Increasing Physical Activity Intentions and Physical Activity Behaviour using a Media-Based Intervention Informed by Protection Motivation Theory in Women at an Increased Risk of Developing Breast Cancer

By

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Abstract

Purpose: Physical activity (PA) has been shown to decrease breast cancer risk. Using protection motivation theory (PMT), this study explored whether a media-based intervention that presented factual breast cancer and PA information could motivate at-risk women to increase their PA levels. **Method:** Inactive women (*N*= 60) were randomly assigned to one of three groups: (1) PMT intervention, (2) attention control, or (3) non-contact control group. The PMT intervention watched a DVD containing information on PA and breast cancer risk based on PMT constructs (i.e., perceived severity [PS], perceived vulnerability [PV], response efficacy [RE], and self-efficacy [SE]), while the attention control group watched a DVD that contained general diet and cancer information. PMT constructs and PA intentions were measured pre- and post-DVD, and PA was measured subjectively and objectively pre- and post-DVD and at 4-week follow-up. **Results:** Participants in the PMT intervention group showed significant improvements in coping appraisal constructs after watching the DVD (i.e., RE and SE). RE was also found to significantly predict PA intention scores pre-DVD and post-DVD. No significant changes were found for PA behaviour. **Conclusions:** The PMT-based PA intervention successfully increased participants' belief that PA decreases breast cancer risk and that they can perform the required amount of PA to decrease their risk. Further research is needed on the threat appraisal component of PMT and on the inclusion of objective measures of PA in intervention research.

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List of Abbreviations

ACSM – American College of Sports Medicine

BMI – Body Mass Index

CCS – Canadian Cancer Society

CCSACS - Canadian Cancer Society's Advisory Committee on Cancer Statistics

CSEP – Canadian Society for Exercise Physiology

HBM – Health Belief Model

LSI – Leisure Score Index

MVPA – Moderate-to-Vigorous Physical Activity

$MVPA_{10+}$ – Objectively-Measured Weekly PA Adjusted for Ten Minute Bouts

$MVPA_{total}$ – Unadjusted Objectively-Measured Weekly PA

PA – Physical Activity

PACC – Physical Activity and Cancer Control

PMT – Protection Motivation Theory

SEU – Subjective Expected Utility

SCT – Social Cognitive Theory

TPB – Theory of Planned Behaviour

TTM – Transtheoretical Model of Behaviour Change

WCRF – World Cancer Research Fund

WHO – World Health Organization

Chapter 1. Introduction

1.1 Background of Study

Physical activity (PA) has been extensively associated with enhanced health and reduced risk of all-cause mortality, particularly through the prevention of several chronic diseases, such as cardiovascular disease, stroke, hypertension, type 2 diabetes mellitus, osteoporosis, sarcopenia, and cognitive disorders (Kruk, 2007; Melzer, Kayser, & Pichard, 2004; Warburton, Nicol, & Bredin, 2006). When exploring the leading causes of death and their characteristics, one of the top risk factors linked to chronic disease is an inactive lifestyle (Penedo & Dahn, 2005). In 2011, the leading cause of death in Canada was cancer, which accounted for nearly 30% of the total deaths in Canada (Statistics Canada, 2011), followed by heart disease, which was linked to 19.7% of deaths (Statistics Canada, 2011). Insufficient PA has been shown to be a risk factor for some cancers (i.e., colon, breast, lung, and endometrial), and this effect is shown to be completely independent of weight status (Canadian Cancer Society's Advisory Committee on Cancer Statistics [CCSACS], 2015).

In our current society, physical inactivity has become a pandemic. Current data suggests that approximately 31% of the world's population is failing to meet the minimum PA guidelines to attain health benefits, and 17% are considered completely sedentary (Kohl et al., 2012). The World Health Organization (WHO) estimates that 3.3 million people die around the world each year due to physical inactivity, making it the fourth leading cause of mortality (Pratt, Norris, Lobelo, Roux, & Wang, 2014). The low rates of PA produce a substantial and increasing economic and health burden. In the

United States, approximately 11% of healthcare expenditures were associated with sedentary behaviour, and inadequate PA levels (Carlson, Fulton, Pratt, Yang, & Adams, 2015). In Canada, the economic burden of physical inactivity in 2001 was estimated to be $5.3 billion (Katzmarzyk & Janssen, 2004). In 2008, physical inactivity accounted for 9% of premature mortality, and more than 5.3 million of the 57 million deaths worldwide (Lee et al., 2012). It was also estimated that if physical inactivity was decreased by 10-25%, between 533,000-1.3 million deaths could be prevented each year (Lee et al., 2012). These statistics provide strong evidence for the need to increase PA in our society. Many early deaths could be prevented, and the economy would greatly benefit by even a slight increase in PA rates. Motivation is of utmost importance for behaviour change given that the adoption of a regular exercise program requires that individuals progress through three sequential phases: (a) increased intention to exercise, (b) initiation and adoption of exercise, and (c) the successful maintenance of the exercise behaviour over time (Estabrooks & Gyurcsik, 2003). Therefore, there is a need for research that focuses on how to motivate individuals to become physically active and to maintain a sufficient level of activity to prevent chronic diseases, such as cancer.

1.2 Physical Activity and Cancer Risk

Despite the well-known benefits of PA, over half of adult Canadians continue to maintain a sedentary lifestyle (Warburton et al., 2006). Increasing PA levels in the general population is of particular importance due to the high levels of sedentary behaviour in our current society and rapidly increasing cancer prevalence rates. About two in five Canadians will develop cancer in their lifetime, and approximately one out of

four Canadians will die from the disease (CCSACS, 2015), there cancer represents a very high occurrence and mortality rate. Cancer is commonly believed to be preventable as only 5-10% of cancer cases are attributed to genetic defects, whereas the other 90-95% are caused by environment and lifestyle factors (Anand et al., 2008). Modifiable lifestyle behaviours are behaviours that are within your control that increase or decrease your risk of developing cancer (CCSACS, 2015), such as cigarette smoking, diet, alcohol, sun exposure, environmental pollutants, infections, stress, obesity, and PA (Anand et al., 2008). Specifically, it has been identified that approximately two-thirds of worldwide cancer cases are linked to diet, tobacco use, obesity and physical inactivity (Colditz et al., 2000). In North America evidence suggests that 50–75% of cancer deaths are caused by modifiable lifestyle behaviours (National Cancer Institute, 2010).

Breast cancer is currently the most common cancer diagnosed in women in Canada, and is second only to lung cancer as the leading cause of death from cancer in Canadian women (CCSACS, 2015). Breast cancer accounted for 25,000 new cases, or 26% of all new female cases in 2015 (CCSACS, 2015). Despite the high prevalence of breast cancer, it is a largely preventable disease that is greatly attributed to several modifiable risk factors. There is consistent evidence that increased body weight and weight gain during adulthood, alcohol intake, and physical inactivity are all modifiable factors associated with an increased risk of breast cancer (Kushi et al., 2012). PA as a breast cancer risk factor was first explored due to its association with weight and hormone metabolism, but in the past two decades has been presented as an independent risk factor in its own right (Kushi et al., 2012). A recent review of the epidemiological

evidence conducted by Friedenreich, Neilson, and Lynch (2010) conservatively estimates that PA decreases breast cancer risk by 25-30%, with the greatest risk reduction being from recreational activity of a moderate intensity and activity done after menopause. Another significant finding identified that risk reductions were found for all types of PA, including PA in lower doses, and PA done over the lifetime (Friedenreich et al., 2010). This suggests the existence of a dose-response relationship between PA and breast cancer risk; however the exact levels of PA required to produce a risk reduction have not been completely identified. Kruk and Czerniak (2013) conducted another review exploring the relationships between PA and different cancer types. Their findings suggest that the most convincing evidence is for the association between colon cancer risk and PA (i.e., 40-70% risk reduction), followed by post-menopausal breast cancer and PA (i.e., 20-30% risk reduction), and then pre-menopausal breast cancer and PA (i.e., 27% risk reduction; Kruk & Czerniak, 2013). The exact biological mechanisms behind PA and decreased breast cancer risk are somewhat unknown, but the proposed mechanisms include a decrease in adiposity, sex hormones, and metabolic hormones, reduced inflammation, and improved immune function (McTiernan, 2008). Existing evidence suggests that PA can suppress concentrations of 17a-estradiol in women, which has been tied to the development of breast cancer (Kruk, 2007).

1.3 Current Knowledge of Physical Activity and Breast Cancer Risk

Research has clearly established that PA is an effective strategy to reduce breast cancer risk through several important mechanisms. Increasing awareness of the associations between PA and breast cancer risk may contribute to PA promotion, and

help prevent cancer at the population level. Few studies have assessed the population's general knowledge of the link between PA and cancer risk. An internet-based cross cultural survey was conducted in Japan that assessed the awareness of the role of PA in breast cancer prevention, and found that only 31.5% of the 1,000 Japanese women aged 20–69 years that they studied were aware of a link between PA and breast cancer risk (Miyawaki, Shibata, Ishii, & Oka, 2014). These findings, taken with the evidence on the association of breast cancer risk with insufficient PA, suggest that strategies are needed to increase awareness, especially in subgroups that are at a higher risk of developing breast cancer due to lifestyle behaviours (e.g., physical inactivity). In another study examining the awareness of PA as a means of reducing colon cancer risk, only 15% of respondents were aware of the link between PA and colon cancer risk, and awareness was especially low among individuals 50 years and older, and physically inactive individuals (Coups, Hay, & Ford, 2008). The studies clearly demonstrate a gap between the knowledge of the benefits of PA established in the research and the knowledge of the general public. The results are particularly concerning for the inactive individuals who reported less awareness, as inactivity is an important risk factor for several types of cancer (CCSACS, 2014).

There has been a large increase in the amount of literature that focuses on PA, diet, and overweight or obesity interventions published in the last decade (Stephens et al., 2014). PA interventions are one technique that has been studied with mixed results. In order to receive health benefits, PA must be sustained over the long-term; however, clinical programs have a dropout rate of 50% or greater within the first six months (Speck

& Harrell, 2003). Current evidence regarding PA intervention effectiveness in an adult population is still inconclusive, however techniques such as self-monitoring, group-based strategies, and motivational posters were all shown to be promising strategies to increase PA (Brand et al., 2014). These findings indicate a consistent need to pinpoint an effective intervention strategy that increases PA levels over the long-term for individuals at risk for chronic diseases associated with inactivity.

1.4 Physical Activity Intervention Strategies and Psychological Theories

While several intervention techniques have shown promising results, basing health behaviour change interventions upon psychological theories have led to improved results (Brown et al., 2011; Noar, Benac, & Harris, 2007; Webb & Sheeran, 2006). Health behaviour interventions developed around psychological theories have produced increases in PA, physical functioning, social cognition, self-efficacy, and mobility in various populations (Brawley, 2012; Hatchett, Hallam, & Ford, 2013; Rejeski et al., 2014). A meta-analysis of theory-based interventions showed that this type of intervention significantly impacted PA behaviour, and that interventions based on a single theory had a higher impact (Gourlan et al., 2016). Psychological theories are important to this field of research in multiple ways. First, they provide a framework around which to develop interventions, allowing for potential repeatability of the study and giving future research an outline to follow (Lox, Ginis, & Petruzzelo, 2010). Second, they help to pinpoint what motivates individuals to be physically active and how to produce this effect in inactive individuals over the long-term (Conner & Norman, 2005; Lox et al., 2010). Third, the inclusion of psychological theoretical methods and

manageable amounts of PA may induce greater improvements than traditional methods of simple education regarding healthy eating and PA practices (Annesi & Johnson, 2015). Theory-driven research is crucial in attempts to find out what constructs and personal values must be increased in participants to produce an increase in PA levels (e.g., Hartman, Dunsiger, & Marcus, 2013). PA interventions have been shown to be effective in increasing PA rates in a variety of populations such as cancer patients (e.g., Reeves et al., 2014), cancer survivors (e.g., Spark et al., 2013), and healthy but at-risk populations due to possession of modifiable cancer risk factors (e.g., Graham, Prapavessis, & Cameron, 2006; Hartman et al., 2013; McGowan & Prapavessis, 2010).

Several health behaviour theories have been developed to facilitate the understanding and the adoption of a given health behaviour, such as PA (e.g., the Health Belief Model [HBM]- Rosenstock, Strecher, & Becker, 1988; Protection Motivation Theory [PMT]- Rogers, 1975; 1983; Rogers & Prentice-Dunn, 1997; Theory of Planned Behaviour [TPB]- Ajzen & Fishbein, 1980; Ajzen, 1991; and Subjective Expected Utility [SEU]- Fischhoff, Goitien, & Shapira, 1981). These theories are based on the premise that in order to motivate individuals to engage in a protective activity, the individual must perceive a direct threat and have a desire to avoid the potential negative outcome, as well as a cost-benefit analysis where the individual weighs the cost of the protective behaviour against the expected benefits (Floyd, Prentice-Dunn, & Rogers, 2000). Each theory has advantages and disadvantages, which will be explored further in the literature review, and is why multiple theories remain in use today. According to Rothman (2000), several of the most popular theories (e.g., the HBM, PMT, Social Cognitive Theory [SCT]-

Bandura, 1986; TPB, Transtheoretical Model of Behaviour Change [TTM]- Prochaska, DiClemente, & Norcross, 1992) employ a similar conceptual framework; in essence, that the decision to adopt a certain behaviour is a result of cost versus benefit, with the main difference between the various theories being the certain set of constructs that translate into behaviour change.

It is important that the framework chosen for the intervention is appropriate to the selected population. PMT was selected for the current study as it has been most commonly applied to healthy populations in PA intervention studies. Bui, Mullan, and McCaffery (2013) reviewed 20 studies that applied PMT and measured PA (7 were intervention studies). The results of the review were promising for the use of PMT as all studies showed larger increases in PA intentions in PMT groups compared to control, and 4 out of 6 studies that measured actual PA behaviour showed improvement (Bui et al., 2013). These promising results taken with the limited existing research examining PA behaviour change in healthy populations using PMT demonstrates a significant gap in the literature.

Additional reasoning behind the selection of PMT was that it was primarily developed to change PA intentions/motivations, and interventions based on this theory have been effective at producing positive outcomes for a variety of health behaviours, such as smoking cessation, cancer screening, and nutrition (Floyd, Prentice-Dunn, & Rogers, 2000; Bui et al., 2013). In the current study, intervention materials will be presented using PMT as a framework for reducing the risk of breast cancer. PMT interventions have been applied and produced positive results to encourage health

behaviors associated with skin cancer risk (Baghianimoghadam, Mohammadi, Noorbala, & Mazloomy Mahmoodabad, 2011; McClendon & Prentice-Dunn, 2001), colon cancer risk (Courneya & Hellsten, 2001, Graham et al., 2006; McGowan & Prapavessis, 2010), and to improve cancer-screening methods (Gu, Chan, Twinn, & Choi, 2012; Helmes, 2002). PMT has been shown to produce increases in PA intention when used in interventions containing information on colon cancer risk in healthy populations (i.e., Courneya & Hellsten, 2001; Graham et al., 2006) and at-risk populations (McGowan & Prapavessis, 2010). PMT-based interventions have also been shown to produce significant increases in subjectively measured PA behaviour (Graham et al., 2006).

PMT, shown in Figure 1, is a social-cognitive model that was designed to explain health behaviour motivation from the perspective of disease prevention (Courneya & Hellsten, 2001; McGowan & Prapavessis, 2010). Health-related behaviour is explained in terms of two cognitive processes: threat appraisal and coping appraisal. PMT suggests that the individual be first exposed to threat increasing information, such as the potential to develop cancer if they do not become physically active. Threat appraisal is made up of the constructs of perceived severity (PS) of a health-related threat, and their perception of vulnerability (i.e., perceived vulnerability, PV) to the threat. Once threat appraisal has been established, the individual should be presented with information on how to build coping strategies to manage the potential threat. The coping appraisal process is composed of response-efficacy (RE) and self-efficacy (SE) constructs as well as response costs. RE is the individual's belief that the recommended coping response (e.g., PA) is effective at reducing the risk of the health condition and SE is an individual's belief that

they can successfully perform the coping response. RE and SE increase the probability of performing the health-related behaviour, while response costs decrease the probability (Bui et al., 2013).

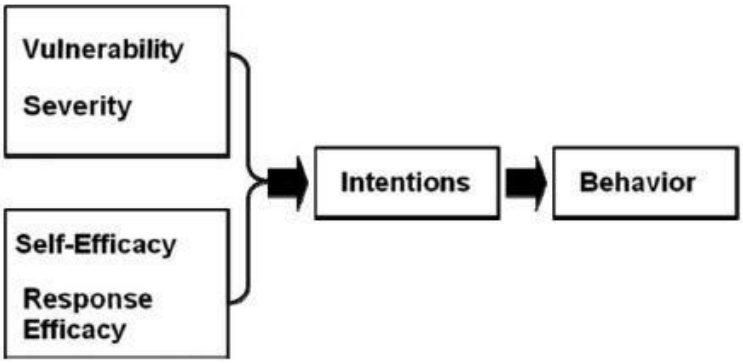

Figure 1. Protection Motivation Theory (PMT; Rogers, 1983, image; McGowan & Prapavessis, 2010).

It is well known that PA provides positive health benefits and the majority of individuals believe that PA is important (Crombie et al., 2004; Belanger-Gravel, Godin, Bilodeau, Poirier, & Dagenais, 2013). However, the modernization of our society has greatly reduced the need for PA, as well as its value, and has led to an enormous increase in the levels of sedentary behaviour in our country and all over the Western world (Lee et al., 2012; Kohl et al., 2012). This contradiction between beliefs and behaviour leads to a large amount of over-reporting PA in research conducted using self-report measures (Sallis & Saelens, 2000). When asked if they were meeting the recommended guidelines of 150-minutes of activity per week, 52.5% of Canadian adults believed that they were. However when this data is contrasted with objective data through use of activity monitors, it shows a huge discrepancy as only 15% were actually meeting the

recommended amounts (Colley et al., 2011). This relatively new technology of activity monitoring has highlighted a gap in the literature in regards to measuring PA rates.

Previous research has demonstrated that PMT is effective at increasing PA intention and subjectively measured PA behaviour. The current study will extend the PMT literature by including objective measures of PA behaviour using accelerometry. To the best of our knowledge, this is the first study to include an objective measure of PA in the PMT and cancer risk literature to date. Therefore, this study will provide novel information on how effective a PMT-based intervention technique is in regards to objectively measured PA behaviour. In the current study we will be making use of self-report activity questionnaires, as well as objectively measured data collected through ActiGraph™ accelerometers to determine the impact of the PMT-based intervention on subjectively and objectively measured PA behaviour.

1.6 Research Objectives and Hypotheses

1.6.1. Objectives

The primary objective of the current study is to extend the literature by examining the effectiveness of an intervention grounded in PMT that seeks to change beliefs toward breast cancer and PA, PA intentions, and PA behaviour in inactive women as they are at an increased risk of developing breast cancer. Secondary objectives are to: explore which of the four PMT variables are the most predictive of PA behaviour, and examine the relationship between subjectively and objectively measured PA.

1.6.2. Hypotheses

Based on previous research exploring PMT-based interventions, it is hypothesized for the primary objective that participants receiving the PMT intervention will show

higher change scores from baseline in PV, PS, SE and RE compared to those in the attention control and non-contact control groups (Floyd et al., 2000). Consistent with the theory (see Figure 1), for the secondary objective it is hypothesized that all four PMT constructs will predict PA intention (Graham et al., 2006). However, it is predicted that RE and SE will be the most salient predictors of PA intention (McGowan & Prapavessis, 2010; Milne, Sheeran, & Orbell, 2000). It is also hypothesized that PA intention will predict subjectively measured PA behaviour (Graham et al., 2006). No hypotheses were generated for the prediction of objective PA behaviour due to the exploratory nature of this component of the study.

1.6.3. Significance of the Study

In the current study we will focus on the effects of a PMT-based PA intervention on breast cancer beliefs, PA intention, and PA behaviour. Due to the protective nature of PA, it is of utmost importance to increase PA behaviour in populations at an increased risk of developing breast cancer, as well as in the general population. We chose women who deem themselves to be physically inactive as they are at an increased risk for developing breast cancer due to being physically inactive, which is a modifiable risk factor for breast cancer. It has been shown that people respond better to health information when it is more tailored to them and their beliefs (Noar, Harrington, & Aldrich, 2009; Pelletier & Sharp, 2008). Women who deem themselves to be physical inactive are likely to be more receptive to health and PA information, and are therefore more likely to respond to the intervention.

PMT-based interventions have been shown to be successful when applied to

information regarding colon cancer risk. However, to the best of our knowledge this is the first study to explore the effectiveness of a PMT-based PA intervention to increase PA intention and behaviour by presenting information on the link between PA and breast cancer. Another significant and novel part of this study is the use of objective and subjective measurements of PA, which will demonstrate if the PMT intervention can change '*actual*' PA behaviour. As current research highlights the importance of PA for cancer prevention, there needs to be confirmation that the self-report methods that are consistently used in studies are providing reliable evidence, as the success of interventions and programs is often based on self-report measures. This validation will ensure that our efforts are being directed at thresholds that '*actually*' produce improvements in PA motivation and PA performance. The use of accelerometers in this type of research is a relatively new measurement technique, but early results are promising in regards to confirming the validity of self-report methods that have been the most popular activity tracking method to date (Yang & Hsu, 2010).

As a final note, the present dissertation was completed using Memorial University's manuscript format. Included in this dissertation is an introduction (Chapter 1), review of the relevant literature (Chapter 2), research manuscript (Chapter 3), and conclusion (Chapter 4). Based on this formatting some of the information presented in the dissertation may be repetitive.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice Hall.

Anand, P., Kunnumakara, A. B., Sundaram, C., Harikumar, K. B., Tharakan, S. T., Lai, O. S., ... & Aggarwal, B. B. (2008). Cancer is a preventable disease that requires major lifestyle changes. *Pharmaceutical Research*, *25*(9), 2097-2116.

Annesi, J. J., & Johnson, P. H. (2015). Theory-based psychosocial factors that discriminate between weight-loss success and failure over 6 months in women with morbid obesity receiving behavioral treatments. *Eating and Weight Disorders, 20*(2), 223-232

Baghianimoghadam, M. H., Mohammadi, S., Noorbala, M. T., & Mazloomy Mahmoodabad, S. S. (2011). An intervention based on protection motivation theory in reducing skin cancer risk. *Journal of Pakistan Association of Dermatologists, 21*(3), 141-148.

Bandura, A. (1986). *Social foundations of thought and action*. New Jersey: Prentice-Hall.

Bélanger-Gravel, A., Godin, G., Bilodeau, A., Poirier, P., & Dagenais, G. R. (2013). Physical activity beliefs among overweight/obese older adults results from a theory of planned behavior elicitation study. *International Journal of Sport Psychology, 44*(2), 145-159. doi:10.7352/IJSP2013.44.145

Brand, T., Pischke, C. R., Steenbock, B., Schoenbach, J., Poettgen, S., Samkange-Zeeb, F., & Zeeb, H. (2014). What works in community-based interventions promoting physical activity and healthy eating? A review of reviews. *International Journal of Environmental Research and Public Health, 11*(6), 5866-5888.

Brawley, L., Rejeski, W. J., Gaukstern, J. E., & Ambrosius, W. T. (2012). Social cognitive changes following weight loss and physical activity interventions in obese, older adults in poor cardiovascular health. *Annals of Behavioral Medicine,44*(3), 353-364. doi:10.1007/s12160-012-9390-5

Brown, J. C., Huedo-Medina, T. B., Pescatello, L. S., Pescatello, S. M., Ferrer, R. A., & Johnson, B. T. (2011). Efficacy of exercise interventions in modulating cancer-related fatigue among adult cancer survivors: a meta-analysis. *Cancer, Epidemiology, Biomarkers & Prevention, 20*(1), 123-133.

Bui, L., Mullan, B., & McCaffery, K. (2013). Protection motivation theory and physical activity in the general population: A systematic literature review. *Psychology, Health and Medicine*, *18*(5), 522-542.

Canadian Cancer Society's Advisory Committee on Cancer Statistics. Canadian Cancer Statistics 2015. Toronto, ON: Canadian Cancer Society; 2015.

Carlson, S. A., Fulton, J. E., Pratt, M., Yang, Z., & Adams, E. K. (2015). Inadequate physical activity and health care expenditures in the United States. *Progress in Cardiovascular Diseases*, *57*(4), 315-323.

Colditz, G., Atwood, K., Emmons, K., Monson, R., Willett, W., Trichopoulos, D., & Hunter, D. (2000). Harvard Report on Cancer Prevention Volume 4: Harvard

Cancer Risk Index. *Cancer Causes & Control, 11*(6), 477-488.

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011). Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports*, *22*(1), 7-14.

Conner, M., & Norman, P. (2005). *Predicting Health Behaviour* (2nd Edition). Berkshire, GBR: McGraw-Hill.

Coups, E. J., Hay, J., & Ford, J. S. (2008). Awareness of the role of physical activity in colon cancer prevention. *Patient Education and Counseling*, *72*(2), 246-251.

Courneya, K. S., & Hellsten, L. M. (2001). Cancer prevention as a source of exercise motivation: An experimental test using protection motivation theory. *Psychology, Health and Medicine, 6*(1), 59-64.

Crombie, I. K., Irvine, L., Williams, B., McGinnis, A. R., Slane, P. W., Alder, E. M., & McMurdo, M. E. (2004). Why older people do not participate in leisure time physical activity: a survey of activity levels, beliefs and deterrents. *Age and Ageing*, *33*(3), 287-292.

Estabrooks, P. A., & Gyurcsik, N. C. (2003). Evaluating the impact of behavioral interventions that target physical activity; issues of generalizability and public health. *Psychology of Sport and Exercise*, *4*(1), 41-55.

Fischhoff, B., Goitein, B., & Shapira, Z. (1981). Subjective expected utility: A model of decision-making. *Journal of the American Society for Information Science, 32*(5), 391-399.

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology, 30*(2), 407-429.

Friedenreich, C. M. (2010). Physical activity and breast cancer: review of the epidemiologic evidence and biologic mechanisms. In *Clinical Cancer Prevention* (125-139). Heidelberg, Berlin: Springer.

Friedenreich, C. M., Bryant, H. E., & Courneya, K. S. (2001). Case-control study of lifetime physical activity and breast cancer risk. *American journal of epidemiology*, *154*(4), 336-347.

Friedenreich, C. M., Neilson, H. K., & Lynch, B. M. (2010). State of the epidemiological evidence on physical activity and cancer prevention. *European journal of cancer*, *46*(14), 2593-2604.

Gourlan, M., Bernard, P., Bortolon, C., Romain, A. J., Lareyre, O., Carayol, G., … & Boiché, J. (2016). Efficacy of theory-based interventions to promote physical activity. A meta-analysis of randomised controlled trials. *Health Psychology Review, 10*(1), 50-66.

Graham, S. P., Prapavessis, H., & Cameron, L. D. (2006). Colon cancer information as a source of exercise motivation. *Psychology and Health*, *21*(6), 739-755

Gu, C., Chan, C. W. H., Twinn, S., & Choi, K. C. (2012). The influence of knowledge and perception of the risk of cervical cancer on screening behavior in mainland Chinese women. *Psycho-Oncology, 21*(12), 1299-1308. doi:10.1002/pon.2037

Hartman, S. J., Dunsiger, S. I., & Marcus, B. H. (2013). A pilot study of a physical activity intervention targeted towards women at increased risk for breast cancer. *Psycho-Oncology, 22*(2), 381-387.

Hatchett, A., Hallam, J. S., & Ford, M. A. (2013). Evaluation of a Social Cognitive Theory-based email intervention designed to influence the physical activity of survivors of breast cancer. *Psycho-Oncology, 22*(4), 829-836. doi:10.1002/pon.3082

Helmes, A. W. (2002). Application of the protection motivation theory to genetic testing for breast cancer risk. *Preventive Medicine, 35*(5), 453-462. doi:10.1006/pmed.2002.1110

Katzmarzyk, P. T., & Janssen, I. (2004). The economic costs associated with physical inactivity and obesity in Canada: an update. *Canadian journal of applied physiology*, *29*(1), 90-115.

Katzmarzyk, P.T., & Tremblay, M.S. (2007). Limitations of Canada's physical activity data: implications for monitoring trends. *Canadian Journal of Public Health, 98*(2), S185-194.

Kohl III, H. W., Craig, C. L., Lambert, E. V., Inoue, S., Alkandari, J. R., Leetongin, G., . . . Wells, J. C. (2012). The pandemic of physical inactivity: Global action for public health. *The Lancet, 380*(9838), 294-305.

Kruk, J. (2007). Lifetime physical activity and the risk of breast cancer: A case-control study. *Cancer Detection and Prevention*, *31*(1), 18-28

Kruk, J., & Czerniak, U. (2013). Physical activity and its relation to cancer risk: Updating the evidence. *Asian Pacific Journal of Cancer Prevention, 14*(7), 3993-4003.

Kushi, L. H., Doyle, C., McCullough, M., Rock, C. L., Demark-Wahnefried, W., Bandera, E. V., . . . Gansler, T. (2012). American cancer society guidelines on nutrition and physical activity for cancer prevention: Reducing the risk of cancer with healthy food choices and physical activity. *CA: A Cancer Journal for Clinicians, 62*(1), 30-67. doi:10.3322/caac.2014

Lee, I., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., Katzmarzyk, P. T., Alkandari, J.R., Anderson, L.B., Bauman, A.E., Brownson, R.C., Bull, F.C., Craig, C.L., Ekelund, U., …Wells, J.C., (2012). Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *The Lancet, 380*(9838), 219-229.

Lox, C., Martin Ginis, K., & Petruzzello, S. (2003). *The psychology of exercise : Integrating theory and practice*. Scottsdale, Arizona: Holcomb Hathaway.

McClendon, B. T., & Prentice-Dunn, S. (2001). Reducing skin cancer risk: An intervention based on protection motivation theory. *Journal of Health Psychology, 6*(3), 321-328.

McGowan, E. L., & Prapavessis, H. (2010). Colon cancer information as a source of exercise motivation for relatives of patients with colon cancer. *Psychology, Health and Medicine, 15*(6), 729-741.

McTiernan, A. (2008). Mechanisms linking physical activity with cancer. *Nature Reviews Cancer*, *8*(3), 205-211.

Melzer, K., Kayser, B., & Pichard, C. (2004). Physical activity: The health benefits outweigh the risks. *Current Opinion in Clinical Nutrition and Metabolic Care, 7*(6), 641-647. doi:10.1097/00075197-200411000-00009

Milne, S., Sheeran, P., & Orbell, S. (2000). Prediction and intervention in health-related behavior: A meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology*, *30*(1), 106-143.

Miyawaki, R., Shibata, A., Ishii, K., & Oka, K. (2014). Awareness and correlates of the role of physical activity in breast cancer prevention among Japanese women: results from an internet-based cross-sectional survey. *BMC Women's Health*, *14*(1), 80.

Noar, S. M., Benac, C. N., & Harris, M. S. (2007). Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychological Bulletin, 133*(4), 673-693.

Noar, S. M., Harrington, N. G., & Aldrich, R. S. (2009). The role of message tailoring in the development of persuasive health communication messages. *Annals of the International Communication Association*, *33*(1), 73-133.

Pelletier, L. G., & Sharp, E. (2008). Persuasive communication and proenvironmental behaviours: How message tailoring and message framing can improve the integration of behaviours through self-determined motivation. *Canadian Psychology/Psychologie canadienne*, *49*(3), 210.

Penedo, F., & Dahn, J. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry, 18*(2), 189-93.

Pratt, M., Norris, J., Lobelo, F., Roux, L., & Wang, G. (2014). The cost of physical inactivity: Moving into the 21st century. *British Journal of Sports Medicine, 48*(3), 171-173. doi:10.1136/bjsports-2012-091810

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology, 51*(3), 390-395.

Reeves, M. M., Terranova, C. O., Eakin, E. G., & Demark-Wahnefried, W. (2014). Weight loss intervention trials in women with breast cancer: A systematic review. *Obesity Reviews, 15*(9), 749-768.

Rejeski, W. J., Spring, B., Domanchuk, K., Tao, H., Tian, L., Zhao, L., & McDermott, M. M. (2014). A group-mediated, home-based physical activity intervention for patients with peripheral artery disease: Effects on social and psychological function. *Journal of Translational Medicine, 12*(1) doi:10.1186/1479-5876-12-29

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change. *Journal of Psychology, 91*(1), 93-114.

Rogers, R. W. (1983). Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. In J. R. Cacioppo & R. E. Petty (eds.), *Social Psychology: A Sourcebook* (153-176). New York, NY: Guilford Press.

Rogers, R. W., & Prentice-Dunn, S. (1997). Protection motivation theory. In D. S. Gochman (ed.), *Handbook of Health Behavior Research I: Personal and social determinants* (113-132). New York, NY: Plenum Press.

Rosenstock, I., Strecher, V., & Becker, M. (1988). Social Learning Theory and the Health Belief Model. *Health Education & Behavior, 15*(2), 175-183.

Spark, L. C., Reeves, M. M., Fjeldsoe, B. S., & Eakin, E. G. (2013). Physical activity and/or dietary interventions in breast cancer survivors: A systematic review of the maintenance of outcomes. *Journal of Cancer Survivorship, 7*(1), 74-82

Speck, B. J., & Harrell, J. S. (2003). Maintaining regular physical activity in women: evidence to date. *Journal of Cardiovascular Nursing*, *18*(4), 282-293.

Statistics Canada. (2011). *Table 1:Ranking, number and percentage of deaths for the 10 leading causes, Canada, 2000, 2010 and 2011* Retrieved Dec 10, 2014 from Statistics Canada: http://www.statcan.gc.ca/daily-quotidien/140128/t140128b001-eng.htm

Stephens, S. K., Cobiac, J & Veerman, L. (2014). Improving diet and physical activity to reduce population prevalence of overweight and obesity: An overview of current evidence. *Preventive Medicine, 62*(1), 167-178.

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: The evidence. *Canadian Medical Association Journal, 174*(6), 801-809.

Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132*(2), 249-268.

Yang, C. C., & Hsu, Y. L. (2010). A review of accelerometry-based wearable motion detectors for physical activity monitoring. *Sensors*, *10*(8), 7772-7788.

Chapter 2: Literature Review

2.0 Introduction and Purpose

There are many well-established health risks associated with a lack of physical activity (PA) and many protective benefits associated with regular PA. Insufficient PA is one of the 10 leading factors for premature death worldwide, and is a key risk factor for non-communicable diseases, such as cardiovascular disease, cancer, and diabetes (World Health Organization [WHO], 2013). However, despite the well-established benefits, at least 60% of the world's population fails to engage in the recommended amounts of PA required to produce health benefits (WHO, 2009). In fact, without intervention, 50% of individuals who adopt a PA program will drop out within the first year (American College of Sports Medicine [ACSM], 2006). These statistics demonstrate that adopting and maintaining PA behaviours is complex. The complexity of changing behaviours is unfortunate as a healthy lifestyle, including PA, plays a critical role in preventing, controlling and reducing the impact of chronic diseases by prolonging survival and enhancing health and wellbeing (Roberts & Barnard, 2005; Kruk, 2007; Martinez-Gonzalez, 2003; Pratt et al., 2014; Stocchi, 2007). Therefore, interventions designed to increase PA behaviours to attain health benefits are essential. A successful means of producing healthier lifestyle choices is through behaviour change interventions. That is, interventions and support strategies that are specifically designed to facilitate the implementation and long-term maintenance of healthy behaviours or termination of unhealthy behaviours (e.g., smoking, alcohol consumption). Behaviour change

interventions are particularly important in populations with an elevated risk of developing a debilitating chronic disease due to modifiable lifestyle behaviours, such as PA.

The purpose of this literature review is to demonstrate the specific risks of developing cancer associated with physical inactivity, and the benefits and protective effects associated with PA shown throughout research. Through establishing the effects of PA on health and chronic diseases such as cancer, and specifically breast cancer, this will clearly demonstrate the necessity for our study and outline the implications for future behaviour change research.

2.1 Physical Activity Definitions and Guidelines

The terms "PA" and "exercise" describe different concepts but are often used interchangeably. PA is conceptualized as "any bodily movement produced by skeletal muscles that require energy expenditure" (Casperson, Powell, & Christenson, 1985, p. 126). PA in daily life can be categorized into occupational, sports, conditioning, household, or other activities (Casperson et al., 1985). Exercise is a subset of PA that is planned, structured, and repetitive, and has as a final or an intermediate objective of the improvement or maintenance of physical fitness (Casperson et al., 1985).

The current study will use the term "PA" and not "exercise" as it is in agreement with the recommendations for achieving health benefits that have been determined by the Canadian Society for Exercise Physiology (18-64 years of age; CSEP, 2011). The CSEP guidelines for adults state that adults should perform a minimum of 150-minutes per week of moderate-to-vigorous intensity aerobic PA in 10-minute bouts or more to achieve health benefits. The guidelines also recommend incorporating muscle and bone

strengthening exercise using major muscle groups at least 2 days per week (Tremblay et al., 2011). Following these guidelines has been shown to reduce the risk of premature death, cardiovascular disease (CVD), stroke, hypertension, colon cancer, breast cancer, type 2 diabetes, and osteoporosis and result in improvements in body composition, fitness, and mental health indicators (Tremblay et al., 2011). The current study will use the term PA and not exercise, as we are interested in the amount of activity that is performed throughout the day. The study is focused on PA performed in bouts of 10 minutes or more as that is in agreement with the CSEP recommended guidelines.

2.2 Physical Activity Prevalence and General Health

There is overwhelming research evidence that has been accumulated over the last 100 years, which has very convincingly established that PA and diet interventions can mitigate the progression of chronic disease, and even reverse the effects of existing diseases (Roberts & Barnard, 2005). Modern chronic diseases such as CVD, type 2 diabetes, metabolic syndrome, and cancer, are the leading causes of mortality in westernized societies and have all been shown to be associated with insufficient PA (Roberts & Barnard, 2005). Lack of PA and poor diet were estimated to be the second leading cause of total deaths in the US in 2000 accounting for 16.6%, following smoking at 18.1% (Kruk, 2007), and increasing weekly PA by 1 MET (equivalent to 1000 kcal/week) causes a 20% reduction in all-cause mortality (Kruk, 2007).

For coronary artery disease the evidence indicates that physical inactivity and dietary factors contribute independently to developing atherosclerosis, and consequently coronary artery disease (Roberts & Barnard, 2005). Evidence on type 2 diabetes has

shown that aerobic and resistance PA training has been shown to slow progression of this disease and reverse the effects in some severe cases (Roberts & Barnard, 2005). Comprehensive evidence clearly establishes that lack of PA affects every cell, organ, and system in the body causing sedentary dysfunction and accelerated death (Booth, Roberts, & Laye, 2012). PA is a necessary part of life, in the same way as food and reproduction, but modernization has allowed it to become an avoidable behaviour, and as a result longer-term health has suffered (Booth et al., 2012).

Current data suggests that approximately 31% of the world's population is not meeting minimum guidelines for PA and 17% are sedentary (sedentary– spending most time sitting or lying down; Kohl et al., 2012). Due to the harmful health and environmental consequences of physical inactivity and the substantial amount of PA promotional strategies, this problem has developed into a global public health priority. An analysis by Lee et al. (2012) attempts to quantify the effects of worldwide physical inactivity on the prevalence of major non-communicable diseases and determined the prevalence of inactivity in people who eventually developed several types of disease. For individuals who developed coronary heart disease, 42.2% were inactive, for type 2 diabetes 43.2% were inactive, for breast cancer 40.7 % were inactive, for colon cancer 42.9% were inactive, and for all-cause mortality 42.9% were inactive (Lee et al., 2012; Table 1). The population attributable fraction was also determined, which is an estimate of physical inactivity as a risk factor on disease incidence in a population, per country. In Canada, the population attributable factor is 5.6% for coronary heart disease, 7.0% for type 2 diabetes, 9.2% for breast cancer and 10.0% for colon cancer.

As we can see from several comprehensive reviews, PA has a preventive effect for the development of numerous diseases and illnesses such as hypertension, high blood pressure, coronary artery disease (Kruk & Czerniak, 2007; Roberts & Barnard, 2005), type 2 diabetes, prostate cancer, colon cancer, breast cancer (Booth et al., 2012; Kruk & Czerniak, 2007; Roberts & Barnard, 2005), lung cancer (Booth et al., 2012; Kruk & Czerniak, 2007; Roberts & Barnard, 2005; Thune & Lund, 1997) and depression (Kruk & Czerniak, 2007). This extensive evidence on disease, combined with the percentage of people not meeting recommended PA guidelines in our current society, indicates a need for research on how to increase PA levels in the general population. Although the detrimental effects of physical inactivity are well established, how to decrease sedentary behaviour in adults is still largely unknown (Booth et al., 2012).

2.3 Physical Activity and Cancer Risk

Now that we have established the effects of PA on health and prevention of diseases, and the current PA rates in our society, we can narrow our focus to the specific relationship between PA and cancer. To date, much of the PA and cancer literature has focused on PA as a means of primary cancer prevention (Winzer, Whiteman, Reeves, & Paratz, 2011). The current data is still relatively new but increasing, and there is some evidence to support the role of PA in modulating various cancer pathways (Winzer et al., 2011). PA may have a preventive effect on cancer at any stage; be it protective, or pre-diagnosis, post-diagnosis, during treatment, and after treatment as well (Friedenreich, 2010). The preventive effects of PA have been demonstrated in primary, secondary, and tertiary mechanisms. Primary prevention refers to health promotion and contributes to

general wellness, decreasing the likelihood of developing disease. Secondary prevention refers to the detection and management of pre-symptomatic disease and prevents further progression. Tertiary prevention refers to the treatment of a symptomatic disease in an effort to slow down progression to disability or death. The greatest health benefit of PA is proposed to be in primary prevention (Booth et al., 2012).

The review by Kruk and Czerniak (2013) summarized the recent evidence for the prevention of cancer by PA, and found the following: colon cancer shows the most definitive risk reduction of 20-25% (evidence is convincing), post menopausal breast cancer shows a risk reduction of 20-30% (evidence shows a probable association), endometrial cancer shows a risk reduction of 20-30% (probable association), premenopausal breast cancer shows a risk reduction of 27% (limited evidence of protective effect), and the other more common types; prostate, lung, ovarian, pancreatic, and gastric all show limited evidence that PA has a preventive effect. McCullough et al. (2011) asked 111,966 non-smoking men and women to complete an extensive questionnaire that asked about diet, lifestyle, weight, PA, and alcohol consumption. Over the 14 years of follow-up on this large, cohort sample, it was found that the men and women who exhibited behaviours most consistent with the cancer prevention guidelines had a 42% lower risk of death from any cause and a significantly lower risk of death from cancer than individuals with less consistent behaviour (Kushi et al. 2006; McCullough et al., 2011).

To date the findings concerning the preventive benefits of PA on cancer development is most conclusive for colon and breast cancers (Kruk & Czerniak, 2013),

indicating a need to increase PA behaviour in individuals who are at an increased risk for these cancers in particular. However, research has not established the specific strength and dose-response of PA needed to prevent cancer. Therefore, the duration, frequency, intensity, timing, and type of activity that is necessary to provide prevention against cancer development is still unknown. Research on colon cancer, which is the third most common type of cancer worldwide, shows that men and women who engage in 3-4 hours of moderate or vigorous intensity PA per week experience an average risk reduction of 30% compared to individuals who accumulated less than 30 minutes per week (Kruk & Czerniak, 2013). Breast cancer is the most common cancer diagnosed in women worldwide, with 50% of cases occurring in developed countries (Siegel et al., 2012). There are multiple risk factors for developing this type of cancer, such as older age, greater exposure to estrogens over the lifetime, genetic mutations, family history, obesity, and sedentary lifestyle (CCS, 2013). While some of these factors are non-modifiable, there exists strong evidence that risk of developing this cancer is significantly decreased among those who meet the guidelines for PA (Kruk & Czerniak, 2013). The average risk reduction due to PA is estimated to be 25% with the strongest association being found for moderate-vigorous recreational activity that is done throughout the lifetime or after menopause (Kruk & Czerniak, 2013). A dose-response relationship was found for breast cancer in 33 of 51 studies with greater duration of moderate and vigorous activity resulting in a greater risk reduction of 23-65% for case-control studies and 21-39% from cohort studies (Monninkhof et al., 2007). This data suggests the need for more cohort studies and controlled PA intervention trials to give answers to the issues of what dose of

PA is optimal, if PA impact varies by cancer subtype, and which type of activity and dosage provides the strongest risk reduction.

Friedenreich et al. (2010) provided another review on the epidemiological evidence of PA and cancer prevention. Despite the finding that PA is a modifiable lifestyle behaviour that reduces the risk of some cancers, there still exists uncertainty towards the necessary strength, consistency and dose-response factor of the association. Convincing evidence was found for the beneficial effect of PA on the risk of breast, colon, and endometrial cancers, but somewhat weaker evidence for this association in ovarian, lung, and prostate cancers (Friedenreich, 2010). For breast cancer, population-attributable risk was 20% and estimated preventable cases were 83,353 for insufficiently active women in Europe. These numbers indicate a clear need to increase activity levels globally in order to decrease the number of breast cancer cases due to physical inactivity (Sjostrom et al., 2006).

Courneya and Friedenreich (2007) published an overview of the PA research on cancer-related benefits, but applied it across the entire cancer control continuum. In 2001, Courneya and Friedenreich proposed a framework called Physical Exercise Across the Cancer Experience (PEACE) to organize, focus, and stimulate research on PA and cancer control (Courneya & Friedenreich, 2001). The 2001 framework focused mainly on the supportive care outcomes (i.e., physical function, quality of life), so in 2004 this framework was adapted to highlight the clinical outcomes as well (i.e., disease and treatment-related outcomes; Courneya & Friedenreich, 2004). In the most recent 2007 study the two previous frameworks are integrated and incorporate the Institute of

Medicine's adaptation of the National Cancer Institute's Cancer Control Continuum (Courneya & Friedenreich, 2007). The newly developed framework is titled the PA and Cancer Control (PACC) framework and is shown in Figure 2.

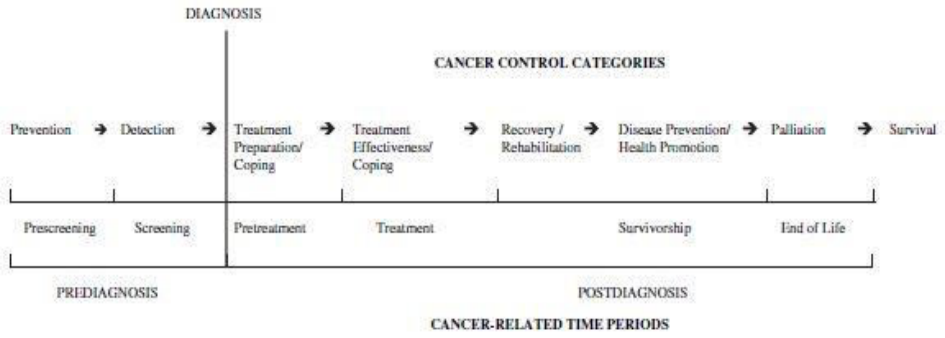

Figure 2. Physical Activity and Cancer Control (PACC) framework (Courneya & Friedenreich, 2007).

The PACC framework proposes six cancer-related time periods. The first two are pre-diagnosis and include: pre-screening, which is the entire lifetime prior to cancer screening; and screening, which is the time from a given screening test until the result of the test is known and can last weeks or months. The other four time periods are post-diagnosis. The first time period is pre-treatment, which is the time period after a definitive cancer diagnosis until treatment has been initiated. Treatment is the second time period of the post-diagnosis stage and has become difficult to define because of the development of longer-term and less-intensive treatments, but focuses on the "primary" cancer treatments such as surgery, radiation, and chemotherapy. Survivorship is a newly incorporated time period that is based on the Institute of Medicine's definition of survivorship as: "the period following the first diagnosis and treatment and prior to the

development of a recurrence of cancer or death" (Hewitt, Greenfield, & Stovall, 2006, p. 23). The "end of life" time period is also an addition according to the Institute of Medicine's cancer control continuum.

Research has demonstrated that PA can positively impact each of the cancer control categories, but the influence of PA may work through different biological mechanisms depending on the stages of the cancer continuum (Courneya & Friedenreich, 2007). In the prevention stage, there have been over 250 studies conducted, and it is concluded that PA may reduce the risk of developing a primary cancer, and PA is *convincingly* associated with the reduced risk of developing breast and colon cancers. PA is also suggested to help during cancer treatments as it may allow difficult treatments to go forward, help to manage the disease and symptoms, and to manage the side effects from treatment, improve physical functioning, and prevent muscle loss and fat gain after treatment (Courneya & Friendenreich, 2007). PA is also recommended during the cancer recovery stage as 50% of cancer survivors show a preference for starting a PA program immediately after treatment, indicating this time period as an opportunity to promote PA (Courneya & Friendenreich, 2007). Essentially, PA may help the general population, high-risk populations, and cancer patients by reducing the risk of cancer occurrence and recurrence, slow cancer progression, and reduce the risk of developing other life-threatening diseases, including second primary cancers (Courneya & Friedenreich, 2007). Assessment of association with PA during the eight cancer control categories suggests the importance of supportive research in PA behaviour change for cancer prevention, and the

importance of future research to determine if primary cancer prevention is a meaningful source of PA motivation in the general public and high-risk groups.

PA can have beneficial effects on all aspects of the cancer continuum, in particular towards cancer prevention, and it is proposed that increasing PA in the general population and those at a higher-risk for developing cancer is of utmost importance for prevention of several cancer types (Courneya & Friedenreich, 2007). Friedenreich's (2010) article showed the prevalence physically inactive and sedentary individuals in developed countries, and how high levels of inactivity are related to cancer occurrence. Finally, Kruk and Czerniak (2013) provided an up-to-date review on the strong linkages between PA and breast, colon, and endometrial cancer, and highlight the importance of conducting intervention studies on various cancer types to determine specific motivation factors for PA, as well as the necessary type, dose, and frequency of PA needed for risk prevention. Now that extensive associations have been established between PA and cancer, the focus of our review can be narrowed further to the effects of PA on breast cancer.

2.4 Physical Activity and Breast Cancer Risk

There is 'convincing' evidence that PA has a protective effect against breast cancer (Friedenreich & Orenstein, 2002). Friedenreich's (2010) review includes information on the epidemiological evidence and biological mechanisms of this established association. The review included 73 case-control and cohort studies published before February 2010. Due to the heterogeneity of the studies the review is limited to including crude averages of risk reductions to determine the magnitude of the effect.

Therefore, a conservative estimate is that PA decreases breast cancer risk by 25%, with the greatest risk reduction being found for recreational activity of at least moderate intensity, and for activity done after menopause. Importantly, a dose-response relationship has been documented to exist, with a reduction of risk increasing with greater amounts (Lynch et al., 2011; Monnikhof et al., 2007) and higher intensity of PA (Lynch et al., 2011). It is likely that PA decreases breast cancer risk via multiple interrelated biological pathways that involve adiposity, sex hormones, insulin resistance, adipokines and chronic inflammation (Friedenreich, 2010). Given the large quantity of evidence regarding the dose-response relationship observed in epidemiological studies, Friedenreich (2010) suggests that randomized controlled PA intervention trials are the next step in advancing our understanding of how PA influences breast cancer.

Wu, Zhang, and Kang (2013) and Volaklis, Halle, and Tokmakidis (2013) provided two up-to-date reviews on PA and breast cancer risk. Wu et al. (2013) present a meta-analysis, which included 31 prospective studies that explored the relationship between the risk of breast cancer and overall PA, type and intensity of PA, population subgroups, and timing of PA and made use of relative risk (RR) which is the probability of developing a disease in an at at-risk group (i.e., inactive) compared to a non-risk group (i.e. active). Results showed the RR for breast cancer and PA was 0.88 and subgroup analysis showed that occupational activity was associated with a RR of 0.90 and non-occupational activity was associated with a RR of 0.87. A linear relationship was found between breast cancer risk and PA level, with a 3% decreased risk for every 10 MET-hour/week increment in recreational activity and 5% decrease for every 2-hour/week

increase in moderate or vigorous activity. PA is shown to be significantly associated with a reduced risk of breast cancer and PA should be recommended for the primary prevention of this disease.

The review by Volaklis et al. (2013) presents data from multiple studies, which show a protective effect of PA on breast cancer. The first study by McTiernan et al. (2004) showed that a greater amount of baseline PA was associated with a lower risk of breast cancer compared to controls, and increasing amounts of weekly PA enhanced risk reduction. Specifically, women who have engaged in strenuous PA at least three times per week at 35 years of age showed a decreased risk of breast cancer by 14% compared with women who were physically inactive. Another large prospective study found that compared to women who performed less than three METs/week, women who engaged in greater than 27 METs/week had a lower breast cancer risk by 15%(Eliassen, Hankinson, Rosner, Holmes, & Willett, 2010). The large amounts of scientific evidence have prompted the WHO to include in their guidelines that increased levels of fitness may result in a reduced breast cancer risk by 20-40%. The review also suggests that meeting the recommended adult CSEP guidelines (18-64 years of age– 150 mins of MVPA/week; CSEP, 2011) will substantially reduce the risk of developing breast cancer (Volaklis et al., 2013). Establishing a regular PA routine is important for lowering the risk of breast cancer occurrence.

A case-control study by Kruk (2007) focused on the association between lifetime PA and the risk of developing breast cancer. The purpose of the study was to determine whether all types of PA throughout the lifetime might reduce an individual's chance of

developing breast cancer. The study included 250 women with histological confirmed breast cancer and 301 cancer-free, age- and residence-matched controls. Detailed information was obtained through the use of self-report questionnaires on lifetime histories of household, occupational, and recreational PA and the duration, intensity, and frequency of each. Findings from this study showed that in regards to lifetime PA, those who performed less than 110 MET/week/year were associated with an odds ratio of 1.00, those who performed 110-150 MET/week/year were associated with an odds ratio of 0.60, and those who performed greater than 150 MET/week/year throughout the lifetime were associated with an odds ratio of 0.43. The results of the study suggest an inverse relationship between PA and the risk of breast cancer, and confirm physical inactivity as an important risk factor. The study also suggests that there is a need for educational policies that encourage PA program participation in early life and at points in life where women may be at an increased risk for breast cancer such as post-menopause.

Several observational studies have found an inverse association between PA and circulating estrogen levels (Chan et al., 2007; Bertone-Johnson, Tworoger, & Hankinson, 2009), which are linked to the initiation, promotion, and progression of breast cancer tumors (Pike, Krailo, Henderson, Casagrande, & Hoel, 1983). A systematic review by Winzer, Whiteman, Reeves, and Paratz (2011) aimed to review the effect of PA on systematically various biomarkers to understand the role of PA in cancer etiology. The search which included four primary prevention and five tertiary prevention trials determined that PA had a small to moderate effect on improving concentrations of several blood biomarkers that are implicated in breast and colon cancer pathways

including leptin, insulin, estrogens, and apoptosis regulation. A more recent systematic review by Ennour-Idrissi, Maunsell and Diorio (2015) examined the effect of PA on sex hormones in healthy women. Their review determined that PA induces a decrease in circulating sex hormones including total estradiol and free estradiol, which was not entirely explained by weight loss. This effect was more noticeable for non-obese women and for high-intensity PA (Ennour-Iddrissi et al., 2015).

As we can see from several longitudinal and epidemiological studies, PA has been shown to have a dose-response relationship with breast cancer risk, meaning that increased amounts of moderate-to-vigorous lifetime PA result in a decreased risk of developing breast cancer (Eliassen et al., 2010; Friedenreich, 2010; Kruk et al., 2007; Mctiernan et al., 2003; Wu et al., 2013). The biological mechanisms of this relationship are still unknown but it is likely that PA has a preventive effect on breast cancer occurrence through maintenance of a healthy body weight and lower adiposity (Friedenreich, 2010; Wu et al., 2013), sex hormones (Bertone-Johnson et al., 2009; Chan et al., 2007; Ennour-Iddrissi et al., 2015; Pike et al., 1983), insulin resistance, adipokines, and chronic inflammation (Friedenreich, 2010). The evidence suggests that there are multiple interrelated biological pathways through which PA protects again breast cancer risk and should therefore be recommended for primary prevention of this disease (Friedenreich, 2010; Wu et al., 2013).

2.5 Understanding and Increasing Physical Activity

2.5.1 Predicting Health Behaviours

The findings on the relationship between PA and health demonstrate that there is a need to increase PA in populations who are at risk for developing diseases related to physical inactivity, such as breast cancer. The important question for researchers to answer is how to enact a lasting change in PA levels and change individuals' PA behaviours so that they can achieve health benefits. If we could predict and understand who performs health behaviours, this would allow us to understand the variation in the distribution of health in our society, and would indicate targets for interventions to change health behaviours (Conner & Norman, 2005). A variety of factors account for the individual differences in the probability of undertaking health behaviours, including demographic factors, social factors, emotional factors, perceived symptoms, access to medical care, personality factors, and cognitive factors (Rosenstock, 1974; Taylor, 1991; Adler & Matthews, 1994; Baum & Posluszny 1999). The current study will focus on cognitive factors as they have been shown to help determine whether or not an individual will undertake certain health behaviours, such as PA (Conner & Norman, 2005). Cognitive factors have formed a particular area of study in the area of health promotion because they play a mediating role in many of the other factors outlined earlier (i.e., demographic, environmental, behavioural) and they are believed to be a good focus in attempting to change health behaviours (Conner & Norman, 2005). The main cognitive factors that have been studied in health behaviour interventions include perceptions of health risk, potential efficacy of behaviours to reduce the risk, perceived social pressures

to perform the behaviour, and control over performance of the behaviour (Conner & Norman, 2005).

2.5.2 Social Cognition Models

In order to enhance PA participation there must be an understanding of the underlying motivations to engage in PA. Many theoretical frameworks have been used to investigate and understand PA behaviours in inactive populations. Theoretical frameworks are useful for understanding how these correlates may influence human behaviours such as PA and help to identify what factors specifically influence behaviour and predict behavioural outcomes (Biddle & Fuchs, 2009). Social cognitive factors (i.e., beliefs, attitudes, knowledge) have been central to most of the models of the determinants of health behaviours. The reason that these factors have been commonly employed is because they are enduring characteristics of the individual that shape their behaviour and are acquired through the socialization processes (Conner & Norman, 2005). They are also open to change, and therefore represent a likely route to influencing the adaptation and performance of health behaviours.

There are two types of social cognition models that are commonly applied in health psychology. The first type are attribution models that are concerned with individuals' causal explanation of health-related events (King, 1982) and are mostly used to focus on how people respond to developing a range of serious illnesses such as cancer (Taylor et al., 1984), coronary heart disease (Affleck, Tennen, Croog, & Levine, 1987), and diabetes (Tennen, Affleck, Allen, McGrade, & Ratzan, 1984). The second type of model examines various aspects of an individual's cognition that are used to predict and

prevent future health-related behaviours and includes the Health Belief Model (HBM; Janz & Becker, 1984), Protection Motivation Theory (PMT; Rogers, 1975; Maddux & Rogers 1983), Theory of Reasoned Action/ Theory of Planned Behaviour (TRA/TPB; Azjen & Fishbein, 1980; Azjen, 1991), Social Cognitive Theory (SCT; Bandura, 1986; Schwarzer, 1992), and Health Locus of Control (HLC; Wallston, 1992; Norman & Bennett, 1995). We will be focusing on the second type of model as our study is interested in preventive health behaviours in currently healthy, but at-risk individuals. A brief overview of each of the other preventive health models is provided before the discussion of PMT and relevant PMT-based research, as this is the framework that was selected for the current study.

The HBM may be the oldest and most widely used social cognition model in health psychology (Rosenstock, 1966; Becker, 1974), however it has been considered to be a loose association of variables that predict health behaviours rather than a formal model of health behaviour (Conner & Norman, 2005). The HBM employs two aspects of health behaviour in response to threat of illness: perceptions of illness threat and the evaluation of behaviours that counteract this threat (Janz & Becker, 1984). The HBM is based on the understanding that a person will take a health-related action (i.e., quit smoking) if that person: (1) believes that the negative health condition (i.e., cancer) can be avoided, (2) has an expectation that by taking the health-related action they will avoid the negative health outcome (i.e., quitting smoking will prevent lung cancer), and (3) believes that they can successfully perform the recommended action. The HBM originally included four constructs that represented the individual's readiness to perform

a certain health behaviour; (i.e., perceived susceptibility, perceived severity, perceived benefits, and perceived barriers). Later the concepts of *cues to action* and *self-efficacy* were added to help the HBM better fit the challenges of changing habitual unhealthy behaviours (Glanz & Rimer, 1997; Glanz, Rimer, & Lewis, 2002). The likelihood of a person changing a health behaviour is determined through the weighing of perceived benefits versus barriers to behavioural change and the likelihood of behavioural change is mediated as well through perceived threat of the disease and cues to action (i.e., education, exhibiting symptoms, media information; Glanz et al., 2002).

The TPB is a model developed by social psychologists that outlines the factors that determine an individual's decision to follow a particular behaviour (Ajzen, 1991; Armitage & Conner, 2001). The TPB is an extension to the TRA (Fishbein & Azjen, 1975; Azjen & Fishbein, 1980) and proposes that the determinants of behaviour are the individual's intention to engage in the behaviour and their perception of control over the behaviour. Intention is determined by: (1) their own attitude toward the specific behavior, (2) their subjective norms (i.e., how others will view the behaviour) and (3) their perceived behavioral control (i.e., the individual's perceptions of their ability to perform a given behavior; Ajzen, 1991; Ajzen, 2002). An increase in the individual's attitude, subjective norm, and perceived behavioural control should lead to an increase in the individual's intention to perform certain health behaviours (Ajzen, 1991; Ajzen, 2002). Intention is the person's motivation in the sense of their conscious plan or decision to make the effort to perform the behaviour, and the perceived behavioural control is the

expectancy that the behaviour is within the individual's control (Ajzen, 1991; Ajzen, 2002).

In SCT (Bandura, 1986) human motivation and action are based upon three types of expectancies: (1) situation-outcome (i.e., susceptibility to a health threat), (2) action-outcome (i.e., belief that a behaviour will lead to a given outcome), and (3) perceived self-efficacy (i.e., belief that a behaviour is or is not within an individual's control). There is a clear causal ordering among these three expectancies where situation-outcome expectancies are distal determinants of behaviour and mostly act through action-outcome expectancies (Schwartzer, 1992). Action-outcome expectancies influence behaviour by influencing goals and intention and acting on self-efficacy expectations, and self-efficacy expectancies directly impact behaviour via their influence on intentions (Schwartzer, 1992).

HLC (Norman & Bennett, 1995; Wallston, 1992), which originated from Rotter's (1954) Social Learning Theory, centers around the tenet that the likelihood of performing a certain behaviour is based upon a combination of the expectancy that the behaviour will lead to a specific reinforcement and the extent that the reinforcement is valued. The original HLC was developed as a unidimensional measure of an individual's belief that their health is or is not determined by their behaviour (Wallston et al., 1976). Health-internals (i.e., those with low scores on the HLC) believe that their own health is determined directly by their behaviour, and health-externals (i.e., those with high scores on the HLC) believe that luck, fate, chance, or factors over which they have no control determine their health (Wallston et al., 1978). Wallston et al. (1978) built upon this tenet

to develop the multidimensional HLC which has three dimensions that measure health expectancy beliefs: the extent the person believes their health is under their own personal control (i.e., health-internal), under powerful others control, or due to chance (i.e., health-external). The likelihood that a person will perform a certain health behaviour is higher if they have a higher score on the health-internal component of the HLC theory and is lower if they have a higher score on the health-external component (Wallston et al., 1978; Wallston, 1992; Wallston & Wallston, 1981).

The theories outlined above are all useful models for beahviour change; however, PMT was chosen as PMT was designed to explain health behaviour motivation from the perspective of disease prevention (Courneya & Hellsten, 2001; McGowan & Prapavessis, 2010). Additionally, PMT has also been shown to produce positive outcomes for a wide variety of health behaviours, such as smoking cessation, cancer screening, and nutrition (Floyd, Prentice-Dunn & Rogers, 2000; Bui et al. 2013).

PMT (Rogers, 1975) is a social cognition model that was proposed to provide conceptual clarity to the understanding of fear appeals and has been revised on several occasions (Norman, Boer, & Seydel, 2005). In the revised theory (Maddux & Rogers, 1983), it is presented as a hybrid theory (Prentice-Dunn & Rogers, 1986) with vulnerability, severity, and response-efficacy derived from the HBM, and the self-efficacy component originating from Bandura's Self-Efficacy Theory (Bandura, 1986). In this theory, health-related behaviour is explained in terms of two cognitive processes: threat appraisal and coping appraisal. PMT suggests that the individual be first exposed to threat increasing information, such as developing cancer if they do not become physically

active. Threat appraisal is made up of the constructs of perceived severity (PS) of a health-related threat (e.g., breast cancer), and their perception of vulnerability (perceived vulnerability- PV) to the threat (e.g., probability of developing breast cancer). Once threat appraisal has been established, the individual should be presented with information on how to build coping strategies. The coping appraisal process is composed of response-efficacy (RE) and self-efficacy (SE) constructs as well as response costs. SE is the individual's belief in their ability to perform the coping response (e.g., PA) and RE is the belief that the coping response can reduce the risk of the health-related threat (e.g., PA reduces breast cancer risk). Increases in RE and SE lead to increased probability of performing the health-related behaviour (Bui et al., 2013).

PMT research has typically taken two forms: first, PMT has been used as a framework to develop and evaluate persuasive communications; and second, PMT has been used as a social cognition model to predict health behaviour (Norman, Boer, & Seydel, 2005). It is believed that the two forms of PMT align well with the study at hand as it will be making use of persuasive communications through an educational DVD, and is also interested in exploring whether the manipulation of the PMT constructs will predict health behaviour outcome (e.g., increasing PA). The following sections will describe the literature on PMT that is most relevant to the current study.

2.5.3 Protection Motivation Theory and Health Behaviour

One strategy to increase PA in individuals at risk of negative health outcomes due to inactivity is through the use of theory-based interventions, such as PMT (Rogers, 1975; 1983). PMT is an appropriate model to use in regards to populations that are

currently healthy but are at an elevated risk of developing a disease as it is a social-cognition model that was designed to explain health behaviour motivation from the perspective of disease prevention (Courneya & Hellsten, 2001; McGowan & Prapavessis, 2010).

Floyd, Prentice-Dunn, and Rogers (2000) provide the first meta-analysis on the research involving PMT, and how it can explain the initiation and maintenance of protective behaviours. The meta-analysis is comprised of 65 relevant studies on PMT's effect on intention or actual behaviour. The effect sizes from the studies included showed that increases in PS, PV, RE, and SE significantly increased protective intentions or behaviours. The constructs that showed the strongest impact on protection motivation (i.e., intention) were SE, followed by RE, and finally PV and PS. The relationship between intention and behaviour for each of the four PMT constructs was also examined in the analysis. They determined that the effect size for an increase in intention for the threat appraisal variables was 0.56 (large effect size) and for an increase in behaviour it was 0.41 (medium-to-large effect size). The effect sizes were larger for the coping appraisal variables (i.e., RE and SE) in regard to intention (0.70, very large) and behaviour (0.51, large). The PMT variables significantly increased intentions and behaviour increased as a result of the increase in intentions, but at a moderate magnitude. Floyd et al. (2000) shows that PMT is a useful framework for changing an individual's intentions and behaviours, and provides an understanding of how behaviour and attitudes can change when confronted with a threat, demonstrating support for the PMT.

Milne, Sheeran, and Orbell (2000) conducted a meta-analysis to determine the success of PMT as a predictive model of health-related behaviours and intentions. Another aim was to evaluate the success of each component of the model in predicting intention and behaviour to identify the variables to target in health-education interventions. This review contained 27 studies, 15 were correlational, eight had specific experimental manipulations and three compared health education versus no education. Results of the analysis showed that all four of the PMT variables were significantly correlated with intention in the predicted direction to a $p <$. 001 level. SE was the variable that was most often associated with intention across all studies, and PV and PS were less often associated with intention. The analysis showed that the variables for coping appraisal (i.e., RE and SE) proved to be more strongly and consistently associated with intention than the threat appraisal variables (i.e., PV and PS).

Building upon the results found by Milne et al. (2000) and Floyd et al. (2000), Bui et al. (2013) provide us with a more recent review on PMT and its effectiveness on PA intention and motivation. Before this review was published only one other review on PMT for PA behaviour existed (Plotnikoff & Trinh, 2010). Bui et al.'s (2013) analysis aimed to determine the effectiveness of the model's main constructs in explaining PA intentions and behaviour and the results were split into four different categories based on the various research designs. The prediction studies suggested that SE might be the strongest predictor of PA participation. In experimental manipulation studies, targeting PMT constructs can be useful in developing intervention strategies and increasing the coping appraisal constructs (i.e., RE and SE) facilitated PA intentions and behaviour.

This suggests that populations who are at an increased risk of cancer due to an inactive lifestyle may benefit from threat appeals. Finally, intervention studies were found to support the application of PMT for PA promotion, and generally a positive effect of PMT on PA intentions, and a positive but small effect on PA behaviour were found.

The last three reviews have identified SE to be a salient predictor of PA intentions in PA interventions using PMT. Wood (2008) offers significant support for PMT-based PA interventions compared to other theory-based interventions, which do not include SE as a separate component. Although there is growing evidence that PA can reduce the risk of breast cancer, data showed that less than 50% of women participate in PA and more than 25% are not active at all (Wood, 2008). This article attempts to identify the theoretical framework most effective for studying PA motivation for breast cancer risk reduction in an attempt to pinpoint a theory to use to increase PA in this target population. Several possible theories are identified, such as the Health Promotion Model (Pender, 1996), Self-Determination Theory (Deci & Ryan, 1985), SCT (Bandura, 1986), HBM (Rosenstock, 1974; Becker et al., 1977), Transtheoretical model (TTM; Prochaska & DiClemente, 1983), TPB (Ajzen, 1988), and finally PMT (Rogers, 1983). Results from the literature on these theories showed that PMT may be useful to examine the effects of perceived risk and SE to help motivate women to PA to facilitate health-related behaviour change (Wood, 2008).

Plotnikoff, Rhodes, and Trinh (2009) conducted a longitudinal test on the effectiveness of the PMT to predict PA behaviour among a large sample of Canadian adults. The primary objective of the study was to test PMT's predictive behaviour for an

untreated, population-based sample of adults over two six-month periods. The hypothesis stated that all four PMT constructs (i.e., PS, PV, RE, and SE) would have strong, positive significant associations with PA intention and behaviour. Participants were selected using a computer-assisted telephone interviewer system, which randomly generated resident telephone numbers from the region's telephone exchange. The participants were interviewed twice, six months apart, and were assessed for PS, PV, RE, SE, intention, and sociodemographic information. Results of the study showed that SE and intention explained 4% and 20% of the variance in PA behaviour respectively at the time of the first interview, and 3% and 25% at the time of the second interview. PA intention was significantly linked to RE, SE and PS, and SE was found to be the strongest predictor of PA behaviour overall. This study also supports the assertion by Ajzen and Fishbein (1980) that behavioural intention does predict actual behaviour as a significant association was found between PA intention and behaviour. This suggests that intention is the strongest and most immediate predictor of behaviour in the PMT model. This study was the first longitudinal study that employed PMT to predict PA intention and behaviour, and the findings provide evidence for the usefulness of PMT in the general population.

The studies summarized above on PMT and general health demonstrate that the variables of SE and intention are strengths of the PMT model. In several of the studies SE was found to be the most salient predictor of intentions to increase positive health behaviours (Floyd et al., 2000; Milne et al., 2000; Plotnikoff et al., 2009) and some studies reported that increased SE scores predicted increases in exercise behaviour (Bui et

al., 2013; Plotnikoff et al., 2009). Wood (2008) also offers support to PMT over other theories in PA interventions because it includes SE as a separate component. These results indicate that through a PMT-based intervention, if SE scores and intentions to exercise are increased then PA behaviour should increase as a result.

2.5 Protection Motivation Theory and Cancer Risk

Previous literature shows that the PMT is effective in increasing intention to participate in health-promotion behaviours. This review will now examine the effectiveness of this theory in increasing PA intention and behaviour to prevent the risk of developing cancer. The three studies by Courneya and Hellsten (2001), Graham, Prapavessis, and Cameron (2006), and McGowan and Prapavessis (2010) represent research exploring the use of colon cancer information along with PMT to increase PA motivation and behaviour.

Courneya and Hellsten (2001) examined whether cancer prevention is a meaningful source of PA motivation using the PMT. Research has established that PA reduces colon cancer risk, but this study aimed to answer whether one's knowledge of this relationship will impact PA motivation. The four PMT constructs were manipulated using written persuasive communications, which contained fictitious information on colon cancer. For example, the construct PV was manipulated by representing the risk of developing colon cancer as 1 in 200 (i.e., low PV) or 1 in 9 (i.e., high PV), and the RE construct was manipulated by either saying that PA produced a risk reduction for colon cancer of 10% and inconsistent (i.e., low RE) or 60% and consistent (i.e., high RE). Following reading the communication, participants were asked to complete a

questionnaire, which assessed the four constructs and their PA intentions before being presented with accurate information on colon cancer. In a sample of 427 undergraduate psychology students, results demonstrated that each of the four constructs had a significant relationship with protection motivation (i.e., intention), and explained 29% of the response variance. This study provides some preliminary support that cancer prevention information may be a substantial source of PA motivation. In particular, the persuasive communications were effective in manipulating PS and RE, which influenced protection motivation. However, there are several limitations to this study, which the current study will build upon. The first is the use of young, physically active undergraduate students. This population may not consider themselves to be at risk for developing colon cancer, and this may affect their intention to participate in PA to prevent this outcome. This could be a possible explanation for the failure to influence the subjects' PV and RE. The results of this study are not generalizable beyond young, active, undergraduate students, and the associations do not apply to actual PA behaviour, solely PA motivation.

Graham et al. (2006) extended Courneya and Hellsten's (2001) work by examining the effectiveness of a PMT-based intervention to improve PA behaviour and PA intention in inactive, middle-aged adults. The study employed a three-armed randomized controlled experimental design with experimental, attention control and non-contact control groups. The PMT group watched an educational DVD based on PMT and colon cancer and PA, which manipulated the four PMT constructs and aimed to increase intention to PA. The attention control group watched an educational DVD based on diet

and cancer, while the non-contact control group received no further information. The results of this study supported the implication made by Courneya and Hellsten (2001) that colon cancer prevention is a meaningful source of PA motivation, and showed that intention to engage in more PA was significantly related to all PMT constructs except PV. PS, RE, and SE explained 44% of the variance in PA intention. Intention to engage in more PA was the only variable related to an increase in PA behaviour and intention accounted for 10% of the variance in PA behaviour, which was measured through self-report measures.

McGowan and Prapavessis (2010) extended this line of research by exploring the effectiveness of an intervention grounded in PMT that sought to *change* beliefs towards colon cancer and PA and PA intentions in an "at-risk" sample (i.e., inactive and relative of colon cancer). A secondary purpose was to examine which of the four PMT constructs would be the most predictive of PA intention. The study used a two-group randomized control design. Participants included 166 inactive first- and second-degree relatives of patients with colon cancer aged 18-62 years. The intervention and attention control DVDs that were developed for this study were similar to those used in Graham et al. (2006). Experts in the field presented factual information on colon cancer risk and PA in the intervention DVD, and general information on diet and cancer for the attention control DVD. The measurements used were the same as Graham et al. (2006) but did not assess PA behaviour, just beliefs towards colon cancer and PA and PA intentions. These questionnaires were completed one week before viewing the DVD and immediately after the viewing. Results of the study showed a slight increase in the PMT intervention

group's scores from pre-to post-DVD while the attention control group showed no change. The effects size for RE was large, medium effect sizes were found for SE and PV, and no effect was found for PS. Following the intervention, the PMT group believed they were more vulnerable to developing colon cancer, and that they had greater RE and SE to reduce the risk compared to the control group. The failure to manipulate PS was in line with Graham et al. (2006) but not with Courneya and Hellsten (2001), however the latter included false colon cancer information. The results also showed that coping appraisal was important for PA intentions due to the changes in the SE and RE constructs related to changes in PA intentions.

These three studies provide a good foundation to build from, as each study incorporates different original elements. The use of PMT-based cancer prevention information in PA intervention studies has been shown to be a meaningful source of PA motivation and intention (Courneya & Hellsten, 2001; Graham et al., 2006; McGowan & Prapavessis, 2010). The coping appraisal variables of SE (Graham et al., 2006; McGowan & Prapavessis, 2010) and RE (Courneya & Hellsten, 2001; McGowan & Prapavessis, 2010) predicted the most variance in PA intention and intention was the only predictor for self-report PA behaviour (Graham et al., 2006). The current study will build upon the previous studies as it will contain factual cancer prevention information, it will include a non-contact control group, and it will assess a change in beliefs towards breast cancer and PA by assessing pre- and post-DVD intervention.

2.7 Measuring Physical Activity in Cancer Research

2.7.1 Subjective Measures

Subjective methods, such as questionnaires, activity diaries, and interviews, are inexpensive, easy to administer and can provide information on the types of activities performed, which is why they have been so popular in PA research to date (Meng & Kim, 2012). In previous PA research, PA rates and information on PA for large populations has been mainly collected through self-report measures due to their cost-effectiveness and easy distribution, in particular for large-scale studies. Previous research on cancer information and PA motivation for healthy at-risk populations has employed the use of the Leisure Score Index (LSI) of the Godin and Shephard (1985) Leisure Time Exercise Questionnaire (Graham et al., 2006). The LSI is a 4-item self-administered questionnaire often used to assess leisure time PA in oncology research (Liu et al, 2011; Su et al., 2014). The LSI is used to rank individuals from lowest to highest PA levels (Mâsse & de Niet, 2012) and can be used to classify subjects into active and insufficiently active categories according to the recommended PA guidelines for public health (18-64 years of age; CSEP, 2011; Garber et al., 2011). The LSI has been shown to possess acceptable test-retest reliability and concurrent validity (i.e., correlates with objective indicators of exercise such as CALTRAC accelerometer and VO_2 max; Jacobs, Ainsworth, Hartman & Leon, 1993). A modified version has been commonly used in both the PA and cancer literature that measures both average duration and frequency of PA at various intensities (Graham et al., 2006; Karvinen et al., 2006, 2007b; McGowan et al., 2013; Stevinson et al., 2007). This modified version allows for comparisons with the public health PA

guidelines. The results of these studies suggest that the LSI is a useful measure to quantify PA information for studies including healthy and cancer-free participants. The LSI allows the determination of current PA levels and classification of participants as active or inactive along the recommended PA guidelines. However self-report measures possess shortcoming as well, which will be outlined in the following section.

2.7.2 Moving away from Self-Report Measures

Accurate measurement of PA through the usage of self-report measures still remains a challenge as these methods have been shown to have low validity and reliability (Helmerhost et al., 2012). Self-report measures are subject to common forms of error and bias such as memory decay, memory of rare events alone, lack of motivation in memory recall, and show low to modest validity coefficients and non-existent interest correlations (Baranowski, 1988; Welk, 2008). The length of the recall period that participants are required to remember the PA that they have performed affects the accuracy of recall (Dishman, Washburn, & Schoeller, 2001; Shepphard, 2003), and social desirability bias may influence the validity of self-report PA in intervention studies with PA as a primary outcome (Senso, Anderson, Crain, Sherwood, & Martinson, 2014). These two factors lead to an overestimation of PA, as participants tend to respond consistently with cultural norms (Dishman et al., 2001; Eslinger & Tremblay, 2007; Shepphard, 2003), therefore more recent research is suggesting and supporting the use of more objective measures of PA (Durante & Ainsworth, 1996).

Studies that compare self-reported PA to objectively measured PA have shown discrepancies between the two types of measures. Previous statistics on Canadian PA

levels make use of self-report measures and suggest that the percentage of adults who are physically active is increasing, and 52.5% of Canadian adults reported that they were moderately active during their leisure time (Statistics Canada, 2009). In contradiction to these findings, obesity rates in Canada have increased with 25% of adults now being classified as obese (Shields et al., 2010), high blood pressure prevalence has increased by 25% since 2000, and from 1999-2009 the prevalence of diabetes has increased by 70% (Public Health Agency of Canada, 2011). All of these findings would be extremely surprising if Canadian PA levels were actually increasing. The findings from a Canada-wide survey that used self-report measures and accelerometers show that contrary to self-report measures, objective measurement determined that 85% of adults are not active enough to meet Canada's new PA recommendations, 150 minutes of moderate-to-vigorous PA (MVPA) per week (Colley et al., 2011).

These contradictory findings have led to a shift towards the use of objective measures in PA research in place of self-report (Katzmarzyk & Tremblay, 2007), particularly within the most-recent version of the Canadian Health Measures Survey (CHMS; 2007-2009). This survey determined that 68% of men and 69% of women were found to spend the majority of their waking hours in sedentary behaviours, and only 5% of adults were found to '*actually'* be meeting the PA guidelines on a regular basis (Canadian Fitness & Lifestyle Research Institute, 2009). Objective measures of PA can overcome some of the limitations of self-report such as memory recall, social desirability bias, and therefore, can increase the accuracy of measures of PA (Prince et al., 2008). A review of objective versus subjective measures of PA showed that correlations between

self-report and direct measures were generally low-to-moderate and self-report measures of PA were both higher and lower than directly measured levels of PA (Prince et al., 2008). These findings suggest that objective measures may be more likely to detect significant associations between PA and important health outcomes (Janz, 2006; Prince et al., 2008).

Objective measures of PA include direct observation by the researcher or through the use of devices like pedometers and accelerometers that measure the amount of movement produced by the subject. Pedometers and accelerometers are non-invasive and easy to wear devices that record information about the subject's real world activity. Accelerometers have advantages over pedometers as they provide information on not only step count but also the duration and intensity of activity. Some types of accelerometers can provide calorie expenditure and can measure the amount of time spent sitting, lying down, and standing. Accelerometers have not been widely used but have recently been growing in popularity in the PA literature (Umstattd Meyer, Baller, Mitchell, & Trost, 2013). The basic function of an accelerometer is to generate an output proportional with an acceleration input through the detection of accelerations in one of three orthogonal planes (anteroposterior, mediolateral, and vertical; Meng & Kim, 2012).

2.7.3 Accelerometer Research

In regards to research employing them, accelerometers have advantages such as noninvasive measurement and low subject burden, and early results are promising (Meng & Kim, 2012). PA estimates made by three accelerometer data reduction approaches, step counts, and two self-report measures were shown to vary substantially; therefore,

validating accelerometer data reduction approaches remains an important research area (Umstattd Meyer et al., 2013). A PA intervention study, which included healthy, sedentary adults, found moderate correlations between PA questionnaires and accelerometer data from Actigraph™ accelerometers for moderate and vigorous levels of activity (Napolitano et al., 2010). The intervention group recorded significantly more minutes of moderate or higher intensity PA compared to the control group at six months (Napolitano et al., 2010). The researchers concluded that accelerometers have modest concordance with other PA assessment tools and that self-report measures of PA should be used in conjunction with accelerometers until there is more information validating their use in clinical trials (Napolitano et al., 2010). Two clinical trials (Keep Active Minnesota & Keep It Off) compared self-reported PA and accelerometry information and found that accelerometer-measured PA was consistent between studies, while self-reported PA differed significantly (Senso et al., 2014). These varying results suggest the need for greater comparisons between self-report and PA measures and accelerometer-measures PA. The American Heart Association recently released a scientific statement on the assessment of PA for clinical and research applications (Strath et al., 2013). Reports were unable to provide clear recommendations for use of subjective and objective measurement methods of PA despite using evidence-based appraisals and application information. The report concludes that there still exists little evidence to guide the selection of a PA assessment technique that could be used for a wide variety of PA applications, which indicates the need for more research using accelerometer data to quantify PA in observational research and increase PA in intervention studies.

Because accelerometers are still a relatively new technology to be used in the field of PA research, they still need to be extensively validated before their use attempts to replace self-report measures (Umstattd Meyer et al., 2013). Ekblom et al. (2015) conducted a study that aimed to assess the concurrent validity of self-report PA using accelerometry as an objective reference measure. The study used five different instruments for measuring self-report PA and used a triaxial accelerometer (ActiGraph GT3X) to objectively measure activity patterns over seven consecutive days. The results showed that agreement between self-reports and objectively assessed PA was low-to-moderate with large misclassifications regarding time-spent sitting/sedentary and in moderate-to-vigorous PA.

Oyeyemi et al. (2014) aimed to compare components of PA measured with an adapted version of the international PA questionnaire and the accelerometer in a sample of 144 Nigerian adults. The participants wore an ActiGraph accelerometer for seven days and completed the questionnaire assessing moderate-vigorous PA and sedentary time on the eighth day. Results showed that higher time in moderate-vigorous PA and total PA were reported through the self-report measure with low to moderate correlations with the accelerometer data. A study by Siebeling et al. (2012) examined reproducibility and validity of the self-administered Longitudinal Ageing Study Amsterdam Physical Activity Questionnaire (LAPAQ) against a triaxial accelerometer (ACTR; Sensewear® Pro) in older adults. Eighty-nine participants wore the accelerometer for two consecutive weeks and then completed the LAPAQ, which covers the frequency of six activities during the previous two weeks. Results reported that the LAPAQ underestimates PA and

seems unsuitable for exact PA measurement in older adults. It may be useful to determine if a person's PA level is below the recommended level.

Another advantage of accelerometers is that they capture all activity, even PA performed in sporadic, short bouts, and not only PA in bouts of 10-minutes or more, which is the type of PA measured in some commonly used self-report PA questionnaires (LSI- Courneya et al., 2004; Graham et al., 2006; IPAQ – Craig et al., 2003; IPAQ, 2005). There is some support that living an active lifestyle that incorporates all types of activity and not just leisure time, intentional PA, can improve health outcomes (Ayabe et al., 2012; Glazer et al., 2013). Self-report measures could not possibly capture this information the same way that accelerometers could as it would be impossible to recount every small movement one made throughout the course of the day. However, the accuracy of accelerometers are still under question because of their novelty of use in research.

These studies demonstrate that there is a significant gap in the literature, as there exists little evidence on the standardization of the use and interpretation of self-report measures through objective measurement. The number of studies that compare concurrent and predictive validity of self-report measures and accelerometer data are increasing in recent years, but the results are still conflicting. Accelerometers present a promising research tool that could possibly eradicate the inconsistencies of self-report data and provide us with a more accurate picture of PA being performed by various populations. More evidence on the correlations between the two PA measurement

methods is needed to further the research in this area and to validate the use of objective measures of PA to receive health benefits.

2.8 Research Significance, Objectives, and Hypotheses

2.8.1 Significance of the Study

In the current study we will focus on the effects of a PMT-based PA intervention on breast cancer beliefs, PA intention, and PA behaviour. Due to the protective nature of PA it is of utmost importance to increase PA behaviour in populations at an increased risk of developing breast cancer, as well as in the general population. We chose to target women who deem themselves to be physical inactive because physical inactivity is a significant risk factor for the development of breast cancer and it is a modifiable risk factor.

PMT-based interventions have shown to be successful when applied to colon cancer risk. However, to the best of our knowledge this is the first study to explore the effectiveness of a PMT-based PA intervention to increase PA intention and behaviour to reduce breast cancer risk. Another significant and novel part of this study is the use of objective and subjective measurements of PA, which will show if the PMT intervention can change actual PA behaviour. As current research highlights the importance of PA for cancer prevention, there needs to be confirmation that the self-report methods that are consistently used are providing reliable evidence, as the success of interventions and programs is often based on self-report measures. The use of accelerometers in this type of research is a relatively new measurement technique, which will help to supplement the

self-report methods that have been the most popular activity tracking method to date (Yang & Hsu, 2010).

2.8.2 Objectives

The primary objective of the current study is to extend the literature by examining the effectiveness of an intervention grounded in PMT that seeks to change attitudes and beliefs toward breast cancer and PA, PA intentions, and PA behaviour in inactive women as they are at an increased risk of developing breast cancer. The main objective of the study is determined by the change in scores of each of the four PMT constructs and PA intention, and if the group receiving the PMT-based intervention will show an increase in PV, PS, SE, RE, and intention scores compared to the attention control and non-contact control groups. A secondary objective is to explore which of the four PMT variables is the most predictive of PA intention, and whether intention would lead to an increase in objectively- and subjectively-measured PA behaviour.

2.8.3 Hypotheses

Based on previous research exploring PMT-based interventions, it is hypothesized that participants receiving the PMT intervention will show higher change scores from baseline in PV, PS, SE and RE compared to those in the attention control and non-contact control groups (Floyd et al., 2000). Consistent with theory it is hypothesized that all four PMT constructs will predict PA intention (Graham et al., 2006). However, it is predicted that RE and SE will be the most salient predictors of PA intention (McGowan & Prapavessis, 2010; Milne, 2000). It is also hypothesized that PA intention will predict subjectively measured PA behaviour (Graham et al., 2006). There will be no hypothesis

made regarding the outcome of PMT constructs and objectively measured PA behaviour due to the exploratory nature of this component of the study.

References

Affleck, G., Tennen, H., Croog, S., & Levine, S. (1987). Causal attribution, perceived benefits, and morbidity after a heart attack: an 8-year study. *Journal of consulting and clinical psychology*, *55*(1), 29.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Ajzen, I. (2002). Perceived Behavioral Control, Self-Efficacy, Locus of Control, and the Theory of Planned Behavior. *Journal of Applied Social Psychology, 32*(4), 665-683

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice Hall.

Anand, P., Kunnumakara, A. B., Sundaram, C., Harikumar, K. B., Tharakan, S. T., Lai, O. S., ... & Aggarwal, B. B. (2008). Cancer is a preventable disease that requires major lifestyle changes. *Pharmaceutical Research*, *25*(9), 2097-2116.

Annesi, J. J., & Johnson, P. H. (2015). Theory-based psychosocial factors that discriminate between weight-loss success and failure over 6 months in women with morbid obesity receiving behavioral treatments. *Eating and Weight Disorders, 20*(2), 223-232

Ayabe, M., Kumahara, H., Morimura, K., Ishii, K., Sakane, N., & Tanaka, H. (2012). Very short bouts of non-exercise physical activity associated with metabolic syndrome under free-living conditions in Japanese female adults. *European journal of applied physiology*, *112*(10), 3525-3532.

Baghianimoghadam, M. H., Mohammadi, S., Noorbala, M. T., & Mazloomy Mahmoodabad, S. S. (2011). An intervention based on protection motivation theory in reducing skin cancer risk. *Journal of Pakistan Association of Dermatologists, 21*(3), 141-148.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Baranowski, T. (1988). Validity and reliability of self report measures of physical activity: An information-processing perspective. *Research Quarterly for Exercise and Sport, 59*(4), 314-327.

Barg, C. J., Latimer, A. E., Pomery, E. A., Rivers, S. E., Rench, T. A., Prapavessis, H., & Salovey, P. (2012). Examining predictors of physical activity among inactive middle-aged women: An application of the health action process approach. *Psychology and Health, 27*(7), 829-845.

Becker, M. (1974). The Health Belief Model and Sick Role Behavior. *Health Education & Behavior, 2*(4), 409-419.

Bertone-Johnson, E. R., Tworoger, S. S., & Hankinson, S. E. (2009). Recreational physical activity and steroid hormone levels in postmenopausal women. *American Journal of Epidemiology*, *170*(9), 1095–1104. doi: 10.1093/aje/kwp254

Biddle, S. J. H., & Fuchs, R. (2009). Exercise psychology: A view from Europe. *Psychology of Sport and Exercise, 10*(4), 410-419.

Biddle, S. J., & Mutrie, N. (2007). *Psychology of physical activity: Determinants, well-being and interventions*. London, England: Routledge.

Booth, F. W., Roberts, C. K., & Laye, M. J. (2012). Lack of exercise is a major cause of chronic diseases. *Comprehensive Physiology, 2*(2), 1143-1211.

Bouchard, C., Blair, S. N., Haskell, W. L. (2007). Why Study Physical Activity and Health? In: Bouchard C, Blair, S.N., Haskell, W.L. (1st). *Physical activity and health* (3-20). Champaign, IL, USA: Human Kinetics.

Brand, T., Pischke, C. R., Steenbock, B., Schoenbach, J., Poettgen, S., Samkange-Zeeb, F., & Zeeb, H. (2014). What works in community-based interventions promoting physical activity and healthy eating? A review of reviews. *International Journal of Environmental Research and Public Health, 11*(6), 5866-5888.

Brawley, L., Rejeski, W. J., Gaukstern, J. E., & Ambrosius, W. T. (2012). Social cognitive changes following weight loss and physical activity interventions in obese, older adults in poor cardiovascular health. *Annals of Behavioral Medicine,44*(3), 353-364. doi:10.1007/s12160-012-9390-5

Bui, L., Mullan, B., & McCaffery, K. (2013). Protection motivation theory and physical activity in the general population: A systematic literature review. *Psychology, Health and Medicine*, *18*(5), 522-542.

Canadian Cancer Society. (2013). *Physical Activity.* Retrieved from https://www.cancer.ca/en/prevention-and-screening/live-well/nutrition-and-fitness/physical-activity/?region=nl

Canadian Cancer Society's Advisory Committee on Cancer Statistics. (2015). *Canadian Cancer Statistics 2015*. Toronto, ON: Canadian Cancer Society; 2015.

Canadian Fitness & Lifestyle Research Institute. (2009). *Let's Get Active! 2008 Physical*

Activity Monitor: Facts and Figures. Retrieved from http://www.cflri.ca/node/82

Canadian Society for Exercise Physiology, (2011). *Canadian Physical Activity Guidelines for Adults 18-64 Years.* Retrieved from: http://www.csep.ca/CMFiles/Guidelines/CSEP_PAGuidelines_adults_en.pdf

Carlson, S. A., Fulton, J. E., Pratt, M., Yang, Z., & Adams, E. K. (2015). Inadequate physical activity and health care expenditures in the United States. *Progress in Cardiovascular Diseases*, *57*(4), 315-323.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports, 100*(2), 126–31.

Chan, M. F., Dowsett, M., Folkerd, E., Bingham, S., Wareham, N., Luben, R., ... & Khaw, K. T. (2007). Usual physical activity and endogenous sex hormones in postmenopausal women: the European Prospective Investigation into Cancer–Norfolk Population Study. *Cancer Epidemiology Biomarkers & Prevention*, *16*(5), 900-905.

Church, T. S., Thomas, D. M., Tudor-Locke, C., Katzmarzyk, P. T., Earnest, C. P., Rodarte, R. Q., ... & Bouchard, C. (2011). Trends over 5 decades in US occupation-related physical activity and their associations with obesity. *PloS one*, *6*(5). Retrieved from: http://dx.doi.org/10.1371/journal.pone.0019657

Colditz, G., Atwood, K., Emmons, K., Monson, R., Willett, W., Trichopoulos, D., & Hunter, D. (2000). Harvard Report on Cancer Prevention Volume 4: Harvard Cancer Risk Index. *Cancer Causes & Control, 11*(6), 477-488.

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011). Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Reports*, *22*(1), 7.

Conner, M., & Norman, P. (2005). *Predicting health behaviour*. London, United Kingdom: McGraw-Hill Education.

Coups, E. J., Hay, J., & Ford, J. S. (2008). Awareness of the role of physical activity in colon cancer prevention. *Patient Education and Counseling*, *72*(2), 246-251.

Courneya, K. S., & Friedenreich, C. M. (2001). Framework PEACE: an organizational model for examining physical exercise across the cancer experience. *Annals of Behavioral Medicine*, *23*(4), 263-272.

Courneya, K. S., & Friedenreich, C. M. (2007). Physical activity and cancer control. *Seminars in Oncology Nursing, 23*(4), 242-252.

Courneya, K. S., & Hellsten, L. M. (2001). Cancer prevention as a source of exercise motivation: An experimental test using protection motivation theory. *Psychology, Health and Medicine, 6*(1), 59-64.

Courneya, K. S., Jones, L. W., Rhodes, R. E., & Blanchard, C. M. (2004). Effects of different combinations of intensity categories on self-reported exercise. *Research Quarterly for Exercise & Sport, 75*(4), 429-433.

Craig, C. L., Marshall, A. L., Sjostrom, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., ... & Oja, P. (2003). International Physical Activity Questionnaire: 12-country reliability and validity. *Medicine & Science in Sport & Exercise, 35*(8), 1381-1395.

Dishman, R. K., Washburn, R. A., & Schoeller, D. A. (2001). Measurement of physical activity. *Quest, 53*(3), 295-309.

Durante, R., & Ainsworth, B. E. (1996). The recall of physical activity: using a cognitive model of the question-answering process. *Medicine & Science in Sports & Exercise*. *28*(10), 1282-1291.

Ekblom, Ö., Ekblom-Bak, E., Bolam, K. A., Ekblom, B., Schmidt, C., Söderberg, S., ... & Börjesson, M. (2015). Concurrent and predictive validity of physical activity measurement items commonly used in clinical settings–data from SCAPIS pilot study. *BMC public health*, *15*(1).

Eliassen, A. H., Hankinson, S. E., Rosner, B., Holmes, M. D., & Willett, W. C. (2010). Physical activity and risk of breast cancer among postmenopausal women. *Archives of internal medicine*, *170*(19), 1758-1764.

Ennour-Idrissi, K., Maunsell, E., & Diorio, C. (2015). Effect of physical activity on sex hormones in women: A systematic review and meta-analysis of randomized controlled trials. *Breast Cancer Research, 17*(1). doi:10.1186/s13058-015-0647-3

Eslinger, D.W., & Tremblay, M.S. (2007). Physical activity and inactivity profiling: the next generation. *Applied Physiology, Nutrition and Metabolism, 32*(Suppl. 2), 195-207. Retrieved from http://www.nrcresearchpress.com/doi/pdf/10.1139/H07-107

Estabrooks, P. A., & Gyurcsik, N. C. (2003). Evaluating the impact of behavioural interventions that target physical activity: issues of generalizability and public health. *Psychology of Sport and Exercise*, *4*(1), 41-55.

Fischhoff, B., Goitein, B., & Shapira, Z. (1981). Subjective expected utility: A model of decision-making. *Journal of the American Society for Information Science, 32*(5), 391-399.

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology, 30*(2), 407-429.

Friedenreich, C. M. (2010). Physical activity and breast cancer: review of the epidemiologic evidence and biologic mechanisms. In *Clinical Cancer Prevention* (125-139). Heidelberg, Berlin: Springer.

Friedenreich, C. M., Neilson, H. K., & Lynch, B. M. (2010). State of the epidemiological evidence on physical activity and cancer prevention. *European Journal of Cancer, 46*(14), 2593-2604.

Friedenreich, C. M., & Orenstein, M. R. (2002). Physical activity and cancer prevention: etiologic evidence and biological mechanisms. *The Journal of Nutrition*, *132*(11), 3456-3464.

Garber, C. E., Blissmer, B., Deschenes, M. R., Franklin, B. A., Lamonte, M. J., Lee, I. M., ... & Swain, D. P. (2011). American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Medicine and Science in Sports and Exercise*, *43*(7), 1334-1359.

Gaston, A., & Prapavessis, H. (2014). Using a combined protection motivation theory and health action process approach intervention to promote exercise during pregnancy. *Journal of Behavioral Medicine, 37*(2), 173-184.

Glanz, K., & Rimer, B. K. (1997). *Theory at a glance: A guide for health promotion practice* (No. 97). US Dept. of Health and Human Services, Public Health Service, National Institutes of Health, National Cancer Institute.

Glanz, K., Rimer, B.K. & Lewis, F.M. (2002). *Health Behavior and Health Education. Theory, Research and Practice.* San Francisco, CA: Wiley & Sons.

Glazer, N. L., Lyass, A., Esliger, D. W., Blease, S. J., Freedson, P. S., Massaro, J. M., ... & Vasan, R. S. (2013). Sustained and shorter bouts of physical activity are related to cardiovascular health. *Medicine and Science in Sports and Exercise*, *45*(1), 109-115

Godin, G., Shephard, R.J. (1985). A simple method to assess exercise behavior in the community. *Canadian Journal of Applied Sport Science, 10*(3), 141-6.

Godin, G. (2011). The Godin-Shephard Leisure-Time Physical Activity Questionnaire. *Health and Fitness Journal of Canada, 4*(1), 18-22.

Godin G, Shephard RJ. (1997). Godin leisure-time exercise questionnaire. *Medicine & Science in Sports & Exercise, 29*(6), 36-38.

Graham, S. P., Prapavessis, H., & Cameron, L. D. (2006). Colon cancer information as a source of exercise motivation. *Psychology and Health*, *21*(6), 739-755

Grossman, P., Deuring, G., Garland, S. N., Campbell, T. S., & Carlson, L. E. (2008). Patterns of objective physical functioning and perception of mood and fatigue in

posttreatment breast cancer patients and healthy controls: an ambulatory psychophysiological investigation. *Psychosomatic Medicine*, *70*(7), 819-828.

Gu, C., Chan, C. W. H., Twinn, S., & Choi, K. C. (2012). The influence of knowledge and perception of the risk of cervical cancer on screening behavior in mainland Chinese women. *Psycho-Oncology, 21*(12), 1299-1308. doi:10.1002/pon.2037

Hagger, M. S., & Luszczynska, A. (2014). Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward. *Applied Psychology: Health and Well-being, 6*(1), 1-47.

Hansen, A. W., Dahl-Petersen, I., Helge, J. W., Brage, S., Grønbæk, M., & Flensborg-Madsen, T. (2014). Validation of an internet-based long version of the international physical activity questionnaire in Danish adults using combined accelerometry and heart rate monitoring. *Journal of Physical Activity and Health, 11*(3), 654-664. doi:10.1123/jpah.2012-0040

Harris, T. J., Owen, C. G., Victor, C. R., Adams, R., Ekelund, U., & Cook, D. G. (2009). A comparison of questionnaire, accelerometer, and pedometer: Measures in older people. *Medicine and Science in Sports and Exercise, 41*(7), 1392-1402.

Harris, T., Kerry, S., Victor, C., Ekelund, U., Woodcock, A., Iliffe, S., . . . Cook, D. (2013). Randomised controlled trial of a complex intervention by primary care nurses to increase walking in patients aged 60-74 years: Protocol of the PACE-lift (pedometer accelerometer consultation evaluation - lift) trial. *BMC Public Health, 13*(5). Retrieved from http://bmcpublichealth.biomedcentral.com/articles/10.1186/1471-2458-13-5

Haskell, W. L., Lee, I-M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., ... Bauman, A. (2007). Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Medicine & Science in Sports & Exercise, 39*(8), 1423-34.

Hartman, S. J., Dunsiger, S. I., & Marcus, B. H. (2013). A pilot study of a physical activity intervention targeted towards women at increased risk for breast cancer. *Psycho-Oncology, 22*(2), 381-387.

Hatchett, A., Hallam, J. S., & Ford, M. A. (2013). Evaluation of a social cognitive theory-based email intervention designed to influence the physical activity of survivors of breast cancer. *Psycho-Oncology, 22*(4), 829-836. doi:10.1002/pon.3082.

Helmerhorst, H. J. F., Brage, S., Warren, J., Besson, H., & Ekelund, U. (2012). A systematic review of reliability and objective criterion-related validity of physical activity questionnaires. *International Journal of Behavioral Nutrition and Physical Activity, 9*(103). doi:10.1186/1479-5868-9-103

Helmes, A. W. (2002). Application of the protection motivation theory to genetic testing for breast cancer risk. *Preventive Medicine, 35*(5), 453-462. doi:10.1006/pmed.2002.1110

Hewitt M., Greenfield, S., Stovall, E. (2006). *From Cancer Patient to Cancer Survivor: Lost in Transition.* Washington, DC: The National Academies Press.

Ibrahim, S., Karim, N. A., Oon, N. L., & Ngah, W. Z. W. (2013). Perceived physical activity barriers related to body weight status and sociodemographic factors

among Malaysian men in Klang valley. *BMC Public Health, 13*(275) doi:10.1186/1471-2458-13-275

International Physical Activity Questionnaire. (n.d.). *Questionnaires.* Retrieved from https://sites.google.com/site/theipaq/questionnaires

International Physical Activity Questionnaire. (2005). *Guidelines for data processing and analysis of the international physical activity questionnaire (IPAQ)-short and long forms.* Retrieved from https://sites.google.com/site/theipaq/questionnaires

Jacobs, Jr. D.R., Ainsworth, B.E., Hartman, T.J., Leon, A.S. (1993). A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Medicine & Science in Sports & Exercise, 25*(1), 81-91.

Janz, K. F. (2006). Physical activity in epidemiology: moving from questionnaire to objective measurement. *British Journal of Sports Medicine*, *40*(3), 191-192.

Jewson, E., Spittle, M., & Casey, M. (2008). A preliminary analysis of barriers, intentions, and attitudes towards moderate physical activity in women who are overweight. *Journal of Science and Medicine in Sport, 11*(6), 558-561. doi:10.1016/j.jsams.2007.08.002

Karvinen, K. H., Courneya, K. S., Campbell, K. L., Pearcey, R. G., Dundas, G., Capstick, V., & Tonkin, K. S. (2006). Exercise preferences of endometrial cancer survivors: a population-based study. *Cancer nursing*, *29*(4), 259-265.

Katzmarzyk, P.T., & Tremblay, M.S. (2007). Limitations of Canada's physical activity data: implications for monitoring trends. *Canadian Journal of Public Health, 98*(Suppl. 2), 185-194.

King, J. B. (1982). The impact of patients' perceptions of high blood pressure on attendance at screening: An extension of the health belief model. *Social Science and Medicine, 16*(10), 1079-1091. doi:10.1016/0277-9536(82)90184-8

Knox, E. C. L., Webb, O. J., Esliger, D. W., Biddle, S. J. H., & Sherar, L. B. (2014). Using threshold messages to promote physical activity: Implications for public perceptions of health effects. *European Journal of Public Health, 24*(2), 195-199.

Kohl III, H. W., Craig, C. L., Lambert, E. V., Inoue, S., Alkandari, J. R., Leetongin, G., . . . Wells, J. C. (2012). The pandemic of physical inactivity: Global action for public health. *The Lancet, 380*(9838), 294-305.

Koizumi, D., Rogers, N. L., Rogers, M. E., Islam, M. M., Kusunoki, M., & Takeshima, N. (2009). Efficacy of an accelerometer-guided physical activity intervention in community-dwelling older women. *Journal of Physical Activity and Health, 6*(4), 467-474.

Kruk, J. (2007). Lifetime physical activity and the risk of breast cancer: A case-control study. *Cancer Detection and Prevention, 31*(1), 18-28

Kruk, J. (2007). Physical activity in the prevention of the most frequent chronic diseases: An analysis of the recent evidence. *Asian Pacific Journal of Cancer Prevention, 8*(3), 325-338.

Kruk, J., & Czerniak, U. (2013). Physical activity and its relation to cancer risk: Updating the evidence. *Asian Pacific Journal of Cancer Prevention, 14*(7), 3993-4003.

Kushi, L. H., Doyle, C., McCullough, M., Rock, C. L., Demark-Wahnefried, W., Bandera, E. V., . . . Gansler, T. (2012). American cancer society guidelines on

nutrition and physical activity for cancer prevention: Reducing the risk of cancer with healthy food choices and physical activity. *CA: A Cancer Journal for Clinicians, 62*(1), 30-67. doi:10.3322/caac.20140

Kushi, L. H., Byers, T., Doyle, C., Bandera, E. V., McCullough, M., Gansler, T., . . . Smith, R. A. (2006). American cancer society guidelines on nutrition and physical activity for cancer prevention: Reducing the risk of cancer with healthy food choices and physical activity. *CA: A Cancer Journal for Clinicians, 56*(5), 254-281. doi:10.3322/canjclin.56.5.254

Lee, I., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., Katzmarzyk, P. T., Alkandari, J.R., Anderson, L.B., Bauman, A.E., Brownson, R.C., Bull, F.C., Craig, C.L., Ekelund, U., …Wells, J.C., (2012). Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *The Lancet, 380*(9838), 219-229.

Liu, R. D., Buffart, L. M., Kersten, M. J., Spiering, M., Brug, J., van Mechelen, W., & Chinapaw, M. J. (2011). Psychometric properties of two physical activity questionnaires, the AQuAA and the PASE, in cancer patients. *BMC Medical Research Methodology*, *11*(30), 1-10. Retrieved from http://bmcmedresmethodol.biomedcentral.com/articles/10.1186/1471-2288-11-30

Lox, C., Martin Ginis, K., & Petruzzello, S. (2003). *The psychology of exercise: Integrating theory and practice*. Scottsdale, Arizona: Holcomb Hathaway.

Marcus, B. H., Rakowski, W., & Rossi, J. S. (1992). Assessing motivational readiness and decision making for exercise. *Health Psychology, 11*(4), 257-261. doi:10.1037//0278-6133.11.4.257

Martinez-Gonzalez, M. Á. (2003). Physical activity and psychological well-being. *Journal of Epidemiology and Community Health*, *57*(3), 232.

Mâsse, L. C., & de Niet, J. E. (2012). Sources of validity evidence needed with self-report measures of physical activity. *Journal of Physical Activity and Health*, *9*(1), S44-S55.

McClendon, B. T., & Prentice-Dunn, S. (2001). Reducing skin cancer risk: An intervention based on protection motivation theory. *Journal of Health Psychology, 6*(3), 321-328.

McCullough, M. L., Patel, A. V., Kushi, L. H., Patel, R., Willett, W. C., Doyle, C., . . . Gapstur, S. M. (2011). Following cancer prevention guidelines reduces risk of cancer, cardiovascular disease, and all-cause mortality. *Cancer Epidemiology Biomarkers and Prevention, 20*(6), 1089-1097.

McGowan, E. L., & Courneya, K. S. (2011). Exercise interventions in supportive oncology. In D.P. Mellar, *Supportive Oncology* (414-428). Philadelphia, USA: Elsevier/Saunders

McGowan, E. L., & Prapavessis, H. (2010). Colon cancer information as a source of exercise motivation for relatives of patients with colon cancer. *Psychology, Health and Medicine, 15*(6), 729-741.

Mcmath, B. F., & Prentice-Dunn, S. (2005). Protection motivation theory and skin cancer risk: The role of individual differences in responses to persuasive appeals. *Journal of Applied Social Psychology, 35*(3), 621-643.

McTiernan, A. (2008). Mechanisms linking physical activity with cancer. *Nature Reviews Cancer*, *8*(3), 205-211.

McTiernan, A., Kooperberg, C., White, E., Wilcox, S., Coates, R., Adams-Campbell, L. L., ... & Ockene, J. (2003). Recreational physical activity and the risk of breast cancer in postmenopausal women: the Women's Health Initiative Cohort Study. *Journal of the American Medical Association*, *290*(10), 1331-1336.

Melzer, K., Kayser, B., & Pichard, C. (2004). Physical activity: The health benefits outweigh the risks. *Current Opinion in Clinical Nutrition and Metabolic Care, 7*(6), 641-647. doi:10.1097/00075197-200411000-00009

Meng, Y., & Kim, H. C. (2012). A review of accelerometer-based physical activity measurement. In *Proceedings of the International Conference on IT Convergence and Security 2011*(223-237). Netherlands: Springer

Mishra, S.I., Scherer, R.W., Geigle, P.M., Berlanstein, D.R., Topaloglu, O., Gotay, C.C., et al. (2012). Exercise interventions on health-related quality of life for cancer survivors (Review). *The Cochrane Database of Systematic Reviews*, *8*(CD007566). doi: 10.1002/14651858.CD007566.pub2.

Milne, S., Orbell, S., & Sheeran, P. (2002). Combining motivational and volitional interventions to promote exercise participation: Protection motivation theory and implementation intentions. *British Journal of Health Psychology, 7*(2), 163-184.

Milne, S., Sheeran, P., & Orbell, S. (2000). Prediction and intervention in health-related behavior: A meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology*, *30*(1), 106-143.

Miyawaki, R., Shibata, A., Ishii, K., & Oka, K. (2014). Awareness and correlates of the role of physical activity in breast cancer prevention among Japanese women: Results from an internet-based cross-sectional survey. *BMC Women's Health, 14*(80), 1-7. Retrieved from http://bmcwomenshealth.biomedcentral.com/articles/10.1186/1472-6874-14-80

Monninkhof, E. M., Elias, S. G., Vlems, F. A., van der Tweel, I., Schuit, A. J., Voskuil, D. W., & van Leeuwen, F. E. (2007). Physical activity and breast cancer: a systematic review. *Epidemiology*, *18*(1), 137-157.

Motl, R. W., McAuley, E., & Dlugonski, D. (2012). Reactivity in baseline accelerometer data from a physical activity behavioral intervention. *Health Psychology, 31*(2), 172-175.

Napolitano, M. A., Borradaile, K. E., Lewis, B. A., Whiteley, J. A., Longval, J. L., Parisi, A. F., ... & Marcus, B. H. (2010). Accelerometer use in a physical activity intervention trial. *Contemporary clinical trials*, *31*(6), 514-523.

Neilson, H. K., Robson, P. J., Friedenreich, C. M., & Csizmadi, I. (2008). Estimating activity energy expenditure: How valid are physical activity questionnaires? *The American Journal of Clinical Nutrition*, *87*(2), 279-291.

Norman, P., Boer, H., & Seydel, E.R. (2005) Protection Motivation Theory. In Conner, M. & Norman, P. (eds) *Predicting Health Behaviour* (81-126). Berkshire, GBR: McGraw-Hill Professional Publishing.

Norman, P. & Bennett, P. (1995). Health locus of control and health behaviours. In M. Conner and P. Norman (eds.) *Predicting Health Behaviour: Research and Practice with Social Cognition Models* (62-94). Buckingham, UK: Open University Press.

Oyeyemi, A. L., Umar, M., Oguche, F., Aliyu, S. U., & Oyeyemi, A. Y. (2014). Accelerometer-determined physical activity and its comparison with the international physical activity questionnaire in a sample of Nigerian adults. *PLoS ONE, 9*(1) doi:10.1371/journal.pone.0087233

Parschau, L., Fleig, L., Warner, L. M., Pomp, S., Barz, M., Knoll, N., . . . Lippke, S. (2014). Positive exercise experience facilitates behavior change via self-efficacy. *Health Education and Behavior, 41*(4), 414-422. doi:10.1177/1090198114529132

Pedišić, Ž., & Bauman, A. (2015). Accelerometer-based measures in physical activity surveillance: Current practices and issues. *British Journal of Sports Medicine, 49*(4), 219-223.

Penedo, F., & Dahn, J. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry, 18*(2), 189-93.

Pike, M. C., Krailo, M. D., Henderson, B. E., Casagrande, J. T., & Hoel, D. G. (1983). 'Hormonal'risk factors, 'breast tissue age' and the age-incidence of breast cancer. *Nature, 303*(5920), 767-770.

Plotnikoff, R. C., Rhodes, R. E., & Trinh, L. (2009). Protection motivation theory and physical activity: A longitudinal test among a representative population sample of canadian adults. *Journal of Health Psychology*, *14*(8), 1119-1134.

Pratt, M., Norris, J., Lobelo, F., Roux, L., & Wang, G. (2014). The cost of physical inactivity: Moving into the 21st century. *British Journal of Sports Medicine, 48*(3), 171-173. doi:10.1136/bjsports-2012-091810

Prestwich, A., Ayres, K., & Lawton, R. (2008). Crossing two types of implementation intentions with a protection motivation intervention for the reduction of saturated fat intake: A randomized trial. *Social Science and Medicine, 67*(10), 1550-1558.

Prince, S. A., Adamo, K. B., Hamel, M. E., Hardt, J., Gorber, S. C., & Tremblay, M. (2008). A comparison of direct versus self-report measures for assessing physical activity in adults: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1).

Prochaska, J. O., & DiClemente, C. C. (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology, 51*(3), 390-395.

Reeves, M. M., Terranova, C. O., Eakin, E. G., & Demark-Wahnefried, W. (2014). Weight loss intervention trials in women with breast cancer: A systematic review. *Obesity Reviews, 15*(9), 749-768.

Rejeski, W., Spring, B., Domanchuk, K., Tao, H., Tian, L., Zhao, L., & Mcdermott, M. (2014). A group-mediated, home-based physical activity intervention for patients with peripheral artery disease: Effects on social and psychological function. *Journal of Translational Medicine, 12* (29). Retrieved from http://doi.org/10.1186/1479-5876-12-29

Roberts, C. K., & Barnard, R. J. (2005). Effects of exercise and diet on chronic disease. *Journal of Applied Physiology, 98*(1), 3-30.

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change. *Journal of Psychology, 91*(1), 93-114.

Rogers, R. W. (1983). Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. In J. R. Cacioppo & R. E. Petty (1st.), *Social psychology: A Sourcebook* (153-176). New York, NY: Guilford Press.

Rogers, R. W., & Prentice-Dunn, S. (1997). Protection motivation theory. In D. S. Gochman (1st.), *Handbook of health behavior research I: Personal and social determinants* (113-132). New York, NY: Plenum Press.

Rosenstock, I. (1974). The health belief model and preventive health behavior. *Health Education & Behavior, 2*(4), 354-386.

Rosenstock, I., Strecher, V., & Becker, M. (1988). Social learning theory and the health belief model. *Health Education & Behavior, 15*(2), 175-183.

Sallis, J. F., & Saelens, B. E. (2000). Assessment of physical activity by self-report: Status, limitations, and future directions. *Research Quarterly for Exercise and Sport*, *71*(Suppl. 2), 1-14.

Salmon, J., Crawford, D., Owen, N., Bauman, A., & Sallis, J. F. (2003). Physical activity and sedentary behavior: A population-based study of barriers, enjoyment, and preference. *Health Psychology, 22*(2), 178-188. doi:10.1037/0278-6133.22.2.178

Santos-Lozano, A., Santín-Medeiros, F., Cardon, G., Torres-Luque, G., Bailón, R., Bergmeir, C., . . . Garatachea, N. (2013). Actigraph GT3X: Validation and determination of physical activity intensity cut points. *International Journal of Sports Medicine, 34*(11), 975-982. doi:10.1055/s-0033-1337945

Schwarzer, R. (1992). Self-efficacy in the adoption and maintenance of health behaviors: theoretical approaches and a new model. In R. Schwarzer (ed.) *Self-efficacy: Thought Control of Action* (217-243). London, UK: Hemisphere.

Senso, M. M., Anderson, C. P., Crain, A. L., Sherwood, N. E., & Martinson, B. C. (2014). Self-reported activity and accelerometry in 2 behavior-maintenance trials. *American Journal of Health Behavior, 38*(2), 254-264.

Sheppard, R.J. (2003). Limits to the measurement of habitual physical activity by questionnaires. *British Journal of Sports and Medicine, 37*(3), 197-206. doi:10.1136/bjsm.37.3.197

Shields M, Tremblay MS, Laviolette M, Craig, C.L., Janssen, I., & Gorber, S.C. (2010). Fitness of Canadian adults: Results from the 2007-2009 Canadian Health

Measures Survey. *Health Reports* (Statistics Canada, Catalogue 82-003), *21*(1), 1-15

Siebeling, L., Wiebers, S., Beem, L., Puhan, M. A., & ter Riet, G. (2012). Validity and reproducibility of a physical activity questionnaire for older adults: Questionnaire versus accelerometer for assessing physical activity in older adults. *Clinical Epidemiology, 4*(1), 171-180. doi:10.2147/CLEP.S30848

Siegel, R., Naishadham, D., & Jemal, A. (2012). Cancer statistics, 2012. *CA: A Cancer Journal for Clinicians*, *62*(1), 10-29.

Sjöström, M., Oja, P., Hagströmer, M., Smith, B. J., & Bauman, A. (2006). Health-enhancing physical activity across European Union countries: The eurobarometer study. *Journal of Public Health*, *14*(5), 291-300.

Spark, L. C., Reeves, M. M., Fjeldsoe, B. S., & Eakin, E. G. (2013). Physical activity and/or dietary interventions in breast cancer survivors: A systematic review of the maintenance of outcomes. *Journal of Cancer Survivorship, 7*(1), 74-82.

Statistics Canada. (2011). *Table 1: Ranking, number and percentage of deaths for the 10 leading causes, Canada, 2000, 2010 and 2011* Retrieved Dec 10, 2014 from Statistics Canada: http://www.statcan.gc.ca/daily-quotidien/140128/t140128b001-eng.htm

Statistics Canada. Popularity of Physical Recreation Activities of Adults, Age 20+ (Canadian Community Health Survey, 2009). Retrieved from: http://www.cflri.ca/eng/levels/popular_pa_adults.php.

Stein, C.J., & Colditz, G.A. (2004). Modifiable risk factors for cancer. *British Journal of Cancer*, *90*(2), 299-303.

Stephens, S.K., Cobiac, J & Veerman, L. (2014). Improving diet and physical activity to reduce population prevalence of overweight and obesity: An overview of current evidence. *Preventive Medicine, 62*(1), 167-178.

Stocchi, V., De Feo, P., & Hood, D.A. (2007). *Role of Physical Exercise in Preventing Disease and Improving the Quality of Life*. Milan: Springer-Verlag.

Strath, S. J., Kaminsky, L. A., Ainsworth, B. E., Ekelund, U., Freedson, P. S., Gary, R. A., . . . Swartz, A. M. (2013). Guide to the assessment of physical activity: Clinical and research applications: A scientific statement from the american heart association. *American Heart Association Journals, 128*(20), 2259-2279.

Su, C. C., Lee, K. D., Yeh, C. H., Kao, C. C., & Lin, C. C. (2014). Measurement of physical activity in cancer survivors: a validity study. *Journal of Cancer Survivorship*, *8*(2), 205-212.

Taylor, A. H., Cable, N. T., Faulkner, G., Hillsdon, M., Narici, M., & Van der Bij, A. K. (2004). Physical activity and older adults: A review of health benefits and the effectiveness of interventions. *Journal of Sports Sciences, 22*(8), 703-725.

Tennen, H., Affleck, G., Allen, D. A., McGrade, B. J., & Ratzan, S. (1984). Causal attributions and coping with insulin-dependent diabetes. *Basic and Applied Social Psychology*, *5*(2), 131-142.

Thune, I., & Lund, E. (1997). The influence of physical activity on lung-cancer risk: a prospective study of 81, 516 men and women. *International Journal of Cancer*, *70*(1), 57-62.

Tillmann, V., Darlington, A. S. E., Eiser, C., Bishop, N. J., & Davies, H. A. (2002). Male sex and low physical activity are associated with reduced spine bone mineral density in survivors of childhood acute lymphoblastic leukemia. *Journal of Bone and Mineral Research*, *17*(6), 1073-1080.

Tremblay, M. S., Warburton, D. E. R., Janssen, I., Paterson, D. H., Latimer, A. E., Rhodes, R. E., . . . Duggan, M. (2011). New Canadian physical activity guidelines. *Applied Physiology, Nutrition and Metabolism, 36*(1), 36-46.

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine and Science in Sports and Exercise*, *40*(1), 181.

Trost, S. G., McIver, K. L., & Pate, R. R. (2005). Conducting accelerometer-based activity assessments in field-based research. *Medicine and Science in Sports and Exercise*, *37*(11), 531-543.

Umstattd Meyer, M. R., Baller, S. L., Mitchell, S. M., & Trost, S. G. (2013). Comparison of 3 accelerometer data reduction approaches, step counts, and 2 self-report measures for estimating physical activity in free-living adults. *Journal of Physical Activity and Health, 10*(7), 1068-1074.

U.S. Department of Health & Human Services. *Physical Activity Guidelines Advisory Committee report.* (2008). Retrieved from: http://www.health.gov/paguidelines/

Van't Riet, J., & Ruiter, R. A. C. (2013). Defensive reactions to health-promoting information: An overview and implications for future research. *Health Psychology Review, 7*(Suppl. 1), 104-136. doi:10.1080/17437199.2011.606782

Volaklis,K.A., Halle,M., Tokmakidis, S.P., (2013). Exercise in the prevention and rehabilitation of breast cancer. *The Central European Journal of Medicine. 125*(11), 297-301

Wallston, K. A. (1992). Hocus-pocus, the focus isn't strictly on locus: Rotter's social learning theory modified for health. *Cognitive Therapy and Research, 16*(2), 183-199. doi:10.1007/BF01173488

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.

Wallston, B. S., Wallston, K. A., Kaplan, G. D., & Maides, S. A. (1976). Development and validation of the health locus of control (HLC) scale. *Journal of consulting and Clinical Psychology*, *44*(4), 580-585.

Warburton, D. E. R., Nicol, C. W., & Bredin, S. S. D. (2006). Health benefits of physical activity: The evidence. *Canadian Medical Association Journal, 174*(6), 801-809.

Welk, G. J. (2008). The role of physical activity assessments for school-based physical activity promotion. *Measurement in Physical Education and Exercise Science, 12*(3), 184-206.

Westerterp, K. R. (1999). Physical activity assessment with accelerometers. *International Journal of Obesity, 23*(Suppl. 3), 45-49.

Wood, M. E. (2008). Theoretical framework to study exercise motivation for breast cancer risk reduction. *Oncology Nursing Forum*, *35*(1), 89-95.

World Cancer Research Fund / American Institute for Cancer Research. (2007). *Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective*. Washington, DC: American Institute for Cancer Research. Retrieved from http://discovery.ucl.ac.uk/4841/1/4841.pdf

World Health Organization. (2009). *Global Health Risks.* Retrieved from: http:// www.who.int/healthinfo/global_burden_disease/global_health_risks/en/index.html.

World Health Organization. (2013). *Global action plan for the prevention and control of NCDs 2013-2020.* Retrieved from: http://apps.who.int/iris/bitstream/10665/94384/1/9789241506236_eng. pdf.

Winzer, B. M., Whiteman, D. C., Reeves, M. M., & Paratz, J. D. (2011). Physical activity and cancer prevention: a systematic review of clinical trials. *Cancer Causes and Control, 22*(6), 811-826. doi: 10.1007/s10522-011-9761-4

Wu, Y., Zhang, D., & Kang, S. (2013). Physical activity and risk of breast cancer: A meta-analysis of prospective studies. *Breast Cancer Research and Treatment, 137*(3), 869-882.

Wurtele, S. K., & Maddux, J. E. (1987). Relative contributions of protection motivation theory components in predicting exercise intentions and behavior. *Health Psychology, 6*(5), 453-466.

Yang, C. C., & Hsu, Y. L. (2010). A review of accelerometry-based wearable motion detectors for physical activity monitoring. *Sensors*, *10*(8), 7772-7788.

Chapter 3 Thesis Manuscript

3.0 Abstract

Purpose: Physical activity (PA) has been shown to decrease breast cancer risk. Using protection motivation theory (PMT), this study explored whether a media-based intervention that presented factual breast cancer and PA information could motivate at-risk women to increase their PA levels. **Method:** Inactive women (*N*= 60) were randomly assigned to one of three groups: (1) PMT intervention, (2) attention control, or (3) non-contact control group. Group (1) watched a DVD containing information on PA and breast cancer risk based on PMT constructs: perceived vulnerability (PV); perceived severity (PS); response efficacy (RE); and self-efficacy (SE), while the attention control DVD contained diet and cancer information. PMT variable scores were measured pre- and post-DVD, and PA was measured subjectively and objectively pre- and post-DVD and at 4-week follow-up. **Results:** Participants in the PMT group showed significant improvements in RE scores (F (1,57) = 19.54, $p < 0.001$, $\eta_p^2 = 0.21$) and SE scores (F(1,57) = 4.10, $p = 0.022$, $\eta_p^2 = 0.13$). RE was also found to significantly predict PA intention scores pre-DVD (B = .384, t = 3.00, $p < 0.05$) and post-DVD (B = 0.434, t = 4.07, $p < 0.01$). No significant change was found for PA behaviour. **Conclusions:** The PMT-based PA intervention was successful in increasing participants' RE and SE in regards to PA and breast cancer risk, but only RE was a significant predictor for intention to perform PA. Future research should examine methods to increase scores in the threat appraisal construct of PMT, and should continue to include objective measures of PA.

3.1 Introduction

Regular participation in physical activity (PA) is an important health behaviour for the prevention and management of common, and often life-threatening chronic diseases, such as cardiovascular disease, type 2 diabetes, and cancer (Haskell et al., 2007; Biddle & Mutrie, 2007; WCRF, 2007). Despite the link between PA and disease, the prevalence of individuals not meeting recommended PA levels continues to grow throughout Canada. Modern society allows for more and more opportunities for sedentary behaviour, and as a result, PA has become a marginal aspect of life for a large percentage of the population. In 2009, 52.5% of Canadian adults reported themselves as being sufficiently active (Statistics Canada, 2009), however, it was estimated through objective measures of PA that only 15% of Canadian adults are actually reaching PA levels required to achieve health benefits (Colley et al., 2011). The greatest health benefit of PA is proposed to be in primary prevention, which refers to health promotion and contributes to general wellness, decreasing the likelihood of developing disease (Booth, Roberts, & Laye, 2012). The proven protective benefits of PA makes it important to increase PA participation in healthy populations when its effects are the most beneficial. The development of effective interventions to increase PA remains an important challenge for researchers, clinicians, and public health authorities (Brenner, 2014).

Physical inactivity in Canada is especially important in regards to cancer occurrence. Cancer is the leading cause of death in Canada, and is responsible for nearly 30% of all deaths (Canadian Cancer Society's Advisory Committee on Cancer Statistics [CCSACS], 2015). Research indicates that in 2007, 7.9% of cancer cases were attributed

to physical inactivity with a greater burden of disease in women compared to men (Brenner, 2014). Insufficient amounts of PA have been linked to the development of several types of cancer, with the strongest evidence for breast (Monninkhof et al., 2007), colon (Friedenreich et al., 2006), endometrium (Friedenreich et al., 2007), prostate (Liu et al., 2011), lung (Sun et al., 2012) and ovarian cancers (Patel, Rodriguez, Pavluck, Thun, & Calle, 2006). Breast cancer is the most commonly diagnosed cancer for women, and accounts for 26% of all new cancer cases in women (CCSACS, 2015). PA alone has been shown to decrease breast cancer risk by 25-30% (Friedenreich, Neilson, & Lynch, 2010), and a linear relationship has been shown to exist between breast cancer risk and PA level, suggesting that higher levels of PA leads to greater risk reduction (Wu, Zhang & Kang, 2013). These results indicate that it is essential to increase PA behaviour in women who are at an increased risk of developing breast cancer due their inactivity. Several studies have been conducted to increase PA motivation (McGowan & Prapavessis, 2010) and PA behaviour (Graham, Prapavessis, & Cameron, 2006) in healthy, but high-risk individuals. Results showed that educating high-risk individuals of the risk of developing colon cancer and how they can reduce this risk by performing PA was effective for increasing their PA motivation. This research method has yet to been applied to other cancers where PA is also protective.

One effective way of increasing PA behaviour is through the use of PA interventions grounded in psychological theories of behaviour (Annesi & Johnson, 2015). Protection Motivation Theory (PMT) was chosen for the current study, as it was primarily developed to change PA intentions, it has been previously used in PA

interventions which target healthy populations, and has also been shown to produce positive outcomes for a wide variety of health behaviours, such as smoking cessation, cancer screening, and nutrition (Floyd, Prentice-Dunn & Rogers, 2000; Bui, Mullan, & McCaffery, 2013). PMT is a social-cognitive model that was designed to explain health behaviour motivation from the perspective of disease prevention (Courneya & Hellsten, 2001; McGowan & Prapavessis, 2010). Health-related behaviour is explained in terms of threat: perceived vulnerability (PV) and perceived severity (PS), and coping appraisal: response efficacy (RE) and self-efficacy (SE). Threat appraisal is influenced by an individual's perception of the likelihood of developing a particular health condition (i.e., breast cancer− PV), as well as the severity of the condition itself (i.e., breast cancer mortality rate, painful treatment - PS). Coping appraisal consists of an individual's belief that the recommended coping response (e.g., PA) will be effective at reducing the risk of developing the health condition (i.e., RE), and the belief that they can successfully perform the coping response (i.e., SE). Based on PMT, it is proposed that PV, PS, RE, and SE all influence an individual's intention to perform the health behaviour (i.e., PA), and then intention influences actual PA behaviour (see Figure 1).

To date, three studies have been conducted using PMT–based interventions to assess whether information about protective benefits of PA for colon cancer risk can impact an individual's PA intention. Using a sample of undergraduate students, Courneya and Hellsten (2001) found that providing information regarding PA and colon cancer prevention is a meaningful source of PA motivation. Results showed that participants who were presented information that led them to believe that colon cancer was a severe

disease (i.e., PS) and that PA could effectively reduce their risk (i.e., RE) were the most motivated (i.e., increased intention) to perform PA. However, a major limitation of this study was the intervention presented non-factual colon cancer information to a healthy, active undergraduate population. These limitations were addressed in the study by Graham et al. (2006) that examined whether factual colon cancer prevention information could motivate inactive individuals to consider becoming physically active. The results showed that the intervention group scored higher on coping appraisal variables of RE and SE, and PA intention and a trend effect was found for exercise behaviour. Finally, McGowan and Prapavessis (2010) further extended the literature by examining the effectiveness of a media-based intervention grounded in PMT to change beliefs toward colon cancer and PA, and PA intentions in inactive relatives of patients with colon cancer. Results showed that a single media exposure intervention grounded in PMT was effective in changing PA and colon cancer beliefs, as well as PA intentions in individuals at an increased risk of developing colon cancer. The study also demonstrated that changes in SE, RE and PS, but not PV, were related to increases in PA intentions.

Previous PMT-based intervention research has shown success in increasing beliefs about the relationship between PA and colon cancer risk, and subsequently increasing intention to be physically active (Courneya & Hellsten, 2001; Graham et al., 2006; McGowan & Prapavessis, 2010), and PA behavior (Graham et al., 2006). The present study aimed to extend the PMT literature by exploring whether factual breast cancer information could serve as a meaningful source of PA motivation, and in turn whether this information could impact self-reported and objectively measured PA levels.

The primary objective of the current study is to examine the effectiveness of an intervention, grounded in PMT, that seeks to change beliefs toward breast cancer and PA, PA intentions, and PA behaviour in women at an increased risk of developing breast cancer (i.e., inactive). Specifically, the main objective is determined by the change in scores of each of the four PMT constructs and PA intention, and if the group receiving the PMT-based intervention will show an increase in PV, PS, SE, RE, and intention scores compared to the attention control and non-contact control groups. A secondary objective is to explore which of the four PMT variables is the most predictive of PA intention, and whether intention would lead to an increase in objectively- and subjectively-measured PA behaviour[1]. Based on previous research exploring PMT-based interventions, it is hypothesized that participants receiving the PMT intervention will have larger increases in scores from baseline for PV, PS, SE and RE compared to those in the attention control and non-contact control groups (Floyd et al., 2000). For the secondary objective, consistent with theory (see Figure 1), it is hypothesized that all four PMT constructs would predict PA intention (Graham et al., 2006). It is believed that RE and SE will be the most salient predictors of PA intention as these constructs have been shown to strongly predict PA intention in previous research (McGowan & Prapavessis, 2010). It is also hypothesized that PA intention will predict subjectively measured PA behaviour (Graham et al., 2006).

[1] No significant findings for PA behaviour were found.

3.2 Methods

3.2.0 Participants and Procedures

Ethical approval was obtained from the host institutions ethics committee prior to recruiting participants. The study used a prospective, three-armed, randomized controlled design. Participants were recruited through university listservs, social media, newspaper ads, and posters. Interested individuals were asked to contact the primary researcher directly to receive further information about the research study and to determine eligibility. Eligible participants were invited to take part in the study, and were scheduled in for an initial meeting where consent, demographic information (e.g., age, education level), subjective and objective PA, and baseline (Pre-DVD) measures of their beliefs towards PA and breast cancer were collected in person.

Participants included 60 inactive, females who ranged in age from 19 to 60 years (M= 43.08; SD=10.88). The majority of participants (96.7%) classified themselves as Caucasian. In order to meet our inactivity criteria, participants completed the stage of PA readiness questionnaire (SERQ; Marcus, Rakowski, & Rossi, 1992). Based on this questionnaire, 3.3% of the participants were in the pre-contemplation stage (n= 2), 40.0% (n= 24) were in the contemplation phase, 41.7% (n= 25) were in the preparation stage, 13.3% (n= 8) were in the action phase and 1.7% (n=1) was in the maintenance phase. Our initial intent was that participants would be eligible to participate in the study if they classified themselves in the pre-contemplation, contemplation, or preparation stages of TTM, however we did include some participants who were in the action stage and one in

the maintenance stage because they felt that they were inactive.[2] Following completion of baseline measures, the principal investigator randomized participants in a 1:1:1 ratio into one of three groups using a computer-generated random numbers list (GraphPad Software, San Diego, CA): (1) PMT intervention, (2) attention control, and (3) non-contact control groups. Participants were then given an accelerometer to wear for the next seven days. One week post the initial meeting, participants in the intervention and the attention control group returned to view the DVD created for their group. Before viewing the DVD, accelerometers were collected and downloaded, and a self-report PA questionnaire (LSI; Godin & Shepard, 1985) was completed. The DVDs were presented to participants in groups that ranged in size from 1 to 5 participants. Immediately following the viewing, participants were asked to complete the post-DVD questionnaire package, which contained the beliefs toward breast cancer and PA questionnaire and PA intention measure. Following viewing the DVD and completing the questionnaires participants wore the accelerometer for the following seven days. The non-contact control group did not view a DVD but did complete the measures, and wore the accelerometer for the following seven days. One week later, participants returned their accelerometers and completed a PA questionnaire to assess any changes in PA behaviours post-DVD viewing. Finally, two weeks later (a month after the initial meeting), participants re-wore the accelerometer for seven days for PA behaviour follow-up. When accelerometers were

[2] To ensure that the participants in the maintenance and active stages did not impact our results, statistics were re-run with these participants removed, and the results parallel those reported in text.

returned, participants completed a PA questionnaire to collect subjective PA information at follow up. Tri-council guidelines for research involving human participants were closely followed. The overall flow of participants in the study can be found in Figure 2**.**

3.2.1 Development of the Protection Motivation Theory DVD and other material

The intervention DVD was designed to manipulate the four PMT constructs: PV, PS, RE, and SE. The DVD featured a chief medical oncologist from the local cancer center. The oncologist presented factual information regarding an individual's PV (e.g., "it [breast cancer] is the most common cancer in women in Canada; about one out of four women will develop breast cancer in their lifetime... and it [breast cancer] is the second leading cause of death from cancer in Canadian women") and the PS of developing breast cancer (e.g., "there are several [treatment options] and they really fall into three groups: surgery, chemotherapy, and radiation"). An exercise and health psychology expert was enlisted to present information on the links between PA and breast cancer ("… in fact, one can reduce one's risk of developing breast cancer by about 30-40% it appears through regular PA…"- RE), as well as to provide some tips on how to increase one's SE to engage in PA ("write these activity goals out and put reminders around the house…"- SE). The viewing time of the DVD was approximately 20 minutes. Video format was chosen as it ensures that the content was standardized, and covered a broad range of literacy levels (Meade, 1996). The attention control DVD contained information on the associations between nutrition and cancer in general and was presented by a certified nutritionist. The attention control DVD was approximately 20 minutes in length.

3.2.2 Measures

Demographic and health characteristics of all participants were assessed through self-report. Demographic characteristics included age, marital status, education level, family income, and current employment status. Health characteristics included diagnoses of several health conditions (e.g., high blood pressure, high cholesterol, etc.). The questionnaire also assessed the individual's smoking and alcohol consumption and if their PA was limited in the past month by a health condition or disability. There was also space to disclose any other possible health condition. Objective measures of height and weight were taken using a scale and tape measure for height during the initial meeting, and this information was used to calculate body mass index (BMI).

3.2.3 Beliefs towards breast cancer and Physical Activity questionnaire

The primary outcome of the study was to determine if the intervention was effective in changing beliefs towards PA and breast cancer risk, leading to an increase in PA intention and PA behaviour. Change in PMT variable scores were assessed using the 'beliefs towards breast cancer and PA questionnaire', which is a 16-item measure, which contains four items for each of the PMT constructs. The questionnaire was adapted from the 'beliefs toward colon cancer and PA questionnaire' used in the PMT literature by Courneya and Hellsten (2001), Graham et al. (2006), and McGowan and Prapavessis (2010). The items are rated on a 7-point Likert scale, ranging from 1= "strongly disagree" to 7= "strongly agree". Sample items related to breast cancer include: "Personally I feel vulnerable to developing breast cancer at some point in my life" (i.e., PV); "I feel breast cancer would be a very serious illness for me to develop" (i.e., PS); "I feel that PA would

help me to personally reduce my risk of breast cancer" (i.e., RE); and " If I wanted I could easily do the types and amount of PA necessary to reduce my risk of breast cancer" (i.e., SE). The subscales all demonstrated acceptable levels of internal consistencies ranging from .682 to .936 for pre-DVD measures and from .712 to .942 for post-DVD measures.

3.2.4 Physical Activity Intentions

PA intentions were assessed using four-items, which are commonly used in the PMT literature (Graham et al., 2006; McGowan & Prapavessis, 2010). The items are rated on a seven-point Likert scale, ranging from 1 = "extremely unlikely" to 7 = "extreme likely". A sample item for intention is: "Would you seriously consider starting an exercise program designed to reduce your risk of breast cancer?" The scale demonstrated an acceptable level of internal consistency of .824 for the pre-DVD assessment and of .810 for the post-DVD assessment.

3.2.5 Subjectively Measured Physical Activity Behaviour

Subjective PA behaviour was assessed using the Leisure Score Index (LSI) of the Godin Leisure Time PA Questionnaire (Godin & Sheppard, 1985) that has been extensively validated (Jacobs et al., 1993). The LSI contains four questions to assess the frequency of light, moderate and vigorous PA, and resistance training performed over the previous week that lasted for at least 10-minutes and was done during leisure time. The LSI was modified to also include average duration, a common modification in the PA and cancer literature (Courneya et al., 2002; Karvinen et al., 2006). This modification allowed for the calculation of the endpoint of PA minutes defined as vigorous minutes plus

moderate minutes based on the public health PA guidelines (18-64 years of age; CSEP, 2011).

3.2.6 Objectively Measured Physical Activity Behaviour

PA was objectively measured using the ActiGraph wGT3X-BT tri-axial accelerometer, which has been found to be a valid and reliable PA measurement tool (Santos-Lozano et al., 2013). The device provides information on a participant's activity counts, energy expenditure, and activity levels. Participants were given the device pre-programmed with their weight and height and were shown how to wear the accelerometer by the primary researcher during the initial meeting. To further ensure proper wear of the accelerometer, written instructions were provided for each participant that included pictures displaying the proper placement. Participants were instructed to wear the device on their hip for seven consecutive days, for all their waking hours. The device automatically collects data at 10-second epochs. For complete data, participants were required to provide a minimum wear time of ten hours per day for at least four days (including one weekend day; Trost, McIver, & Pate, 2005). Data was analyzed using the ActiLife software (version 6.11.9). Cut points for moderate-to-vigorous PA used for this study were Troiano Adult (2008) cut points. These cut points categorize sedentary behaviour as 0-99 counts per minute (CPM), light activity as 100-2019 CPM, moderate as 2020-5998 CPM, and vigorous as >5999 CPM. As accelerometers are not fully able to capture resistance training behaviours these were assessed using the LSI (Godin & Shepphard, 1985; Jacobs et al., 1993). Participants were asked the frequency, duration, and type of resistance activities they had taken part in over the previous week.

3.2.7 Statistical Analyses

Chi-square and one-way ANOVA procedures were used to test for group equivalency between the three groups on demographic characteristics as these factors may influence beliefs about PA and breast cancer, PA intentions, and PA behaviour. To explore the primary outcome of the study, separate 3 (group) x 2 (time-pre/post-DVD) repeated measures ANOVAs were conducted to examine interaction effects for PV, PS, RE, SE, and intention scores. A 3 (group) x 3 (time-pre/post-DVD/ one month follow-up) repeated measures ANOVAs was conducted to examine interaction effects for the secondary objectives of both objective and subjective PA behaviour (i.e., MVPA/week). Bonferroni corrections were applied to the ANOVAs to adjust for multiple comparisons.

The other secondary objective of the study was to determine which of the PMT variables significantly predicted PA intention and PA behaviour. To achieve this, bivariate correlations were conducted to examine the relationships among PMT variables, PA intention, and PA behaviour, for the pre-DVD, post-DVD, and one-month follow-up time points. If relationships were found between the predictor variables (i.e., PMT) and the criterion variable (i.e., PA intention) of interest they were then entered into a regression analysis to determine how much of the total variation in the criterion variable could be explained by the predictor variable.

To overcome the problem of missing data, the study made use of the intention to treat analysis (Fisher et al., 1990). The participant's last recorded value was carried forward for each measure following dropout.

3.3 Results

3.3.1 Group Equivalency

As can be seen in Table 1, there was group equivalency across all of the demographic and health variables, aside from education level. For education level the attention control group had a significantly higher education level than the intervention and non-contact control groups ($p < 0.05$). Correlations were also conducted to examine the relationships among the demographic variables (i.e., age, BMI, income level, ethnicity, stage of PA readiness), the PMT variables and PA intentions, and PA behaviour. Descriptive statistics were also conducted for the PMT variables, PA intention, and PA behaviour (both objectively- and subjectively-measured). These results are presented in Table 2.

3.3.2 Beliefs towards Physical Activity and Breast Cancer and Physical Activity Intention

The results are presented in Table 3. For RE, results revealed a significant interaction effect, $F(1,57) = 7.42$, $p < 0.001$, $\eta_p^2 = 0.21$. Specifically, the RE scores for the intervention group increased to a larger extent whereas the attention control and non-contact control groups' scores increased minimally (i.e., 0.3 and 0.1, respectively). Post hoc tests, using the Bonferroni correction, revealed that the change in RE scores for the intervention group differed from attention control with a mean difference of 0.498 (S_{error} = .256), and non-contact control groups with a mean difference of 0.591 (S_{error} = .253) but were not statistically significant (p = .171 and p = .069, respectively).

For SE, a significant interaction effect was also found ($F(1,57) = 4.10$, $p = 0.022$, η_p^2 =0.13). Post hoc tests, using the Bonferroni correction, revealed that the change in SE

scores for the intervention group differed from the attention control group with a mean difference of 0.516 (S_{error} = .226), and non-contact control groups with a mean difference of 0.162 (S_{error} = .223) but were not statistically significant (p = .078 and p = 1.00, respectively).

There was a significant time effect found for PV, ($F(1,57) = 5.43$, $p = 0.023$, $\eta_p^2 = 0.087$) but no interaction effect, as all groups had increases in their PV scores over time. There were no significant interaction or time effects for PS. No significant interaction effect was found for PA intention between the three treatment groups was found. See Table 3 for results.

3.3.4 Physical Activity Behaviour

A 3 (group) x 3 (time-pre/post-DVD/ one month follow-up) repeated measures ANOVAs was conducted to examine interaction effects for both objective and subjective PA behaviour (i.e., moderate-vigorous PA minutes/week). No significant effect was found for subjective weekly MVPA or for $MVPA_{total}$ or $MVPA_{10+}$. The results for PA behaviour are presented in Table 4.

3.3.5 Relationships between Protection Motivation Theory Constructs, Physical Activity Intentions and Physical Activity Behaviour

Pre-DVD PV was highly correlated with Post-DVD PV ($p < 0.01$) and also correlated with Post-DVD intention ($p < 0.05$). Pre-DVD RE was highly correlated with Pre-DVD intention ($p < 0.01$) and Post-DVD RE ($p < 0.01$). Post-DVD RE was correlated with Post-DVD intention ($p < 0.01$). All correlations are displayed in Table 5.

3.3.6 Predicting Physical Activity Intention

For the pre-DVD intervention period, intention was related to RE only. When pre-DVD RE and PA intention were entered into a standard linear regression, RE made a significant contribution to predicting PA intention, explaining 13.5% of the response variance (Table 7). For the post-DVD intervention period, PA intention was also related to RE only. When this post-DVD RE and post-DVD PA intention were entered into a standard multiple regression, RE made a significant and unique contribution to predicting PA intention, explaining 22.2% of the response variance (Table 8).

3.3.7 Predicting Physical Activity Behaviour

Regression analyses of the correlations between PA behaviour and the four PMT constructs showed that none of the PMT constructs or PA intention significantly predicted objective or subjective PA behaviour[3].

3.4 Discussion

Our results did not support the notion that breast cancer information is a meaningful source of PA motivation and effective in increasing PA behaviour in individuals at an increased risk for developing breast cancer. Contrary to our hypothesis, the PMT intervention was effective for coping appraisal variables (i.e., RE and SE) but was not effective in changing participants' threat appraisal variable scores (i.e., PV and

[3] Regression analyses were conducted to determine the prediction of our PA behaviour measures. The general results were: for the pre-DVD intervention period, objective $MVPA_{10+}$ was correlated with intention and subjective MVPA, but baseline subjective MVPA was the only factor that made a significant and unique contribution to predicting objective $MVPA_{10+}$, explaining 52.2% of the response variance. Subjective MVPA at follow-up was associated with Post-DVD PV, objective $MVPA_{10+}$ and subjective MVPA. The regression analysis showed that post-DVD PV and Post-DVD subjective MVPA made significant and unique contributions to predicting subjective MVPA at follow-up, explaining 39.1% of the response variance.

PS). Specifically, the PMT intervention group believed that PA was an effective strategy for reducing the risk of developing breast cancer and that they had greater coping resources to reduce the threat compared to the attention control and non-contact groups. However, the PMT group did not change their perception on the severity of breast cancer or their own vulnerability to the disease following the intervention. Cohen (1988) recommended using the following values to interpret the strength of the effect: .01 small, .06 medium, and .14 large. According to these recommendations the effect size for change in RE scores was very large (0.21) and the effect size for SE was medium-to-large (0.13). The increase in RE and SE scores is in line with previous PMT research (Floyd et al., 2000; McGowan & Prapavessis, 2010).

Manipulation of the coping variables (e.g., SE and RE) was an important effect of the intervention as these constructs have been shown in the literature to be the most significantly associated with protective health behaviours and following of medical-treatment regimens (Floyd et al., 2000). Meta-analyses have also suggested that the coping appraisal component of PMT may be the most important area in which to intervene to achieve optimal health benefits for patients (Floyd et al., 2000; Milne et al., 2000). In regards to PA specifically, analysis of prediction studies suggests that SE might be the strongest predictor of PA participation (Bui et al., 2013). These results taken with the results from the current study suggest that the coping appraisal variables may be easier to manipulate than the threat appraisal variables of PMT. While the coping appraisal variables have been shown to be successful in increasing health-related behaviours it is important to determine the best way to construct PMT intervention

materials that can manipulate all four constructs to increase intention to perform these behaviours.

The three groups did not differ on their appraisal of the threat of developing breast cancer occurrence or the severity of breast cancer (i.e., PS and PV). The failure to manipulate PS could be due to the high prevalence rate of breast cancer. This type of cancer is very common which makes it difficult to find someone that has not been affected by breast cancer. Therefore, participants in the study were likely previously aware of the severity of this disease, and a ceiling effect may have been operating as all scores were high at baseline, which may have influenced the impact of the PS material. Additionally, our sample was comprised of all females, and as breast cancer is the most common type of cancer in women, they may have been more aware of the severity of this disease. Our failure to manipulate PS is in line with the Graham et al. (2006) study and McGowan and Prapavessis (2010), but not with the Courneya and Hellsten (2001) study, however the latter study presented false cancer information that likely accounted for the change in PS scores. These combined results suggest that the variable of PS may be especially difficult to manipulate in regards to studies that are associated with cancer risk. It is plausible that cancer is such a well-known and widespread disease that the threat variables of PMT are especially difficult to manipulate for this disease when we present factual cancer information. In future studies, the severity of the disease and details regarding negative symptoms, painful treatments, and long-term effects of treatment could be emphasized more prominently in an effort to increase PS scores.

Changes in PV scores between the three treatment groups were also non-significant. This could be due to the fact that health-promoting material has been found to sometimes be least effective for individuals to which it is most relevant (Berkowitz & Cottingham, 1960; Block & Williams, 2002; Croyle, Sun, & Louie, 1993; Ditto & Lopez, 1992; Earl et al., 2009; Good & Abraham, 2007; Kessels, Ruiter, & Jansma, 2010; Noguchi, Albarracı´n, Durantini, & Glasman, 2007). Health-promoting messages can result in avoidance, denial, and dismissal of the information by participants in order to discount themselves from the threat or to blunt its psychological impact (Brown & Locker, 2009; Brown & Smith, 2007; Kessels et al., 2010; Liberman & Chaiken, 1992). Our findings for PV are in line with previous cancer prevention research (Courneya & Hellsten, 2001; Graham et al., 2006), and may suggest that altering perceptions of vulnerability to breast cancer could present a major challenge in regards to cancer prevention.

Contrary to our hypothesis, the PMT intervention was not effective in changing participants' PA intentions. This lack of increase in intention is likely due to a failure to manipulate PS and PV. These failures are problematic, as according to theory, all four constructs of the PMT framework must be manipulated to test its ability to facilitate PA intentions and behaviour through breast cancer prevention information. In order to take protective action, the individual must believe there is some harm (e.g., breast cancer development from inactivity) and that they are vulnerable to this harm (e.g., by being insufficiently inactive). The threat appraisal variables provide motivation to initiate the coping process (e.g., RE and SE), which in turn leads to the decision to adopt the coping

response (e.g., intention to increase PA). High baseline intention scores in all three of the treatment groups (see Table 3) may indicate that a ceiling effect was taking place in regards to PA intention. Response bias was a likely confounding factor, as the individuals who expressed interest were looking to increase their PA behaviour, as they perceived themselves to be inactive, and therefore had high PA intention before entering the study.

Since PA intention was not effectively manipulated, the study was not able to determine if changing PA intentions through PMT had an effect on PA behaviour. Graham et al. (2006) showed an increase in self-reported PA behaviour two weeks post-intervention but not at the four-week follow up point. The increase in PA behaviour observed in their study was likely due to their ability to increase PA intention, which was not the case in the current study. The sampling technique that Graham et al. (2006) used was to include individuals of all exercise levels to avoid singling out non-exercisers. Perhaps if the current study had employed a more random sampling technique that did not specifically target currently inactive participants the response bias could have been avoided.

With respect to predicting PA intentions, RE made a significant and unique contribution to pre-DVD intention scores across all three-treatment groups, explaining 13.5% of the response variance. RE scores also were significantly correlated with post-DVD intention scores explaining 26.6% of the response variance. These results suggest that when the participants believed that PA was effective in decreasing breast cancer risk (i.e., RE) they were likely to increase their intention to perform PA. These findings are in

line with previous PMT research that presented RE as the most significant predictor of PA intentions (Graham et al., 2006; McGowan & Prapavessis, 2010; Milne et al., 2000).

As with all well designed research studies, a few limitations exist. One limitation of the current study was participant recruitment. Recruitment proved to be a challenge that was not anticipated, as a large proportion of the Newfoundland population is considered inactive. Our low recruitment numbers limit our ability to make conclusions about the strength of the intervention, since the study is underpowered to detect small differences in our outcomes. The inability to demonstrate increases in the PMT threat variables (i.e., PS and PV) is likely due to the small sample size, therefore further research and continued recruitment is warranted. Another component that could have limited the results of the current study is message tailoring and ensuring that the message being delivered corresponds with the participants' style of processing. Messages that are tailored to an individual's processing style are more effective than those that are not (Salovey & Williams-Piehota, 2004). Also, PA messages that contain a threshold value, such as the recommended PA for health benefits presented in the PMT intervention DVD (e.g. a minimum of 150-minutes/week of MVPA) have been associated with lower perceived health benefits (Knox, Webb, Esliger, Biddle, & Sherar, 2014). The sample was also comprised of a large percentage of overweight or obese females (86.7%), which is a known risk factor for breast cancer. A sample of overweight women would have presented a more at-risk population than just being inactive by possessing two risk factors. As our sample did include a percentage of women who were of normal weight we are unable to generalize our results to this group as well. A final limitation was the

inclusion of a mostly Caucasian sample, which limits our ability to generalize our results to other ethnicities.

3.5 Conclusions and Future Directions

In conclusion, the results of the current study demonstrated that a single exposure media intervention grounded in PMT was effective in changing at-risk participants' RE and SE beliefs towards breast cancer and PA. However, the intervention was not successful at manipulating PV and PS scores, and therefore was not effective at changing PA intention or objectively and subjectively measured PA behaviour. One strategy that likely would have strengthened the current study would be the addition of an action planning approach, such as an implementation intention intervention (Milne et al., 2002; Prestwich, Ayres, & Lawton, 2008) or the addition of a Health Action Process Approach (Gaston & Prapavessis, 2014). Implementation intentions are specific plans regarding when, where and how an individual will behave, leading to an increase in the likelihood of the behavior occurring. These types of interventions have been shown to promote PA post-intervention and at follow-up (Bélanger-Gravel, Godin, & Amireault, 2011). Literature suggests that augmenting a PMT intervention with an implementation intention intervention approach may help to bridge the intention-action gap (Prestwich, Ayres, & Lawton, 2008) and an engaging action planning intervention has been shown to be effective in increasing PA behaviour in middle-age and older adults (Ziegelmann, Lippke, & Schwarzer, 2006). Studies have shown a significant effect on PA behaviour when combining a PMT-based intervention with an implementation intervention compared to a PMT-based intervention alone (Milne, Orbell, & Sheeran, 2002). An

overview of the literature suggests that current evidence supports the effectiveness of planning interventions in regard to health behaviour interventions with the major advantages being the low cost and response burden (Hagger & Luszczynska, 2014).

Future research should focus on the best way to manipulate the threat variables of PMT-based interventions as this presents a reoccurring issue in this research area. It is suggested that a PMT-based intervention be applied to various types of disease aside from cancer prevention to determine if the lack of increase in PS and PV is due to the high cancer prevalence rate or due to factors in the theory itself. Inclusion of a sample that possesses more risk factors for breast cancer aside from being physically inactive may be a promising target group as they may be more susceptible to the threat appraisal constructs of PMT. Further suggestions for future research include the addition of an implementation intention or action planning approach to supplement the PMT-based approach. The continued usage of objective measurement of PA is suggested as well to examine if PMT-based interventions can impact '*actual'* PA behaviour, as this is a novel addition to this field of study.

3.6 Tables

Table 1. Baseline characteristics for the three treatment conditions

Demographic	Overall (N = 60)	Intervention (*n* = 19)	Attention Control (*n* = 20)	Non-Contact (*n* = 21)	Statistic	*p*-level
Age (years)	M = 43.08 (SD= 10.88)	M = 44.32 (SD= 12.10)	M = 42.15 (SD = 9.76)	M = 42.86 (SD = 11.17)	$F(2, 57) = 0.194$	.824
Education level						
High School	1.7%	0.0%	0.0%	4.8%	$X^2(8, n = 60) =$ 19.06	.015*
Some University	15.0%	10.5%	20.0%	14.3%		
Bachelor Degree	43.3%	57.9%	10.0%	61.9%		
Some Graduate School	3.3%	0.0%	10.0%	0.0%		
Masters Degree	36.7%	31.6%	60.0%	19.0%		
BMI Classification						
Normal (<25)	13.3%	15.8%	10.0%	14.3%		
Overweight (25- 29.9)	26.7%	21.1%	25.0%	33.3%		
Obese (>30)	60.0%	63.2%	65.0%	52.4%		
Ethnicity						
Caucasian	96.7%	94.7%	95.0%	100.0%	$X^2(4, n =60) =$ 4.195	.380
Aboriginal	1.7%	5.3%	0.0%	0.0%		
Other	1.7%	0.0%	5.0%	0.0%		
Employment Status						
Disability	1.7%	5.3%	0.0%	0.0%	$X^2(8, n =60) = 9.02$	.341
Retired	1.7%	5.3%	0.0%	0.0%		
Part Time	5.0%	5.3%	10.0%	0.0%		
Full Time	90.0%	78.9%	90.0%	100.0%		
Unemployed	1.7%	5.3%	0.0%	0.0%		
Annual Family Income						
< 20,000	5.2%	5.3%	0.0%	10.5%	$X^2(10, n =60)= 9.21$	.512
20-39,999	8.6%	10.5%	5.0%	10.5%		
40-59,999	15.5%	5.3%	20.0%	21.1%		
60-79,999	10.3%	10.5%	5.0%	15.8%		
80-99,999	24.1%	26.3%	20.0%	26.3%		
> 100,000	36.2%	42.1%	50.0%	15.8%		
Stage of PA Readiness						
Pre-contemplation	3.3%	5.3%	5.0%	0.0%	$X^2(8, n =60) = 6.91$	.547
Contemplation	40.0%	52.6%	40.0%	28.6%	$F(2,57) = 1.897$	
Preparation	41.7%	36.8%	35.0%	52.4%		.159
Action	13.3%	5.3%	15.0%	19.0%		
Maintenance	1.7%	0.0%	5.0%	0.0%		
Smoking level	n=60	n=19	n=20	n=21	$F(2,57) = 0.278$	.759
Never Smoked	56.7%	47.4%	70%	52.4%		
Ex-Smoker	36.7%	47.4%	20%	42.9%		
Occasional	1.7%	0.0%	5.0%	0.0%		
Regular Smoker	5.0%	5.3	5.0%	4.8%		
Alcohol Consumption	n=59*	n=18*	n=20	n=21	$F(2,57) = 1.336$	.271
Never Drink	8.3%	10.5%	5.0%	14.3%		
Social Drinker	86.7%	84.2%	95.0%	81.0%		

Regular Drinker	3.3%	0.0%	0.0%	4.8%S		
Missing	1.7%	5.3%	0.0%	0.0%		
Comorbidities						
High Blood Pressure	28.3%	42.1%	15.0%	28.6%	$F(2,57) = 1.780$	.178
Chronic Bronchitis	1.7%	0.0%	5.0%	0.0%	$F(2,57) = 1.000$	.374
Diabetes	6.7%	0.0%	5.0%	14.3%	$F(2,57) = 1.641$	.203
Cancer Diagnosis	1.7%	5.3%	0.0%	0.0%	$F(2,57) = 1.082$	.346
Arthritis	20.0%	26.3%	5.0%	28.6%	$F(2,57) = 2.173$	.123
Other	21.7%	21.1%	20.0%	23.8%	$F(2,57) = 0.045$	.956
Total Comorbidities	n=60	n=19	n=20	n=21		
0	40.0%	26.3%	55.0%	38.1%	$F(2,57) = 2.447$	0.096
1	28.3%	42.1%	30.0%	14.3%		
2	26.7%	26.3%	15.0%	38.1%		
3	5.0%	5.3%	0.0%	9.5%		

Table 2. Descriptive Statistics for the PMT variables, PA intention and PA behaviour

	Intervention group (*n*)		Attention control group (*n*)		Non contact control group (*n*)	
	Mean	S_{Error}	Mean	S_{Error}	Mean	S_{Error}
Baseline/pre-DVD intervention						
Vulnerability	3.93	0.36	4.41	0.28	4.13	0.26
Severity	6.16	0.17	5.79	0.19	6.0	0.21
Self-efficacy	4.72	0.20	4.49	0.19	4.83	0.24
Response efficacy	4.86	0.20	4.66	0.15	5.0	0.18
Intention	5.63	0.26	5.37	0.18	5.25	0.21
Subjective MVPA	41.99	13.85	71.0	14.63	57.62	17.97
Weekly Objective MVPA (total)	230.71	27.5	213.11	16.55	249.02	32.97
Weekly Objective $MVPA_{10+}$	28.99	12.13	43.09	13.52	66.81	22.84
Post-DVD intervention						
Vulnerability	4.09	0.33	4.63	0.29	4.39	0.23
Severity	5.99	0.20	5.84	0.14	6.00	0.20
Self-efficacy	5.21	0.17	4.41	0.17	4.77	0.22
Response efficacy	5.15	0.16	4.65	0.15	4.88	0.16
Intention	5.74	0.21	5.20	0.17	5.19	0.19
Subjective MVPA	50.30	16.27	72.5	14.05	86.91	28.28
Weekly Objective MVPA (total)	198.35	24.6	224.28	22.57	286.30	37.8
Objective $MVPA_{10+}$	33.15	14.27	51.11	16.55	48.28	19.41

MVPA = moderate-to-vigorous PA

$MVPA_{10+}$ = Objective total MVPA minutes adjusted for 10 minute bouts

Table 3. Group differences for the four PMT variables and PA intention

Variable	Baseline Mean (SD)	Post-intervention Mean (SD)	Repeated measures *p* value	Effect size (η_p^2)	power
Perceived Vulnerability					
Intervention (*n*=19)	3.9 (1.6)	4.1 (1.4)	0.898	0.004	0.066
Attention control (*n*=20)	4.4 (1.3)	4.6 (1.3)			
Non-contact control (*n*=21)	4.1 (1.2)	4.4 (1.1)			
Perceived Severity					
Intervention (*n*=19)	6.2 (0.7)	6.0 (0.9)	0.467	0.026	0.175
Attention control (*n*=20)	5.8 (0.8)	5.8 (0.6)			
Non-contact control (*n*=21)	6.0 (1.0)	6.0 (0.9)			
Response efficacy					
Intervention (*n*=19)	4.8 (0.9)	5.8 (0.7)	0.001**	0.207	0.929
Attention control (*n*=20)	4.7 (0.8)	5.0 (0.8)			
Non-contact control (*n*=21)	4.7 (1.1)	4.8 (1.0)			
Self-efficacy					
Intervention (*n*=19)	4.7 (1.0)	5.2 (0.8)	0.022*	0.126	0.703
Attention control (*n*=20)	4.5(0.8)	4.4 (0.8)			
Non-contact control (*n*=21)	4.8 (0.7)	4.8 (0.7)			
PA intention					
Intervention (*n*=19)	5.6 (1.13)	5.7 (0.91)	0.581	0.019	0.136
Attention control (*n*=20)	5.4 (0.82)	5.2 (0.75)			
Non-contact control (*n*=21)	5.3 (0.98)	5.2 (0.87)			

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

Table 4. Interaction effects for PA behaviour

Variable	Baseline Mean (SD)	Post-DVD Mean (SD)	Week 5 Follow up Mean (SD)	Between-group comparisons Mean (95% CI)	*p* value for between group comparisons	overall *p value*
Subjective MVPA (min/week)						
Intervention (*n* = 19)	42 (60)	50 (71)	48 (56)	Intervention vs. Non-contact -24 (-72 to 24)	0.688	0.387
Attention Control (*n* = 20)	71 (65)	73 (63)	53 (62)	Attention control vs. Intervention 19 (-30 to 67)	1.00	
Non-contact control (*n* = 21)	58 (82)	87 (130)	66 (95)	Non-contact vs. Attention Control 5 (-43 to 52)	1.00	
Objective $MVPA_{10+}$ (min/week)						
Intervention (*n* = 19)	29 (53)	33 (62)	34 (73)	Intervention vs. Non-contact -20 (-71 to 31)	.999	0.226
Attention Control (*n* = 20)	43 (60)	51 (74)	23 (48)	Attention control vs. Intervention 7 (-44 to 59)	1.00	
Non-contact control (*n* = 21)	67 (108)	48 (89)	41 (72)	Non-contact vs. Attention Control 13 (-37 to 63)	1.00	

Note: MVPA = moderate-to-vigorous PA, $MVPA_{10+}$ = MVPA adjusted for 10 minute bouts

Table 5. Baseline inter-correlations for the PMT variables, PA intentions, and PA behaviour

Measures	1	2	3	4	5	6	7
1. PV Baseline	1	0.086	0.193	-0.025	0.178	-0.023	0.059
2. PS Baseline		1	0.086	-0.025	0.102	0.023	0.089
3. RE Baseline			1	0.014	.367**	-0.091	-0.086
4. SE Baseline				1	0.088	-0.095	0.033
5. Intention Baseline					1	-0.23	-0.314*
6. Self-report MVPA Baseline						1	.706**
7. Objective $MVPA_{10+}$ Baseline							1

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

Table 6. Post-DVD and Follow-up inter-correlations for the PMT variables, PA intentions, and PA behaviour

Measures	1	2	3	4	5	6	7	8	9
1. PV Post-DVD	1	0.088	0.25	-0.148	0.237	-0.089	-0.004	-0.292*	0.038
2. PS Post-DVD		1	0.256*	0.008	0.104	-0.062	0.058	0.02	-0.051
3. RE Post-DVD			1	0.178	0.471**	-0.142	-0.141	-0.084	0.009
4. SE Post-DVD				1	0.239	-0.074	-0.003	-0.058	0.02
5. Intention Post-DVD					1	0.062	-0.085	-0.068	-0.095
6. Self-report MVPA Post-DVD						1	0.263*	0.563**	0.25
7. Objective $MVPA_{10+}$ Post DVD							1	0.261*	0.647**
8. Self-report MVPA Follow-up								1	0.404**
9. Objective $MVPA_{10+}$ Follow-up									1

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

Note: MVPA = moderate-to-vigorous PA, $MVPA_{10+}$ = MVPA adjusted for 10 minute bouts

Table 7. Predicting baseline PA intentions through RE scores

	B	t	R	R^2
Response Efficacy	.384*	3.003*	.367**	.135**

**$p < .001$, *$p < .005$

Table 8. Predicting post-DVD PA intentions through RE scores

	B	t	R	R^2
Response Efficacy	.434**	4.07**	.541**	.222**

**$p < .001$, *$p < .005$

3.7 Figures

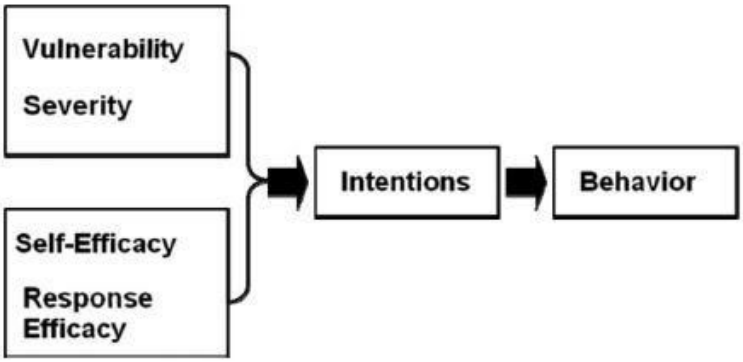

Figure 1. PMT Conceptual model (PMT; Rogers, 1983; image-McGowan & Prapavessis, 2010).

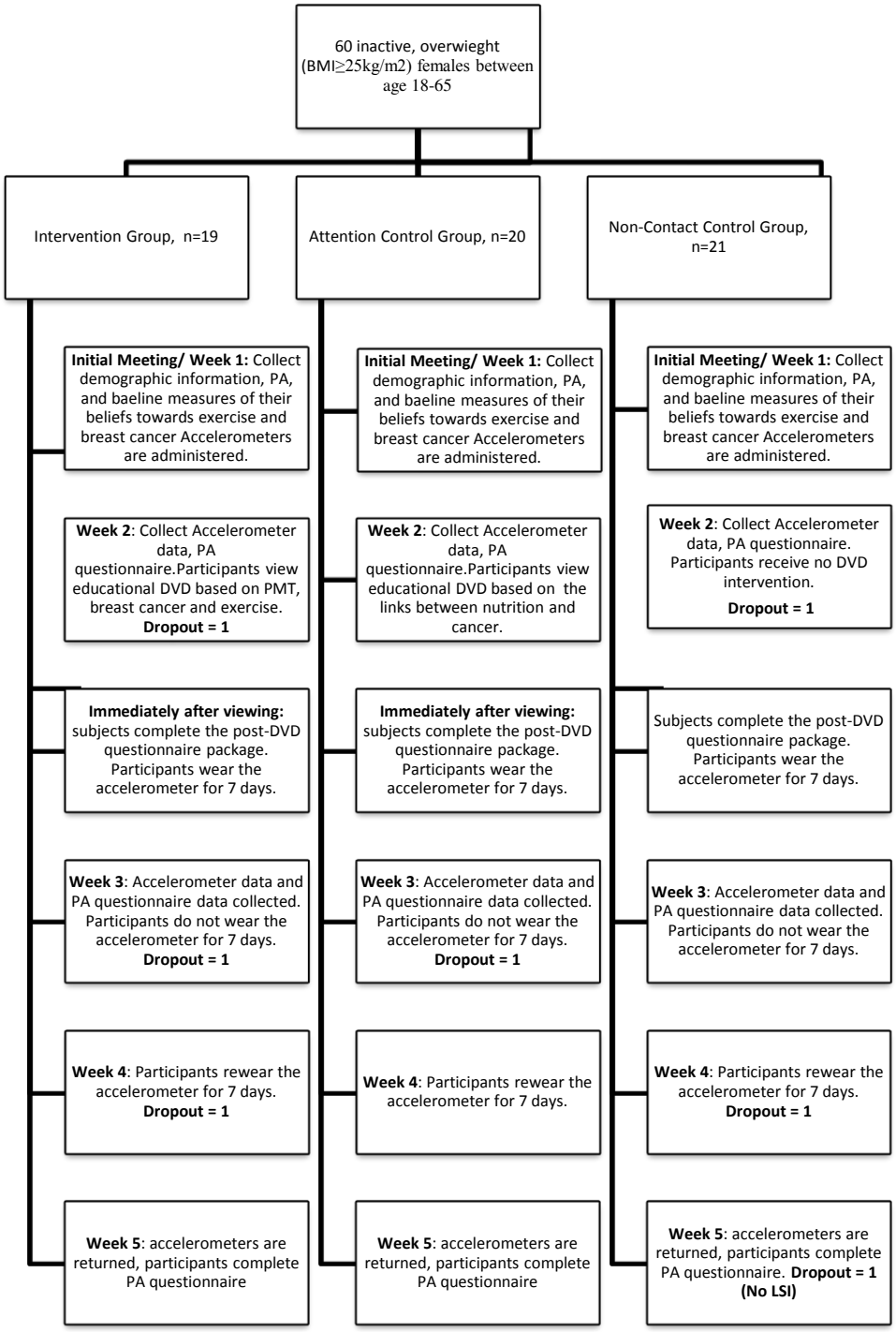

Figure 2. Detailed flow of participants through the trial and overall procedure.

References

Annesi, J. J., & Johnson, P. H. (2015). Theory-based psychosocial factors that discriminate between weight-loss success and failure over 6 months in women with morbid obesity receiving behavioral treatments. *Eating and Weight Disorders, 20*(2), 223-232

Bélanger-Gravel, A., Godin, G., & Amireault, S. (2013). A meta-analytic review of the effect of implementation intentions on physical activity. *Health Psychology Review, 7*(1), 23-54. doi:10.1080/17437199.2011.560095

Berkowitz, L., & Cottingham, D. R. (1960). The interest value and relevance of fear arousing communications. *The Journal of Abnormal and Social Psychology*, *60*(1), 37-43.

Biddle, S. J., & Mutrie, N. (2007). *Psychology of physical activity: Determinants, well-being and interventions*. London, England: Routledge.

Block, L. G., & Williams, P. (2002). Undoing the effects of seizing and freezing: Decreasing defensive processing of personally relevant messages. *Journal of Applied Social Psychology*, *32*(4), 803-833.

Booth, F. W., Roberts, C. K., & Laye, M. J. (2012). Lack of PA is a major cause of chronic diseases. *Comprehensive Physiology, 2*(2), 1143-1211.

Brenner, D. R. (2014). Cancer incidence due to excess body weight and leisure-time physical inactivity in Canada: Implications for prevention. *Preventive Medicine, 66*(1), 131-139. doi:10.1016/j.ypmed.2014.06.018

Brown, S. L., & Locker, E. (2009). Defensive responses to an emotive anti-alcohol message. *Psychology & Health, 24*, 517-528.

Brown, S. L., & Smith, E. Z. (2007). The inhibitory effects of a distressing anti-smoking message on risk perceptions in smokers. *Psychology and Health*, *22*(3), 255-268.

Bui, L., Mullan, B., & McCaffery, K. (2013). Protection motivation theory and physical activity in the general population: A systematic literature review. *Psychology, Health and Medicine, 18*(5), 522-542.

Canadian Cancer Society. (2013). *Physical Activity.* Retrieved from https://www.cancer.ca/en/prevention-and-screening/live-well/nutrition-and-fitness/physical-activity/?region=nl

Canadian Cancer Society's Advisory Committee on Cancer Statistics. *Canadian Cancer Statistics 2015*. Toronto, ON: Canadian Cancer Society; 2015.

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011). Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health reports*, *22*(1), 7.

Courneya, K. S., & Hellsten, L. M. (2001). Cancer prevention as a source of PA motivation: An experimental test using protection motivation theory. *Psychology, Health and Medicine, 6*(1), 59-64.

Croyle, R. T., Sun, Y. C., & Louie, D. H. (1993). Psychological minimization of cholesterol test results: Moderators of appraisal in college students and community residents. *Health Psychology*, *12*(6), 503-507.

Ditto, P. H., & Lopez, D. F. (1992). Motivated skepticism: Use of differential decision criteria for preferred and nonpreferred conclusions. *Journal of Personality and Social Psychology*, *63*(4), 568-584.

Earl, A., Albarrac´ın, D., Durantini, M.R., Gunnoe, J.B., Leeper, J., & Levitt, J.H. (2009). Participation in counseling programs: High-risk participants are reluctant to accept HIV prevention counseling. *Journal of Consulting and Clinical Psychology, 77*(4), 668-679.

Fisher, L. D., Dixon, D. O., Herson, J., Frankowski, R. K., Hearron, M. S., Peace, K. E. (1990). Intention to treat in clinical trials. In: K.E. Peace (Ed.), *Statistical issues in drug research and development* (331-350). New York, NY: Marcel Dekker.

Floyd, D. L., Prentice-Dunn, S., & Rogers, R. W. (2000). A meta-analysis of research on protection motivation theory. *Journal of Applied Social Psychology, 30*(2), 407-429.

Friedenreich, C. M. (2010). Physical activity and breast cancer: review of the epidemiologic evidence and biologic mechanisms. In *Clinical Cancer Prevention* (125-139). Heidelberg, Berlin: Springer.

Friedenreich, C. M., Neilson, H. K., & Lynch, B. M. (2010). State of the epidemiological evidence on physical activity and cancer prevention. *European Journal of Cancer, 46*(14), 2593-2604.

Friedenreich, C., Norat, T., Steindorf, K., Boutron-Ruault, M. C., Pischon, T., Mazuir, M., ... & Johnsen, N. F. (2006). Physical activity and risk of colon and rectal

cancers: The European prospective investigation into cancer and nutrition. *Cancer Epidemiology Biomarkers & Prevention*, *15*(12), 2398-2407.

Friedenreich, C. M., Cust, A., Lahmann, P. H., Steindorf, K., Boutron-Ruault, M. C., Clavel-Chapelon, F., ... & Schulz, M. (2007). Physical activity and risk of endometrial cancer: The European prospective investigation into cancer and nutrition. *International Journal of Cancer*, *121*(2), 347-355.

Gaston, A., & Prapavessis, H. (2014). Using a combined protection motivation theory and health action process approach intervention to promote physical activity during pregnancy. *Journal of Behavioral Medicine, 37*(2), 173-184.

Godin, G., Shephard, R.J. (1985). A simple method to assess exercise behavior in the community. *Canadian Journal of Applied Sport Science, 10*(3), 141-6.

Good, A., & Abraham, C. (2007). Measuring defensive responses to threatening messages: A meta-analysis of measures. *Health Psychology Review,* 1, 208229.

Graham, S. P., Prapavessis, H., & Cameron, L. D. (2006). Colon cancer information as a source of physical activity motivation. *Psychology and Health,* 21(6), 739-755

Hagger, M. S., & Luszczynska, A. (2014). Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward. *Applied Psychology: Health and Well-being, 6*(1), 1-47.

Haskell, W. L., Lee, I-M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., ... Bauman, A. (2007). Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Medicine & Science in Sports & Exercise, 39*(8), 1423-34.

Jacobs, Jr. D.R., Ainsworth, B.E., Hartman, T.J., Leon, A.S. (1993). A simultaneous evaluation of 10 commonly used physical activity questionnaires. *Medicine & Science in Sports & Exercise, 25*(1), 81-91.

Karvinen, K. H., Courneya, K. S., Campbell, K. L., Pearcey, R. G., Dundas, G., Capstick, V., & Tonkin, K. S. (2006). Exercise preferences of endometrial cancer survivors: a population-based study. *Cancer Nursing*, *29*(4), 259-265.

Kessels, L.T.E., Ruiter, R.A.C., & Jansma, B.M. (2010). Increased attention but more efficient disengagement: Neuroscientific evidence for defensive processing of threatening information. *Health Psychology, 29*(4), 346-354.

Knox, E. C. L., Webb, O. J., Esliger, D. W., Biddle, S. J. H., & Sherar, L. B. (2014). Using threshold messages to promote physical activity: Implications for public perceptions of health effects. *European Journal of Public Health, 24*(2), 195-199.

Liberman, A., & Chaiken, S. (1992). Defensive processing of personally relevant health messages. *Personality and Social Psychology Bulletin, 18*(6), 669-679.

Liu, Y., Hu, F., Li, D., Wang, F., Zhu, L., Chen, W., ... & Zhao, Y. (2011). Does physical activity reduce the risk of prostate cancer? A systematic review and meta-analysis. *European Urology*, *60*(5), 1029-1044.

Marcus, B. H., Rakowski, W., & Rossi, J. S. (1992). Assessing motivational readiness and decision making for exercise. *Health Psychology, 11*(4), 257-261. doi:10.1037//0278-6133.11.4.257

McGowan, E. L., & Prapavessis, H. (2010). Colon cancer information as a source of exercise motivation for relatives of patients with colon cancer. *Psychology, Health and Medicine, 15*(6), 729-741.

Milne, S., Orbell, S., & Sheeran, P. (2002). Combining motivational and volitional interventions to promote PA participation: Protection motivation theory and implementation intentions. *British Journal of Health Psychology, 7*(2), 163-184.

Milne, S., Sheeran, P., & Orbell, S. (2000). Prediction and intervention in health-related behavior: A meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology*, 30(1), 106-143.

Monninkhof, E. M., Elias, S. G., Vlems, F. A., van der Tweel, I., Schuit, A. J., Voskuil, D. W., & van Leeuwen, F. E. (2007). Physical activity and breast cancer: a systematic review. *Epidemiology*, *18*(1), 137-157.

Noguchi, K., Albarrac´ın, D., Durantini, M.R., & Glasman, L.R. (2007). Who participates in which health promotion programs? A meta-analysis of motivations underlying enrollment and retention in HIV-prevention interventions. *Psychological Bulletin, 133*(6), 955-975.

Patel, A. V., Rodriguez, C., Pavluck, A. L., Thun, M. J., & Calle, E. E. (2006). Recreational physical activity and sedentary behavior in relation to ovarian cancer risk in a large cohort of US women. *American Journal of Epidemiology*, *163*(8), 709-716.

Prestwich, A., Ayres, K., & Lawton, R. (2008). Crossing two types of implementation intentions with a protection motivation intervention for the reduction of saturated fat intake: A randomized trial. *Social Science and Medicine, 67*(10), 1550-1558.

Salovey, P., & Williams-Piehota, P. (2004). Field experiments in social psychology message framing and the promotion of health protective behaviors. *American Behavioral Scientist*, *47*(5), 488-505.

Santos-Lozano, A., Santín-Medeiros, F., Cardon, G., Torres-Luque, G., Bailón, R., Bergmeir, C., . . . Garatachea, N. (2013). Actigraph GT3X: Validation and determination of physical activity intensity cut points. *International Journal of Sports Medicine, 34*(11), 975-982. doi:10.1055/s-0033-1337945

Statistics Canada (2009). *Canadian Community Health Survey, 2003, 2005, 2007, 2008, and 2009.* Retrieved from http://www.statcan.gc.ca/pub/82-625-x/2010002/article/11267-eng.htm

Statistics Canada. (2011). *Table 1:Ranking, number and percentage of deaths for the 10 leading causes, Canada, 2000, 2010 and 2011.* Retrieved Dec 10, 2014 from Statistics Canada: http://www.statcan.gc.ca/daily-quotidien/140128/t140128b001-eng.htm

Sun, J. Y., Shi, L., Gao, X. D., & Xu, S. F. (2012). Physical activity and risk of lung cancer: A meta-analysis of prospective cohort studies. *Asian Pacific Journal of Cancer Prevention*, *13*(7), 3143-3147.

Trost, S. G., McIver, K. L., & Pate, R. R. (2005). Conducting accelerometer-based activity assessments in field-based research. *Medicine and Science in Sports and Exercise*, *37*(11), 531-543.

World Cancer Research Fund/American Institute for Cancer Research. (2007). *Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective.* Washington, DC: AICR

Wu, Y., Zhang, D., & Kang, S. (2013). Physical activity and risk of breast cancer: A meta-analysis of prospective studies. *Breast Cancer Research and Treatment*, 137(3), 869-882.

Ziegelmann, J. P., Lippke, S., & Schwarzer, R. (2006). Adoption and maintenance of physical activity: Planning interventions in young, middle-aged, and older adults. *Psychology & Health*, *21*(2), 145-163.

Chapter 4: Summary

Increasing physical activity (PA) participation in our society is of utmost importance due to rising levels of chronic diseases that are caused by not being physically active and that pose an enormous burden on our physical health (Roberts & Barnard, 2005; Kruk, 2007; Pratt et al., 2014), psychological well being (Martinez-Gonzalez, 2003), quality of life (Stocchi, 2007), and economy (Kohl, 2012; Lee, 2012). As PA has been shown to have substantial effects on preventing disease (Booth, Roberts, & Laye, 2012), research should be focused on how we can increase PA levels in healthy and at-risk individuals before development of a chronic disease occurs. Cancer is responsible for 29.9% of all deaths in Canada, making it the number one cause of death (Canadian Cancer Society's Advisory Committee on Cancer Statistics [CCSACS], 2015). Research indicates that out of all cancer incidences in 2007, 7.9% (n = 12,885) of cases were attributed to physical inactivity with a greater burden of disease in women compared to men (Brenner, 2014). Certain types that have shown high occurrence rates and mortality rates, such as breast cancer and colon cancer, have been linked extensively to PA levels (Friedenreich, Neilson, & Lynch, 2010; Monninkhof et al., 2007). For this reason, individuals who are at risk of developing these types of cancer should be made aware of the danger they are putting themselves in by not being sufficiently active. Therefore, research that examines how to motivate individuals to become physically active and sustain this activity long-term is warranted.

Effecting change in PA behaviour and intention is a very complex process. This is seen in the drastic contrast between well-known and widespread knowledge of the

benefits of PA and the growing prevalence of physical inactivity worldwide (Colley et al., 2011). In older adults, PA interventions have been shown to be successful in increasing PA behaviour during the course of the intervention, but results demonstrate an issue in increasing participation over the longer term once the intervention has ended (Taylor et al., 2004). PMT-based interventions that present information on PA and cancer risk have been shown to be successful in influencing participants' intentions to perform PA (Courneya & Hellsten, 2001; Graham, Prapavessis, & Cameron, 2006; McGowan & Prapavessis, 2010). In the current study we assigned 60 women who reported themselves as being physically inactive to three different treatment groups; (1) a PMT intervention group, (2) an attention control, and (3) a non-contact control. The PMT intervention group watched a DVD that presented factual breast cancer and PA information, the attention control group watched a DVD that presented nutrition and health information, and the non-contact control group received no DVD intervention. Beliefs towards breast cancer and PA were assessed before and after viewing the DVD using a PMT-based questionnaire which gave a score for all four of the PMT constructs to assess whether the intervention was successful in changing participants' beliefs. PA data was also collected using objective and subjective measures, before the DVD, one-week post-DVD and three weeks post-DVD. The results of the current study showed that the intervention was effective at influencing participants' coping appraisal scores (e.g., RE and SE) but not PA intention scores or PA behaviour. RE was shown to significantly predict PA intention for the pre-DVD and post-DVD time points. Despite the limitations of the current study several suggestions can be made towards future research in this area.

From these results and previous research, it is important to focus on the threat variables of PMT and how future interventions may be able to manipulate them to increase PA in regards to cancer prevention. Targeting a more at-risk population or emphasizing the risks and severity of cancer in PMT-based materials used in future studies are two possible ways to produce an increase in threat appraisal constructs (e.g., PS and PV). Further research on PMT-based interventions could also benefit from the addition of an action-planning approach or implementation intention intervention (Milne, Orbell, & Sheeran, 2002; Prestwich, Ayres, & Lawton, 2008; Bélanger-Gravel, Godin, & Amireault, 2013; Gaston & Prapavessis, 2014; Hagger & Luszczynska, 2014), and more research is needed for objective measures of PA and accelerometer use in assessing health benefits, as this is a novel addition to the research field and presents a promising measure for determining effectiveness of PA interventions.

4.1 References

Bélanger-Gravel, A., Godin, G., & Amireault, S. (2013). A meta-analytic review of the effect of implementation intentions on physical activity. *Health Psychology Review, 7*(1), 23-54. doi:10.1080/17437199.2011.560095

Booth, F. W., Roberts, C. K., & Laye, M. J. (2012). Lack of exercise is a major cause of chronic diseases. *Comprehensive Physiology, 2*(2), 1143-1211.

Brenner, D. R. (2014). Cancer incidence due to excess body weight and leisure-time physical inactivity in Canada: Implications for prevention. *Preventive Medicine, 66*(1), 131-139. doi:10.1016/j.ypmed.2014.06.018

Canadian Cancer Society's Advisory Committee on Cancer Statistics. *Canadian Cancer Statistics 2015*. Toronto, ON: Canadian Cancer Society; 2015.

Colley, R. C., Garriguet, D., Janssen, I., Craig, C. L., Clarke, J., & Tremblay, M. S. (2011). Physical activity of Canadian adults: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health reports*, *22*(1), 7.

Courneya, K. S., & Hellsten, L. -. M. (2001). Cancer prevention as a source of exercise motivation: An experimental test using protection motivation theory. *Psychology, Health and Medicine, 6*(1), 59-64.

Friedenreich, C. M., Neilson, H. K., & Lynch, B. M. (2010). State of the epidemiological evidence on physical activity and cancer prevention. *European Journal of Cancer, 46*(14), 2593-2604.

Gaston, A., & Prapavessis, H. (2014). Using a combined protection motivation theory and health action process approach intervention to promote exercise during pregnancy. *Journal of Behavioral Medicine, 37*(2), 173-184.

Graham, S. P., Prapavessis, H., & Cameron, L. D. (2006). Colon cancer information as a source of exercise motivation. *Psychology and Health*, *21*(6), 739-755

Hagger, M. S., & Luszczynska, A. (2014). Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward. *Applied Psychology: Health and Well-being, 6*(1), 1-47.

Kohl III, H. W., Craig, C. L., Lambert, E. V., Inoue, S., Alkandari, J. R., Leetongin, G., . . . Wells, J. C. (2012). The pandemic of physical inactivity: Global action for public health. *The Lancet, 380*(9838), 294-305.

Kruk, J. (2007). Physical activity in the prevention of the most frequent chronic diseases: An analysis of the recent evidence. *Asian Pacific Journal of Cancer Prevention, 8*(3), 325-338.

Lee, I., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., Katzmarzyk, P. T., Alkandari, J.R., Anderson, L.B., Bauman, A.E., Brownson, R.C., Bull, F.C., Craig, C.L., Ekelund, U., …Wells, J.C., (2012). Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. *The Lancet, 380*(9838), 219-229.

Martinez-Gonzalez, M. Á. (2003). Physical activity and psychological well-being. *Journal of Epidemiology and Community Health*, *57*(3), 232.

McGowan, E. L., & Prapavessis, H. (2010). Colon cancer information as a source of exercise motivation for relatives of patients with colon cancer. *Psychology, Health and Medicine, 15*(6), 729-741.

Milne, S., Orbell, S., & Sheeran, P. (2002). Combining motivational and volitional interventions to promote exercise participation: Protection motivation theory and implementation intentions. *British Journal of Health Psychology, 7*(2), 163-184.

Monninkhof, E. M., Elias, S. G., Vlems, F. A., van der Tweel, I., Schuit, A. J., Voskuil, D. W., & van Leeuwen, F. E. (2007). Physical activity and breast cancer: a systematic review. *Epidemiology*, *18*(1), 137-157.

Pratt, M., Norris, J., Lobelo, F., Roux, L., & Wang, G. (2014). The cost of physical inactivity: Moving into the 21st century. *British Journal of Sports Medicine, 48*(3), 171-173. doi:10.1136/bjsports-2012-091810

Prestwich, A., Ayres, K., & Lawton, R. (2008). Crossing two types of implementation intentions with a protection motivation intervention for the reduction of saturated fat intake: A randomized trial. *Social Science and Medicine, 67*(10), 1550-1558.

Roberts, C. K., & Barnard, R. J. (2005). Effects of exercise and diet on chronic disease. *Journal of Applied Physiology, 98*(1), 3-30.

Stocchi, V., De Feo, P., & Hood, D.A. (2007). *Role of Physical Exercise in Preventing Disease and Improving the Quality of Life*. Milan: Springer-Verlag.

Taylor, A. H., Cable, N. T., Faulkner, G., Hillsdon, M., Narici, M., & Van der Bij, A. K. (2004). Physical activity and older adults: A review of health benefits and the effectiveness of interventions. *Journal of Sports Sciences, 22*(8), 703-725.

World Health Organization. (2013). *Global action plan for the prevention and control of NCDs 2013-2020.* Retrieved from: http://apps.who.int/iris/bitstream/10665/94384/1/9789241506236_eng. pdf.