EXAMINING THE MEDIATORS OF MENTAL HEALTH IMPROVEMENT IN MEN
WITH LOCALIZED PROSTATE CANCER: SELF-EFFICACY, ILLNESS
PERCEPTION, AND HEART RHYTHM COHERENCE IN
PC-PEP VS. STANDARD CARE

by

Cody MacDonald

Submitted in partial fulfilment of the requirements
for the degree of Master of Science

at

Dalhousie University
Halifax, Nova Scotia
March 2024

Dalhousie University is located in Mi'kma'ki, the
ancestral and unceded territory of the Mi'kmaq.
We are all Treaty people.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Background: Understanding how interventions reduce psychological distress in patients with prostate cancer is crucial for enhancing patient care. This research examined the roles of self-efficacy, perceptions of illness, and heart rhythm coherence in mediating the effects of the Prostate Cancer Patient Empowerment Program (PC-PEP) on lessening psychological distress and the need for clinical treatment compared to standard care.

Methods: In a randomized controlled trial, 128 patients with prostate cancer were divided into two groups: those receiving the PC-PEP intervention and those receiving standard care. The PC-PEP focused on relaxation and stress management, diet, exercise, pelvic floor muscle exercises, and improving relationships and intimacy.

Results: Participants in the intervention group experienced notable enhancements in self-efficacy and specific views on their illness (such as personal control and emotional response) compared to the control group. These factors acted as intermediaries in the relationship between the intervention and its psychological benefits, with self-efficacy accounting for 52% of the reduction in psychological distress. No meaningful differences in heart rhythm coherence were observed following the intervention.

Conclusion: This study validates the critical role of self-efficacy and certain illness perceptions in facilitating psychological improvements in prostate cancer patients participating in the PC-PEP. The results underline the effectiveness of the program and identify the essential mechanisms through which it works. Future studies should expand this research to multi-center trials to confirm and broaden these findings, demonstrating the effectiveness of comprehensive interventions in promoting the psychological health of prostate cancer patients.

LIST OF ABBREVIATIONS

PC   Prostate Cancer

PC-PEP   Prostate Cancer Patient Empowerment Program

CSM   Common Sense Model of Illness Regulation

IPQ   Illness Perception Questionnaire

IPQ-R   Illness Perception Questionnaire-Revised

B-IPQ   Brief Illness Perception Questionnaire

SEMCD   Self-Efficacy for Managing Chronic Disease Scale

HRV   Heart Rate Variability

ACKNOWLEDGEMENTS

I would first like to express my deepest gratitude to my thesis committee members, Dr. George Kephart and Dr. Rob Rutledge for your invaluable guidance, expertise, and encouragement.

I would like to especially thank my supervisor, Dr. Gabriela Ilie, for your unwavering and supportive mentorship that has been instrumental in shaping this thesis. Your passion, dedication to the work you do, and your commitment to seeing others interest as your own is truly admirable. I am very grateful for the wealth of knowledge and inspiration you have imparted to me.

I would also like to thank my family, friends, and fellow members of the Soillse Research Lab for your persistent support along the way.

CHAPTER 1: INTRODUCTION

Prostate cancer (PC) is the most frequently diagnosed cancer in Canadian men, accounting for one fifth of all male cancer diagnoses and affecting one in nine Canadian men during their lifetime (Canadian Cancer Statistics Advisory, 2022). Advancements in treatment and early detection as well as the localized nature of most cases means PC has one of the highest 5-year survival rates (95%) of any malignancy (Canadian Cancer Statistics Advisory, 2021). With a low rate of mortality and an ageing population, research has increasingly prioritized improving quality of life and better understanding survivorship needs. Curative treatments, including surgery and radiation therapy, often lead to significant sexual, urinary, and bowel issues that affect PC patient quality of life (Donovan et al., 2016; Barocas et al., 2017). Depression, suicidal ideation, and death by suicide are all increased in this population (Fervaha et al., 2019) and Canadian PC survivors have more than twice the odds of screening positive for both depression and anxiety symptoms compared to those without a lifetime history of cancer (Ilie, et al., 2020; Moodie et al., 2020). These are not only short-term issues following diagnosis or treatment, as poor mental health and quality of life outcomes have been reported long into PC survivorship (Korfage et al., 2006; Friberg et al., 2021; Ralph et al. 2020; Brunckhorst et al., 2021), underscoring the importance for interventions to mitigate these impacts.

The Prostate Cancer Patient Empowerment Program (PC-PEP), a 6-month, multi-dimensional lifestyle intervention provides individuals with PC education, skills, and daily encouragement to adopt healthy lifestyle behaviours and better self-management practices. PC-PEP components focus on meditation/relaxation techniques, exercise, diet,

pelvic floor muscle training, social support, and weekly self-monitoring among others (further described in section 2.5 and 4.2). PC-PEP, compared to standard of care, was found to reduce non-specific psychological distress and symptoms of depression and anxiety (Ilie et al., 2023). However, underlying mechanisms through which this causal relationship manifests remain unknown.

The Common Sense Model (CSM) of Illness Regulation is one prominent framework for describing a patient's response and management of health threats (Leventhal et al., 1980). According to Leventhal and colleagues (1980), individuals generate unique beliefs about their illness, such as beliefs of identity, consequences, and control. These beliefs, or illness perceptions, guide the individual's coping strategies, self-management behaviours, and ultimately impact their health outcomes. Studies have found that individuals with PC and various other types of cancer (e.g., breast, lung cancer) who have more positive illness perceptions (e.g., greater understanding of what their illness is, stronger beliefs that their illness and its impacts can be controlled/cured, etc.) experience better mental health and quality of life (Mickevičienė et al., 2013; Alcorso & Sherman, 2016; Ośmiałowska et al., 2022). Thus, improving illness perceptions in PC patients through interventions may be a relevant mechanism to improving the mental health of cancer patients.

The Self-Efficacy Framework, sharing some similarities to the CSM, is another prominent framework describing how patient beliefs guide behaviour and influence outcomes. Self-efficacy is described as the belief in one's capacity to execute behaviors necessary to produce specific outcomes and reach their goals (Bandura, 1997). Greater self-efficacy in cancer patients has been found to predict their ability to manage the side-effects

2

and challenges of their cancer (Chirico et al., 2017; Merluzzi et al., 2001). Martín-Núñez et al. (2023a) have found an inverse relationship between self-efficacy and psychological distress, suggesting enhancing self-efficacy as a key strategy in alleviating the distress experienced by cancer patients. While the aforementioned CSM focuses on how beliefs regarding the illness guide coping and self-management strategies which then impacts health outcomes, the self-efficacy framework focuses on how beliefs in the individual's ability to execute the coping and self-management strategies guides those behaviours, which then impacts health outcomes. Due to their variance and unique contributing factors, the use of both frameworks has been supported to better understand how patient beliefs relate to improvement in health outcomes (Breland et al., 2020).

To improve emotional self-regulation and coping to the stressors associated with PC, a key component of PC-PEP focuses on relaxation and stress-reduction. Participants in PC-PEP receive a heart rate variability (HRV) biofeedback device from HeartMath Inc. to be used during guided mediation, breathing, and relaxation exercises. The device measures heart rhythm coherence, a physiological phenomenon whereby there is synchronization and rhythmicity of heart rhythm patterns (McCraty & Zayas, 2014). Higher heart rhythm coherence has been found to reduce stress and improve emotional regulation (McCraty & Shaffer, 2015). Small-scale studies have found HRV training alone efficacious at improving heart rhythm coherence in PC patients (Burch et al., 2020), although a small single-arm pilot study of PC-PEP did not find significantly change heart rhythm coherence over 28-days of intervention (Burge et al., 2023). Despite this, there is a need to evaluate the measure in a larger sample over a longer period of

time, as well as to better understand whether this component of the intervention influences the primary outcome: non-specific psychological distress.

In randomized controlled trials, mediation analyses allow us to expand beyond estimating intervention effects to better understand *how* an intervention influences outcomes (Lee et al., 2019). This is especially important for complex, multi-dimensional interventions such as PC-PEP (Skivington et al., 2021). Furthermore, understanding whether a mediation effect is conditional based on different contexts provides valuable information for interpreting the effect (Preacher et al., 2007). In the context of PC, patient's undergoing radical prostatectomy and radiation therapy experience different side-effects and patient reported outcomes (Donovan et al., 2016) which could affect how they perceive their illness. Therefore, even with a similar significant intervention effect seen in both groups (Ilie et al., 2023), the mechanisms behind the effect may differ as a result of their unique experiences and perceptions.

This thesis is a secondary analysis of the PC-PEP randomized controlled trial that examines the effect of PC-PEP, compared to standard-of-care, on self-efficacy, illness perceptions and heart rhythm coherence. We explore whether self-efficacy, illness perceptions and/or heart rhythm coherence mediate the relationship between PC-PEP and reduced non-specific psychological distress and need for clinical treatment, and whether treatment modality moderates the mediating effects. Chapter 2 of this thesis provides a background review of the relevant literature; Chapter 3 outlines the thesis objectives and research questions; Chapter 4 is a publishable manuscript that provides the methods and results of the thesis; and lastly Chapter 5 concludes with a discussion of the findings, strengths and limitations, and clinical significance.

CHAPTER 2: BACKGROUND

2.1 PROSTATE CANCER AND THE AGEING POPULATION

Prostate cancer (PC) is a major cause of morbidity and of high public health significance globally. With over 1.4 million estimated new PC cases worldwide in 2021, it accounted for 7.3% of all new cancer diagnoses (Sung et al., 2021). In men, PC is the most diagnosed malignancy in 112 countries, including Canada (Sung et al., 2021), where approximately 1 in every 5 Canadian men receiving a cancer diagnosis is diagnosed with carcinoma of the prostate (Canadian Cancer Statistics Advisory, 2022). After nearly two decades of declining incidence, the incidence of PC has increased 3% annually from 2014 to 2019 in the United States (Siegel, 2023), and longer-term predictions suggest Canadian incidence rates of PC will rise 34% over the next 20 years (Ruan et al., 2023).

Prostate cancer is a disease of ageing, with over 98% of cases in Canada occurring in those over 50 years of age. The incidence increases considerably each year beyond the age of 50 and peak incidence rates are present in men between the ages of 70 and 79 (Leblanc et al., 2019). In fact, autopsy studies suggest that over one third of Caucasian males and over one half of African-American/Black males in the 70-79 age category have evidence of latent PC (Jahn et al., 2015). The Canadian population is also ageing substantially, and more men are living to these older ages. According to data from Statistics Canada, the number of Canadians aged 65 and older increased from approximately 14.1% of the total population in 2010 to 19.0% in 2022, and it is projected to rise even further to 22.5% by 2030 (Eisen & Emes, 2022).

Despite the high incidence expected to increase with an ageing population, the prognosis of PC from a survival perspective is quite favorable. In fact, of the five leading

causes of cancer death in Canada, prostate cancer has the highest 3, 5, and 10-year predicted net survival at 94%, 91%, and 88% respectively (Canadian Cancer Statistics, 2021). In 2021, the anticipated mortality rate for PC in Canada was 50% lower than what was observed in 1995 (Canadian Cancer Statistics, 2021). This can be attributed to many factors, most notably advancements in treatments as well as increased screening that allows the disease to be detected earlier when there is a greater chance it will be in the localized stage. As this growing incidence and decreasing mortality contribute to a rising prevalence of PC survivors, assessing the psychosocial impacts of the diagnosis, such as mental stress, and planning for supportive healthcare and survivorship services is a priority (Canadian Cancer Statistics Advisory, 2022)

2.2 THE COMMON-SENSE MODEL OF SELF-REGULATION

A person's perception, interpretation, and method of coping with an illness, such as cancer, can vary remarkably from one person to another. The Common-Sense Model of Self-Regulation (CSM) is one framework that has been applied to many chronic health conditions to explain the dynamic processes by which the differences in perception, interpretation, and coping amongst people with the same illness arise (Leventhal et al., 1980; Leventhal et al., 2016). According to the framework, patients make sense of their illness by forming illness perceptions – subjective beliefs of their illness, it's treatment and the consequences it may have (Leventhal et al., 1980; Leventhal et al., 2016). These perceptions are acquired and influenced by numerous factors, including the information patients have received from experts and other sources, their experiences with previous illnesses, interactions with others, and the extent of their symptoms (Bonsaksen et al.,

2015). Early research on the CSM framework describes how patients organize their beliefs into five key illness perception constructs. These include beliefs related to: (1) *identity* – a patients name or label of their illness and the symptoms associated with it (e.g. prostate cancer, tumor), (2) *cause* – patients perception of the determinants or cause of their illness (e.g. hereditary, age, poor diet), (3) *consequences* – the perceived short and long-term impact the illness may have on the patient's life (e.g. life-threatening, changes in physical functioning, economic impacts), (4) *timeline* – the patients' perception of how long their illness will endure (e.g. chronic, acute), and (5) *control* – the belief that treatment, intervention, or what they themselves can do to improve the course of the illness (e.g. curable, incurable) (Broadbent et al., 2006).

According to the CSM, these components construct illness perceptions that guide the patients coping strategies and self-management behaviours, which in turn impacts their health outcomes, such as psychological distress (Leventhal et al., 2016). Coping and self-management are two inter-related and complex concepts closely associated with illness perceptions. Coping focuses on how challenges can be managed through internal and activity-based strategies, whereas self-management, a newer and broader concept, focuses on the things that people do or do not do to manage daily life with their condition, and it also incorporates both emotional and role management (Audulv et al., 2016). Self-management recognizes people as experts in their own care and management, and it involves a person having an active role and awareness in their recovery (Foster et al., 2007). Many studies, since Leventhal first proposed the CSM, have shown the association between illness perceptions, coping, and self-management. A meta-analysis of studies based on the CSM showed that patients of different chronic conditions who

perceived an illness to have serious consequences, a long timeline, and yielding many symptoms had more negative coping behaviours, whereas perceptions of greater control are associated with more positive coping behaviours (Hagger & Orbell, 2003). A more recent systematic review focusing solely on cancer patients also found associations between coping behaviours and illness perceptions (Richardson et al., 2017) while another systematic review found a correlation between self-management behaviours and illness perceptions (Breland et al., 2020). The CSM shares many similarities with other frameworks related to stress and coping, such as Lazarus and Folkman's (1984) Transactional Model of Stress, however the CSM differs by its assumption that cognitive and emotional responses interact and occur in parallel instead of in subsequent steps or stages, and it has been developed specifically to consider coping in response to an illness or health threat, as opposed to other stressful events. Therefore, according to the CSM, a patient perceives a threat to their health, forms a set of personal beliefs around the threat, develops a plan to cope and manage the threat, and then constantly re-assesses that plan as their perceptions change (Horne & Weinman, 1998).

The measurement of illness perceptions was often initially captured by researchers using semi-structured interviews (Meyer et al., 1985). Since then, self-reported, standardized questionnaires have been developed, the first being the 38-item Illness Perception Questionnaire (IPQ) (Weinman et al., 1996). This was followed by the Illness Perception Questionnaire-Revised (IPQ-R), which added an additional 48 items and new subscales (Moss-Morris et al., 2002). Beyond the core constructs of identity, cause, consequences, timeline, and control first proposed in the CSM, the IPQ-R introduced the dimensions of illness coherence and emotional representations (Dempster

et al., 2015). Illness coherence, the extent to which the patient understands and perceives their illness in a coherent way, provides insights into the patient's comprehension of their condition (Dempster et al., 2015). The emotional representations subscale delves into patients' emotional responses and concerns regarding their illness. This emotional component of illness perception is increasingly recognized as a vital factor influencing various aspects of health, including engagement with work and sickness absence across a spectrum of illnesses including cancer (Awasthi & Mishra, 2010; Hopman & Rijken, 2015; de Castro et al., 2012). Patients who have a negative perception of their disease have more functional and emotional insufficiencies in later stages of cancer, and their recovery process is slower than that of other patients (Scharloo et al., 2005; de Catro et al., 2012). While not traditionally encompassed by the CSM, these emotional dimensions and the understanding of illness introduced with the IPQ-R can significantly impact individuals' coping strategies, self-management behaviors, and health outcomes, further highlighting the relevance of assessing them in studies exploring the influence of illness perceptions.

The Brief Illness Perception Questionnaire (B-IPQ), a reduced 8-item tool, is now frequently used as a rapid assessment of illness perceptions (Broadbent et al., 2006). The shorter B-IPQ uses a single item for each of the seven previously aforementioned illness perception constructs (control is split into two items to assess personal control and treatment control). This significantly reduces the burden of time on the participant and a systematic review of the B-IPQ found it to have good psychometric properties, including good concurrent validity with gold-standard quality of life measures (*r* range 0.17 – 0.49) (Broadbent et al., 2015). The B-IPQ was also found to have good test-retest reliability

correlation coefficients at 3 weeks (0.48-0.70) and 6 weeks (0.42-0.75), and it is correlated with the longer IPQ-R (0.32-0.62) (Broadbent et al., 2006).

Other than the IPQ and its revisions or derivatives, the use other measurement tools to assess illness perceptions is rare. Other measures do exist to capture similar and specific illness perception constructs, such as personal control or identity. For example, the Multidimensional Health Locus of Control Scale is commonly used to capture a patients perceived health beliefs related to personal and external control (Wallston et al., 1978). However, no other tools capture the full range of perception constructs as proposed in the CSM (identity, cause, consequences, timeline, and control), making the B-IPQ a good option to rapidly assess a range of illness perceptions and be included as a secondary outcome in studies such as this one here.

2.2.1 Illness Perception and Cancer

Negative illness perceptions have been shown to be significantly associated with higher psychological distress in patients with cancer of the bladder (Zhang et al., 2020), breast (Zhang et al., 2017), lungs (Tian et al., 2022), esophagus (Dempster et al., 2011) and head/neck (Zhang et al., 2018). Yet, the relationship between illness perceptions and psychological distress in PC patients specifically is less clear. Studies have shown that illness perceptions in PC patients do predict concepts related to psychological distress, including emotional well-being (Traeger et al., 2009) and quality of life (Akin-Odanye et al., 2021; Ashley et al. 2015). Illness perceptions have also been shown to be modifiable and thus interventions that can enhance the illness perceptions of PC patients have been deemed to be much needed (Akin-Odanye et al., 2021). While previous research has

implemented and assessed psycho-educational and social support interventions to improve illness perceptions in cancer patients, the interventions were often limited in the breadth of their components and often too short to understand the longer-term effects beyond a few weeks or months (Pourfallahi et al., 2020). Studies have shown that cancer patients who have more social support and feel less isolated have better illness perceptions (Faraci et al., 2022), suggesting interventions that include elements to improve patients' relationships or offering group and peer-to-peer support opportunities could enhance illness perceptions. Other components or elements that reduce the negative treatment symptoms the patient is experiencing or make the patient feel more in control of their illness could have the potential to improve their illness perceptions, and as a result, their health outcomes.

As previously mentioned, advancements in PC diagnosis and treatment have led to an increasing number of PC patients surviving in the long term. However, cancer survivors often grapple with enduring challenges related to their physical and psychological well-being, as well as a diminished quality of life, as the lingering effects of prostate cancer treatment can persist throughout their lifetime (Davis et al., 2014). Additionally, PC survivors frequently face substantial coping demands stemming from the residual effects of cancer and its treatments (Zhang et al., 2016). By establishing connections between prostate cancer survivors' perceptions of their illness and their ability to adapt to these challenges, we can gain valuable insights that can guide the development of cost-effective, precisely targeted interventions (Ilie et al., 2020; Ilie et al., 2023). Such interventions can help minimize stress and enhance the quality of long-term survivorship care (Zhang et al., 2016). In light of these findings, fostering a positive shift

in the way PC patients perceive their illness may empower them to take charge of their self-management, address the emotional turmoil associated with their condition, and effectively manage the daily stress that often accompanies their illness.

2.3 SELF-EFFICACY FRAMEWORK

In Social Cognitive Theory, Bandura (1997) argues that an individuals perceived self-efficacy contributes to how they behave in regard to self-managing their illness. Self-efficacy is defined as the belief or confidence in one's capacity to execute certain behaviors in order to achieve specific outcomes or goals (Bandura, 1997). The framework explains how patients with the same illness, prognosis, knowledge, and general characteristics can vary greatly in their ability to manage the symptoms and impacts of their illness based on these self-efficacy beliefs. How confident individuals are in their ability to act and implement behaviours to improve their health outcomes determines how they act, as in what self-management practices they execute, the effort and intensity of their actions, and how long these actions continue (Bandura, 1997; White et al., 2017). For example, a PC patient who feels highly confident in their ability to do things besides having surgery to improve the impact of their cancer, will be more likely to adhere to health-promoting activities such as an exercise or smoking cessation regime, while another patient with low confidence will not be motivated to execute these health-promoting activities. Both patients may have the knowledge and expectation to do the behaviour, but one may lack the self-efficacy to do so. Therefore, similar to illness perceptions, self-efficacy perceptions are a way through which effective self-management can be reached, and effective self-management then leads to improved health outcomes that the behaviours have an ability

influence (Lorig & Holman, 2003; Lorig et al., 1989). It is also important to note that perceptions of self-efficacy are situation specific, and they are not a personality trait (Bandura, 1997). That is, patients may have high self-efficacy related to managing their symptoms while having different self-efficacy beliefs for a different task, and these beliefs can change over time.

Numerous tools to assess self-efficacy quickly and conveniently are available. Many general cancer-specific scales have been developed and evaluated (Merluzzi & Martinez Sanchez, 1997) as well as scales specifically for men with PC (Lepore & Helgeson, 1999). There are also scales that focus on certain domains of self-efficacy. For example, the target of the Communication and Attitudinal Self-Efficacy Scale is, as its name suggests, communication and attitudinal self-efficacy specifically (Wolf et al., 2005). Non-cancer-specific measures are also frequently used in studies of individuals with cancer. The generalized self-efficacy scale (Schwarzer R. & Jerusalem, 1995) has been a highly influential scale for decades, while the Self-Efficacy for Managing Chronic Disease Scale (SEMCD) is another commonly used scale to measure self-efficacy in a range of chronic health conditions (Lorig et al., 1989). The SEMCD, initially designed in an intervention based on Bandura's (1989) theory, is a short 6-item scale that captures illness management-specific self-efficacy. The SEMCD has been used extensively in trials of self-management type programs and it is the measure of self-efficacy included in the methods of this thesis.

Self-efficacy has been found to predict depression and quality of life in cancer survivors (Philip et al., 2013; Heckman et al., 2011). Self-efficacy is also associated with the concepts of the aforementioned CSM, as a relationship between poor self-efficacy and

more threatening illness perceptions in cancer patients has been shown (Foster et al., 2015).

Without intervention, one study found PC patients self-efficacy to significantly decline six

months after their diagnosis (Paterson et al., 2015). Bandura (2008) argues there are

numerous ways to improve self-efficacy, especially through 'mastery experiences', social

modelling, and social persuasion. Thus, interventions that target these concepts may be key

to promoting self-efficacy. With the growing prominence of self-efficacy theory in the

context of cancer patients, studies assessing various types of interventions for supporting

PC patients have examined self-efficacy and found positive effects (McCaughan et al.,

2013; Yang et al., 2021). Although, findings from a systematic review have indicated the

need for larger, better reported studies in this area (Moore et al., 2015). Thus, obtaining a

greater understanding of self-efficacy in PC patients and how it potentially effects health

outcomes through an intervention such as PC-PEP is warranted.

2.4 STRESS AND HEART RHYTHM COHERENCE

2.4.1 Stress and Prostate Cancer

Stress is a complex concept that can generally be defined as a situation in which

environmental demands surpass one's psychological and physiological capacity to cope

with the demand (Cohen et al., 2016). Stressors are specific, observable events that can

lead to a stress response. In those diagnosed with PC, navigating the consequences of

treatment decisions, changes in urinary and sexual function, as well as the fear of

recurrence can all be stressful and prolonged which lead to chronic stress responses.

Chronic stress, associated with a deregulation of the hypothalamic-pituitary-adrenal axis

and subsequent increases in cortisol and catecholamines, can further harm the body both

physiologically and psychologically (Krizanova et al., 2016). Particularly, depression and

anxiety, closely associated with chronic stress, are both especially high amongst PC patients and survivors (Brunckhorst et al., 2021; Ilie et al., 2020; Moodie et al., 2020; Watts et al., 2014). The management of stress is also an essential component of disease management, and increased stress is found to be barrier to adequate self-management (Schulman-Green et al., 2016).

For decades, stress has been suggested to not only be associated with cancer incidence, but also progression and cancer metastasis (Mravec et al., 2020; Udumyan et al., 2019). In animal studies, stress has been shown to modify the expression of prostate tissue genes (Flores et al., 2017; Hassan et al., 2013) and numerous mechanisms of stress's impact on cancer progression have been identified, including immune suppression and increased inflammation (Dai et al., 2020; Armaiz-Pena et al., 2009). Clinically, a growing body of research has assessed perceived stress in men with PC and the effect it has on oncological outcomes, most notably survival. One study surveyed 4105 Swedish men who were diagnosed with localized prostate cancer and received treatment and found those who reported the highest levels of perceived stress had 1.6 (CI: 1.05-2.63) times the odds of prostate-cancer specific mortality when compared to those with the lowest reported stress levels (Jan et al., 2016). Another study found that prostate cancer patients with low resilience to stress had 2.2 (CI: 1.04-4.62) times the odds of mortality than those with a high resilience to stress, suggesting intervention is particularity important for the former group of patients (Udumyan et al., 2019). Furthermore, cancer recurrence, another key oncological outcome that is also a major stressor in PC survivors, was found to be moderately associated to psychological stress in a recent systematic review (Oh & Son, 2021).

2.4.2 Heart Rate Variability and Heart Rhythm Coherence

Stress can be measured by psychological, perceptual, or physical responses. Most studies that have examined stress in PC patients have traditionally used self-reported questionnaires, such as at the Perceived Stress Scale, that are psychological indicators of stress. These widely used methods of assessing stress have many benefits in research because they are cheap and easy to administer, generally well-validated, and pose little burden on patients compared to other more invasive methods (Crosswell & Lockwood, 2020). However, objective measures also provide interesting information on the physiological response to stress. Many studies have focused on the body's biochemical response to stress by measuring, for example, levels of salivary cortisol, the primary "stress hormone". These studies have found cortisol levels to be higher in men with PC than those without PC (Fabre et al., 2016; Olooto et al., 2021).

More recently, advancements in technology have allowed for an increasing amount of non-intrusive physiological measures to be assessed. One of these measures is heart rate variability (HRV), which is the variation in time between consecutive heart beats (McCraty & Shaffer, 2015). The normal resting sinus rhythm of a healthy heart is in fact not entirely regular, but consists of slight variations (Shaffer et al., 2014). This irregularity, is influenced by the activity of the autonomic nervous system, as it reflects the balance between the competing parasympathetic (inhibitory) and sympathetic (excitatory) branches (Berntson et al., 1997). Stress can influence HRV through this autonomic response. When we're stressed, the sympathetic nervous system becomes more dominant, leading to an increased heart rate and decreased HRV (Kim et al., 2018). This is a natural response designed to prepare the body for quick action in response to

perceived threats. On the other hand, when we're relaxed and unstressed, the parasympathetic nervous system prevails, leading to a slower heart rate and increased HRV (Kim et al., 2018). Higher HRV is considered good for several reasons. HRV has been found to be a predictor of health status, with low HRV being associated with an increased risk of death and coronary heart disease (Dekker et al., 2000). Higher HRV is also associated with better resilience to stress, while lower HRV is an indicator of autonomic inflexibility (Thayer & Lane, 2000). Individuals with higher HRV can adapt to stressors more effectively and recover faster after experiencing stress (Heiss et al., 2021). Lastly, lower-resting state HRV is associated with major depression (Koch et al., 2019) and it has been found to be an indicator of vulnerability to depression in those at risk of developing the condition (Dell'Acqua et al., 2020). In summary, stress affects HRV by altering the balance between the sympathetic and parasympathetic nervous systems, reducing HRV. A higher HRV is considered beneficial as it signifies better stress resilience and more favorable overall physical and emotional health.

A growing body of research suggests that stress can decrease HRV, and the literature supports the use of HRV as an objective, reliable measure of stress (Kim et al., 2018). Systematic reviews have also found that HRV may play a prognostic role in cancer, and patients with higher HRV, have longer survival than those with lower HRV (Kloter et al., 2018; Zhou et al., 2016), which brings forward the importance of HRV assessment in PC patients as both a measure of stress and mental health, and potentially a biomarker for assessing cancer progression and outcomes. Despite the growing use of these assessments, few studies have collected HRV based data in PC patients, and none to

our knowledge have collected them after a multidimensional lifestyle and self-management intervention.

Heart rhythm coherence, also referred to as physiological coherence, is a measure derived from HRV rhythm patterns (McCraty, 2022). Heart rhythm coherence primarily assesses the synchronization and rhythmicity of heart rate patterns, specifically the coherence between heart rate and respiration rate, and it can easily be obtained using a non-invasive device (McCraty, 2022). As with HRV, when heart rhythm coherence is higher, it indicates a more balanced and relaxed autonomic nervous system, which is typically associated with reduced stress and better emotional regulation (McCraty & Shaffer, 2015; McCraty et al., 1995). So, while heart rhythm coherence itself doesn't measure stress directly, it can serve as an indirect indicator of stress levels and overall physiological well-being. Higher heart rhythm coherence is generally associated with lower stress levels, while lower cardiac coherence may suggest increased stress or autonomic imbalance (McCraty & Zayas, 2014). An intervention by Burch et al. (2020) that prescribed heart rhythm biofeedback to PC patients lead to improved heart rhythm coherence post intervention. This study was limited, however, by a small sample and a short intervention duration, highlighting the need for longer studies, with larger sample sizes, that assess changes in heart rhythm coherence following interventions for PC patients.

Given the significant impacts a PC diagnosis has on mental stress and overall health, prioritising the assessment of interventions designed to reduce these impacts is well-timed and necessary. Men with PC who participated in health promotion interventions have shown statistically significant reductions in perceived stress (Walsh et

al., 2023), and participants show a strong desire to participate in these lifestyle interventions, especially shortly after receiving their diagnosis (Green et al., 2014). Numerous lifestyle interventions aimed at reducing stress have been assessed in PC patients, encompassing a broad range of elements, most commonly focusing on meditation, exercise, or diet (Menichetti et al., 2016). A systemic review showed that meditation interventions led to significant reductions in symptoms of psychological stress and depression in cancer patients (Araujo et al., 2019) while a randomized controlled trial found that cancer patients who participated in 15 minutes of mindful breathing exercises for three months has statistically significant reductions in stress compared to controls (Lei Chui et al., 2021). Most of these interventions consist of a single component, while fewer combined multiple components, even despite over a decade of evidence suggesting multi-component interventions are often most efficacious. Jacobsen et al. (2013) found that a combined stress-management and home-based physical activity program for cancer patients was more effective at improving stress related quality of life outcomes, including depression and anxiety, compared to participants receiving only one of either component. Similarly, Zuniga et al. (2020) found that multi-modal interventions that combined stress reduction with diet and exercise provided the greatest clinical benefit to PC patients.

Overall, the current literature highlights psychological stress as a negative impact following a PC diagnosis and suggests that targeting psychological stress through comprehensive, multi-component interventions should be considered as an important adjunct to clinical cancer care (Antoni & Dhabhar, 2019).

2.5 PROSTATE CANCER PATIENT EMPOWERMENT PROGRAM

The Prostate Cancer-Patient Empowerment Program (PC-PEP), is a multifaceted lifestyle intervention developed to specifically address the most common unmet needs and survivorship issues reported in PC survivors. The program targets multiple lifestyle elements, including daily stress reduction through meditation, diet improvement, strength and aerobic exercise, pelvic floor exercises, and social connection. While it is impossible to separate the influence of any one individual component of the program on outcomes, the stress reduction/meditation component of the program is of particular relevance to this thesis, as the literature indicates this may play one of the largest roles in influencing the physiological markers of stress (Pascoe et al., 2017). The details of this component, as well as a full description of the intervention is described in further detail in section 4. PC-PEP has been shown to reduce psychological distress in recently diagnosed PC patients undergoing curative treatment (Ilie et al., 2023), however analysis of the underlying mechanisms explaining this association remains unknown. Understanding potential mediating factors could provide useful information on how and why the intervention was successful in reducing psychological distress.

CHAPTER 3: OBJECTIVES

The first objective was to examine whether participants randomized to PC-PEP had significantly better self-efficacy, illness perceptions, and heart rhythm coherence post-intervention, compared to controls. The second objective was to examine if better self-efficacy, illness perceptions, and heart rhythm coherence post-intervention mediated the relationship between participating in PC-PEP and reduced psychological distress. The third objective was to examine whether treatment modality moderated any mediating effects (Figure 1).
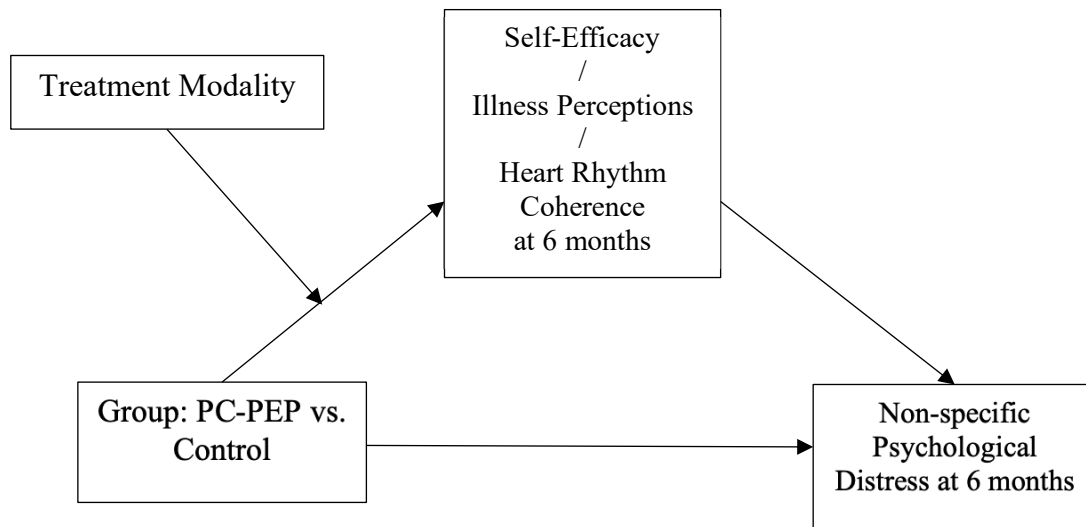
Figure 1. Diagram of the moderated mediation pathway for single mediator models of self-efficacy, illness perceptions and heart rhythm coherence with treatment modality as a moderator in the causal connection between group participation and psychological distress.

These objectives were addressed with the following research questions:

(1) Does the Prostate Cancer Patient Empowerment Program (PC-PEP), when compared to standard care, result in improved self-efficacy, perceptions of illness, or heart rhythm coherence in men diagnosed with localized prostate cancer, from the start of the study (baseline) to six months (post-intervention)?

(2) Do improvements in self-efficacy, illness perceptions, or heart rhythm coherence following the intervention mediate the relationship between the Prostate Cancer Patient Empowerment Program (PC-PEP) intervention and reductions in non-specific psychological distress from baseline to six months?

(3) Does the presence and extent of any observed mediating effects depend on whether participants received radical prostatectomy or radiation therapy as their treatment for prostate cancer?

CHAPTER 4

The Mediating Role of Self-efficacy and Illness Perceptions in the Relationship Between PC-PEP and Improved Mental Health Among Men with   Localized Prostate Cancer: A Secondary Analysis of a Randomized Controlled Trial

Cody MacDonald[1], Gabriela Ilie[1,2,3], George Kephart[1,4,5], Robert David Harold Rutledge[3]

[1] Department of Community Health and Epidemiology, Dalhousie University
[2] Department of Urology, Dalhousie University
[3] Department of Radiation Oncology, Dalhousie University
[4] School of Health Administration, Dalhousie University
[5] Department of Nursing, Umeå University, Umeå, Sweden

4.1 INTRODUCTION

Prostate cancer (PC) is the most common cancer among males (Sung et al. 2021), representing approximately one fifth of all male diagnoses (Canadian Cancer Statistics, 2022). As an age-related disease, the incidence of PC is anticipated to rise as life expectancies increase (Ruan et al., 2023). Despite high survival rates compared to other malignancies, the focus on quality of life remains paramount, given the substantial prevalence of depression, suicide, and psychological distress in men with PC, which can persist long after diagnosis (Canadian Cancer Statistics, 2021; Crump et al., 2023; Fervaha et al., 2019; Ilie et al., 2020; Moodie et al., 2020). This underscores the necessity for effective approaches that alleviate the psychological impacts of PC, spanning from the onset of diagnosis through long-term survivorship.

A growing body of research indicates that lifestyle self-management interventions tailored for PC can enhance mental health and quality of life (Menichetti et al., 2016; Dovey et al., 2023; Martín-Núñez et al. 2023a). The Prostate Cancer Patient Empowerment Program (PC-PEP) embodies one such intervention, offering a multifaceted approach that prioritizes numerous aspects of well-being, including physical activity, healthy nutrition, relaxation/stress reduction techniques, pelvic floor muscle training, human connection, and peer support. The program content is disseminated through daily emails and videos as well as monthly videoconferences over 6 months, providing consistent encouragement and support. The efficacy of the PC-PEP at reducing psychological distress, depression, and anxiety compared to standard care has been previously reported (Ilie et al., 2023), however, the specific mechanisms or pathways underlying this relationship remain to be fully understood.

Self-management encompasses the day-to-day things people do, or do not do, to manage their conditions, recognizing people as experts in their own care (Audulv et al., 2016; Foster et al., 2007). To gain the skills and knowledge to self-manage most effectively, patients often need the support of others (Dwarswaard et al., 2016). The PC-PEP equips PC patients with knowledge, skills, and support, all crucial elements for productive self-management. Moreover, social cognitive theory and the common-sense model of self-regulation (CSM) posit enhancement in self-efficacy and illness perceptions, respectively, are essential for achieving effective self-management that leads to desired outcomes, such as improved mental health (Bandura, 1986; Leventhal et al., 1980).

Self-efficacy has been defined as the belief in one's capacity to execute behaviors necessary to produce specific outcomes (Bandura, 1997). Greater self-efficacy has been associated with better management of cancer related side-effects and challenges (Chirico et al., 2017; Merluzzi et al., 2001). In regard to the impact on mental health, an inverse relationship between self-efficacy and psychological distress in cancer patients has been found, suggesting that enhancing self-efficacy could be a key strategy in alleviating psychological distress (Chirico et al., 2017; Martín-Núñez et al., 2023a). Self-efficacy can be increased through mastery experiences, social modeling, and social persuasion (Bandura, 2008), all of which are targeted in the PC-PEP. For example, participants are challenged to set goals and follow exercises that can progressively get more challenging throughout the program (mastery experiences), they are encouraged to connect with other participants in the program and mentors weekly (social modeling), and they receive daily encouragement and words of motivation (social persuasion). The PC-PEP also incorporates numerous pieces of technology, including daily emails and videos, text message reminders,

website and online resources, and a biofeedback device used in companion with a smartphone app. DiClemente et al. (2019) recommend that health promoting programs better utilize today's widespread technologies, to have greater success at influencing behaviour change and to deliver more tailored interventions that better meet the needs of patients. While self-management programs in general have been shown to improve self-efficacy, those that incorporate new technologies, such as PC-PEP, can break down barriers to access and help better sustain behaviour change, leading to more success in improving self-efficacy (Farley, 2019).

The CSM highlights the importance of individual illness perceptions in self-management (Broadbent et al., 2006; Leventhal et al., 2016). These perceptions include views on the consequences, timeline, personal and treatment control, identity, cause, and emotional impact of the illness. Negative illness perceptions have been found to be significantly associated with psychological distress and reduced quality of life in cancer patients (Zhang et al., 2020; Tian et al., 2022; Akin-Odanye et al., 2021; Ashley et al. 2015), therefore, modifying illness perceptions may be a viable approach to improve health outcomes. The components of PC-PEP provide an avenue for patients to gain a greater sense of personal control over the impacts of their PC diagnosis, and gain knowledge that could influence how they perceive various aspects of the disease. While there are many commonalities between the CSM and self-efficacy framework, the integration and use of both frameworks has been supported to better understand self-management and improve health outcomes (Breland et al., 2020).

An additional component of the PC-PEP intervention is heart rate variability (HRV) training using a biofeedback device from HeartMath Inc., aimed at improving heart rhythm

coherence—a physiological state of heart rate pattern synchronization (McCraty, 1995; McCraty & Zayas, 2014). While this training has been associated with reduced stress and better emotional regulation (McCraty & Shaffer, 2015; McCraty et al., 1995), its impact on heart rhythm coherence and mental health outcomes in a comprehensive lifestyle intervention like PC-PEP remains to be thoroughly investigated, as indicated by mixed results in smaller-scale studies (Burge et al., 2023; Burch et al., 2020).

Considering these factors, we hypothesized that self-efficacy, illness perceptions, and to a lesser extent, heart rhythm coherence, could predict psychological distress and partly explain the efficacy of PC-PEP at reducing it. Investigating these variables under varying conditions, such as different treatment modalities for PC, could provide deeper insights into the mechanisms of action (Preacher et al., 2007; Donovan et al., 2016). Therefore, this secondary analysis of the PC-PEP trial aims to assess whether the intervention (A) enhances self-efficacy, illness perceptions, and heart rate coherence, (B) reduces psychological distress through these factors (mediation), and (C) varies in its effectiveness based on the patient's treatment modality (moderated mediation).

4.2 METHODS

This is a secondary analysis of data from the PC-PEP trial, a single-centre, prospective, delayed crossover, randomized controlled trial comparing the effects of PC-PEP to standard-of-care in men diagnosed with PC and scheduled for curative treatment (Ilie et al., 2023). The study was registered with ClinicalTrials.gov (NCT03660085), received ethical approval by the Nova Scotia Health Research Ethics Board (1024822), and was conducted in accordance with the Declaration of Helsinki.

Participants

Participants were recruited from the Departments of Urology and Radiation Oncology at the Queen Elizabeth II Health Sciences Centre in Halifax, Nova Scotia, Canada from December 2019 to January 2021. Advertisements were also shared with PC support groups, and self-referrals were accepted from interested participants throughout the Maritime provinces of Canada. Eligibility criteria included: biopsy-proven PC diagnosis; age 18 or older; scheduled to receive curative treatment (either radical prostatectomy, primary or salvage radiation therapy) within 6 months of enrollment; approval from study physician for safety and ability to participate in low to moderate physical activity; an email address, computer/smartphone/tablet, and daily internet access to receive the intervention; able to read and understand English; controlled systolic blood pressure < 160 and diastolic pressure < 90; and willing to travel to the study centre for 3 study visits (at baseline, 6 months, and 12 months).

Randomization and Data Collection

Figure 2 illustrates the progression of participants through the study, adhering to the CONSORT 2010 guidelines. Initially, 171 potential participants were screened, 3 of which were ineligible and 28 chose not to participate, leading to a total of 140 participants being randomly allocated to either the intervention or the control group. Post-allocation, one participant withdrew before starting the intervention. An addition 11 participants were excluded from the analysis as they did not undergo curative treatment within 6 months of enrollment, thereby not meeting the post-randomization criteria for inclusion in the study.

Participants meeting eligibility criteria who provided informed consent were asked to complete an online baseline study survey, managed using Research Electronic Data

Capture (REDCap) hosted at Nova Scotia Health (Harris et al., 2019). After completion of the baseline survey, participants attended an in-person baseline study visit to collect all remaining physical measures, including HRV outcomes. Data was collected by a trained research coordinator and certified exercise physiologist. Participants were then randomly allocated to the intervention or waitlist control group.

CONSORT 2010 Flow Diagram
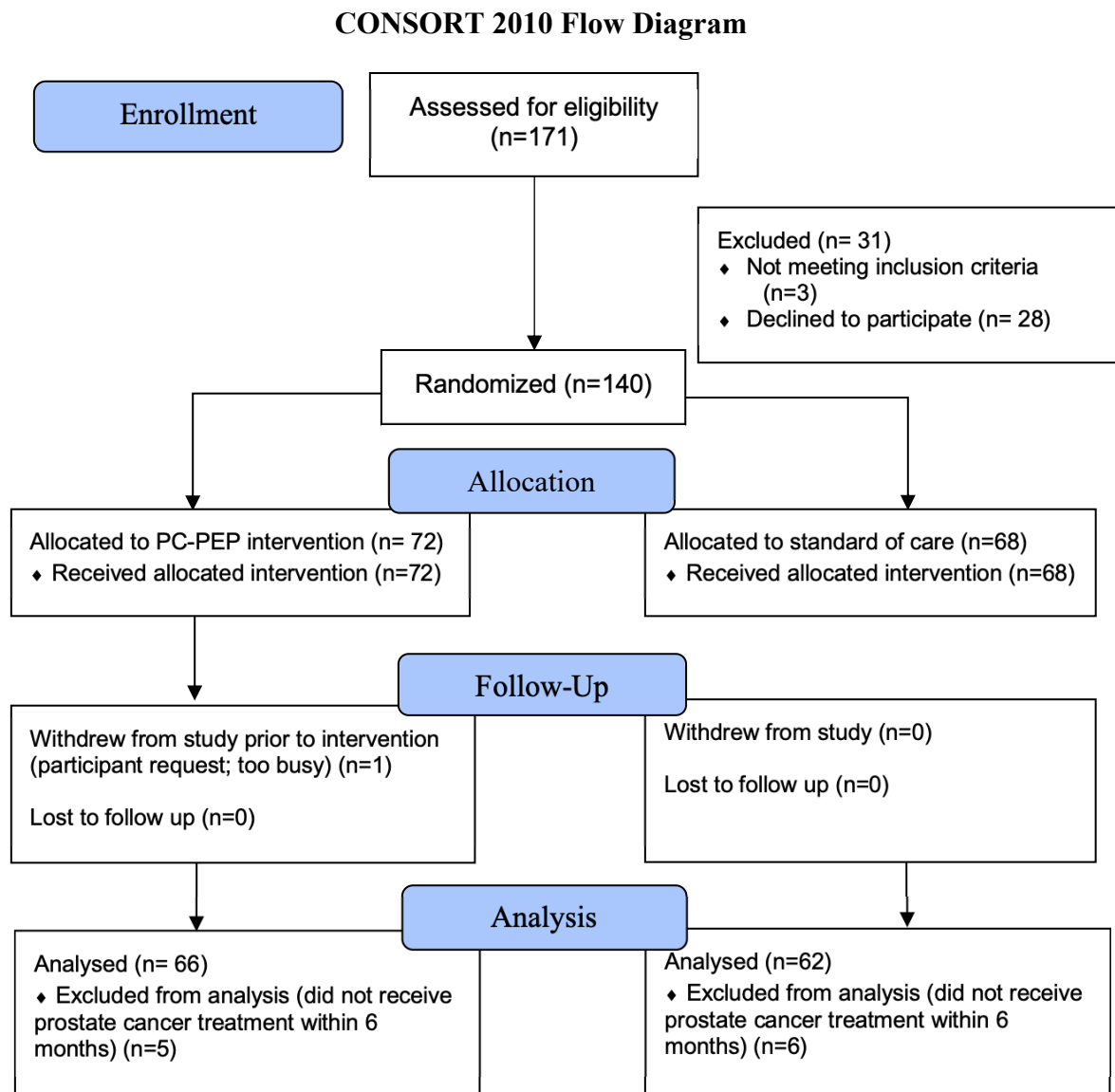
Figure 2. CONSORT 2010 flow diagram. CONSORT = Consolidated Standards of Reporting Trials; PC-PEP = Prostate Cancer Patient Empowerment Program.

Using a fixed block design, randomization was stratified by presence of psychological distress (Kessler Psychological Distress Scale [K10] ≥ 20 or <20) at baseline, curative treatment type (radical prostatectomy, radiation therapy, or salvage radiation post-surgery), and presence or absence of hormone therapy in the patient's treatment plan. This randomization sequence was kept concealed from the research staff responsible for data collection and participant management. Participants were then scheduled for follow-up study visits at the 6-month mark to assess progress and collect further data.

Intervention

The intervention and protocol of the PC-PEP randomized trial are described in detail elsewhere (Ilie et al., 2023). Briefly, participants assigned to the intervention were sent an automated email daily for 6 months, containing a 3–5-minute video message from the principal investigator (GI) and study physician (RR) that promoted healthy lifestyle behaviours, provided daily encouragement, and prescribed the intervention activities.

Key components of the intervention included: (A) *relaxation/stress reduction* – participants were provided a heart rate variability biofeedback device (the Inner Balance or emWave2 by HeartMath Inc.) and asked to use it daily by either following a 10-minute guided mindfulness meditation video or the Quick Coherence® technique (HeartMath Inc., n.d.) that encourages slow, deep breathing matched to a breath pacer along with a sincere attempt at experiencing regenerative feelings such as appreciation or care; (B) *nutrition* – dietary behaviour changes were encouraged, such as increasing fruit and vegetable intake and reducing red meat, (C) *physical activity* – participants are encouraged to exercise daily to reach a minimum of 150-300 minutes per week of aerobic activity and at minimum 2

days of resistance strength training.; *(D) pelvic floor muscle training* – participants were educated by a pelvic floor nurse specialist and asked to follow guided videos for 10 minutes, 3 times per day that were progressively more challenging each week; (E) *relationships and intimacy*– recommendations on addressing intimacy and sexuality issues, as well as tips to improve connections and relationships. An optional one-hour social support videoconference was also hosted monthly, and participants could opt-in to connect with two co-participants and encouraged to call each other weekly as a form of peer-to-peer patient support. Participants also received weekly compliance surveys to report minutes of each activity and to encourage adherence.

Outcome Measures

Primary Outcome

Non-specific Psychological Distress

Non-specific psychological distress was assessed using the Kessler Psychological Distress Scale (K10) (Kessler et al., 2003). The K10 comprises 10 items, each of which are rated from 1 to 5, on 5-point Likert Scale, to assess symptoms of depression and anxiety in the last month (see Appendix C for list of items). The summary score can range from 10 to 50, with higher scores indicating worse psychological distress (Andrews & Slade, 2001). Cut-off points have been established, with a total score of <20 indicating no significant psychological distress, 20-24 indicating mild distress, 25-29 indicating moderate distress, and 30-50 indicating severe levels of distress (Andrews & Slade, 2001). The use of K10 in cancer patients has been found to have good internal consistency (Cronbach's alpha = 0.914) (Thakre et al., 2022).

Mediator Variables

Self-efficacy

Self-efficacy was evaluated using the Self-Efficacy for Managing Chronic Diseases 6-item scale (SEMCD-6) developed by Lorig et al. (2001). This scale employs a 10-point Likert format, where response options for each item range from "not at all confident" (1) to "totally confident" (10), as detailed in Appendix A. The SEMCD-6 Scale has demonstrated high internal consistency in other studies, with Cronbach's alpha values ranging from 0.88 to 0.91, and it is sensitive to detecting changes over time (Ritter & Lorig, 2014). The total score is calculated by averaging the scores of all items, with higher averages indicating greater self-efficacy. The Chronbach's alpha coefficient for our sample was 0.926, suggesting good internal consistency.

Illness Perceptions

Illness perceptions were assessed using the Brief Illness Perception Questionnaire (B-IPQ) (Broadbent et al., 2006). The B-IPQ includes 8 items, each of which captures a unique, individual dimension of illness perception, on a linear 0-to-10-point response scale (see Appendix B). Higher scores represent a more negative perception of illness for 5 of the items [(1) consequences, (2) timeline, (5) identity, (6) coherence (8) concern] and a more positive perception on 3 items [(3) personal control, (4) treatment control, (7) emotional representation]. While the domains of illness perceptions were analysed using their single-item, a continuous composite score was also obtained by reversing the 3 latter items and adding all scores together. Higher composite scores on B-IPQ indicates that a person overall feels more threatened by the illness (Broadbent et al., 2006). However, as reported by Broadbent et al. (2015), the composite score of the B-IPQ may not be valid for

certain illnesses depending on how the unique items are related, and thus must be reported with caution. The B-IPQ has been found to have acceptable predictive and discriminant validity, as well as good test-retest reliability, across multiple language versions and populations (Broadbent et al., 2015). Studies have shown that the B-IPQ has good concurrent validity with the longer IPQ-Revised, quality of life, and it is sensitive to change (Broadbent et al., 2015). The tool has also shown to be reliable and valid in measuring illness perception in various medical conditions (Kuiper et al., 2022; Zhang et al., 2017). Pearson's correlations for test-retest reliability were generally acceptable (range 0.5–0.7) (Broadbent et al., 2006). For our sample, the Chronbach's alpha coefficient was 0.488, suggesting poor internal consistency.

Heart Rhythm Coherence

Data was captured using the Inner Balance (wired model) biofeedback device produced by HeartMath Inc. The instrument uses HRV to derive readings of heart coherence by analyzing the highest peak in the 0.04 Hz to 0.26 Hz range of the HRV power spectrum, followed by a calculation of the integral in a 0.030 Hz wide window that is centered on the maximum peak, and lastly calculating the power of the full spectrum. Participants underwent a 10-minute data collection session that captured the average coherence score for the session. A higher coherence score represents a more coherent heart rhythm and is associated with lower stress and a more positive emotional state (Tiller et al., 1996; McCraty et al., 1995).

Covariates

Drawing from the existing literature on variables associated with the study outcomes (Kurian et al., 2018; World Health Organization, 2017; Rice et al., 2018; Luckenbaugh et al., 2022; Spiker, 2014), the subsequent variables have been selected a-priori as predictive covariates: age (continuous), prescribed medication for depression, anxiety or both (coded as 1 for yes and coded as 0 for no), relationship status (coded as 1 for in a relationship and coded as 0 for single), number of days between start of treatment and date of randomization (continuous), type of curative treatment received (coded as 1 for radical prostatectomy and coded as 2 for primary or salvage radiation therapy), and Charlson Comorbidity index score. These chosen variables have been incorporated as covariates due to their demonstrated prognostic relevance for mental health outcomes in the prostate cancer population and alignment with prior research findings.

Statistical Analysis

Statistical analyses were conducted using SPSS version 28.0 (IBM Corp., Armonk, NY, USA). We report baseline demographic characteristics using descriptive statistics, presenting continuous variables as means and standard deviations, and categorical variables as frequencies and percentages. To compare baseline characteristics between groups, we employed independent samples t-tests for continuous variables and chi-square (χ2) or Fisher Exact tests (for small cell counts) for categorical variables. A p-value of less than 0.05 (two-sided) was considered statistically significant. To evaluate the impact of the intervention on non-specific psychological distress, self-efficacy, illness perceptions (including individual domains and composite score), and heart rhythm coherence at 6 months, we performed separate one level linear mixed modeling analyses with an

unstructured covariance structure, controlling for baseline scores for each outcome alongside prognostic covariates. Statistically significant associations identified through this step were then subjected to mediation analysis using the PROCESS macro version 4.2 for SPSS, model 4 (Hayes, 2017). The PROCESS macro uses a traditional mediation method with ordinary least squares regression (Hayes, 2017). This method has been found to have equivalent effect estimates as newer, casual methods, in relatively simple mediation analyses with continuous mediators and outcomes (Rijnhart et al., 2017), and traditional approaches remain the most commonly utilized and reported method of mediation analyses in randomized controlled trials (Vo et al., 2020). This PROCESS macro calculates regression coefficients for four pathways (a, b, c', and c) within the mediation framework. Pathway 'a' examines the relationship between the independent variable (group assignment) and the potential mediator at 6 months (while controlling for baseline mediator scores and prognostic covariates), whereas pathway 'b' assesses the relationship between the potential mediator at 6 months and the outcome (psychological distress) at 6 months, independent of the group, while controlling for baseline measurement for the mediator and the outcome and baseline prognostic covariates. Pathways c' and c represent the direct and total effect of the association between PC-PEP and psychological distress at 6 months, respectively. The indirect effect (mediation effect) is determined by multiplying coefficients from pathways' 'a' and 'b', with its statistical significance assessed using bootstrapped confidence intervals. We chose 95% confidence intervals with 10,000 bootstrap resamples. An indirect effect's confidence interval that does not include zero indicates significant mediation. The proportion of the effect that was mediated was

calculated by dividing the regression coefficient of the indirect effect by that of the total effect to obtain a percentage.

Moderated mediation analyses, using PROCESS macro model 7, investigated whether treatment modality (radical prostatectomy or radiation therapy) modified the mediation effects. Baseline scores for both the outcome and mediator, along with other prognostic covariates, were included as covariates to adjust for pre-intervention effects. All data from self-reported questionnaires were complete, with no missing data. However, due to COVID-19 restrictions that limited some in-person study visits, approximately 11% of heart rhythm coherence data was missing at baseline, and 25% at 6 months. We conducted complete case analyses for these measures, which led to the exclusion of 37 cases from these specific analyses.

4.3 RESULTS

Participants in the sample were predominately white, retired, and married or in a relationship. At baseline, the average age of participants was 66 years, ranging from 50 to 82 years, and the group was predominantly overweight, with a mean Body Mass Index (BMI) of 29.9 (SD = 6.36). Approximately half of the sample received radical prostatectomy during the study while the other half received radiation therapy or salvage radiation following biochemical recurrence after a previous radical prostatectomy. There were no statistically significant differences in baseline characteristics observed between the PC-PEP and waitlist control groups (Table 1).

Table 1. Baseline sample characteristics of participants in the intervention and control groups in the Prostate Cancer Patient Empowerment Program (PC-PEP) Trial.

	PC-PEP (n=66)	Control (n=62)	p-value
Age (years)	65 (6.8)	67 (7.2)	0.7
Race			0.1
White	60 (91%)	61 (98%)	
Black	4 (6.1%)	0 (0%)	
Latino	1 (1.5%)	0 (0%)	
Middle Eastern	1 (1.5%)	0 (0%)	
Other	0 (0%)	1 (1.6%)	
Education			0.4
Less than high school	8 (12%)	6 (9.7%)	
High school or college diploma	27 (41%)	19 (31%)	
University degree	31 (47%)	37 (60%)	
Relationship status			0.063
In a relationship	59 (89%)	61 (98%)	
Not in a relationship	7 (11%)	1 (1.6%)	
Employment Status			0.7
Working full-time	17 (26%)	19 (31%)	
Working part-time	5 (7.6%)	4 (6.5%)	
Retired	43 (65%)	39 (63%)	
Unemployed	1 (1.5%)	0 (0%)	
Annual Household Income			0.7
< $30,000	12 (18%)	10 (16%)	
$30,000 - $79,999	22 (33%)	16 (26%)	
$80,000 - $100,000	12 (18%)	15 (24%)	
> $100,000	20 (30%)	21 (34%)	
Treatment Modality			0.065
Radical prostatectomy (RP)	29 (44%)	33 (53%)	
Radiation therapy	27 (41%)	27 (44%)	
Salvage radiation, post RP	10 (15%)	2 (3.2%)	
Prescribed hormone therapy	27 (40%)	21 (34%)	0.4
Prescribed medication for anxiety and/or depression	12 (18%)	7 (11%)	0.3
Body Mass Index	30.8 (6.8)	29.0 (5.7)	0.1
Charlson Comorbidity Index	0.36 (0.69)	0.39 (0.58)	0.8

Data presented as means with standard deviation (SD) or n (%).

Effect of Group Intervention on Psychological Distress at 6-Months

Linear modeling analysis revealed a statistically significant difference between groups (Control vs. PC-PEP) in non-specific psychological distress at 6 months (p = 0.013) with the mean difference showing higher psychological distress for the control group at 6 months compared to the PC-PEP group (Table 2), while controlling for baseline psychological distress and prognostic covariates.

Effect of Group Intervention on Potential Mediating Variables at 6-Months

Linear modeling analyses revealed significant differences in self-efficacy levels at the 6-month follow-up, with the control group exhibiting statistically significantly lower self-efficacy compared to the PC-PEP intervention group (p = 0.023; see Table 2). The Chronbach's alpha coefficient was 0.926, suggesting good internal consistency.

In regard to the illness perception domains, participants in the control group reported worse perception of personal control over their prostate cancer diagnosis (p = 0.032) and more negative emotional representation (p = 0.026) than those in the intervention group, as detailed in Table 2. These findings suggest that the intervention had a positive impact on two of the subscales of illness perception, participants' perceived control and emotional response to their diagnosis. No other domains within the illness perception measure showed significant differences between the groups at the 6-month mark. The illness perceptions composite sum score was not found to have a significant difference between the two groups at 6 months (p = 0.085).

Additionally, there were no significant differences in heart rate variability (HRV)
Coherence or HRV Achievement outcomes between the intervention and control groups
at 6 months.

Table 2. Observed means (SD) and estimated group (Control vs. PC-PEP) mean
differences at 6 months in primary outcome and potential mediating variables.

	Baseline Observed Mean (SD)		6 month Observed Mean (SD)		6-month Mean Adjusted Difference* (95% CI)	p
	Control	PC-PEP	Control	PC-PEP		
Psychological Distress (K10)	15 (4.1)	15 (5.2)	17 (9.6)	14 (4.9)	3.4 (0.73, 6.007)	**0.013**
Self-Efficacy	7.3 (1.6)	7.6 (1.6)	7.6 (2.2)	8.4 (1.7)	-0.75 (-1.4, -0.103)	**0.023**
Illness Perceptions						
Consequences	3.3 (2.7)	3.1 (2.8)	4.2 (2.8)	3.3 (2.5)	0.78 (-0.106, 1.7)	0.084
Timeline	4.8 (3.3)	4.3 (2.9)	4.3 (3.6)	4.2 (3.8)	-0.15 (-1.4, 1.1)	0.8
Personal Control	3.9 (3.1)	4.7 (2.6)	3.8 (3.1)	5.4 (2.9)	-1.2 (-2.2, -0.102)	**0.032**
Treatment Control	8.6 (1.7)	9.0 (1.3)	8.1 (2.6)	8.7 (1.9)	-0.74 (-1.6, 0.09)	0.080
Identity	1.9 (2.1)	1.9 (2.1)	3.5 (2.6)	2.6 (2.4)	0.83 (-0.093, 1.8)	0.078
Concern	6.1 (3.1)	6.4 (3.1)	4.2 (3.1)	4.3 (3.2)	0.206 (-0.94, 1.3)	0.7
Coherence	7.3 (2.3)	7.2 (2.4)	7.9 (2.1)	7.8 (2.2)	0.008 (-0.58,0.60)	1.0
Emotional Rep.	4.0 (2.9)	4.2 (2.9)	4.0 (3.2)	3.2 (2.5)	1.03 (0.13, 1.9)	**0.026**
B-IPQ Composite Score	30 (12)	29 (13)	31 (15)	26 (14)	4.2 (-0.57, 8.9)	0.085
HRV Coherence	2.8 (1.3)	2.7 (1.3)	2.7 (1.02)	2.7 (1.2)	0.071 (-0.39, 0.53)	0.8
HRV Achievement	318 (138)	317 (149)	315 (119)	310 (137)	9.3 (-45, 63)	0.8

*K10 = Kessler Psychological Distress Scale. B-IPQ=Brief Illness Perception Questionnaire. HRV=Heart Rate Variability. At 6-mo, 62 participants were in the control group and 66 participants were in the treatment group. Observed means at baseline and 6 months are reported. *Linear mixed effects model adjusted for baseline outcome variable, age, relationship status, Charlson comorbidity index, time between trial randomization, treatment, treatment modality, and prescribed medication for anxiety depression or both. Covariance matrix of within subject measurements was unstructured.*

Mediation Analyses

Figure 3 presents the estimated path coefficients derived from bootstrapped simple mediation analyses, conducted using ordinary least squares path analysis through the PROCESS macro (model 4). These analyses investigated the mediating effects of three variables found to be statistically associated with group in the previous linear modelling analyses, on the relationship between group assignment (intervention vs. control) and outcomes of psychological distress and need for clinical treatment at the 6-month follow-up. Specifically, the analyses explored the mediating roles of (a) self-efficacy, (b) personal control as measured by the Brief Illness Perception Questionnaire (B-IPQ) Personal Control, and (c) emotional representation as assessed by the B-IPQ Emotional Representation, all evaluated at 6 months. This structure allowed for a nuanced examination of how each potential mediator influences the intervention's effect on the outcomes.

The mediation analysis revealed that all paths from the group to the mediators (path a) and from the mediators to the outcome (path b) were statistically significant, as illustrated in Figure 3. The indirect effects of self-efficacy, B-IPQ Personal Control, and B-IPQ Emotional Representation on the relationship between group allocation (PC-PEP vs. control) and outcomes at 6 months were statistically significant, validated by bootstrap confidence intervals. This evidence supports the mediation hypothesis for these variables, as detailed in Table 3.

a)

a: b=0.76, SE= 0.32, 95% CI [0.13,1.4)

Self-Efficacy at 6 months

b: b=-2.2, SE=0.33, 95%CI [-2.9, -1.5]

c: b= -3.3, SE=1.3, 95% CI [-5.9, -0.59]

Group

Psychological Distress at 6 months

c': b= -1.6, SE=1.2, 95% CI [-3.9,0.77]

b)

a: b=1.1, SE= 0.52, 95% CI [0.08, 2.1)

Personal Control at 6 months

b: b=-0.52, SE=0.23, 95%CI [-0.99, -0.06]

c: b= -3.3, SE=1.3, 95% CI [-6.0,-0.63]

Group

Psychological Distress at 6 months

c': b= -2.7, SE=1.4, 95% CI [-5.4,0.05]

c)

a: b=-0.96, SE= 0.45, 95% CI [-1.8,-0.08)

Emotional Representation at 6 months

b: b=1.6, SE= 0.24, 95% CI [1.1, 2.03)

c: b= -3.4, SE=1.3, 95% CI [-6.1, -0.79]

Group

Psychological Distress at 6 months

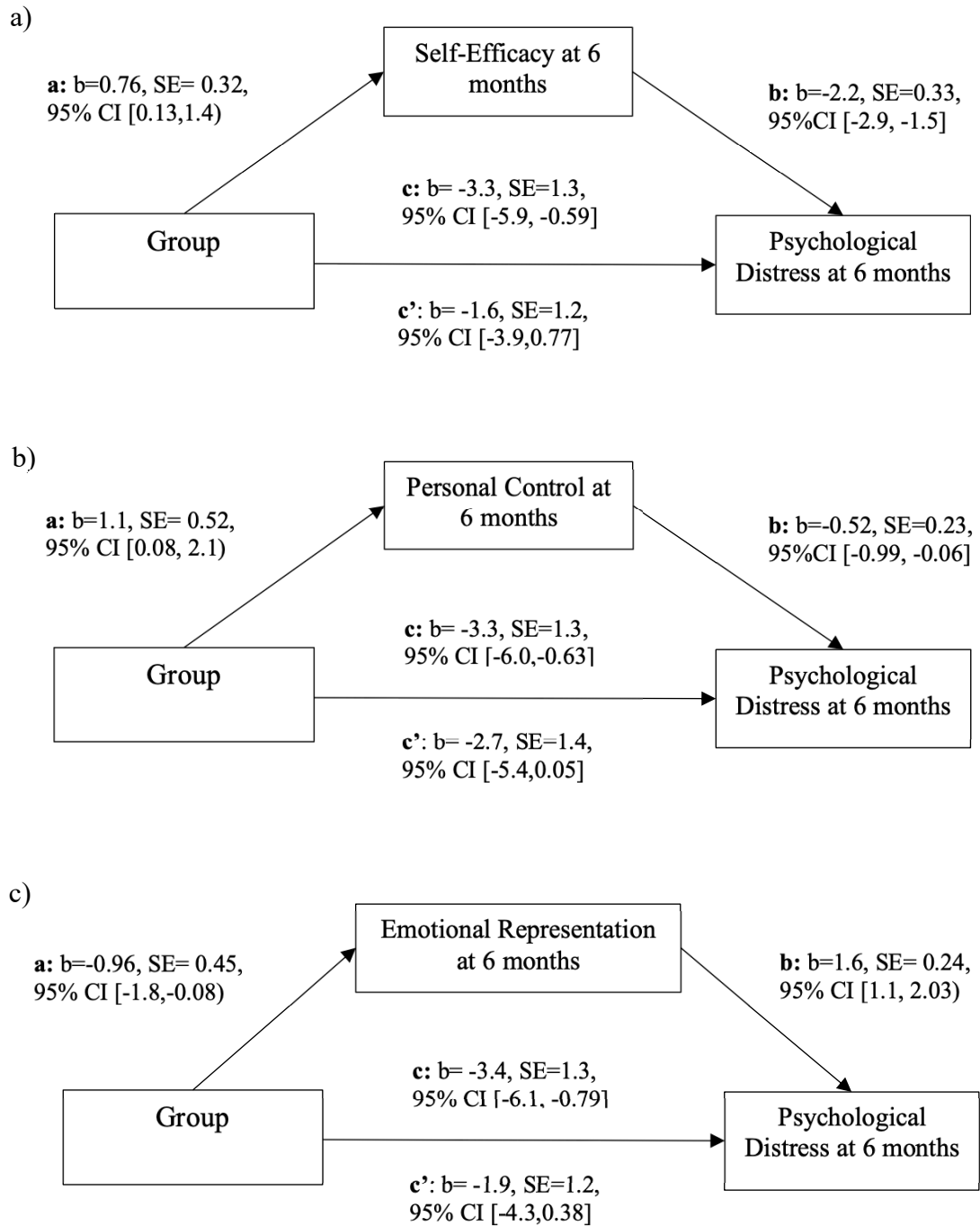**c':** b= -1.9, SE=1.2, 95% CI [-4.3,0.38]

Figure 3. Mediation model including group as the predictor, psychological distress as the outcome, and (a) self-efficacy, (b) personal control, and (c) emotional representation as mediators. Results obtained using PROCESS macro for SPSS, model 4. c = total effect; c'= direct effect; b = standardized regression coefficient.

In addition, the direct effect of B-IPQ Personal Control on the outcome was also statistically significant (p = 0.046), while the direct effect for self-efficacy (p=0.19) and B-IPQ Emotional Representation (p=0.099) were not statistically significant. The improvement in self-efficacy from baseline to 6 months accounted for over half (52%) of the intervention's effect. Meanwhile, in the separate mediation models, changes in B-IPQ Personal Control and Emotional Representation were found to contribute to approximately 18% and 44% of the effect, respectively, as shown in Table 3.

Table 3. Mediation Analysis results at 6 months for each potential mediator on K10.

Mediator	Total effect			Direct effect			Indirect Effect		% Mediated
	Effect size (95% CI)	SE	p	Effect size (95% CI)	SE	p	Effect size (95% CI)	SE	
Self-Efficacy	-3.3 (-5.9, -0.59)	1.3	0.017	-1.6 (-3.9, 0.77)	1.2	0.19	-1.7 (-3.8, -0.17)	0.92	**52%**
B-IPQ Personal Control	-3.3 (-6.0, -0.63)	1.4	0.016	-2.7 (-5.4, -0.05)	1.4	0.046	-0.58 (-1.4, -0.001)	0.36	**18%**
B-IPQ Emotional	-3.4 (-6.1, -0.79)	1.3	0.011	-1.9 (-4.3, 0.38)	1.2	0.099	-1.5 (-3.5, -0.090)	0.87	**44%**

Total n=128. B-IPQ=Brief Illness Perception Questionnaire. K10=Kessler Non-Specific Psychological Distress Scale. SE=standard error; CI=confidence interval – all CIs obtained using bootstrapping (n=10,000). Total, direct, and indirect effects obtained using PROCESS macro for SPSS. The effect size is the adjusted treatment difference (i.e., non-standardized treatment difference).

Moderated Mediation Analysis

The moderated mediation analysis investigating the effect of prostate cancer treatment modality (surgery vs. radiation) on the mediation process revealed no significant effects for any of the mediators. This conclusion is supported by the bootstrapped confidence intervals presented in Table 4, indicating that the treatment modality did not influence the mediation relationships.

Table 4. Moderated mediation analyses for treatment modality, comparing radical prostatectomy and radiotherapy.

Mediator	Effect size	SE	Lower CI	Upper CI
Self-Efficacy	-2.3	1.6	-0.52	5.8
B-IPQ Personal Control	-0.64	0.59	-1.9	0.37
B-IPQ Emotional Representation	1.6	1.4	-1.3	4.4

SE = standard error; CI = confidence interval.

4.4 DISCUSSION

This secondary analysis of the Prostate Cancer Patient Empowerment Program (PC-PEP) randomized controlled trial aimed to explore how changes in self-efficacy, illness perceptions, and heart rhythm coherence influenced the association between the PC-PEP intervention and reductions in psychological distress and the need for clinical treatment. Consistent with our hypotheses and supporting literature (Calvo-Schimmel et al., 2021; Martín-Núñez, et al., 2023a; Martín-Núñez, 2023b; Yang et al., 2021), the PC-PEP intervention significantly improved participants' self-efficacy and perceptions of personal control and emotional impact related to their illness. These improvements align with the concept that self-management interventions can enhance outcomes by empowering patients to manage their health and treatment side effects more effectively. The sample consisted predominantly of white, retired individuals in a relationship, with an average age of 66 years and a tendency towards being overweight. This demographic profile, along with the balanced distribution of treatment modalities (radical

prostatectomy and radiation therapy), provides a specific context in which the intervention's effects were observed. No significant baseline differences between the PC-PEP and control groups were noted, indicating that any post-intervention differences can more confidently be attributed to the intervention itself.

While our findings revealed that PC-PEP notably improved participants' sense of personal control and reduced negative emotional representations associated with their prostate cancer diagnosis, PC-PEP did not significantly impact overall illness perceptions composite score. However, the internal consistency for this score was found to be very low, and as indicated by Broadbent et al. (2015), the composite score may not by valid in the context of all illnesses, depending on how the domains are related in their specific contexts. Thus, the use of this score is likely less useful for clinical applications in PC, as illness perception domains are unique, information is lost when domains are analysed together, and there appears to be low consistency among items. The results suggest that the PC-PEP's focus on lifestyle modifications and promoting healthy behavior changes successfully empowered participants, enhancing their self-efficacy and perception of personal control. However, less emphasis on informational aspects of prostate cancer and its treatments may explain why other illness perception domains were not significantly affected. This suggests that enhancing knowledge or understanding about the disease itself and the mechanisms of treatment might require additional or different educational components within the intervention framework.

Contrary to the positive outcomes observed in self-efficacy and certain illness perceptions, heart rhythm coherence outcomes did not significantly change following the intervention. This finding aligns with the PC-PEP pilot study (Burge et al., 2023) and

contrasts with other research indicating potential benefits of HRV biofeedback training (Burch et al., 2020). The multifaceted nature of the PC-PEP and lower adherence to the HRV training component suggest that participants might have derived more benefit from other intervention aspects, such as physical activity and dietary changes. This insight raises questions about the HRV device's utility within this intervention context, suggesting that omitting it could streamline program integration and enhance its cost-effectiveness.

Mediation analyses underscored the significant roles of self-efficacy, B-IPQ personal Control, and B-IPQ emotional representation in mediating the intervention's effects on psychological distress, with variations in their contributions. Notably, the moderated mediation analysis did not reveal significant effects of prostate cancer treatment modality on these mediation processes, suggesting that the intervention's benefits transcend these treatment distinctions.

This study offers valuable insights into the mechanisms by which the PC-PEP intervention reduces psychological distress among prostate cancer patients, underscoring the significance of bolstering self-efficacy and altering illness perceptions. Conducted within a randomized controlled trial framework, this research provides robust evidence to substantiate these effects. It is noteworthy, however, that the completeness of the dataset varied across measures. While survey-based measures benefitted from complete data sets, approximately 29% of the participants were excluded from analyses specifically concerning heart rhythm coherence data due to missing information. This exclusion suggests that, although the findings related to self-efficacy and illness perceptions are based on full data, the estimates related to heart rhythm coherence may be biased.

Therefore, while the study presents strong evidence for the intervention's efficacy in certain areas, caution is advised in interpreting results related to heart rhythm coherence.

The analyses presented here are however secondary in nature, and the original trial was not designed with the statistical power to assess changes in self-efficacy, illness perceptions, or heart rhythm coherence. This limitation is significant, as it may affect the robustness of findings in these specific areas. As secondary analyses, post-hoc power estimates are not recommended (Dziak et al., 2020). Nonetheless, post-hoc exploratory analyses are still important for generating new knowledge and encouraging future prospective studies that primarily take into account these variables.

The measure used to assess self-efficacy was designed for various chronic diseases, and thus a disease-specific measure might have better captured the construct of self-efficacy in the context of PC. The internal consistency of the measure, however, was found to be high (α=0.926). The measure used to assess illness perception also poses some limitations. The low internal consistency observed indicates that the items may measure different constructs, reducing the reliability of the overall composite score. The strength of this relationship may have been underestimated, requiring cautious interpretation of the findings. Although previous research found concurrent validity with the longer IPQ-Revised (Broadbent et al., 2006), studies were not conducted in PC patients, and the single items may not fully capture the complexities of each domain. Thus, the content validity of the measure may be reduced, again reducing the reliability of the results, and weakening the observed relationships.

Furthermore, the mediator variables and outcome were both assessed at the same time points (pre and post intervention). This limits our ability to understand the temporal

relationships among variables and weakens our ability to establish causality from the mediator to the outcome. Despite this limitation, our assumptions about the causal sequence are grounded in the underlying theoretical frameworks, including the CSM and social cognitive theory, which suggest that illness perception and self-efficacy precede health outcomes like psychological distress (Levanthal et al., 1980; Bandura, 1986). In addition, these analyses serve as an initial exploration within the context of the PC-PEP intervention, offering insights for future research that should assess mediators at multiple or intermediate time points throughout the intervention.

Both the self-efficacy scale item and the B-IPQ item for the emotional representation domain assess aspects related to emotional distress, albeit from slightly different perspectives. These mediators specifically may have a conceptual overlap with the outcome, psychological distress. While the Kessler Psychological Distress Scale assesses symptoms of depression and anxiety, these concepts remain interconnected, potentially inflating observed mediation effects. Particularly, the role of the B-IPQ emotional representation domain, which focused solely on emotional impact and was captured by a single item, may be overemphasized in these analyses.

The use of Hayes' method of mediation in these analyses provides advantages over traditional approaches, such as the method by Baron and Kenny (1986). Particularly, PROCESS employs bootstrapping for obtaining confidence intervals to assess statistical significance, which is suitable for the sample sizes in this study (Hayes, 2017). Nonetheless, more advanced methods such as those that use structural equation modeling provide a more comprehensive framework to mediation analyses, allowing the explicit modeling of measurement error and handling missing data more effectively (Hayes et al.,

2017). Despite its limitations, Hayes' method remains valuable and widely used, especially in exploratory contexts like this study. This study opted for separate single mediator models instead of a multiple mediator model which may oversimplify the mediation pathways and overlook the interrelationships among mediators. Despite this limitation, this is the first study to explore these mediation pathways in the context of PC-PEP, and single mediation models allows us to examine the independent role of each mediator, offering insights into their individual contributions on reducing psychological distress.

Moreover, the recruitment strategy, which relied on volunteer participation and convenience sampling at a single center, introduces potential volunteer bias. This bias, along with the study's single-center setting, may restrict the generalizability of our results to broader and more diverse populations. To overcome these limitations and enhance the validity and applicability of our findings, future research efforts should focus on multi-center trials (currently underway, www.pcpep.org). These expanded studies would not only provide a more powerful analysis of the intervention's effects on self-efficacy, illness perceptions, and heart rhythm coherence but also ensure that the results are representative of a wider patient demographic.

Clinically, identifying patients with low self-efficacy or perception of personal control may enable healthcare providers to tailor recommendations for PC-PEP participation more effectively. Integrating such psychological pre-habilitation into a multimodal approach (Silver & Baima, 2013) could significantly enhance patient support during their cancer journey, potentially mitigating psychological distress proactively.

In conclusion, the PC-PEP intervention demonstrates a promising strategy for reducing psychological distress in prostate cancer patients by improving self-efficacy, personal control, and emotional representation perceptions. These findings underscore the potential of similar interventions to enhance patient outcomes and support their implementation in clinical practice.

CHAPTER 5: CONCLUSION

5.1 SUMMARY OF FINDINGS

A diagnosis of PC often leads to adverse mental health outcomes, and PC-PEP has been shown to alleviate some of these burdens. This thesis presents a secondary analysis of a randomized controlled trial on PC-PEP, that aimed to better understand the mechanisms through which the program decreases psychological distress among men undergoing treatment for localized PC. The specific objectives were to: (A) assess the impact of PC-PEP, compared to standard care, on self-efficacy, illness perceptions, and heart rhythm coherence from baseline to post-intervention; (B) explore whether changes in self-efficacy, illness perceptions, and heart rhythm coherence mediate the relationship between PC-PEP participation and reductions in non-specific psychological distress; and (C) investigate the possibility of treatment modality affecting these mediating effects.

The study found significant improvements in self-efficacy, personal control, and emotional representation among PC-PEP participants compared to the control group after six months. These findings align with the hypothesis and corroborate existing research that supportive care interventions can enhance self-efficacy in PC patients (Calvo-Schimmel et al., 2021; Martín-Núñez, et al., 2023a; Martín-Núñez, 2023b). Notably, the structure of PC-PEP—which introduces gradually more challenging exercises in pelvic floor muscle training, nutrition, and strength workouts over six months—may facilitate mastery experiences that boost self-efficacy and confidence in managing the illness (Zuniga et al., 2020). While other interventions have demonstrated efficacy in improving urinary function through 18 weeks of pelvic floor training (Milios et al., 2019) and physical function through 20 weeks of dietary and exercise regimens (O'Neil et al.,

2015), PC-PEP stands out as the most prolonged (26 weeks) and comprehensive intervention evaluated in a randomized controlled trial. This program has shown notable improvements across a spectrum of outcomes, including mental health, quality of life, urinary, and physical function (Ilie et al., 2023; Lawen et al., 2024; MacNevin et al., 2024). Such comprehensive evidence indicates that PC-PEP not only mitigates the psychological distress typically associated with a prostate cancer diagnosis and treatment but also significantly contributes to the overall well-being and functional recovery of affected individuals. Consequently, PC-PEP establishes a new standard for supportive care interventions in this patient demographic, thereby setting a new benchmark for supportive care interventions in this patient population.

Our findings demonstrate significant improvements in self-efficacy among participants, aligning with our hypothesis and reinforcing existing research that suggests supportive care interventions, similar to PC-PEP, are effective in enhancing self-efficacy in individuals diagnosed with prostate cancer (Martín-Núñez et al., 2023). Although the PC-PEP program is distinct in its methodology, this evidence underscores the effectiveness of supportive care interventions in boosting self-efficacy within this patient population. Bandura (2008) argues that the most dominant and effective way to build self-efficacy is through 'mastery experiences', where a task or challenge is attempted and succeeded. PC-PEP slowing teaches healthy skills and habits over 6 months in numerous areas. For example, the pelvic floor muscle training exercises slowly get more challenging as the weeks progress, nutrition components are broken into weekly themes so not to overwhelm participants from the start, and the strength workouts have varying levels of difficulty, so participants can advance as they build their muscle strength. This

structure of progressive, daily yet attainable challenges over 6 months, may allow participants to have these mastery experiences, driving their improvement in self-efficacy and confidence in their ability to do things to make their illness situation better.

The improvement in the personal control domain of the B-IPQ in the PC-PEP group, aligned with previous findings (Bonsaksen et al., 2013; Griva et al., 2000), underscores the program's effectiveness in enhancing patients' confidence in managing treatment side effects through behavioral changes. However, the absence of significant effects on overall illness perception score and other B-IPQ domains indicates that the intervention targeted and impacted only specific illness perceptions. Additional or more comprehensive education on PC and treatment effects could broaden the illness perception domains that are impacted.

The study yielded no significant effects on heart rhythm coherence, aligning with findings from the PC-PEP pilot study (Burge et al., 2023). This prompts a reassessment of the role of HRV biofeedback within the intervention due to cost and logistical considerations. These results contrast with those of certain studies highlighted in a recent scoping review. This review, encompassing 19 studies involving patients with various types of cancer, reported an increase in HRV coherence following HRV biofeedback interventions in many cases (Spada et al., 2022). However, it is essential to note that most participants in these studies were women with different types of cancer, including advanced and incurable forms, revealing a lack of research specifically addressing HRV biofeedback outcomes in prostate cancer (PC) patients. Moreover, in these studies, HRV biofeedback was often the sole or primary component of the interventions.

The multifaceted nature of the PC-PEP intervention may explain the absence of significant effects on heart rhythm coherence. Participants might have perceived greater value in other components of the intervention, and due to time constraints, chose to prioritize adherence to those aspects. Indeed, Ilie et al. (2023) show that of all components of the PC-PEP program, participants' perceived usefulness (mean 6.46 out of 10) of the program's stress reduction biofeedback device (HRV monitor) and participants' perceived usefulness of the program's meditation videos (mean 5.94 out of 10) were rated among the lowest of all program's components (Ilie et al., 2023). These findings suggest that HRV biofeedback training, as part of PC-PEP, may not exert a notable influence on the primary outcome within the context of this specific intervention. Considering the associated costs and logistical challenges, these findings indicate that omitting the HRV biofeedback device could be justified. A cost-effectiveness analysis comparing the inclusion and exclusion of the HRV biofeedback component would provide valuable insights for assessing its incorporation. However, it's important to acknowledge that approximately 29% of participants were excluded from the analyses due to missing data. While this was primarily due to COVID-19 restrictions preventing study visits rather than participant withdrawal or loss to follow-up, these factors may introduce bias or limitations to the sample size.

In the mediation analyses, we found that self-efficacy, B-IPQ Personal Control, and B-IPQ Emotional Representation mediated the intervention's effects on psychological distress. Self-efficacy was found to have the largest mediating effect, explaining 52% of the effect of the intervention on psychological distress. This finding is in line with the literature that shows increasing levels of self-efficacy will improve

mental health (Rabani Bavojdan et al., 2011). This further supports the consideration of improving self-efficacy in interventions aimed at improving mental health in PC patients.

The results of the moderated mediation analysis did not reveal significant effects of treatment modality on these mediation effects. This suggests that the intervention reduces psychological distress through improvement in self-efficacy, perception of personal control, and perception of emotional impact for both men undergoing radical prostatectomy and radiation therapy. This is important to note, since radical prostatectomy and radiation therapy are two very different experiences for men with PC, that lead to different side-effects, patient reported outcomes, and potentially perceptions around their illness (Donovan et al., 2016). The moderated mediation analysis indicated that the intervention's benefits on psychological distress reduction apply across different treatment modalities, suggesting its broad applicability for men undergoing radical prostatectomy or radiation therapy.

5.2 STRENGTHS AND LIMITATIONS

The study uses prospectively collected data from a rigorously designed randomized controlled trial, strengthening the robustness of the findings. The two groups in this study were found to be well balanced in terms of the measured baseline characteristics, reducing the potential for confounding and enhancing the internal validity of the study. In addition, the absence of participant attrition led to complete data for the questionnaires, providing all data for the outcome and two of the three mediating variables.

This study, however, is not without limitations. Firstly, despite its randomized design, the nature of the intervention means that participants were aware of the interventional components, and thus following baseline data collection they were no longer blinded to their respective randomized groups. This lack of blinding introduces the possibility that participants in the control group may have actively sought ways to incorporate components of the intervention if they believed it could benefit them, potentially influencing the study's outcomes.

Furthermore, it's important to acknowledge that the proposed analyses in this study are secondary in nature. Consequently, the sample size for the trial was not originally powered to adequately assess self-efficacy, illness perception, or heart rhythm coherence measures. This limitation could affect the statistical power of the study and the ability to detect significant effects in these specific outcome measures. Another limitation arises from the recruitment approach, which involved convenience sampling and voluntary participation. This methodology introduces the potential for volunteer bias, as individuals who chose to participate may possess distinct characteristics compared to those who opted not to take part. Additionally, the study's sample predominantly consisted of white participants who were retired and in heterosexual relationships. This homogeneity in the sample may limit the generalizability of the study's findings to a more diverse population of prostate cancer patients.

As the analyses in this thesis relied on secondary outcomes of the PC-PEP randomized controlled trial, data collection methodology first prioritized primary outcome analyses and minimizing participant burden. As a result of these constraints, the mediator and outcome variables are only collected at the same time point (6 months).

This limits our understanding of temporality amongst the variables, and it weakens our ability to infer the causal nature of the mediator on the outcome. It also introduces the potential for reverse causality, for example, if a change in psychological distress influences a change in self-efficacy or the other mediators. These analyses are, however, a preliminary exploration of these variables in the context of the PC-PEP intervention, which can inform further research and hypothesis generation. There is also a strong theoretical framework which guides our assumption of the casual sequence (Leventhal et al., 1980; Bandura, 1986). As described previously, the CSM and social cognitive theory, assert that illness perception and self-efficacy precede health outcomes such as psychological distress, providing justification and support for the measurement of the mediators and outcomes at the same time point.

It is also important to note that there is a potential conceptual overlap amongst some of the mediating variables and the outcome, psychological distress. In particular, one of the six items of the self-efficacy scale assesses how confident the participant is in managing the emotional distress of their condition, while the B-IPQ item for the emotional representation domain assesses how much the participant perceives the illness to affect them emotionally. Both of these mediator variables are assessing aspects related to emotional distress, albeit from slightly different perspectives. The Kessler Psychological Distress Scale also has similarities, although it does differ in that it asks participants to report how often they experienced specific symptoms indicative of depression and anxiety, in contrast to assessing the participants confidence and perception of their emotional state. The theoretical frameworks underlying the mediating variables provide rationale and justification for their influence on the outcome, however

the concepts behind the variables do remain highly interconnected. Therefore, these mediating variables may partially be capturing aspects of the outcome, potentially inflating the mediation effects that were observed. This is especially relevant to the B-IPQ emotional representation domain, as this domain focuses solely on emotional impact and is only captured by a single item. Consequently, the magnitude of the role of B-IPQ emotional representation, and to a lesser extent self-efficacy, may be overemphasized in these analyses.

A limitation of the use of the B-IPQ, in lieu of the longer versions, is that the individual illness perception domains (i.e. identity, treatment control, etc.) are captured by only a single item (Broadbent, 2006). Each domain may have complexities and nuances that are not easily captured through a single item, potentially reducing the content validity of the measure, and leading to measurement error that weakens the observed effects. The Chronbach's alpha for overall illness perception composite score was also found to be low, suggesting that the illness perception items were measuring different constructs. This reduces the reliability of the illness perception composite score significantly and weakens the observed relationship that was found. This may have led to an underestimation of the strength of the relationship observed for the illness perception composite score, and thus interpretation of the findings needs to be done with caution.

The use of Hayes' method of mediation as the statistical analysis approach to mediation in this thesis provides some considerable strengths, as well as limitations. The Hayes' method is highly accessible and a widely used tool to explore mediation in numerous fields (Hayes, 2017). The method utilizes bootstrapping to obtain confidence intervals, a robust method to evaluate the statistical significance of the mediation effects,

appropriate for sample sizes as was found in this study (Hayes, 2017). An assessment of

the statistical significance is not as easily or robustly obtained in the Baron and Kenny

method. Nonetheless, more advanced causal methods to mediation analysis, such as

structural equation modelling (SEM), offer a more comprehensive and flexible

framework for mediation analysis. Methods like SEM allow measurement error to be

explicitly modelled and assess the reliability and validity of the measures (Hayes et al.,

2017). As the measurement of variables at the same time points reduces our

understanding of the temporal sequence from mediator to outcome, newer causal

approaches may increase our understanding of causality in the context of our analyses,

enhancing the findings. The Hayes' method also cannot handle missing data, and as result

cases were dropped for the heart rhythm coherence analyses. Methods such as SEM could

better handle the missing data, reducing the bias and improving the reliability of these

estimates. Despite these limitations, Hayes' method remains valuable and widely used in

similar contexts of exploratory analyses and studies with straightforward mediation

hypotheses (Hayes et al., 2017).

This study also used separate single mediator models, over a multiple mediator

model. Single mediator models are more straightforward to implement, however they

inadvertently oversimplify the complexity of mediation pathways. By treating each

mediator independently, the interrelationships among mediators may have been

overlooked. This limitation becomes particularly pronounced in scenarios where

mediators interact or operate sequentially, as failing to account for these dynamics could

lead to incomplete or inaccurate representations of the underlying causal mechanisms

(VanderWeele & Vansteelandt, 2014). Despite this limitation, the use of separate single

mediator models may be justifiable in this context, as this is the first study to explore these variables in the context of PC-PEP, the mediation pathways were previously poorly understood. Separate single mediator models provide valuable insights into the potential role of each mediator independently, allowing for each domain to be targeted and considered clinically separately.

Moreover, the tool used to measure self-efficacy in this study was developed for various chronic diseases (Lorig et al., 1989). A disease-specific measure might have offered more insights into the intricacies of self-efficacy in the context of prostate cancer specifically. Additionally, the study faced challenges associated with the COVID-19 pandemic, as it was underway when the pandemic was declared, resulting in missed study visits that captured in-person measurement data, which included HRV data. This period of time at the beginning of the COVID-19 pandemic that increased levels of distress for many people, may have influenced the study's outcomes. Lastly, this study was conducted as a single-center trial, which may limit the generalizability of its findings to other sites.

5.3 Clinical Implications and Future Research

This study provides insights into the mechanisms through which participation in PC-PEP, in comparison to a control group, leads to reduced levels of psychological distress among prostate cancer (PC) patients. However, several important considerations and recommendations emerge from these findings.

To address the limitation of a relatively non-diverse sample in this study, future research endeavors, which are currently underway with a Phase 4 Implementation Pan-

Canadian and International multi-site trial (pcpep.org), aim to expand their scope to include multiple sites with the objective of enhancing participant heterogeneity. A more diverse participant pool will likely improve the generalizability of the findings and allow for a broader understanding of the intervention's impact across various demographic and clinical backgrounds.

It's noteworthy that this study exclusively enrolled men with localized PC who were scheduled for treatment but had not yet undergone it at the time of enrollment. This inclusion criterion effectively excluded PC patients with advanced cancer, those on active surveillance, or those in long-term survivorship, who may exhibit distinct characteristics and needs compared to individuals with localized disease. Subsequent research should encompass men at different stages of their cancer journey, representing a more comprehensive spectrum of PC experiences and conditions. The Phase 4 Implementation trial currently underway has expanded the eligibility criteria to include men with metastatic disease, therefore broadening the study's scope and allowing for a more inclusive examination of PC-PEP's impact across various disease stages.

Furthermore, future research efforts should delve into strategies to enhance the improvement in self-efficacy and explore the potential to target other domains of the Illness Perception Questionnaire (IPQ) within the framework of the PC-PEP intervention. This exploration would enable a deeper understanding of how to optimize the intervention's effectiveness and address a broader range of psychological and illness perception aspects. To gain a stronger understanding of the temporal and causal relationship amongst the mediator and outcome variables, future research should attempt to measure the mediating variables at multiple or intermediate time points (e.g. 3

months). Data from qualitative interviews and participant feedback could also provide insights into whether changes in self-efficacy and illness perception occurred prior to change in psychological distress. Utilizing the longer versions of the IPQ would allow for a more comprehensive assessment of the illness perception constructs, which may reduce the potential measurement error and improve the aforementioned reliability concerns. Future research should also seek to better understand the interconnectedness of the mediator and outcome variables, while considering the use of newer causal methods of mediation, such as structural equation modelling, along with multiple mediator models.

From a clinical perspective, the results of this study offer valuable guidance for healthcare professionals. Clinicians who identify patients with low self-efficacy or a diminished perception of personal control, indicating a potential to benefit from PC-PEP, should consider referring them to the program. This referral can play a crucial role in supporting patients throughout their cancer journey and mitigating potential psychological distress. This recommendation aligns with the concept of psychological pre-habilitation, which could be incorporated into the multimodal approach to pre-habilitation advocated by Silver and Baima (2013). By addressing psychological well-being before treatment, healthcare providers can better prepare patients for the challenges ahead and contribute to their overall quality of life during the cancer experience.

In conclusion, this study underscores the importance of targeting self-efficacy and illness perceptions in interventions designed to mitigate psychological distress and improve the mental health of PC patients. This study's findings serve as a valuable guide for healthcare providers, researchers, and policymakers. They highlight the need for tailored interventions that prioritize the enhancement of self-efficacy and the

modification of illness perceptions among PC patients. Such interventions can play a

pivotal role in not only alleviating psychological distress but also in fostering a more

positive and resilient mental health outlook among individuals navigating the challenges

of prostate cancer.

REFERENCES

Akin-Odanye, E.O., Ogo, C.N., Sulaiman, F.A. Suleiman, L., Ogunsanyam M.E., & Odedina, F. T. (2021). Examining the influence of illness perception and financial toxicity on the quality of life of prostate cancer patients. *Afr J Urol*, 27, 72. https://doi.org/10.1186/s12301-021-00173-7

Alcorso, J. & Sherman, K.A. (2016). Factors associated with psychological distress in women with breast cancer-related lymphoedema. *Psychooncology*, 25(7): 865- 872. https://doi.org/10.1002/pon.4021

Andrews, G., & Slade, T. (2001). Interpreting scores on the Kessler Psychological Distress Scale (K10). *Australian and New Zealand journal of public health*, *25*(6), 494–497. https://doi.org/10.1111/j.1467-842x.2001.tb00310.x

Antoni, M. H., & Dhabhar, F. S. (2019). The impact of psychosocial stress and stress management on immune responses in patients with cancer. *Cancer*, 125: 1417-1431. https://doi.org/10.1002/cncr.31943

Araujo, R. V., Fernandes, A. F. C., Nery, I. S., Andrade, E. M. L. R., Nogueira, L. T., & Azevedo, F. H. C. (2019). Meditation effect on psychological stress level in women with breast cancer: a systematic review. *Revista da Escola de Enfermagem da USP*, *53*, e03529.

Armaiz-Pena, G. N., Lutgendorf, S. K., Cole, S. W., & Sood, A. K. (2009). Neuroendocrine modulation of cancer progression. *Brain Behav Immun*, (1):10-5. https://doi.org/10.1016/j.bbi.2008.06.007

Ashley, L., Marti, J., Jones, H., Velikova, G., and Wright, P. (2015) Illness perceptions within 6 months of cancer diagnosis are an independent prospective predictor of

health-related quality of life 15 months post-diagnosis. *Psycho-Oncology*, 24: 1463–1470. https://doi.org/10.1002/pon.3812.

Audulv, Å., Packer, T., Hutchinson, S., Roger, K.S. & Kephart, G. (2016) Coping, adapting or self-managing – what is the difference? A concept review based on the neurological literature. *Journal of Advanced Nursing,* 72(11), 2629–2643. https://doi.org/10.1111/jan.13037

Awasthi, P., & Mishra, R.C. (2010). Illness beliefs of women cancer patients and their relationships with social support. *J Indian Acad Appl Psychol,* 36:317–27.

Bandura, A. (1986). Social Foundations of Thought and Action: A Social Cognitive Theory. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1997). Self-efficacy: The exercise of control. New York: Freeman.

Bandura, A. (2008). An agentic perspective on positive psychology. In S. J. Lopez (Ed.), Praeger perspectives. Positive psychology: Exploring the best in people (Vol. 1., pp. 167–196). Westport, CT: Praeger Publishers/Greenwood Publishing Group.

Barocas, D. A., Alvarez, J., Resnick, M. J., Koyama, T., Hoffman, K. E., Tyson, M. D., Conwill, R., McCollum, D., Cooperberg, M. R., Goodman, M., Greenfield, S., Hamilton, A. S., Hashibe, M., Kaplan, S. H., Paddock, L. E., Stroup, A. M., Wu, X. C., & Penson, D. F. (2017). Association Between Radiation Therapy, Surgery, or Observation for Localized Prostate Cancer and Patient-Reported Outcomes After 3 Years. *JAMA*, *317*(11), 1126–1140. https://doi.org/10.1001/jama.2017.1704

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical

considerations. *Journal of personality and social psychology*, *51*(6), 1173–1182.

https://doi.org/10.1037//0022-3514.51.6.1173

Berntson, G. G., Bigger, J. T., Jr, Eckberg, D. L., Grossman, P., Kaufmann, P. G., Malik,

M., Nagaraja, H. N., Porges, S. W., Saul, J. P., Stone, P. H., & van der Molen, M.

W. (1997). Heart rate variability: origins, methods, and interpretive

caveats. *Psychophysiology*, *34*(6), 623–648. https://doi.org/10.1111/j.1469-

8986.1997.tb02140.x

Bonsaksen, T., Lerdal, A., & Fagermoen, M. S. (2015). Trajectories of illness perceptions

in persons with chronic illness: An explorative longitudinal study. *Journal of*

health psychology, 20(7), 942–953. https://doi.org/10.1177/1359105313504235

Breland, J., Wong, J., & McAndrew, L. (2020). Are Common Sense Model constructs

and self-efficacy simultaneously correlated with self-management behaviors and

health outcomes: A systematic review. *Health Psychology Open,* 7(1).

https://doi.org/10.1177/2055102919898846.

Broadbent, E., Petrie, K. J., Main, J., & Weinman, J. (2006) The brief illness perception

questionnaire. *J Psychosom Res,* 60(6):631–637

https://doi.org/10.1016/j.jpsychores.2005.10.020

Broadbent, E., Wilkes, C., Koschwanez, H., Weinman, J., Norton, S., & Petrie, K. J.

(2015). A systematic review and meta-analysis of the Brief Illness Perception

Questionnaire. *Psychology & health*, *30*(11), 1361–1385.

https://doi.org/10.1080/08870446.2015.1070851

Brunckhorst, O., Hashemi, S., Martin, A., George, G., van Hemeelrijck, M., Dasgupta, P.,

Stewart, R., & Ahmed, K. (2021). Depression, anxiety, and suicidality in patients

with prostate cancer: a systematic review and meta-analysis of observational studies. *Prostate Cancer Prostatic Dis,* 24, 281–289. https://doi.org/10.1038/s41391-020-00286-0

Burch, J. B., Ginsberg, J. P., McLain, A. C., Franco, R., Stokes, S., Susko, K., Hendry, W., Crowley, E., Christ, A., Hanna, J., Anderson, A., Hébert, J. R., & O'Rourke, M. A. (2020). Symptom Management Among Cancer Survivors: Randomized Pilot Intervention Trial of Heart Rate Variability Biofeedback. *Applied psychophysiology and biofeedback*, *45*(2), 99–108. https://doi.org/10.1007/s10484-020-09462-3

Burge, L., Ilie, G., MacDonald, C., Riel, H., & Rutledge, R. D. H. (2023). Changes in Stress Reduction Following a 28-Day Prostate Cancer Patient Empowerment Program (PC-PEP) among Prostate Cancer Survivors. *Current oncology (Toronto, Ont.)*, *30*(9), 7936–7949. https://doi.org/10.3390/curroncol30090577

Calvo-Schimmel, A., Qanungo, S., Newman, S. D., & Sterba, K. R. (2021). Supportive care interventions and quality of life in advanced disease prostate cancer survivors: An integrative review of the literature. *Canadian oncology nursing journal = Revue canadienne de nursing oncologique*, *31*(4), 412–429. https://doi.org/10.5737/23688076314412429

Canadian Cancer Statistics Advisory Committee in collaboration with the Canadian Cancer Society, Statistics Canada and the Public Health Agency of Canada. (2021). Canadian Cancer Statistics 2021. Toronto, ON: Canadian Cancer Society; 2021.

Canadian Cancer Statistics Advisory in collaboration with the Canadian Cancer Society, Statistics Canada and the Public Health Agency of Canada. (2022). *Canadian Cancer Statistics: A 2022 special report on cancer prevalence.* http://cancer.ca/Canadian-Cancer-Statistics-2022-EN

Chirico, A., Lucidi, F., Merluzzi, T., Alivernini, F., Laurentiis, M., Botti, G., & Giordano, A. (2017). A meta-analytic review of the relationship of cancer coping self-efficacy with distress and quality of life. *Oncotarge*t, 8(22), 36800–36811. https://doi.org/10.18632/oncotarget.15758

Cohen, S., Gianaros, P., & Manuck, S. (2016) A stage model of stress and disease. *Perspect Psychol Sci,* 11(4), 456–463. https://doi.org/10.1177/1745691616646305

Crosswell, A. D., & Lockwood, K. G. (2020). Best practices for stress measurement: How to measure psychological stress in health research. *Health psychology open*, *7*(2), 2055102920933072. https://doi.org/10.1177/2055102920933072

Crump, C., Stattin, P., Brooks, J. D., Sundquist, J., Bill-Axelson, A., Edwards, A. C., Sundquist, K., & Sieh, W. (2023). Long-term Risks of Depression and Suicide Among Men with Prostate Cancer: A National Cohort Study. *European urology*, 84(3), 263–272. https://doi.org/10.1016/j.eururo.2023.04.026

Dai, S., Mo, Y., Wang, Y., Xiang, B., Liao, Q., Zhoum, M., Li, X., Li, Y., Xiong, W., Li, G., Guo, C., & Zend, Z. (2020). Chronic stress promotes cancer development. *Front Oncol,* 10, 1492. https://doi.org/10.3389/fonc.2020.01492

Davis, K. M., Kelly, S. P., Luta, G., Tomko, C., Miller, A. B., & Taylor, K. L. (2014). The association of long-term treatment-related side effects with cancer-specific

and general quality of life among prostate cancer survivors. *Urology*, *84*(2), 300–306. https://doi.org/10.1016/j.urology.2014.04.036

de Castro, E. K., Marina, K., Clarissa, P., Machado-Meneghetti, B., & Chem, C. (2012). Longitudinal assessment of illness perceptions in young adults with cancer. *Psicol Reflexão Crít;* 25, 671–8.

Dekker, J. M., Crow, R. S., Folsom, A. R., Hannan, P. J., Liao, D., Swenne, C. A., & Schouten, E. G. (2000). Low heart rate variability in a 2-minute rhythm strip predicts risk of coronary heart disease and mortality from several causes: the ARIC Study. Atherosclerosis Risk In Communities. *Circulation*, *102*(11), 1239–124. https://doi.org/10.1161/01.cir.102.11.1239

Dell'Acqua, C., Dal Bò, E., Messerotti Benvenuti, S., & Palomba, D. (2020). Reduced heart rate variability is associated with vulnerability to depression. *Journal of Affective Disorders Reports*, 1. https://doi.org/10.1016/j.jadr.2020.100006.

Dempster, M., Howell, D., & McCorry, N. K. (2015). Illness perceptions and coping in physical health conditions: A meta-analysis. *Journal of psychosomatic research*, *79*(6), 506–51. https://doi.org/10.1016/j.jpsychores.2015.10.006

Dempster, M., McCorry, N. K., Brennan, E., Donnelly, M., Murray, L. J., & Johnston, B. T. (2011). Do changes in illness perceptions predict changes in psychological distress among oesophageal cancer survivors?. *Journal of health psychology*, *16*(3), 500–509. https://doi.org/10.1177/1359105310386633

DiClemente, R., Nowara, A., Shelton, R., & Wingood, G. (2019). Need for Innovation in Public Health Research. *American journal of public health*, *109*(S2), S117–S120. https://doi.org/10.2105/AJPH.2018.304876

Donovan, J. L., Hamdy, F. C., Lane, J. A., Mason, M., Metcalfe, C., Walsh, E., Blazeby,

    J. M., Peters, T. J., Holding, P., Bonnington, S., Lennon, T., Bradshaw, L.,

    Cooper, D., Herbert, P., Howson, J., Jones, A., Lyons, N., Salter, E., Thompson,

    P., Tidball, S., … ProtecT Study Group* (2016). Patient-Reported Outcomes after

    Monitoring, Surgery, or Radiotherapy for Prostate Cancer. *The New England*

    journal of medicine, *375*(15), 1425–1437.

    https://doi.org/10.1056/NEJMoa1606221

Dovey, Z., Horowitz, A., & Waingankar, N. (2023). The influence of lifestyle changes

    (diet, exercise and stress reduction) on prostate cancer tumour biology and patient

    outcomes: A systematic review. *BJUI compass*, 4(4), 385–416.

    https://doi.org/10.1002/bco2.237

Dwarswaard, J., Bakker, E. J., van Staa, A., & Boeije, H. R. (2016). Self-management

    support from the perspective of patients with a chronic condition: a thematic

    synthesis of qualitative studies. Health expectations : an international journal of

    public participation in health care and health policy, 19(2), 194–208.

    https://doi.org/10.1111/hex.12346

Dziak, J. J., Dierker, L. C., & Abar, B. (2020). The Interpretation of Statistical Power

    after the Data have been Gathered. Current psychology (New Brunswick,

    N.J.), 39(3), 870–877. https://doi.org/10.1007/s12144-018-0018-1

Eisen, B., & Emes, J. (2022). Understanding the Changing Ratio of Working-Age

    Canadians to Seniors and Its Consequences. Fraser Institute.

Fabre, B., Grosman, H., Gonzalez, D., Machulsky, N., Repetto, E., Mesch, V., Lopez, M.,

    Mazza, O., & Berg, G. (2016). Prostate Cancer, High Cortisol Levels and

Complex Hormonal Interaction. *Asian Pacific Journal of Cancer Prevention*, *17*(7), 3167-3171.

Faraci, P. & Bottaro, R. (2022). Association Between Perceived Social Support, Illness Perception, Life Orientation, Life Satisfaction, and Quality of Life Within a Sample of Cancer Patients. *Int J Psychol Res*, *15*(1), 9-19. https://doi.org/10.21500/20112084.5263

Farley H. (2019). Promoting self-efficacy in patients with chronic disease beyond traditional education: A literature review. *Nursing open*, *7*(1), 30–41. https://doi.org/10.1002/nop2.382

Fervaha, G., Izard, J. P., Tripp, D. A., Rajan, S., Leong, D. P., & Siemens, D. R. (2019). Depression and prostate cancer: A focused review for the clinician. *Urologic oncology*, 37(4), 282–288. https://doi.org/10.1016/j.urolonc.2018.12.020

Flores, I. E., Sierra-Fonseca, J. A., Davalos, O., Saenz, L. A., Castellanos, M. M., Zavala, J. K., & Gosselink, K. L. (2017). Stress alters the expression of cancer-related genes in the prostate. *BMC Cancer*, 17(1), 621. https://doi.org/10.1186/s12885-017-3635-4

Foster, C., Breckons, M., Cotterell, P., Barbosa, D., Calman, L., Corner, J., Fenlon, D., Foster, R., Grimmett, C., Richardson, A., & Smith, P. W. (2015). Cancer survivors' self-efficacy to self-manage in the year following primary treatment. *Journal of cancer survivorship : research and practice*, *9*(1), 11–19. https://doi.org/10.1007/s11764-014-0384-0

Foster, C., Brown, J., Killen, M., & Brearley, S. (2007). The NCRI cancer experiences collaborative: defining self management. European journal of oncology nursing :

the official journal of European Oncology Nursing Society, 11(4), 295–297.

https://doi.org/10.1016/j.ejon.2007.08.002

Friberg, A. S., Brasso, K., Larsen, S. B., Andersen, E. W., Kroyer, A., Helgstrand, J. T.,

Roder, M. A., Klemann, N., Kessing, L. V., Johansen, C., & Dalton, S. O. (2021).

Risk of depression after diagnostic prostate cancer workup – A nationwide,

registry-based study. *Psycho-Oncol,* 30(11), 1939-1947.

Green, H. J., Steinnagel, G., Morris, C., & Laakso, E. L. (2014). Health behaviour models

and patient preferences regarding nutrition and physical activity after breast or

prostate cancer diagnosis. *European journal of cancer care*, *23*(5), 640–652.

https://doi.org//10.1111/ecc.12190

Griva, K., Myers, L. B., & Newman, S. (2000). Illness perceptions and self efficacy

beliefs in adolescents and young adults with insulin dependent diabetes

mellitus, Psychology & Health, 15:6, 733-

750. https://doi.org/10.1080/08870440008405578

Hagger, M. S. & Orbell, S. (2003). A meta-analytic review of the common-sense model

of illness representations. *Psychol Health,* 18(2), 141–184.

Harris, P. A., Taylor, R., Minor, B. L., Elliott, V., Fernandez, M., O'Neal, L., McLeod,

L., Delacqua, G., Delacqua, F., Kirby, J., Duda, S. N. (2019). REDCap

Consortium**,** The REDCap consortium: Building an international community of

software partners. *J Biomed Infor*m. https://doi.org/ 10.1016/j.jbi.2019.103208

Hassan, S., Karpova, Y., Baiz, D., Yancey, D., Pullikuth, A., Flores, A., Register, T.,

Cline, J. M.' D'Agostino, R., Jr, Danial, N., Datta, S. R., & Kulik, G. (2013).

Behavioral stress accelerates prostate cancer development in mice. *The Journal of clinical investigation*, *123*(2), 874–886. https://doi.org/10.1172/JCI63324

Hayes, A. F. (2017). Introduction to mediation, moderation, and conditional process analysis, second edition: A regression-based approach (2nd ed.). *Guilford Publications*.

Hayes, A. F., Montoya, A. K., & Rockwood, N. J. (2017). The Analysis of Mechanisms and Their Contingencies: PROCESS versus Structural Equation Modeling. *Australasian Marketing Journal*, 25(1), 76-81. https://doi-org.ezproxy.library.dal.ca/10.1016/j.ausmj.2017.02.001

HeartMath Inc. (n.d.). *Quick Coherence® Technique.* https://www.heartmath.com/quick-coherence-technique/

Heckman, J. E., Chamie, K., Maliski, S. L., Fink, A., Kwan, L., Connor, S. E., & Litwin, M. S. (2011). The role of self-efficacy in quality of life for disadvantaged men with prostate cancer. *The Journal of urology*, *186*(5), 1855–1861. https://doi.org/10.1016/j.juro.2011.06.059

Heiss, S., Vaschillo, B., Vaschillo, E.G., Timko, C.A., & Hormes J.M. (2021). Heart rate variability as a biobehavioral marker of diverse psychopathologies: a review and argument for an "ideal range". *Neurosci. Biobehav. Rev.,* 121, 144-155. https://doi.org/10.1016/j.neubiorev.2020.12.004

Hopman, P., & Rijken, M. (2015). Illness perceptions of cancer patients: relationships with illness characteristics and coping. *Psycho-oncology*, *24*(1), 11–18. https://doi-org.ezproxy.library.dal.ca/10.1002/pon.3591

Horne, R., & Weinman, J. (1998). Predicting treatment adherence: an overview of theoretical models. In L. B. Myers, & K. Medence (Eds.), Adherence to Treatment in Medical Conditions (pp. 25e50). Amsterdam: Harwood Academic Publishers.

IBM Corp. Released 2021. IBM SPSS Statistics for Macintosh, Version 28.0. Armonk, NY: IBM Corp.

Ilie, G., Rutledge, R., Sweeney, E. (2020). Anxiety and depression symptoms in adult males in Atlantic Canada with or without a lifetime history of prostate cancer. *Psychooncology,* 29, 280–286. https://doi.org/10.1002/pon.5244

Ilie, G., Rendon, R., Mason, R., MacDonald, C., Kucharczyk, M. J., Patil, N., Bowes, D., Bailly, G., Bell, D., Lawen, J., Ha, M., Wilke, D., Massaro, P., Zahavich, J., Kephart, G., & Rutledge, R. D. H. (2023). A Comprehensive 6-mo Prostate Cancer Patient Empowerment Program Decreases Psychological Distress Among Men Undergoing Curative Prostate Cancer Treatment: A Randomized Clinical Trial. European urology, 83(6), 561–570. https://doi.org/10.1016/j.eururo.2023.02.009

Jacobsen, P. B., Phillips, K. M., Jim, H. S., Small, B. J., Faul, L. A., Meade, C. D., Thompson, L., Williams, C. C., Jr, Loftus, L. S., Fishman, M., & Wilson, R. W. (2013). Effects of self-directed stress management training and home-based exercise on quality of life in cancer patients receiving chemotherapy: a randomized controlled trial. *Psycho-oncology*, *22*(6), 1229–1235. https://doi.org/10.1002/pon.3122

Jahn, J. L., Giovannucci, E. L., & Stampfer, M. J. (2015). The high prevalence of

   undiagnosed prostate cancer at autopsy: implications for epidemiology and

   treatment of prostate cancer in the Prostate-specific Antigen-era. *International*

   journal of cancer, 137(12), 2795–2802. https://doi.org/10.1002/ijc.29408

Jan, M., Bonn, S. E., Sjölander, A., Wiklund, F., Stattin, P., Holmberg, E., Grönberg, H.,

   Bälter, K. (2016). The roles of stress and social support in prostate cancer

   mortality. *Scand J Urol*, 50(1), 47-55.

   https://doi.org/10.3109/21681805.2015.1079796

Kessler, R. C., Barker, P. R., Colpe, L. J., Epstein, J. F., Gfroerer, J. C., Hiripi, E.,

   Howes, M. J., Normand, S. L., Manderscheid, R. W., Walters, E. E., & Zaslavsky,

   A. M. (2003). Screening for serious mental illness in the general

   population. *Archives of general psychiatry*, *60*(2), 184–189.

   https://doi.org/10.1001/archpsyc.60.2.184

Kim, H. G., Cheon, E. J., Bai, D. S., Lee, Y. H., & Koo, B. H. (2018). Stress and Heart

   Rate Variability: A Meta-Analysis and Review of the Literature. *Psychiatry*

   Investiq, 15(3), 235-45. https://doi.org/ 10.30773/pi.2017.08.17

Kloter, E., Barrueto, K., Klein, S. D., Scholkmann, F., & Wolf, U. (2018). Heart Rate

   Variability as a Prognostic Factor for Cancer Surviv–l - A Systematic

   Review. *Frontiers in physiology*, *9*, 623.

   https://doi.org/10.3389/fphys.2018.00623

Koch, C., Wilhelm, M., Salzmann, S., Rief, W., & Euteneuer, F. (2019). A meta-analysis

   of heart rate variability in major depression. *Psychological Medicine*, 49(12),

   1948-1957. https://doi.org/10.1017/S0033291719001351

Korfage, I. J., Essink-Bot, M. L., Janssens, A. C., Schröder, F. H., & de Koning, H. J.
(2006). Anxiety and depression after prostate cancer diagnosis and treatment: 5-
year follow-up. *British journal of cancer*, *94*(8), 1093–1098.
https://doi.org/10.1038/sj.bjc.6603057

Krizanova, O., Babula, P., & Pacak, K. (2016). Stress, catecholaminergic system and
cancer. *Stress (Amsterdam, Netherlands)*, *19*(4), 419–428.
https://doi.org/10.1080/10253890.2016.1203415

Kurian, C. J., Leader, A. E., Thong, M. S. Y., Keith, S. W., & Zeigler-Johnson, C. M.
(2018). Examining relationships between age at diagnosis and health- related
quality of life outcomes in prostate cancer survivors. *BMC Public Health*, 18,
1060. https://doi.org/10.1186/s12889-018-5976-6

Kuiper, H., van Leeuwen, C. M. C., Stolwijk-Swüste, J. M., & Post, M. W. M. (2022).
Reliability and validity of the Brief Illness Perception Questionnaire (B-IPQ) in
individuals with a recently acquired spinal cord injury. *Clinical
rehabilitation*, *36*(4), 550–557. https://doi.org/10.1177/02692155211061813

Lawen, T., Ilie, G., Mason, R., Rendon, R., Spooner, J., Champion, E., Davis, J.,
MacDonald, C., Kucharczyk, M. J., Patil, N., et al. (2024). Six-month Prostate
Cancer Empowerment Program (PC-PEP) Improves Urinary Function: A
Randomized Trial. *Cancers*, (5):958. https://doi.org/10.3390/cancers16050958

Lazarus, R. S. & Folkman, S. (1984). *Stress, Appraisal and Coping.* New York
Springer.

LeBlanc, A. G., Demers, A., & Shaw, A. (2019). Recent trends in prostate cancer in

    Canada. *Health Reports*, 30(4), 12-17. https://doi.org/10.25318/82-003-

    x201900400002-eng

Lee, H., Herbert, R. D., Lamb, S. E., Moseley, A. M., & McAuley, J. H. (2019).

    Investigating causal mechanisms in randomised controlled trials. *Trials*, *20*(1),

    524. https://doi.org/10.1186/s13063-019-3593-z

Lei Chui, P., Wai, S., Lai, L. L., See, M. H., & Tan, S. B. (2021). Mindful Breathing:

    Effects of a Five-Minute Practice on Perceived Stress and Mindfulness Among

    Patients With Cancer. *Clinical journal of oncology nursing*, *25*(2), 174–180.

    https://doi.org/10.1188/21.CJON.174-180

Lepore, S. J., & Helgeson, V. S. (1999). Psychoeducational support group enhances

    quality of life after prostate cancer. *Cancer Research Therapy and Control*, *8*(1-

    2), 81-91.

Leventhal, H., Meyer, D., & Nerenz, D. (1980). The common sense representation of

    illness danger. In: S Rachman, ed. *Contributions to Medical Psychology*. New

    York: Pergamon Press;1980: 7–30

Leventhal, H., Phillips, L. A., & Burns, E. (2016). The Common-Sense Model of Self-

    Regulation (CSM): a dynamic framework for understanding illness self-

    management. *Journal of behavioral medicine*, *39*(6), 935–946.

    https://doi.org/10.1007/s10865-016-9782-2

Lorig, K., Chastain, R. L., Ung, E., Shoor, S., & Holman, H. R. (1989). Development and

    evaluation of a scale to measure perceived self-efficacy in people with

arthritis. *Arthritis and rheumatism*, *32*(1), 37–44.

https://doi.org/10.1002/anr.1780320107

Lorig, K. R., & Holman, H. (2003). Self-management education: history, definition,

outcomes, and mechanisms. *Annals of behavioral medicine : a publication of the*

Society of Behavioral Medicine, *26*(1), 1–7.

https://doi.org/10.1207/S15324796ABM2601_01

Luckenbaugh, A. N., Wallis, C. J. D., Huang, L. C., Wittmann, D., Klaassen, Z., Zhao,

Z., Koyama, T., Laviana, A. A., Conwill, R., Goodman, M., Hamilton, A. S., Wu,

X. C., Paddock, L. E., Stroup, A., Cooperberg, M. R., Hashibe, M.' O'Neil, B. B.,

Kaplan, S. H., Greenfield, S., Hoffman, K. E., … Barocas, D. A. (2022).

Association between Treatment for Localized Prostate Cancer and Mental Health

Outcomes. *The Journal of urology*, *207*(5), 1029–1037.

https://doi.org/10.1097/JU.0000000000002370

MacNevin, W., Ilie, G., Rendon, R., Mason, R., Spooner, J., Chedrawe, E., Patil, N.,

Bowes, D., Bailly, G., Bell, D., Wilke, D., Zahavich, J. B. L., MacDonald, C., &

Rutledge, R. D. H. (2024). PC-PEP, a Comprehensive Daily Six-Month Home-

Based Patient Empowerment Program Leads to Weight Loss in Men with Prostate

Cancer: A Secondary Analysis of a Clinical Trial. *Current oncology (Toronto,*

Ont.), *31*(3), 1667–1688. https://doi.org/10.3390/curroncol31030127

Martín-Núñez, J., Heredia-Ciuró, A., Valenza-Peña, G., Granados-Santiago, M.,

Hernández-Hernández, S., Ortiz-Rubio, A., & Valenza, M. C. (2023a). Systematic

review of self-management programs for prostate cancer patients, a quality of life

and self-efficacy meta-analysis. *Patient education and counseling*, *107*, 107583. https://doi.org/10.1016/j.pec.2022.107583

Martín-Núñez, J., Raya-Benítez, J., López-López, L., Calvache-Mateo, A., Heredia-Ciuró, A., Navas-Otero, A., & Valenza, M. C. (2023b). Efficacy in urinary symptom burden, psychological distress, and self-efficacy of education-enhanced interventions in prostate cancer patients: a systematic review and meta-analyses. *Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer*, *31*(6), 340. https://doi.org/10.1007/s00520-023-07803-6

Merluzzi, T. V., & Martinez Sanchez, M. A. (1997). Assessment of self-efficacy and coping with cancer: development and validation of the cancer behavior inventory. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association*, *16*(2), 163–170. https://doi.org/10.1037//0278-6133.16.2.163

Merluzzi, T. V., Nairn, R. C., Hegde, K., Martinez Sanchez, M. A., & Dunn, L. (2001). Self-efficacy for coping with cancer: revision of the Cancer Behavior Inventory (version 2.0). *Psycho-oncology*, *10*(3), 206–217. https://doi.org/10.1002/pon.511

McCaughan, E., Prue, G., McSorley, O., Northouse, L., Schafenacker, A., & Parahoo, K. (2013). A randomized controlled trial of a self-management psychosocial intervention for men with prostate cancer and their partners: a study protocol. *Journal of advanced nursing*, *69*(11), 2572–2583. https://doi.org/10.1111/jan.12132

McCraty, R. (2022). Following the Rhythm of the Heart: HeartMath Institute's Path to

> HRV Biofeedback. *Appl Psychophysiol Biofeedback,* 47, 305–316

> https://doi.org/10.1007/s10484-022-09554-2

McCraty, R. & Shaffer, F. (2015). Heart rate variability: new perspectives on

> physiological mechanisms, assessment of self-regulatory capacity, and health

> risk. *Glob Adv Health Med*, 4, 46–61. https://doi.org/10.7453/gahmj.2014.073

McCraty, R., Atkinson, M., Tiller, W. A., Rein, G., & Watkins, A. D. (1995). The effects

> of emotions on short-term power spectrum analysis of heart rate variability. *Am J

> Cardiol*, 76(14), 1089–93. https://doi.org/10.1016/S0002-9149(99)80309-9

McCraty, R., & Zayas, M. A. (2014). Cardiac coherence, self-regulation, autonomic

> stability, and psychosocial well-being. *Frontiers in psychology*, *5*, 1090.

> https://doi.org/10.3389/fpsyg.2014.01090

Menichetti, J., Villa, S., Magnani, T., Avuzzi, B., Bosetti, D., Marenghi, C., Morlino, S.,

> Rancati, T., Van Poppel, H., Salvioni, R., Valdagni, R., & Bellardita, L. (2016).

> Lifestyle interventions to improve the quality of life of men with prostate cancer:

> A systematic review of randomized controlled trials. *Critical reviews in

> oncology/hematology*, *108*, 13–22.

> https://doi.org/10.1016/j.critrevonc.2016.10.007

Meyer, D., Leventhal, H., & Gutmann, M. (1985). Common-sense models of illness the

> example of hypertension. *Health Psychol*, 4, 115-135

Mickevičienė, A., Vanagas, G., Jievaltas, M., & Ulys, A. (2013). Does illness perception

> explain quality of life of patients with prostate cancer?. *Medicina (Kaunas,

> Lithuania)*, *49*(5), 235–241.

Milios, J. E., Ackland, T. R., & Green, D. J. (2019). Pelvic floor muscle training in

    radical prostatectomy: a randomized controlled trial of the impacts on pelvic floor

    muscle function and urinary incontinence. *BMC urology*, *19*(1), 116.

    https://doi.org/10.1186/s12894-019-0546-5

Moodie, L., Ilie, G., Rutledge, R., Andreou, P., Kirkland, S. (2020). Assessment of

    current mental health status in a population-based sample of Canadian men with

    and without a history of prostate cancer diagnosis: an analysis of the Canadian

    Longitudinal Study on Aging (CLSA). *Front Psychiatry,* 11, 586260.

    https://doi.org/ 10.3389/fpsyt.2020.586260

Moore, T. H., King, A. J., Evans, M., Sharp, D., Persad, R., & Huntley, A. L. (2015).

    Supportive care for men with prostate cancer: why are the trials not working? A

    systematic review and recommendations for future trials. *Cancer medicine*, *4*(8),

    1240–1251. https://doi.org/10.1002/cam4.446

Moss-Morris, R., Weinman, J., Petrie, K. J., Horne, R., Cameron, L. D., & Buick, D.

    (2002). The revised illness perception questionnaire (IPQ-R). *Psychology &*

    Health, 17, 1–16.

Mravec, B., Tibensky, M., & Horvathova, L. (2020). Stress and cancer. Part I:

    Mechanisms mediating the effect of stressors on cancer. *Journal of*

    neuroimmunology, *346*, 577311. Advance online publication.

    https://doi.org/10.1016/j.jneuroim.2020.577311

Oh, H.-M., & Son, C.-G. (2021). The Risk of Psychological Stress on Cancer

    Recurrence: A Systematic Review. *Cancers*, *13*(22), 5816.

    http://doi.org/10.3390/cancers13225816

Olooto, W. E., Oyelekan, A. A., Adewole, O. O., Fajobi, A. O., Adebo, A. A., &
Olasimbo, O. (2021). Serum gonadotropins, cortisol, PSA, and micronutrient
levels among men with prostate carcinoma. *Afr J Urol*, 27, 109.
https://doi.org/10.1186/s12301-021-00206-1

O'Neill, R.F., Haseen, F., Murray, L.J., O'Sullivan, J.M., Cantwell, M.M. (2015). A
randomised controlled trial to evaluate the efficacy of a 6-month dietary and
physical activity intervention for patients receiving androgen deprivation therapy
for prostate cancer. *J. Cancer Surviv.,* 9:431–440. https://doi.org/10.1007/s11764-
014-0417-8.

Ośmiałowska, E., Staś, J., Chabowski, M., & Jankowska-Polańska, B. (2022). Illness
Perception and Quality of Life in Patients with Breast Cancer. *Cancers*, *14*(5),
1214. https://doi.org/10.3390/cancers14051214

Pascoe, M.C., Thompson, D.R., Jenkins, Z.M., & Ski, C.F. (2017). Mindfulness mediates
the physiological markers of stress: Systematic review and meta-analysis. *Journal
of Psychiatric Research*, 95, 156–178.
https://doi.org/10.1016/j.jpsychires.2017.08.004

Paterson, C., Robertson, A., & Nabi, G. (2015). Exploring prostate cancer survivors' self-
management behaviours and examining the mechanism effect that links coping
and social support to health-related quality of life, anxiety and depression: a
prospective longitudinal study. *European journal of oncology nursing : the
official journal of European Oncology Nursing Society*, *19*(2), 120–128.
https://doi.org/10.1016/j.ejon.2014.10.008

Philip, E. J., Merluzzi, T. V., Zhang, Z., & Heitzmann, C. A. (2013). Depression and

cancer survivorship: importance of coping self-efficacy in post-treatment

survivors. *Psycho-oncology*, *22*(5), 987–994. https://doi.org/10.1002/pon.3088

Pourfallahi, M., Gholami, M., Tarrahi, M. J., Toulabi, T., & Kordestani Moghadam, P.

(2020). The effect of informational-emotional support program on illness

perceptions and emotional coping of cancer patients undergoing

chemotherapy. *Supportive care in cancer : official journal of the Multinational*

Association of Supportive Care in Cancer, *28*(2), 485–495.

https://doi.org/10.1007/s00520-019-04842-w

Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Addressing Moderated Mediation

Hypotheses: Theory, Methods, and Prescriptions. *Multivariate behavioral*

research, *42*(1), 185–227. https://doi.org/10.1080/00273170701341316

Rabani Bavojdan, M., Towhidi, A., & Rahmati, A. (2011). The Relationship between

Mental Health and General Self-Efficacy Beliefs, Coping Strategies and Locus of

Control in Male Drug Abusers. *Addiction & health*, *3*(3-4), 111–118.

Ralph, N., Ng, S. K., Zajdlewicz, L., Lepore, S. J., Heathcote, P., Kneebone, A., Dunn, J.

C., & Chambers, S. K. (2020). Ten-year quality of life outcomes in men with

prostate cancer. *Psycho-oncology*, *29*(2), 444–449.

https://doi.org/10.1002/pon.5255

Rice, S. M., Oliffe, J. L., Kelly, M. T., Cormie, P., Chambers, S., Ogrodniczuk, J. S., &

Kealy, D. (2018). Depression and Prostate Cancer: Examining Comorbidity and

Male-Specific Symptoms. *American journal of men's health*, *12*(6), 1864–1872.

https://doi.org/10.1177/1557988318784395

Richardson, EM, Schüz, N, Sanderson, K, Scott, JL, Schüz, B. Illness representations, coping, and illness outcomes in people with cancer: a systematic review and meta-analysis. *Psycho-Oncology*. 2017; 26: 724–737. https://doi-org.ezproxy.library.dal.ca/10.1002/pon.4213.

Rijnhart, J. J. M., Twisk, J. W. R., Chinapaw, M. J. M., de Boer, M. R., & Heymans, M. W. (2017). Comparison of methods for the analysis of relatively simple mediation models. Contemporary clinical trials communications, 7, 130–135. https://doi.org/10.1016/j.conctc.2017.06.005

Ruan, Y., Poirier, A., Yong, J., Garner, R., Sun, Z., Than, J., Brenner, D. R. (2023). Long-term projections of cancer incidence and mortality in Canada: The OncoSim All Cancers Model. *Preventive Medicine*, 168. https://doi.org/10.1016/j.ypmed.2023.107425.

Scharloo, M., Baatenburg de Jong, R. J., Langeveld, T. P., van Velzen-Verkaik, E., Doorn-op den Akker, M. M., & Kaptein, A. A. (2005). Quality of life and illness perceptions in patients with recently diagnosed head and neck cancer. *Head & neck*, *27*(10), 857–863. https://doi-org.ezproxy.library.dal.ca/10.1002/hed.20251

Skivington, K., Matthews, L., Simpson, S. A., Craig, P., Baird, J., Blazeby, J. M., Boyd, K. A., Craig, N., French, D. P., McIntosh, E., Petticrew, M., Rycroft-Malone, J., White, M., & Moore, L. (2021). A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. *BMJ (Clinical research ed.)*, *374*, n2061. https://doi.org/10.1136/bmj.n2061

Schulman-Green, D., Jaser, S. S., Park, C., & Whittemore, R. (2016). A metasynthesis of factors affecting self-management of chronic illness. *Journal of advanced nursing*, *72*(7), 1469–1489. https://doi.org/10.1111/jan.12902

Schwarzer, R., & Jerusalem, M. (1995). Generalized Self-Efficacy scale. In J. Weinman, S. Wright, & M. Johnston, Measures in health psychology: A user's portfolio. Causal and control beliefs (pp. 35-37). Windsor, UK: NFER-NELSON.

Shaffer, F., McCraty, R., & Zerr, C. L. (2014). A healthy heart is not a metronome: an integrative review of the heart's anatomy and heart rate variability. *Frontiers in psychology*, *5*, 1040. https://doi.org//10.3389/fpsyg.2014.01040

Siegel, R. L., Miller, K. D., Wagle, N. S., & Jemal, A. (2023). Cancer statistics, 2023. *CA: a cancer journal for clinicians*, *73*(1), 17–48. https://doi.org/10.3322/caac.21763

Silver, J. K., & Baima, J. (2013). Cancer prehabilitation: an opportunity to decrease treatment-related morbidity, increase cancer treatment options, and improve physical and psychological health outcomes. *American journal of physical medicine & rehabilitation*, *92*(8), 715–727. https://doi.org/10.1097/PHM.0b013e31829b4afe

Spada, G. E., Masiero, M., Pizzoli, S. F. M., & Pravettoni, G. (2022). Heart Rate Variability Biofeedback in Cancer Patients: A Scoping Review. *Behavioral sciences (Basel, Switzerland)*, *12*(10), 389. https://doi.org/10.3390/bs12100389

Spiker, R.L. (2014). Mental Health and Marital Status. In The Wiley Blackwell Encyclopedia of Health, Illness, Behavior, and Society (eds W.C. Cockerham, R. Dingwall and S. Quah). https://doi.org/10.1002/9781118410868.wbehibs256

Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray,

F. (2021). Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence

and Mortality Worldwide for 36 Cancers in 185 Countries. *CA: a cancer journal*

for clinicians, *71*(3), 209–249. https://doi.org/10.3322/caac.21660

Thakre, M. N., Sathe, H. S., Talapalliwar, M. R. (2022). Psychometric properties of

Kessler's Psychological Distress Scale (K10) in cancer patients. *Archives of*

Mental Health, 23(2):101-106. https://doi.org/10.4103/amh.amh_104_21

Thayer, J. F., & Lane, R. D. (2000). A model of neurovisceral integration in emotion

regulation and dysregulation. *Journal of affective disorders*, *61*(3), 201–216.

https://doi.org/10.1016/s0165-0327(00)00338-4

Tian, X., Tang, L., Yi, L-J., Qin, X-P., Chen, G-H. &Jiménez-Herrera, M.F. (2022)

Mindfulness Affects the Level of Psychological Distress in Patients With Lung

Cancer via Illness Perception and Perceived Stress: A Cross-Sectional Survey

Study. *Front. Psychol.* 13:857659. https://doi.org/10.3389/fpsyg.2022.857659

Tiller, W. A., McCraty, R., & Atkinson, M. (1996). Cardiac coherence: a new,

noninvasive measure of autonomic nervous system order. *Altern Ther Health*

Med, 2(1), 52–65.

Traeger, L., Penedo, F.J., Gonzalez, J.S., Dahn, J.R., Lechner, S.C., Schneiderman, N., &

Antoni, M.H. (2009). Illness perceptions and emotional well-being in men treated

for localized prostate cancer. *Journal of Psychosomatic Research,* 67(5), 389-397.

https://doi.org/10.1016/j.jpsychores.2009.03.013.

Udumyan, R., Montgomery, S., Fang, F., Valdimarsdottir, U., & Fall, K. (2019). Stress

Resilience in Late Adolescence and Survival among Cancer Patients: A Swedish

Register-Based Cohort Study. *Cancer epidemiology, biomarkers & prevention : a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology*, *28*(2), 400–408. https://doi.org/10.1158/1055-9965.EPI-18-0451

VanderWeele, T. J., & Vansteelandt, S. (2014). Mediation Analysis with Multiple Mediators. *Epidemiologic methods*, *2*(1), 95–115. https://doi.org/10.1515/em-2012-0010

Vo, T. T., Superchi, C., Boutron, I., & Vansteelandt, S. (2020). The conduct and reporting of mediation analysis in recently published randomized controlled trials: results from a methodological systematic review. *Journal of clinical epidemiology*, 117, 78–88. https://doi.org/10.1016/j.jclinepi.2019.10.001

Wallston, K. A., Wallston, B. S., & DeVellis, R. (1978). Development of the Multidimensional Health Locus of Control (MHLC) Scales. *Health education monographs*, *6*(2), 160–170. https://doi.org/10.1177/109019817800600107

Walsh, E. A., Boland, C. L., Popok, P. J., Pedreira, P. B., Fox, R. S., Moreno, P. I., Yanez, B., & Penedo, F. J. (2023). Marital status and perceived stress in men with advanced prostate cancer: A randomized-controlled trial of cognitive behavioral stress management. *J Psychosom Res*, 167. https://doi.org/10.1016/j.jpsychores.2023.111198.

Watts, S., Leydon, G., Birch, B., Prescott, P., Lai, L., Eardley, S., & Lewith, G. (2014). Depression and anxiety in prostate cancer: A systematic review and meta-analysis of prevalence rates. *BMJ Open*, 4(3). https://doi.org/10.1136/bmjopen-2013-003901

Weinman, J., Petrie, K.J., & Moss-Morris, R. (1996). The illness perception

    questionnaire: a new method for assessing the cognitive representation of illness.

    Psychol Health, 11.

White, L.L., Cohen, M.Z., Berger, A.M., Kupzyk, K.A., SworeFletcher, B.A., &

    Bierman, PJ. (2017). Perceived self-efficacy: A concept analysis for symptom

    management in patients with cancer [Online exclusive]. *Clinical Journal of*

    Oncology Nursing, 21, E272-E279. https://doi.org/10.1188/17.CJON.E272-E279

Wolf, M. S., Chang, C. H., Davis, T., & Makoul, G. (2005). Development and validation

    of the Communication and Attitudinal Self-Efficacy scale for cancer (CASE-

    cancer). *Patient education and counseling*, *57*(3), 333–341.

    https://doi.org/10.1016/j.pec.2004.09.005

World Health Organization. (2017). *Mental health of older adults*.

    https://www.who.int/news-room/fact-sheets/detail/mental- health-of-older-adults.

Yang, R., Lu, Z., Gu, X., & Dai, B. (2021). The Effect of an Information Support

    Program on Self-Efficacy of Prostate Cancer Patients during Hormonal

    Therapy. *Asia-Pacific journal of oncology nursing*, *8*(6), 639–652.

    https://doi.org/10.4103/apjon.apjon-2138

Zhang, N., Fielding, R., Soong, I., Chan, K. K., Lee, C., Ng, A., et al. (2018). Illness

    perceptions as predictors of psychological distress among head and neck cancer

    survivors: a longitudinal study. *Head Neck,* 40, 2362–2371.

    https://doi.org/10.1002/hed.25343

Zhang, N., Fielding, R., Soong, I., Chan, K. K., Lee, C., Ng, A., et al. (2017).

    Psychometric assessment of the Chinese version of the brief illness perception

questionnaire in breast cancer survivors. *PLoS One* 12:e0174093.

https://doi.org/10.1371/journal.pone.0174093

Zhang, N., Fielding, R., Soong, I., Chan, K. K., Tsang, J., Lee, V., Lee, C., Ng, A., Sze, W. K., Tin, P., & Lam, W. W. (2016). Illness perceptions among cancer survivors. *Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer*, 24(3), 1295–1304.

https://doi.org/10.1007/s00520-015-2914-3

Zhang, Z., Yang, L., Xie, D., Wang, Y., Bi, L., Zhang, T., et al. (2020). Illness perceptions are a potential predictor of psychological distress in patients with non-muscle-invasive bladder cancer: a 12-month prospective, longitudinal, observational study. *Psychol. Health Med*. 25, 969–979.

https://doi.org/10.1080/13548506.2019.1707242

Zhou, X., Ma, Z., Zhang, L., Zhou, S., Wang, J., Wang, B., & Fu, W. (2016). Heart rate variability in the prediction of survival in patients with cancer: A systematic review and meta-analysis. *Journal of psychosomatic research*, *89*, 20–25.

https://doi.org/10.1016/j.jpsychores.2016.08.004

Zuniga, K. B., Chan, J.M., Ryan, C.J., & Kenfield, S. A (2020). Diet and lifestyle considerations for patients with prostate cancer. *Urol Oncol,* 38, 105–117.

https://doi.org. 10.1016/j.urolonc.2019.06.018

APPENDICES

Appendix A: Self-Efficacy for Managing Chronic Diseases 6-item Scale

1. How confident are you that you can keep the fatigue caused by your disease from interfering with the things you want to do?

not at all confident 1 2 3 4 5 6 7 8 9 10 totally confident

2. How confident are you that you can keep the physical discomfort or pain of your disease from interfering with the things you want to do?

not at all confident 1 2 3 4 5 6 7 8 9 10 totally confident

3. How confident are you that you can keep the emotional distress caused by your disease from interfering with the things you want to do?

not at all confident 1 2 3 4 5 6 7 8 9 10 totally confident

4. How confident are you that you can keep any other symptoms or health problems you have from interfering with the things you want to do?

not at all confident 1 2 3 4 5 6 7 8 9 10 totally confident

5. How confident are you that you can do the different tasks and activities needed to manage your health condition so as to reduce you need to see a doctor?

not at all confident 1 2 3 4 5 6 7 8 9 10 totally confident

6. How confident are you that you can do things other than just taking medication to reduce how much you illness affects your everyday life?

not at all confident 1 2 3 4 5 6 7 8 9 10 totally confident

Appendix B: Brief Illness Perception Questionnaire (B-IPQ)

For the following questions, please circle the number that best corresponds to your views:

How much does your illness affect your life?

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

no affect
at all

severely
affects my life

How long do you think your illness will continue?

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

a very
short time

forever

How much control do you feel you have over your illness?

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

absolutely
no control

extreme amount
of control

How much do you think your treatment can help your illness?

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

not at all

extremely
helpful

How much do you experience symptoms from your illness?

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

no symptoms
at all

many severe
symptoms

How concerned are you about your illness?

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

not at all
concerned

extremely
concerned

How well do you feel you understand your illness?

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

don't
understand
at all

understand
very clearly

How much does your illness affect you emotionally? (e.g. does it make you angry, scared, upset or depressed?)

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

not at all
affected
emotionally

extremely
affected
emotionally

Appendix C: Kessler Psychological Distress Scale (K-10)

		None of the time	A little of the time	Some of the time	Most of the time	All of the time
1	In the past 4 weeks, about how often did you feel tired out for no good reason?	1	2	3	4	5
2	In the past 4 weeks, about how often did you feel nervous?	1	2	3	4	5
3	In the past 4 weeks, about how often did you feel so nervous that nothing could calm you down?	1	2	3	4	5
4	In the past 4 weeks, about how often did you feel hopeless?	1	2	3	4	5
5	In the past 4 weeks, about how often did you feel restless or fidgety?	1	2	3	4	5
6	In the past 4 weeks, about how often did you feel so restless you could not sit still?	1	2	3	4	5
7	In the past 4 weeks, about how often did you feel depressed?	1	2	3	4	5
8	In the past 4 weeks, about how often did you feel that everything was an effort?	1	2	3	4	5
9	In the past 4 weeks, about how often did you feel so sad that nothing could cheer you up?	1	2	3	4	5
10	In the past 4 weeks, about how often did you feel worthless?	1	2	3	4	5