way for treatment groups?	☐	☐	☐	☐
11. Were outcomes measured in a reliable way?	☐	☐	☐	☐
12. Was appropriate statistical analysis used?	☐	☐	☐	☐
13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

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Appendix II: JBI critical appraisal checklist for cohort studies

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JBI Critical Appraisal Checklist for Cohort Studies

Reviewer_______________________________________Date____________________________

Author ____Year_________Record Number______

	Yes	No	Unclear	Not applicable
1. Were the two groups similar and recruited from the same population?	☐	☐	☐	☐
2. Were the exposures measured similarly to assign people to both exposed and unexposed groups?	☐	☐	☐	☐
3. Was the exposure measured in a valid and reliable way?	☐	☐	☐	☐
4. Were confounding factors identified?	☐	☐	☐	☐
5. Were strategies to deal with confounding factors stated?	☐	☐	☐	☐
6. Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	☐	☐	☐	☐
7. Were the outcomes measured in a valid and reliable way?	☐	☐	☐	☐
8. Was the follow up time reported and sufficient to be long enough for outcomes to occur?	☐	☐	☐	☐
9. Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	☐	☐	☐	☐
10. Were strategies to address incomplete follow up utilized?	☐	☐	☐	☐
11. Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

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____

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Appendix III: JBI critical appraisal checklist questions for RCTs

Question 1: Was true randomization used for assignment of participants to treatment groups?

Question 2: Was allocation to treatment groups concealed?

Question 3: Were treatment groups similar at baseline?

Question 4: Were participants blind to treatment assignment?

Question 5: Were those delivering treatment blind to treatment assignment?

Question 6: Were outcomes assessors blind to treatment assignment?

Question 7: Were treatment groups treated identically other than the intervention of interest?

Question 8: Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?

Question 9: Were participants analysed in the groups to which they were randomized?

Question 10: Were outcomes measured in the same way for treatment groups?

Question 11: Were outcomes measured in a reliable way?

Question 12: Was appropriate statistical analysis used?

Question 13: Was the trial design appropriate , and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?

Appendix IV: JBI critical appraisal checklist questions for cohort studies

Table 4.6: Critical appraisal of

Question 1: Where the two groups similar and recruited from the same population?

Question 2: Where the exposures measured similarly to assign people to both exposed and unexposed groups?

Question 3: Was the exposure measured in a valid and reliable way?

Question 4: Were confounding factors identified?

Question 5: Were strategies to deal with confounding factors stated?

Question 6: Were groups/participants free of the outcome at the start of the study (or at the moment of exposure)?

Question 7: Were outcomes measured in a valid and reliable way?

Question 8: Was the follow up time reported and sufficient to be long enough for the outcomes to occur?

Question 9: Was the follow up complete, and if not, were the reasons to loss of follow up described and exposed?

Question 10: Were strategies to address incomplete follow up utilized?

Question 11: Was appropriate statistical analysis used?

Appendix V: Excluded studies

Ahmed MT, Mohammed AH, Amansour A. Biofeedback on the Recovery of Urinary Continence after Radical Prostatectomy. 2012;(March 2010):18.

Reason for exclusion: Does not include robotic prostatectomies.

Arroyo Fernández R, García-Hermoso A, Solera-Martínez M, Martín Correa MT, Ferri Morales A, Martínez-Vizcaíno V. Urologia Internationalis. 2015;94(2):132.

Reason for exclusion: A meta-analysis, does not include robotic prostatectomies.

Eaton K. MOJ Yoga & Physical Therapy. 2016;1(1):4.

Reason for exclusion: A literature review.

Garg T, Young AJ, Kost KA, Park AM, Danella JF, Kirchner HL. Investigative and Clinical Urology. 2017;58(5):338.

Reason for exclusion: Does not include pelvic floor rehabilitation.

Goonewardene SS, Gillatt D, Persad R. Journal of Robotic Surgery. 2018;

Reason for exclusion: A systematic review.

Haga N, Ogawa S, Yabe M, Akaihata H, Hata J, Sato Y, *et al.* Journal of Endourology. 2015;29(6):690.

Reason for exclusion: No postoperative pelvic floor rehabilitation.

Hirschhorn AD, Kolt GS, Brooks AJ. BJU International. 2014;113(3):392.

Reason for exclusion: The study measures receipt of PFMT (pelvic floor muscle training) only.

Hou GL, Luo Y, Di JM, Lu L, Yang Y, Pang J, *et al.* Urology Journal. 2015;12(1):2027.

Reason for exclusion: Does not include robotic prostatectomies.

Hsu LF, Liao YM, Lai FC, Tsai PS. International Journal of Nursing Studies. 2016;60.

Reason for exclusion: A systematic review and meta-analysis.

Jafri SM, Nguyen LN, Sirls LT. International Urology and Nephrology. 2018;50(12):2191.

Reason for exclusion: Does not include pelvic floor rehabilitation.

Kaplan JR, Lee Z, Eun DD, Reese AC. Current Urology Reports. 2016;17(6).

Reason for exclusion: A literature review.

Kim M, Park M, Shim M, Choi SK, Lee SM, Lee ES, *et al.* International Urology and Nephrology. 2016;48(1):63.

Reason for exclusion: A systematic review.

Lee SR, Kim HW, Lee JW, Jeong WJ, Rha KH, Kim JH. Yonsei Medical Journal. 2010;51(6):887.

Reason for exclusion: Does not include pelvic floor rehabilitation.

Lin YH, Yang MS, Chia-Hsiang Lin V, Yu TJ, Chiang PH. International Journal of Urological Nursing. 2011;5(3):122.

Reason for exclusion: Does not include robotic prostatectomies.

MacDonald R, Fink HA, Huckabay C, Monga M, Wilt TJ. BJU International. 2007;100(1):81.

Reason for exclusion: A systematic review. Does not include robotic prostatectomies.

Manley L, Gibson L, Papa N, Beharry BK, Johnson L, Lawrentschuk N, *et al.* Journal of Robotic Surgery. 2016;

Reason for exclusion: A Pilot study.

Milios J, Atkinson C, Naylor L, Millar D, Thijssen D, Ackland T, *et al.* New Zealand Continence Journal. 2018;24(4):112.

Reason for exclusion: Does not include robotic prostatectomies.

Neumann P, Fuller A, Sutherland P. Australian and New Zealand Continence Journal, The. 2015;21(3):84.

Reason for exclusion: The study does not measure or include urinary incontinence.

Peyromaure M, Ravery V, Boccon-Gibod L. BJU International. 2002;90(2):161.

Reason for exclusion: Does not include robotic prostatectomies.

Rebuck DA, Haywood S, McDermott K, Perry KT, Nadler RB. BJU International. 2011;108(5):738.

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Santa Mina D, Au D, Alibhai SM., Jamnicky L, Faghani N, Hilton WJ, *et al.* BMC Urology. 2015;15(1):10.

Reason for exclusion: A study protocol.

Schroeck FR, Krupski TL, Sun L, Albala DM, Price MM, Polascik TJ, *et al.* European Urology. 2012;62(3):417.

Reason for exclusion: A systematic review and meta-analysis.

Skolarus TA, Weizer AZ, Hedgepeth RC, He C, Wood DP, Hollenbeck BK. Surgical Innovation. 2012;19(1):10.

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Sridhar AN, Abozaid M, Rajan P, Sooriakumaran P, Shaw G, Nathan S, *et al.* Current Urology Reports. 2017;18(9).

Reason for exclusion: A literature review. Does not include pelvic floor rehabilitation.

Tienforti D, Sacco E, Marangi F, Addessi AD, Racioppi M, Gulino G, *et al.* BJU International. 2012;1011.

Reason for exclusion: Does not include robotic prostatectomies.

Wang W, Huang QM, Liu FP, Mao QQ. BMC Urology. 2014;14(1).

Reason for exclusion: A meta-analysis.

Appendix VI: Characteristics of included studies

Table: Characteristics of Included Studies - Randomized Controlled Trial Form

Study	Country	Setting/context	Participant characteristics	Groups	Outcomes measured	Description of main results
Geraerts I, Van Poppel H, Devoogdt N, Joniau S, Van Cleynenbreugel B, De Groef A, *et al.* (2013)	Belgium	University Hospitals Leuven	180 men who were undergoing a robot-assisted laparoscopic radical prostatectomy or an open radical prostatectomy who had preoperative and postoperative pelvic floor muscle training for urinary incontinence.	The experimental group included 91 patients who started pelvic floor muscle training 3 weeks prior to surgery and continued postoperatively. The control group included 89 patients who only started pelvic floor muscle training postoperatively once their catheters were removed.	Urine loss was measured using the 24-hour pad test. Continence was defined as 0g of urine loss for 3 consecutive days. The 1-hour pad test, the Visual Analog Scale (VAS), International Prostate Symptom Score (IPPS) and quality of life (King's Health Questionnaire (KHQ)) were also used to measure secondary outcomes.	Three sessions of preoperative pelvic floor muscle training did not make any significant difference in the post-operative duration of urinary incontinence.

Aydın Sayılan A, Özbaş A. (2018)	Turkey	Dr. Sadi Konuk Training and Research Hospital Urology Clinic in Istanbul	60 men in total who were scheduled to have a robot-assisted radical prostatectomy. Men with localised prostate cancer. Men without urinary incontinence prior to surgery. A BMI of less than 30. Education of at least elementary school level. Age between 30 and 75 years old. Participants should participate in the study.	30 patients in the experimental group. The experimental group were given pelvic floor muscle exercises that they had to do 3 times a day for 6 months.30 patients in the control group. No exercises were given to the control group.	Incontinence Diagnosis Questionnaire: 14 questions aimed at the frequency and number of episodes of incontinence. Incontinence Assessment Scale: International Consultation on Incontinence Questionnaire Short-Form (ICIQ-SF): Continence was defined as an ICIQ-UI score of 0. Self-reported recovery of continence 6 months post-prostatectomy: Incontinence scale and the number of pads that were used weekly.	There was a significant difference in the first month and the first six months following surgery. More men in the experimental group used less pads compared to the control group that continued to use several pads per week. Pelvic muscle exercises were shown to assist patients who had incontinence problems post robot-assisted radical prostatectomy.

Appendix VII: Characteristics of included studies – cohort form

Study	Country	Setting/context	Participant characteristics	Groups	Outcomes measured	Description of main results
Basto MY, Vidyasagar C, Te Marvelde L, Freeborn H, Birch E, Landau A, *et al.* (2014)	Australia	Three Melbourne-based hospitals: Peter MacCallum Cancer Centre, Epworth Healthcare and Cabrini hospital.	262 patients who underwent a robot-assisted radical prostatectomy (RARP) from May 2008 to September 2012, performed by two surgeons. All men were referred to a specialised pelvic floor physiotherapist for pelvic floor muscle training pre-operatively.	Men who were 70 years old and older (24). Men who were younger than 70 years old (238).	Urinary continence was measured as pads/day. Fully continent was defined as zero pads/day.	At 4-6 weeks post RARP, the number of pads/day was greater the group agreed 70 years old or older.
Ku JY, Lee CH, Lee JZ, Ha HK. (2017)	Busan, South Korea	Pusan National University Hospital	712 patients who underwent a laparoscopic radical prostatectomy (LRP) and a robot-assisted laparoscopic radical prostatectomy.	614 men who underwent a LRP and had individual pelvic floor muscle exercises taught to them by a physician-assisted nurse	The International Prostate Symptom Score (IPSS) questionnaire was used to evaluate the recovery of continence as	Patients who had a RARP gained continence earlier than patients who had a LRP.

				once the urethral catheter was removed post-operatively. 98 men who had underwent a RARP and had individual pelvic floor muscle exercises taught to them by a physician-assisted nurse once the urethral catheter was removed post-operatively.	well as counting the number of pads used. Continence was defined as 3 continuous days of 0g of urine leakage using the 24-h pad test.	
Neumann PB, O'Callaghan M. (2018)	Australia	Data extracted from South Australian Prostate Cancer Clinical Outcome Collaborative database.	Men who had undergone a robotic-assisted radical prostatectomy (RARP) and had participated in pre-surgical physiotherapy for pelvic floor muscle strengthening between 2012 and 2015.	Men with prostate cancer who underwent a RARP and attended pre-operative physiotherapy. Physiotherapy was for pelvic floor rehabilitation to assess the continence outcomes post-operatively. Patients attended pre-operative physiotherapy	Bladder neck displacement was measured by the physiotherapist, using a two-dimensional transperineal ultrasound (2D-TPUS). The measurement is associated with the contraction of the puborectal muscle. The Urinary Incontinence domain score	Displacement of the bladder neck is not associated with continence outcomes. The puborectal muscle is not significant in recovery of continence following a RARP.

				for an hour, where they were educated about the pelvic floor muscles and instructed about contracting the muscles.	of the Expanded Prostate Cancer Index Composite (EPIC-26) was used to assess continence at 3, 6 and 12 months preoperatively.	
Sathianathen NJ, Johnson L, Bolton D, Lawrentschuk NL. (2017)	Australia	Database of men who had undergone a robotic-assisted laparoscopic radical prostatectomy (RALP) between January 2013 and July 2016.	45 men who had undergone a robotic-assisted laparoscopic radical prostatectomy done by two senior urological surgeons.	45 men participated in a pelvic floor rehabilitation program preoperatively and continued post-operatively, once the catheter was removed. The rehabilitation program was physiotherapist led.	Daily urinary leakage was documented in a diary. This included a recording of the their 24-hour wet pad wight minus the dry pad weight. Continence was defined as 0ml of urine on a pad over 24-hours.	There was a significant improvement in urinary leakage for men who had undergone a RALP and had participated in a structured physiotherapist guided pelvic floor rehabilitation program.
Mungovan SF, Huijbers BP, Hirschhorn AD, Patel MI. (2013)	Australia	Urological cancer center in Western Sydney	33 patients having a radical prostatectomy (Open radical prosatectomy (ORP) and robotic assisted laparoscopic prostatectomy (RALP)) between	9 ORP patients attended perioperative physiotherapy for pelvic floor muscle strengthening and physical activity prescription. Patients were seen (by the	The International Physical Activity Questionnaire (IPAQ) was used to measure levels of physical activity. All patients wore the Sense Wear	There was no significant relationship between preoperative level of physical activity and post-prostatectomy urinary incontinence.

			December 2011 and May 2012.	physiotherapist) before pre-operatively and at 3 and 6 weeks post-operatively.24 RALP patients attended perioperative physiotherapy for pelvic floor muscle strengthening and physical activity prescription. Patients were seen (by the physiotherapist) before pre-operatively and at 3 and 6 weeks post-operatively.	Pro3 Armband as a physical activity monitor. The 24-hour pad test as well as the International Consultation on Incontinence Questionnaire - Urinary Incontinence Short form were used to measure urinary incontinence at 3 and 6 weeks postoperatively.	
Kumar A, Samavedi S, Bates AS, Coelho RF, Rocco B, Palmer K, *et al.* (2015)	United States of America	Department of Urology, University of Central Florida College of Medicine and Global Robotics Institute, Florida Hospital Celebration Health, Celebration, Florida, USA	3362 men who had undergone a robot-assisted radical prostatectomy (RARP) by a single surgeon, between January 2008 and November 2012. The men had a minimum of one year follow-p and	451 patients aged 70 years and older. 197 patients with a Body Mass Index (BMI) of 35kg/m2 and higher. 103 patients who had previous bladder neck procedures. 280 patients with a prostate weight of 80g and	A questionnaire was completed by the patients during their visits and also done via telephonic interviews. Continence was assessed using the Expanded Prostate cancer Index Composite (EPIC). Data	Adverse risk factors such as an older age, a higher BMI, increased prostate weight and previous bladder neck surgery had lower continence rates compared to patients

			were divided into 6 groups. All patients were educated and advised about Kegel exercises. They had to do the exercises preoperatively and continue postoperatively until continence was achieved.	higher. 41 patients who needed to salvage the prostatectomy. 2447 patients with no risk factors.	was collected at 1.5 , 4 , 6, 9 and 12 months postoperatively.	without those risk factors.
Palisaar JR, Roghmann F, Brock M, Löppenberg B, Noldus J, von Bodman C. (2015)	Germany	Department of Urology, Maarien hospital Herne, Ruhr-University Bochum, Widumer Strasse, Herne Germany	2998 patients who had undergone an open retropubic prostatectomy (ORP) or a robot-assisted transperitoneal prostatectomy (RARP) and completed a 3 week rehabilitation program post-operatively.	All men had further rehabilitation at an acute rehabilitation facility. Each patient had individual physical pelvic floor training guided by a physiotherapist twice per day. The rehabilitation also included biofeedback and electrical stimulation.	Daily pad usage was assessed via interview at the end of the rehabilitation program (after 3 weeks). Less than 1 pad over a 24-hour period was defined as continent.	1962 (65,4%) were continent after 6 weeks.
Nason GJ, O'Kelly F, White S, Dunne E,	Ireland	Beaumont Hospital and Mater Private Hospital, Dublin	A database performed between 2011 and 2014. 292 men who	85 RARP patients. Robotic surgery was performed in the private	The International Prostate Symptom Score (IPSS), the	There was no difference in urinary function at 3 months, 6

Smyth GP, Power RE. (2017)			underwent a radical prostatectomy. 85 had a robotic assisted radical prostatectomy (RARP), 100 had a laparoscopic radical prostatectomy (LRP) and 107 underwent an open radical prostatectomy. Mean age of the patients was 61,3 years old.	sector. The surgery was performed with the Da Vinci robot system, using a transperitoneal approach. Patients had to mobilise independently post-operatively before discharge. 10 to 14 days postoperatively, patients were issued with pelvic floor exercises advised by a pelvic floor physiotherapist, who advised Kegel exercises.100 LRP patients. An extra-peritoneal approach was performed for the surgery. Patients had to mobilise independently post-operatively before	International Index of Erectile Function (IIEF-5) and a self-reported continence score which included a questionnaire for number pads used per day.	months, 9 months or at 12 months between the three surgeries (RARP, LRP and ORP).

				discharge. 10 to 14 days postoperatively, patients were issued with pelvic floor exercises advised by a pelvic floor physiotherapist, who advised Kegel exercises.107 ORP patients. A standard retropubic procedure was performed for the surgery. Patients had to mobilise independently post-operatively before discharge. 10 to 14 days postoperatively, patients were issued with pelvic floor exercises advised by a pelvic floor physiotherapist, who advised Kegel exercises.		

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