THE IMPACT OF HEALTHCARE PROVIDERS' PRESCRIPTION OF PHYSICAL ACTIVITY ON CANCER SURVIVORS' PHYSICAL ACTIVITY LEVELS

by

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Cancer survivors may experience adverse health effects (e.g., fatigue, anxiety, depression) even after cancer treatment is completed. Physical activity is one way cancer survivors may suppress or treat these side effects. Despite the known benefits, nearly 82% of cancer survivors do meet ACSM physical activity guidelines. One strategy that may increase cancer survivors' physical activity is for health care providers to prescribe a physical activity prescription. This study's purpose was to compare physical activity levels between cancer survivors who were prescribed physical activity by their healthcare provider and those who were not. We hypothesized that cancer survivors who received a physical activity prescription post-treatment would report higher levels of physical activity than survivors who did not. Participants completed an online survey that inquired about demographics, cancer history, physical activity prescription, physical activity levels, anxiety, depression, fatigue, sleep quality, stress, and health-related quality of life. Participants ($N$ = 39) were mostly female (74.4%) and Caucasian (92.3%), with a mean age of 48.1 ± 17. 9 years. Participants reported being diagnosed with breast (41%), 'other' (e.g., lymphoma, ovarian, stomach) (30.8%), leukemia (12.8%), kidney (7.7%), prostate (5.1%), and endometrial cancer (2.6%). Post-treatment physical activity prescription was reported by 46% of participants. Data revealed no significant difference in physical activity levels ($p$ = .896; $d$ = .042), anxiety ($p$ = .400; $d$ = .400), depression ($p$ = .510;

*d* = .510), fatigue (*p* = .207; *d* = -.412), sleep quality (*p* = .984; *d* = .007), stress (*p* = .968; *d* = .017), and health-related quality of life (*p* = .435; *d* = .254) scores between participants who received a physical activity prescription post-cancer treatment and those who did not. Findings indicated no differences in physical activity levels in individuals who were prescribed physical activity versus those who were not. With the discrepancy in effectiveness between written and oral physical activity prescriptions, future research should inquire about what type of physical activity prescription participants received (e.g., written, oral, etc.) while also considering a larger, more diverse sample size. From a public health perspective, future research is warranted to determine how patients receive physical activity prescriptions to improve their effectiveness.

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## Chapter I. Introduction

The American Cancer Society predicts that in 2019 there will be approximately 1,762,450 new cancer cases diagnosed along with 606,880 cancer-related deaths in the United States (American Cancer Society, 2019). Notably, cancer survivors are a growing population; the National Cancer Institute estimates that as of January 2019, there are 16.9 million cancer survivors in The United States (NIH, 2019). It is predicted that the survivorship population will increase to 21.7 million survivors by the year 2029 and 26.1 million by the year 2040 (NIH, 2019). With the survivorship population rising in the United States, it is essential to understand the unique benefits that physical activity can provide cancer survivors.

Physical activity can alleviate or lessen the adverse effects cancer survivors may experience from treatment. One commonly reported side effect of cancer treatment is cancer-related fatigue. Cancer-related fatigue is one of the most distressing and debilitating cancer treatment symptoms (Jones et al., 2016). The type of cancer treatment can influence fatigue prevalence and severity, with 4%-97% of cancer survivors experiencing severe cancer-related fatigue (Tabrizi & Alizadeh, 2017). Another symptom of treatment that cancer survivors may experience is a change in body weight. Cancer survivors may lose weight, while others may gain weight during cancer treatment. Weight gain is commonly seen in breast cancer survivors, with more than half of women with breast cancer experiencing weight gain (ASCO, 2012). Obesity has many adverse health effects for cancer survivors, including an increased prevalence of lymphedema, decreased quality of life, increased fatigue, and an increased risk of adverse cardiac events such as hypertension, ischemia, left ventricular dysfunction, venous thromboembolism, and bradycardia (Picon-Ruiz et al., 2017; Schmitz et al., 2013). Cancer survivors may also experience symptoms such as anxiety and depression. The prevalence of anxiety among cancer survivors is 17.9%-24%, while depression among cancer survivors is 11.6%-20% (Boyes et al., 2011; Mitchell et al., 2013; Smith et al., 2016). Factors that may contribute to cancer survivors experiencing anxiety and depression are feelings of loneliness and feeling unsupported after having a high level of support or attention during cancer treatment (Yi & Syrjala, 2017).

Sleep quality is another domain that is commonly affected by cancer treatment. Prevalence of significantly poor sleep quality is estimated to be between 38%-40%, with an estimated 83% of cancer survivors experiencing worse sleep quality post-treatment than before treatment (Li et al., 2017; Lowery-Allison et al., 2018). These adverse side effects from cancer treatment may ultimately lead to a lower Health-Related Quality of Life (HRQOL). Assessing health-related quality of life may provide insight into cancer survivors' mental and physical functioning and their perceptions of their health status (Rodriguez et al., 2015). As such, physical activity can benefit survivors by maintaining a healthy weight, improving quality of life, lowering the chance of cancer recurrence, reducing anxiety and depression, among other health benefits. (NCI, 2017).

The cancer survivorship population is at an all-time high and continues to rise (Siegel et al., 2019). Cancer survivors may experience many unique and adverse challenges after treatment. Cancer survivors may experience fatigue, poor sleep quality, changes in body weight, depression, anxiety, and a decreased health-related quality of life, among other side effects. Physical activity is one approach to help alleviate these potentially negative consequences of cancer treatment. Understanding that physical activity is beneficial for cancer survivors is the next step is to influence cancer survivors to become more active.

One way to improve physical activity levels among cancer survivors may be through a physical activity prescription by patients' healthcare providers. Previous literature has shown the benefits of an exercise prescription on an individual's physical activity levels (Rodjer et al., 2016; Yaman et al., 2018). Although a physical activity prescription may work in the general population, there is a lack of evidence demonstrating that a physical activity prescription improves cancer survivors' physical activity levels. If healthcare providers can influence cancer survivors to become physically active after cancer diagnosis, physical activity benefits may alleviate cancer treatment's side effects.

**Purpose Statement**

The purpose of this pilot, exploratory study is to examine differences in physical activity levels between cancer survivors who received a physical activity prescription during or post-cancer treatment compared to cancer survivors who did not receive a physical activity prescription from their healthcare provider during or post-cancer treatment.

**Hypothesis**

Cancer survivors who received a physical activity prescription during treatment or post-treatment would report higher levels of physical activity than survivors who were not prescribed physical activity from their healthcare provider during or post-cancer treatment.

**Delimitations**

A delimitation to the study is that all participants are one-year post-cancer treatment and 18 years of age or above.

**Significance of Study**

Cancer survivors face many health-related challenges after their cancer diagnosis and may need to readjust their lives after treatment to modify activities they enjoyed before treatment. Cancer treatment may have many consequences, both physically and mentally, that survivors may experience. Some of the debilitating effects of cancer treatment may include fatigue, body composition changes, sleep quality, anxiety, and depression, which can all influence health-related quality of life.

Physical activity is one promising strategy to help survivors cope with these detrimental side effects. Health care providers can promote and prescribe physical activity to cancer survivors to improve their physical activity levels, thereby leading to increased overall health-related quality of life. One possible solution for increasing physical activity among cancer survivors may be a healthcare provider's physical activity prescription. For this pilot, exploratory study, the relationship between physical activity prescription and cancer survivors' physical activity level will be examined. The main objective is to explore the relationship between a healthcare provider prescribing physical activity and cancer survivors' physical activity level. Determining ways to increase cancer survivors' physical activity levels may lead to favorable health outcomes such as decreased fatigue, depression, anxiety, stress, maintaining a healthy body weight, and improving sleep quality health-related quality of life.

# Chapter II. Review of Literature

The purpose of the chapter is to review the literature regarding the benefits of physical activity for cancer survivors for fatigue, body composition, sleep quality, anxiety, depression, and health-related quality of life (HRQOL).

This chapter is organized in the following order: a) Physical Activity Guidelines, b) Benefits of Physical Activity, c) Benefits of a Physical Activity Prescription, d) Conclusion. This review aims to demonstrate the need for cancer survivors to participate in physical activity for various reasons.

## Physical Activity Recommendations for Cancer Survivors

Campbell et al. (2019) published physical activity guidelines for cancer survivors to the American College of Sports Medicine (ACSM). A committee collaborated and concluded what is safe, feasible, and effective for cancer survivors experiencing a multitude of symptoms from treatment. Their recommendations are categorized by what is most effective for each symptom. For anxiety, it would be most beneficial for cancer survivors to perform aerobic activity at 60-80% HRmax, for 30-60 minutes per session, three days per week, for 12 weeks. Resistance training alone has not been shown to provide benefits for reducing anxiety when performed alone. Aerobic and resistance training has been proven effective when aerobic activity is performed at 60-80% HRmax for 20-40 minutes, two to three days per week, for six to twelve weeks. Resistance training should be performed 65-85% 1-RM for two sets of eight to twelve repetitions per set, for a minimum of six weeks.

To reduce depressive symptoms, recommendations state that cancer survivors should perform aerobic activity three days per week, at an intensity of 60-80% HRmax, for twelve weeks. Like anxiety, resistance training was found not to be effective when performed alone to treat depressive symptoms. Aerobic and resistance training has proven effective when both are completed for at least twelve weeks, and aerobic activity is performed at an intensity of 60-80% HRmax for a duration of 20-40 minutes, two to three days per week. Resistance training should be performed at 65-85% 1-RM for eight to twelve repetitions, for two sets, two to three days per week.

Fatigue is best managed when aerobic activity is performed at 65% HRmax for 30 minutes, three days per week, for twelve weeks. Unlike anxiety and depression, resistance training helps cancer survivors reduce feelings of fatigue. Resistance training should be performed at 60% 1-RM for two sets of 12-15 repetitions, twice a week, for twelve weeks. Aerobic and resistance training can be completed simultaneously to provide relief from fatigue symptoms. If performed together, aerobic activity should be performed at 65% HRmax, performed for 30 minutes, three times per week, for twelve weeks. Resistance training should be performed at 60% 1-RM for two sets of 12-15 repetitions, twice a week, for twelve weeks.

Health-related quality of life (HRQOL) can be improved by being physically active. Aerobic activity should be performed at 60-80% HRmax, for 30 minutes, two to three times per week, for twelve weeks. Resistance training should be done at 60-75% 1-RM for two to three sets of 8-15 repetitions for twelve weeks. Lastly, for the combination of aerobic and resistance, aerobic training can be performed at 60-80% HRmax for 20-30 minutes, two to three times per week, for twelve weeks, while resistance training is performed at 60-80% 1-RM for two sets of 8-15 reps, for twelve weeks. Despite the symptoms the cancer survivor is experiencing, it is recommended that adults accumulate at least 150 minutes of moderate-intensity or 75 minutes of vigorous physical activity each week and perform resistance training twice per week. Meeting physical activity guidelines in one way to ensure a higher quality of life and longer life expectancy among cancer survivors (Campbell et al., 2019).

**Prevalence of Physical Activity in Cancer Survivors**

Tarasenko et al. (2017) collected self-reported physical activity levels among adult cancer survivors. Participants were middle-aged (45-64 years; $N = 786$), young-old (65-74 years; $N = 627$), and old-old (>75 years; $N = 786$). The survey included questions about sociodemographic characteristics, health status, health conditions, disabilities, health behaviors, access to care, and healthcare use. Survey findings showed that 44.4% of young-old and 44.6% of old-old cancer survivors were inactive, while 33.7% of middle-aged cancer survivors were inactive ($p < .001$). Over 50% of all surveyed cancer survivors did not meet the recommended amounts of aerobic activity. Results illustrated that significantly fewer young-old (34.0%, $p < .001$) and old-old (35.4%, $p < .001$) cancer survivors were aerobically active compared to middle-aged cancer survivors (44.3%). Over half (56.8%) of the cancer survivors surveyed did not meet strength and aerobic training guidelines. Results also showed that fewer young-old (11.6%, $p < .002$) and old-old (10.6%, $p < .001$) cancer survivors met both strength and aerobic guidelines, compared to middle-aged cancer survivors (19.1%). Young-old (8.5%) cancer survivors met the resistance training recommendation significantly more than middle-aged (3.1%, $p < .001$) and old-old (5.0%, $p < .01$) survivors (Tarasenko et al., 2017). The majority of cancer survivors reported not meeting aerobic or resistance training guidelines. Of the three age groups, the old-old adults reported the lowest level of physical activity. Results from this study indicate that adult cancer survivors often do not meet physical activity guidelines. Thus, it is imperative to understand why adult cancer survivors do not meet physical activity guidelines.

Similarly, the annual National Health Interview Survey gathered information about cancer survivors' physical activity levels. Approximately 17% (16.7%) of cancer survivors older than 18 met aerobic and muscle-strengthening recommendations, with men (18.3%) reporting a higher percentage of physical activity than women (15.4%). Almost 36% (35.5%) of cancer survivors reported no leisure-time physical activity, and women reported a higher rate of no leisure-time physical activity (37.1%) than men (34.1%). The National Center for Health Statistics found differences in leisure-time physical activity based on age. Twenty-two percent of participants aged 18-44 reported no leisure-time physical activity, and 29.5% of 45-64-year-old participants reported no leisure-time physical activity. The 65+ age group had the highest level of leisure-time physical inactivity (41.1%) (Mishra et al., 2015). Findings from this study suggest that older cancer survivors are reporting higher physical inactivity levels. Future research should focus on interventions to increase physical activity in older cancer survivors.

Researchers sampled cancer survivors using the Pennsylvania Cancer Registry to investigate cancer survivors' prevalence of meeting the ACSM exercise and cancer roundtable guidelines. Participants ($N$ = 585) received a Behavioral Risk Factor Surveillance System (BRFSS) based questionnaire via mail. Findings showed that 144 (32.1%) participants met recommendations for aerobic physical activity per week, 28 (6.2%) met the strength training guidelines, and 84 (18.7%) met both guidelines. Subsequently, 192 (43%) of participants did not meet any aspect of the physical activity guidelines (Wiskemann et al., 2018). This data shows an insufficient amount of cancer survivors meet physical activity guidelines. Physical activity provides many benefits for cancer survivors; thus, more research is needed to improve cancer survivors' physical activity levels.

## Benefits of Physical Activity for Cancer Survivors

**Fatigue.** Cancer-related fatigue is a common and unsetting symptom that most cancer survivors experience (Corbett et al., 2016; Savina & Zaydiner, 2019a). Fatigue is the most common side effect of chemotherapy, radiation therapy, or selected biologic response modifiers, all common cancer treatments. Cancer-related fatigue is defined as "a distressing, persistent, subjective sense of physical, emotional, and cognitive tiredness or exhaustion related to cancer and cancer treatment that is not proportional to recent activity and interferes with usual functioning" (Bower, 2014). The estimation of cancer survivors who experience cancer-related fatigue varies widely and has been reported to be between 40% to 100% of the survivors experiencing symptoms (Savina & Zaydiner, 2019b). This wide range is due to a lack of commonly accepted assessment tools and diagnostic criteria for fatigue (Savina & Zaydiner, 2019b). Cancer-related fatigue is still the most frequently anticipated side effects of cancer treatment. It is estimated that 95% of cancer survivors treated with chemotherapy or radiotherapy are expected to experience some degree of fatigue during treatment, which may continue into survivorship (Savina & Zaydiner, 2019b). Kessels et al. (2018) conducted a meta-analysis on the effects of exercise on cancer-related fatigue symptoms. The criteria for the studies to be included were that participants were at least 18 years of age, participated in a physical activity intervention, a comparison between the intervention group and control, and the studies had a primary outcome of measuring fatigue. Across eleven studies ($N$ = 788), the intervention groups significantly improved fatigue scores compared to the control group ($p$ = .01; Cohen's $d$ = .61; 95% CI: .24-.98; Kessels et al., 2018a). The two aerobic exercise trials ($\Delta$ = 1.009, CI: 0.22–1.80) showed a significantly higher effect than the four interventions that combined aerobic and resistance training ($p \leq .01$; $\Delta$ = 0.34, CI: 0.13–0.55). Lastly, the meta-analysis showed a significant effect size on adherence ($Q$ (1) = 5.93, $p$ = .01). With low adherence (<56% of sessions), the effect size on fatigue is 0; with high adherence to a program that consists of aerobic training, strength training, or a combination of both, the effect size can be as large as .8 for programs with 100% adherence. Adherence to a physical activity program can provide benefits to cancer survivors who are experiencing fatigue post-treatment. Aerobic activity may be more beneficial than a combination of aerobic and resistance training. Still, any mode of physical activity that a cancer survivor can adhere to can lower the fatigue they may experience. Cancer survivors who engage in aerobic training, resistance training, or a combination of both may experience a significant decrease in fatigue symptoms.

With the known benefits of physical activity on fatigue symptoms (Kessels et al., 2018b), Shin et al. (2017) studied the association between the amount of physical activity and fatigue symptoms to investigate if there is a dose-response relationship. Two hundred thirty-one breast cancer survivors (48.1 ± 8.4 years) completed a survey on topics such as the type, duration, and frequency of physical activity they engage in. Furthermore, each participant listed up to three types of exercise they commonly perform, along with the sessions' duration and frequency. The EORTC QLC-C30 and EORTC QLQ-BR23 were used to assess health-related quality of life. These measures capture physical, emotional, cognitive, and social functioning, along with fatigue, nausea and vomiting, pain, body image, and sexual functioning. Participants were classified into three groups based on their activity level: tertile one, tertile two, and tertile three. Tertile one engaged in 7.2 ± 5.3 MET-hours of activity per week; tertile two engaged in 27.0 ± 6.4 MET-hours of activity per week; tertile three engaged in 66.8 ± 27.6 MET-hours of activity per week. Findings demonstrated  participants in tertile three reported significantly lower fatigue scores (13.3; 95% CI: 9.6-18.4; $p$ = .001) than participants in tertile one (21.6; 95% CI: 16.1-

29.1) or two (21.0; 95% CI: 15.2-29.0; $p$ = .001)(Shin et al., 2017). Thus, breast cancer survivors who were more active experienced significantly less fatigue than survivors who were not.

Similarly, Aguinaga et al. (2018) conducted a cross-sectional study looking at the effects of physical activity on psychological well-being outcomes in breast cancer survivors ($N$ = 387; 57.7 ± 9.6 years) pre-diagnosis to post-treatment survivorship. Participants completed a survey that inquired about diagnosis date, type of treatment, physical activity levels pre-and post-diagnosis, fatigue, anxiety, depression, and quality of life. Participants were categorized based on their physical activity levels pre-and post-diagnosis as low-active maintainers, increasers, decreasers, or high-active maintainers. Findings demonstrated that high-active maintainers reported significantly lower fatigue scores (43.2 ± .81, $p$ < .005) compared to the low-active maintainers (38.7 ± .83) and decreasers (37.6 ± 1.3). Participants that increased their physical activity levels after diagnosis reported significantly lower fatigue scores (43.0 ± 1.1, $p$ < .005) compared to the decreasers (37.6 ± 1.3) and low-active maintainers (38.7 ±.83). The effect sizes between increasers and decreasers ($d$ = .65), increasers and low-active maintainers ($d$ = .49), high-active maintainers and decreasers ($d$ = .75), and high-active maintainers and low active maintainers ($d$ = .59) are clinically significant. Increasing physical activity or maintaining a high activity level after diagnosis was associated with lower fatigue scores than low activity levels or decreasing physical activity after diagnosis. Thus, physical activity may influence the amount of fatigue a cancer survivor experiences post-cancer treatment.

Irwin et al. (2017) studied the LIVESTRONG program's effects at the YMCA on cancer survivor’s physical activity levels and fatigue in a community setting. The LIVESTRONG program entails two 90-minute sessions per week, led by two fitness instructors, who tailor each session to the cancer survivor’s current fitness level concerning aerobic and resistance training.

Participants (*N* = 186, 59.3 ± 10.4 years) were assigned to either the LIVESTRONG program or a control waitlist group. Physical activity was measured using an interview administered physical activity questionnaire, which assessed the previous three months of activity. Fatigue was assessed using the Functional Assessment of Cancer Therapy-Fatigue scale (FACT-F). At the end of the three-month program, 71% of the participants reported at least 150 minutes of activity per week, while 26% of the control group reported at least 150 minutes of activity ($p < .05$) (Irwin et al., 2017). Participants in the intervention group increased their activity by 127 minutes/week compared to decreased 5.8 minutes/week in the control group ($p = .0001$). At the end of the three-month intervention, participants who were less than 3.6 years from diagnosis and participated in the intervention reported significant positive changes to fatigue scores (3.1, 95% CI: 1.1-5.0; $p = .03$) than participants less than 3.6 years from diagnosis in the control group (-.4, 95% CI: -2.3-2.2). Cancer survivors who participated in a cancer-specific activity program significantly increased their physical activity and significantly reduced fatigue compared to participants who did not participate. Group activity is one way to increase physical activity, leading to increased quality of life in cancer survivors less than four years removed from their cancer diagnosis.

In a similar context to Irwin et al. (2017), Pugh et al. (2020) conducted a twelve-week physical activity program for young adult cancer survivors. The program included meeting with an exercise specialist every third week to assess participants' (*N* = 49; 29.0 ± 5.4 years) physical activity and answer any questions participants may have. The researchers utilized the Godin-Leisure Time Exercise Questionnaire (GLTEQ) to assess physical activity and the Functional Assessment of Chronic Illness Therapy Fatigue (FACIT-F) to assess fatigue. There was a significant increase in physical activity from T0-T2 via the GLTEQ (baseline – one-month follow-up) (22.1 ± 3.3; $p < .01$). There was also a significant improvement in fatigue scores from baseline (23.2 ± 1.2) to the one-month follow-up (23.2 ± 1.2 to 31.2 ± 1.0; $p < .01$). Cancer survivors who participated in this program significantly reduced their feelings of fatigue over twelve-weeks. Specific physical activity programs for cancer survivors with exercise specialists' check-ins are one means to decrease fatigue in cancer survivors. Irwin et al. (2017) and Pugh et al. (2020) provide data to show the effectiveness of physical activity programs accessible to cancer survivors in the community.

Because previous research has been inconclusive if a health education intervention affects cancer survivors' fatigue levels (Gjerset et al., 2019), Sheehan et al. (2020) studied the effects a health education intervention had on cancer survivors' fatigue levels compared to a physical activity intervention. Thirty-seven cancer survivors (55.1 ± 2.2 years) participated in the study. Participants in the activity group ($N = 19$) attended supervised two classes per week for the first five weeks, then once per week for the remaining five weeks. The health education group ($N = 18$) consisted of a weekly one-hour session focused on sleep hygiene, diet and nutrition, and cognitive behavioral therapy. Fatigue was measured using the FACT-F, and physical activity was measured using the IPAQ. Findings showed a significant reduction in fatigue in the health education group from baseline (21.9 ± 2.2) to post-intervention (29.6 ± 2.5; $p < .001$) as well as the physical activity group from baseline (19.3 ± 2.2) to post-intervention (40.3 ± 2.4) and at 26 weeks from baseline (42.4 ± 2.7; $p < .001$) (Sheehan et al., 2020). Both groups significantly decreased fatigue, with the physical activity group showing greater improvements and sustained improvements at the 16-week follow-up compared to the health education group. Health education may provide short-term benefits for cancer survivors who experienced fatigue levels, but physical activity will provide a greater reduction for a sustained time.

Another group at risk of cancer-related fatigue, are testicular cancer survivors (Orre et al., 2008). Adams et al. (2018) conducted a twelve-week intervention investigating high-intensity interval training and its effects on testicular cancer survivors' fatigue ($N$ = 63, 43.7 ± 10.8 years). Participants were stratified by age (<50 vs. ≥ 50 years) and treatment (surgery-only vs. any adjuvant therapy), then randomized to the HIIT or usual care (UC) group. Participants in the HIIT group attended three supervised HIIT sessions per week, consisting of uphill treadmill walking or running. The usual care group exercised at the same intensity as their baseline assessment for the intervention's entirety. Researchers used the Functional Assessment of Cancer Therapy Fatigue (FACT-F) to measure fatigue at baseline, post-intervention, and three-month follow-up. Compared to UC, the HIIT group significantly improved fatigue at post-intervention (adjusted between-group difference =4.4; 95% CI: 1.5-7.3; $p$ = .003), and three-month follow-up (adjusted between-group difference =3.7; 95% CI: .4-7.1; $p$ = .031) (Adams et al., 2018). This study shows that high-intensity interval training is an effective method to significantly reduce fatigue in testicular cancer survivors.

With an estimated 40-100% of cancer survivors experiencing fatigue as a side effect from cancer treatment, cancer survivors must have a way to combat fatigue throughout survivorship. Aerobic activity, resistance training, and a combination of both have shown to be effective modes of activity to reduce fatigue levels among cancer survivors. Despite the mode of activity, cancer survivors who are active throughout survivorship will experience less fatigue than sedentary cancer survivors.

**Body Weight.** A higher body mass index (BMI) at the time of a cancer diagnosis is associated with poorer survival outcomes for certain types of cancer such as breast (Sparano et al., 2012), leukemia and lymphomas (Abar et al., 2019), and oral (Iyengar et al., 2014). To further support this claim, Sparano et al. (2012) investigated the relationship between obesity at the time of cancer diagnosis and survival outcomes. The researchers also investigated health outcomes among the different types of breast cancer, specifically, hormone receptor-positive, HER-2 positive, and triple-negative ($N$ = 4770; 36.6% obese, 32.3% overweight, 30.3% normal BMI, 0.8% underweight). The researchers evaluated the relationship between BMI and the outcomes from three adjuvant chemotherapy trials. Findings showed that obese women had significantly lower disease-free survival (DFS) (HR: 1.17; 95% CI: 1.04-1.31; $p$ = .0077) and overall survival (OS) compared to non-obese women (HR: 1.23; 95% CI: 1.08-1.40; $p$ = .0025) (Sparano et al., 2012). For women with hormone receptor-positive breast cancer, obesity was associated with less favorable outcomes for DFS (HR: 1.31; 95% CI: 1.12-1.53; $p$ = .0009) and OS (HR: 1.46; 95% CI: 1.21-1.77; $p$ = .0001) (Sparano et al., 2012). Findings from this study show an inverse relationship between obesity, disease-free survivorship, and overall survivorship. Specifically, women with hormone receptor-positive breast cancer paired with obesity tend to see worse survival rates.

Previous research has determined an association between physical activity and vitality among cancer survivors (Bower, 2014; Cramp & Byron-Daniel, 2012). Although it is known that physical activity has a positive impact on vitality, previous literature has not studied the impact that BMI and physical activity have on vitality. Kenzik et al. (2018) investigated BMI and physical activity changes and how those factors influenced vitality during a weight-loss trial in breast cancer survivors. Participants ($N$ = 432, 57.3 ± 9.1 years old; 79.4% Non-Hispanic White) completed assessments semi-annually to assess physical activity levels, BMI, vitality, and depression for two years. Baseline data showed a negative correlation between vitality and depressive symptoms ($r$ = -.57; $p$ < .0001) and breast cancer symptom scores ($r$ = -.50; $p$ < .0001). Participants who reported higher physical activity levels also reported a lower BMI ($B$ = -.07; $p$ < .001) and higher vitality ($B$ = .22; $p$ = .001). Participants with above-average physical activity levels ($B$ = .37; $p$ < .001) and a below-average BMI ($p$ < .001) were more likely to have higher vitality. Findings show that participants who were more physically active and reported a lower BMI also reported greater vitality scores than participants with a higher BMI and lower physical activity levels.

Rossi et al. (2017) conducted a cross-sectional study among endometrial cancer survivors ($N$ = 62; 63.1 ± 10.0 years) to examine if there are body composition differences among cancer survivors of varying activity levels. Participants were asked questions about their current physical activity level via the Rapid Assessment of Physical Activity and the Yale Physical Activity Survey (YPAS), while weight and height were obtained from current medical records. Twenty-nine of sixty-two participants (46.7%) reported meeting the ACSM physical activity guidelines. Although the differences in BMI were not statistically different ($p$ = .06) between the physically active group (32.4 ± 5.6) and insufficiently active group (35.7 ± 10.2), there was a moderate effect size ($d$ = .40) between physical activity level and BMI, providing a clinically meaningful difference (Rossi et al., 2017). Although this study demonstrates no significant difference in BMI among the active and insufficiently active group, a clinically significant effect size was found to demonstrate that women who reported higher amounts of physical activity reported lower BMI’s. Future research in this area should focus on measuring physical activity objectively to assess physical activity more accurately.

The association between BMI and mortality has been conflicting as some studies suggest a higher BMI increases mortality risk, while other studies indicate overweight cancer survivors have a lower mortality risk, otherwise known as the obesity paradox in cancer (Caan et al., 2017; Campbell et al., 2015; Park et al., 2018; Shachar & Williams, 2017). Nelson et al. (2016) examined the impact of very low physical activity levels (<1.5 MET h/wk), BMI, and comorbidities on mortality among breast cancer survivors. The researchers used data from the After-Breast Cancer Pooling Project (ABCPP), which consisted of 9513 breast cancer survivors (20-83 years). The data included the participants' BMI, self-reported physical activity levels, and comorbidities. The data analysis indicated no significant ($p$ = .055) rates of breast cancer-specific mortality among the BMI classifications (underweight, normal, overweight, obese 1, obese 2). Women classified as underweight had significantly higher all-cause mortality rates than women of other BMI classifications ($p$ < .0001). Breast cancer-specific mortality (14.7%) and all-cause mortality (31.8%) were significantly ($p$ < .0001) higher among women who reported very low physical activity levels. Lastly, very low physical activity levels were significantly associated with a 22% increased risk of breast cancer mortality (HR: 1.22, 95% CI: 1.05, 1.42) (Nelson et al., 2016). Thus, an underweight BMI may lead to higher all-cause mortality in breast cancer survivors, but regardless of BMI classification, low physical activity levels indicated higher mortality rates in breast cancer survivors.

Similarly, Maliniak et al. (2018) investigated the association between obesity and physical activity with breast cancer-specific mortality (BCSM) among older breast cancer survivors. Data was tracked between 1992 and 2013, studying the association between BMI, physical activity, and mortality outcomes. The data revealed a positive linear association between pre-diagnosis BMI and BCSM among women >65 years old (HR: 1.27, 95% CI: 1.14-

1.41; $p < .001$) but not among women diagnosed <65 years of age (HR: 1.06, 95% CI: .89-1.27; $p < .51$). Among women <65 years of age, having a pre-diagnosed physical activity of 8.75 to <17.5 MET-hours/wk (HR .66, 95% CI: .39-1.11) was associated with a lower risk of BCSM compared to lower physical activity levels (HR: 1.38, 95% CI: .77-2.48; $p < .001$). Pre- (HR: .98, 95% CI: .97-1.00; $p < .01$) and post- (HR: .97, 95% CI: .95-.98; $p < .001$) diagnosis physical activity of at least 8.75 MET h/wk was significantly associated with reduced all-cause mortality despite age (Maliniak et al., 2018). This study revealed that physical activity, pre-or post-diagnosis, may lower all-cause mortality in breast cancer survivors despite age or BMI.

While Maliniak et al. (2018) reported an association between physical activity, BMI, and mortality in breast cancer survivors, Kenzik et al. (2018) investigated the relationship between physical activity, BMI, and vitality in breast cancer survivors. This study is a secondary analysis of the Exercise and Nutrition to Enhance Recovery and Good Health for You (ENERGY), which utilized a sample of 432 breast cancer survivors (57.3 ± 9.1 years). Participants were sent questionnaires at baseline, six-months, twelve-months, and twenty-four-months to assess physical activity, vitality, and BMI, which were measured using the Godin Leisure-Time Exercise Questionnaire, the four-item vitality subscale on the SF-36, and reporting their height and weight, respectively. Findings show that assessments when participants reported higher physical activity, BMI was significantly lower ($B = -.07$, $p < .001$), and vitality was significantly higher ($B = .22$, $p < .001$). Next, there was no direct relationship between lower BMI and higher vitality ($B = -.12$, $p = .167$) after controlling for the relationship of physical activity with vitality (Kenzik et al., 2018). These findings demonstrate that having a lower BMI is not enough for breast cancer survivors to have higher vitality scores, and it shows that physical activity is the moderator between a lower BMI and higher vitality scores.

BMI has been associated with cancer survivors' survival rates and vitality throughout survivorship. Cancer survivors classified as overweight, obese, or underweight often experience less favorable outcomes than cancer survivors classified as having a "normal" BMI. Thus, cancer survivors must aim to maintain a healthy body weight and strive to have a normal BMI.

**Sleep Quality.** Sleep quality is a significant issue that cancer survivors face; physical activity may help improve sleep quality. Poor sleep quality in cancer survivors is associated with higher fatigue levels and lower quality of life (Rafie et al., 2018). Sleep problems are associated with poor clinical outcomes for cancer survivors, such as lower survival rates, more rapid disease progression, and even poor responses to their treatment (George et al., 2016). Cancer survivors rated sleep quality as one of the top five ways to maintain or improve their quality of life after treatment (Hollen et al., 2015). Because good sleep quality is vital to cancer survivors, it is essential to identify strategies to improve sleep quality.

To assess sleep quality in endometrial cancer survivors ($N$ = 114, 58.1 ± 11.0), Tuyan Ilhan et al. (2017) measured sleep quality using the Pittsburgh Sleep Quality Index (PSQI) before treatment, one-month post-treatment, three months post-treatment, and six months post-treatment. Participants were categorized into one of four groups based on treatment type: surgery ($N$ = 53); surgery and brachytherapy (BRT; $N$ = 14); surgery and external beam radiotherapy (EBRT; $N$ = 12); surgery, ERBT, BRT, and chemotherapy ($N$ = 35). Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI) at four different time points: before treatment, one-month post-treatment, three-months post-treatment, and six-months post-treatment. According to the PSQI, a score greater than five is considered poor sleep quality. Before treatment, the mean scores for sleep quality for each group were 4.05 ± 2.17 (surgery), 4.50 ± 2.70 (BRT), 4.16 ± 2.60 (EBRT), and 5.62 ± 2.60 (EBRT, BRT, chemotherapy), respectively ($p$

$< .001$). One-month post-treatment mean sleep quality scores were 6.86 ± .40 (surgery), 6.28 ± 2.80 (BRT), 6.58 ± 2.70 (EBRT), and 11.11 ± 4.90 (EBRT, BRT, chemotherapy), respectively ($p < .001$). Three-months post-treatment, the group's results were 5.79 ± 3.0 (surgery), 4.92 ± 1.50 (BRT), 6.62 ± 1.40 (EBRT), and 9.11 ± 4.70 (EBRT, BRT, chemotherapy), respectively ($p < .004$)**.** Six-months post-treatment the group means were: 5.90 ± 3.40 (surgery), 5.42 ± 3.10 (BRT), 5.25 ± 3.10 (EBRT), and 8.42 ± 3.60 (EBRT, BRT, chemotherapy), respectively ($p < .001$)**.** The data suggest that poor sleep quality is prevalent amongst endometrial cancer survivors regardless of their treatment. Although all treatments negatively affected sleep quality, this data shows that those who received EBRT, BRT, and chemotherapy had significantly worse sleep quality than participants in other groups at time points two (one-month post-treatment)(OR: 3.67; 95% CI: $p = .011$), three (three months post-treatment)(OR 6.24; 95% CI: $p < .001$), and four (six months post-treatment)($p < .008$) (Tuyan İlhan et al., 2017)**.** This data suggests that sleep quality will worsen for cancer survivors despite the treatment type, but the treatment type may influence the severity of the effect.

One previously implemented method to improve sleep quality has been physical activity interventions (Armbruster et al., 2018a). Physical activity interventions have been implemented to assess if physical activity is an appropriate method to improve sleep quality among cancer survivors. Rogers et al. (2017) conducted a physical activity intervention (BEAT cancer) to improve sleep quality among two hundred and twenty-two breast cancer survivors (54.5 ± 8.5 years) who were at least eight weeks post-primary treatment for breast cancer. For the first six weeks, participants attended twelve supervised exercise sessions consisting of aerobic and resistance training. After the twelve sessions, they exercised independently but continued meeting with an exercise specialist every two weeks for counseling sessions. Participants wore a wrist accelerometer for seven nights and recorded the time they got in and out of bed. The participants' sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI). After three months, intervention participants significantly improved sleep quality compared to the usual care group who received written materials regarding physical activity for cancer survivors (mean between-group difference = -1.4; 95% CI=-2.1 to -0.7, $p < .001$)(Rogers et al., 2017a). Significant improvement were also seen after six months (mean between-group difference = -1; 95% CI = -1.7 to -.2, $p = .0$) (Rogers et al., 2017a). This data shows that a physical activity behavior intervention significantly improved breast cancer survivors' perceived sleep quality.

Uterine cancer is the fourth most common cancer for women in the United States, and it is important to understand the effect physical activity has on improving sleep quality in this population. The American Society of Clinical Oncology estimates that 65,620 women will be diagnosed with uterine or endometrial cancer in 2020. Over 90% of uterine cancers occur in the endometrium (ASCO., 2020). Armbruster et al. (2018) examined the impact of physical activity intervention on endometrial cancer survivors' sleep quality. Ninety-five women (57.1 years; range 25-76 years) participated in Steps to Health, a pedometer-based intervention. All participants received an individualized exercise prescription based on their initial fitness level. The researchers assessed participants' physical activity at baseline (T0), 2 (T1), 4 (T2), and 6 (T3) months after enrollment. Researchers also measured sleep, quality of life, and stress at baseline and T3. Baseline scores indicated that 61% of participants had poor sleep quality (PSQI>5), with 24% reporting fairly or very bad sleep. In the previous month, 83% of participants experienced an episode of daytime dysfunction at least once. From T0 (7.3 ± 3.8) to T3 (6.2 ± 3.6), the mean global PSQI score did not significantly change ($p = .625$). Although the score did not significantly change, an unadjusted analysis indicated that sleep quality changes were associated with changes in physical activity level from T0 to T3. Specifically, sleep quality improved significantly in cancer survivors who increased their weekly total physical activity or MVPA throughout the intervention ($p = .004$ and $p < .05$). PSQI scores for participants that increased total physical activity decreased from 7.4 ± 3.5 at baseline to 5.4 ± 2.9 at T3 ($p = .0037$), indicating improved sleep quality. Similarly, participants who increased MVPA had a decrease in PSQI scores from baseline (7.6 ± 3.4) to T3 (6.2 ± 3.2; $p = .0499$) (Armbruster et al., 2018b). Only participants who increased their total physical activity or MVPA significantly improved their sleep from baseline to T3. These findings support physical activity may improve sleep quality in cancer survivors.

A similar study conducted a randomized dose-response trial of aerobic exercise and sleep quality among colon cancer survivors. Participants (64% < 60 years, 62% women) in the intervention group were randomly assigned to either the low-dose (150 minutes/week; 50-70% age-predicted maximum heart rate) or the high-dose (300 minutes/week; 50-70% age-predicted maximum heart rate) group. Sleep quality was assessed at baseline and six months post-intervention using the Pittsburgh Sleep Quality Index (PSQI). Compared to the control group, the low-dose group decreased PSQI scores by .3 ± 1.0 ($d = -.11$), and the high-dose group decreased by 1.1 ± 1.1 ($d = -.30$; $p = .049$) (Brown et al., 2018). The PSQI subscales that significantly improved for both groups included sleep quality (low-dose=-.08 ± .13, high-dose=-.37 ± .14; $p = .043$) and sleep latency (low-dose = .08 ± .22, high-dose = -.27 ± .24; $p = .042$). Participants in both groups improved sleep quality across the six-week study, with the high-dose group reporting more perceived benefits to their sleep quality than the low-dose group. Study findings show achieving physical activity guidelines of 150 minutes of moderate aerobic activity may provide modest benefits to enhance cancer survivors' sleep quality, while engaging in 300+ minutes of activity may provide more benefits for cancer survivors.

To help cancer survivors improve sleep quality, Pugh et al. (2020) conducted a 12-week physical activity intervention that included meetings with an exercise specialist. Participants ($N = 48$; 29.0 ± 5.4 years) received a gym membership and access to four sessions with an experienced exercise specialist. The Godin Leisure-Time Exercise Questionnaire (GLTEQ) measured physical activity, and the Pittsburgh Sleep Quality Index (PSQI) measured sleep quality. Participants' physical activity increased significantly from T0 (baseline) (37.9 ± 3.1) to T2 (1-month follow-up; 16 weeks from baseline) (60.0 ± 1.6; $p < .01$). Along with improvements in physical activity, sleep quality also significantly improved from T0 (7.2 ± .4) to T2 (6.1 ± .4; $p = .034$) (Pugh et al., 2020). Findings from this study show that cancer survivors that increased their physical activity significantly improved their sleep quality. Providing cancer survivors with a gym membership and access to an exercise specialist at least every three weeks is a strategy to significantly improve physical activity and, thus, sleep quality among cancer survivors.

Although the benefits of physical activity on cancer survivors' sleep quality are well documented, Chen et al. (2020) studied if the time of day when a cancer survivor was physically active influenced their sleep quality. Researchers conducted a twelve-week home-based exercise intervention, which involved moderate-intensity walking for forty minutes three times per week. Participants ($N = 43$; 63.9 ± 11.9 years) were assigned to either the active group ≥ four hours before bedtime or ≤ four hours before bedtime. The researchers utilized the 3-d PAR to assess physical activity and the PSQI to assess sleep quality, along with an Actigraph unit. Participants in the group that was active ≥ four hours from bedtime reported significantly higher sleep quality via the PSQI at month three (5.9 ± 3.3) and month six (6.0 ± 4.1) compared to the group that was active ≤ four hours from bedtime (M3 = 7.0 ± 4.6; M6 = 8.3 ± 6.0; $p < .05$) (Chen et al., 2020). This data reveals that participants who were physically active more than four hours before they went to sleep reported higher sleep quality scores. Physical activity is important in improving sleep quality in cancer survivors, but the time they are active may also influence their sleep quality.

Identifying strategies to improve cancer survivors' sleep quality is essential due to poor sleep quality associated with clinical outcomes, survival rates, disease progression, and treatment responses. The current body of literature supports physical activity as one way to improve sleep quality in cancer survivors.

**Anxiety.** Cancer survivors may experience heightened levels of distress, leading to a clinical diagnosis of an anxiety disorder. Distress exists along a continuum, ranging from feelings of sadness and vulnerability to anxiety, depression, social isolation, and panic (Holland et al., 2013). Post-cancer treatment, cancer survivors may fear physical sensation when testing for recurrence (Holland et al., 2013). Boyes et al. (2011) investigated the prevalence of anxiety among cancer survivors who were six months post-diagnosis (*N* = 1323, 63 ± 11). The researchers mailed a questionnaire to participants with physician approval to contact patients. Findings showed that 24% of survivors had cases of anxiety, and 10% of participants' had comorbid anxiety-depression. (Boyes et al., 2011). Their findings suggest that about one in four cancer survivors experience anxiety six months post-treatment.

A similar study by Sun et al. (2019) explored the fear of cancer recurrence and anxiety in adolescents and young adult cancer survivors. Participants (*N* = 249; 33.1 ± 4.8 years) completed the General Anxiety Disorder Questionnaire (GAD-7) to assess anxiety levels. Results indicated that 35.7% of survivors experienced dysfunctional levels of fear of cancer recurrence (FCR), while 32.9% of patients experienced anxiety symptoms. These findings suggest that more than three out of every ten cancer survivors will experience anxiety symptoms.

To study the association between physical activity and anxiety, Phillips et al. (2015) studied the association between self-reported physical activity levels and anxiety in breast cancer survivors. Participants ($N$ = 1348; 56.3 ± 9.3 years) completed a survey that inquired about physical activity levels, measured with the Godin Leisure-Time Exercise Questionnaire, and anxiety, measured with the Hospital Anxiety and Depression Scale. Women who increased physical activity post-diagnosis reported significantly lower anxiety scores (4.9 ± 3.1) than women who decreased physical activity (5.7 ± 3.7; $p$ = .01). Breast cancer survivors can help alleviate feelings of anxiety post-diagnosis by increasing their physical activity after diagnosis. Thus, it is important to promote physical activity among cancer survivor's post-diagnosis.

Similarly, Patsou et al. (2018) studied physical activity in cancer survivors and the varying impact levels on anxiety. Cancer survivors ($N$ = 171, 51.7 ± 7.3 years) completed the IPAQ about their current physical activity level and the State-Trait Anxiety Inventory (STAI) to measure anxiety. They then completed a $VO_2$ max test for an objective measure of fitness, and the researchers acknowledged that $VO_2$ max is a test of physical fitness and acknowledged that a more physically active individual would most likely have a higher $VO_2$ max. A significantly negative moderate correlation was found between the MET level on the $VO_2$ max test and anxiety ($r$ = -.44, $p$ < .001). This study shows that cancer survivors who were more physically active and had a higher $VO_2$ max had significantly lower anxiety scores than less active survivors.

While most research focuses on cancer survivors' overall physical activity, Amritanshu et al. (2017) conducted a study focusing on only one type of physical activity: yoga. The purpose of the study was to compare anxiety scores from cancer survivors who regularly participated in yoga to cancer survivors who did not participate in yoga. Participants ($N$ = 27, 51.2 ± 11.0 years) were recruited for the yoga group if they reported more than six months of regular yoga during the past year, and individuals who had attended less than three yoga sessions in the past year qualified for the group that does not perform yoga ($N$ = 25, 53.1 ± 10.4 years). Participants' anxiety was measured using the Spielberg's state and trait anxiety questionnaire. Participants in the yoga group reported significantly lower state anxiety (32.6 ± 8.5 vs. 62.0 ± 10.4; $p < .001$) and trait anxiety (34.3 ± 7.8 vs. 64.3 ± 11.3; $p < .001$) compared to the group that did not regularly perform yoga ($p < .001$) (Amritanshu et al., 2017). Findings show that cancer survivors who regularly performed yoga experienced significantly less state and trait anxiety than survivors who did not regularly perform yoga.

With an abundance of correlational studies suggesting that cancer survivors who are more physically active report lower levels of anxiety, physical activity interventions are needed to help support the claim that physical activity is beneficial for lowering anxiety. Chen et al. (2015) studied the effectiveness of a home-based walking program on anxiety in lung cancer survivors. Participants ($N$ = 116, 64.2 ± 10.9 years) were assigned to either the home-based walking group ($N$ = 58) or the control group ($N$ = 58). The intervention consisted of a 12-week home-based, moderate-intensity walking program, which included three 40-minute sessions per week and weekly activity counseling. Anxiety was measured using the Hospital Anxiety and Depression Scale at baseline, three months, and six months from the beginning of the intervention. The intervention group did not significantly ($p = .17$) reduce their anxiety scores from baseline (4.6 ±

3.46) to six months (3.55 ± 3.3; $p$ = .17) (Chen et al., 2015). The control group experienced a significant increase in anxiety scores from baseline (3.5 ± 3.9) to six months (4.6 ± 3.9, $p$ = .012). Although the intervention did not significantly lower participants' anxiety scores, they did not increase like the control group. Walking for 120 minutes per week is beneficial for cancer survivors, so anxiety scores do not increase throughout survivorship. Previous research has shown a dose-response relationship between physical activity and mental health among cancer survivors, indicating that more than 120 minutes may be necessary to lower anxiety, but it may be enough, so anxiety does not increase throughout survivorship (Thraen-Borowski et al., 2013).

To provide a more structured exercise setting, Rogers et al. (2017) conducted an exercise intervention to improve breast cancer survivors' ($N$ = 222; 54.4 ± 8.5 years) anxiety scores. The Better Exercise Adherence After Treatment (BEAT) for cancer intervention included twelve supervised exercise sessions for the first six weeks and counseling with an exercise specialist every two weeks during the final six weeks. An exercise specialist provided behavior change counseling for each participant during the first nine weeks of the intervention to aid in physical activity adherence. Researchers used the Hospital Anxiety and Depression scale to measure anxiety at baseline, month three (M3, immediately post-intervention), and month six (M6, three-months post-intervention). Participants in the intervention group ($N$ = 110) reported significantly lower anxiety scores at M3 (-1.25; 95% CI = -1.98 to -.53; $d$ = -.33; $p$ < .001) and M6 (-.75; CI = -1.49 to -.02; $d$ = -.21; $p$ = .044) compared to the usual care group (Rogers et al., 2017a). The BEAT cancer intervention demonstrates that being physically active is one way to alleviate anxiety symptoms after cancer treatment.

With more than three out of every ten cancer survivors experiencing anxiety symptoms, there is a demand to help alleviate these symptoms. The current body of literature shows convincing evidence that physical activity is an effective means to help cancer survivors lessen anxiety throughout survivorship.

**Depression.** Cancer survivors may have a higher prevalence of depression than people among the general population. Inhestern et al. (2017) aimed to investigate the prevalence of depression among cancer survivors. In the analysis, there were 3370 participants (74% female, 26% male; 50 ± 6.8 years) with an average time since diagnosis of 44 months (Inhestern et al., 2017a). Participants completed the Hospital Anxiety and Depression Scale (HADS-D), a 14-item scale with items being scored from 0-3 to measure depression. After completion, participants were classified into a category based on the total score: normal (0-7), moderate (8-10), and high (11 and above). The mean depression score was found to be 4.1 ± 4.0; 19% reported moderate to high scores, which indicated clinically relevant levels of depression (Inhestern et al., 2017a). There were also no significant differences between survivors who were less than two years from diagnosis, 3-4 years post-diagnosis, 5-6 years post-diagnosis, and more than six years post-diagnosis (Inhestern et al., 2017a). This study shows that even though the cancer survivors were classified under the “normal” category for the HADS-D questionnaire (4.1 ± 4.0), there were still 19% reporting clinically significant levels of depression.

Similarly, Bevilacqua et al. (2018) investigated the prevalence of depression in older (65+ years; $N$ = 508, 76.6 ± 5.0 years) and younger (30-55 years; $N$ = 504, 49.2 ± 5.0 years) adult cancer survivors. Participants completed the Patient Health Questionnaire-9 (PHQ-9) to measure depression. This scale measures participants’ experiences in the previous two weeks, with a score of 10 or above indicating clinically significant depressive symptoms. There was no significant difference ($p$ = .38) between the older adult and younger adult groups (OA: 8.5%, YA: 10.1%, $X^2(1) = .77$). The younger adult group demonstrated higher mean PHQ-9 depression scores (3.4 ± 4.5) than the older adult group (2.9 ± 4.6). Although the mean was higher, it was not significantly higher ($t$ = 1.63, $p$ = .103; Bevilacqua et al., 2018). Between the two groups, 9.3% of participants met the criteria for depression in the last two weeks. There were no significant differences between race and ethnicity ($p$ = .23). Women survivors in either group showed double the rate of clinically significant depression (10.5%) compared to the men (5.2%) ($X^2(1) = 6.2$; $p$ = .013) (Bevilacqua et al., 2018). This significant difference is shown in the mean PHQ-9 scores, which for women was 3.5 ± 4.83 compared to the men's mean of 2.0 ± 3.36 ($t$ = -4.43; $P < .001$) (Bevilacqua et al., 2018). This study showed that there might not be a difference in the prevalence of depression among different age groups, but there may be a significant difference between sexes, specifically women showing a higher prevalence of depression than men.

With the previous literature (Inhestern et al., 2017) showing that cancer survivors experience higher rates of depression than the general population, physical activity interventions have been implemented to help alleviate depressive symptoms in cancer survivors. Rogers et al. (2017) conducted a physical activity intervention to improve breast cancer survivors' ($N$ = 222; 54.4 ± 8.5 years) depression scores. The intervention, BEAT Cancer, included twelve supervised exercise sessions for the first six weeks and counseling with an exercise specialist every two weeks during the intervention's final six weeks. During the first nine weeks of the intervention, additional behavior change counseling supplemented the physical activity intervention. The researchers used the Hospital Anxiety and Depression Scale to measure depression at baseline, month three (immediately post-intervention), and month six (three-month follow-up). Participants in the intervention group ($N$ = 110) reported significantly lower depression scores at M3 (-1.31; 95% CI = -1.98 to -.64; $d$ = -.38; $p < .001$) and M6 (-.71; CI = -1.39 to -.02; $d$ = -.21;

$p$ = .042) compared to the usual care group (Rogers et al., 2017a). The BEAT cancer intervention demonstrates that being physically active is one way to alleviate depressive symptoms after cancer treatment.

To measure the effect physical activity has on psychological well-being, Aguinaga et al. (2018) conducted a cross-sectional study with breast cancer survivors ($N$ = 387; 57.7 ± 9.6 years). Participants completed a survey that inquired about physical activity levels from pre-diagnosis, post-diagnosis, along with depressive symptoms. Participants were categorized as either a low-active maintainer, increaser, decreaser, or high-active maintainer from their results from pre-to post-diagnosis. Findings from the study showed that high-active maintainers reported significantly fewer depressive symptoms (3.1 ± .34; $p < .05$) compared to low-active maintainers (4.9 ± .34; $p < .05$) and the decreasers (6.1 ± .54; $p < .005$) (Aguiñaga et al., 2018b). Also, participants who increased their physical activity post-diagnosis reported significantly fewer depressive symptoms (3.6 ± .45; $p < .005$) compared to participants who decreased their physical activity levels post-diagnosis (6.1 ± .54; $p < .005$). This study demonstrates that increasing physical activity or maintaining a high amount of physical activity from pre-to post-diagnosis can help cancer survivors experience fewer depressive symptoms.

To further study the association between physical activity and depressive symptoms, Phillips et al. (2015) completed a cross-sectional study. Participants ($N$ = 1348; 56.3 ± 9.3 years) completed a survey that inquired about physical activity levels, measured with the Godin Leisure-Time Exercise Questionnaire, and depression, measured with the Hospital Anxiety and Depression Scale. Women who increased physical activity post-diagnosis reported significantly lower depression scores than women who decreased physical activity (3.6 ± 3.3 vs. 5.2 ± 4.1; $p$ <

.001). Cancer survivors can utilize physical activity as means for reducing depressive symptoms during survivorship.

To study the relationship between physical activity and depressive symptoms, Patsou et al. (2018) had participants (*N* = 171, 51.7 ± 7.3 years) complete a questionnaire on their current physical activity levels and depressive symptoms. Along with the questionnaire, participants also completed a VO2 max test for an objective fitness measure. The survey featured the IPAQ to measure physical activity and the Profile of Mood States (POMS) questionnaire. Results showed a significantly negative moderate correlation between the MET level on the $VO_2$ max test and depression ($r = -.55$, $p < .001$). This study shows that cancer survivors with a greater aerobic capacity and higher physical activity levels experience significantly fewer depressive symptoms than less active cancer survivors.

African-American breast cancer survivors experience worse mental health symptoms than Caucasian breast cancer survivors (Matthews et al., 2012), so it is important to study the impact physical activity can have on African-American breast cancer survivors' mental health, specifically depression. Beebe-Dimmer et al. (2020) conducted a study investigating physical activity and depression in African-American cancer survivors. Members of the Detroit research on cancer survivors' group (*N* = 1137, female = 58%) completed a baseline survey and are contacted annually to update physical activity and depression information. The researchers used the IPAQ-SF and the Patient-Reported Outcomes Measurement Information System (PROMIS) scale to measure physical activity and depression. Participants were classified into the "no reported PA" group, "0 to < 150 min of PA" group, or the "≥ 150 minutes of physical activity group. Participants in the ≥ 150 minutes of PA group reported significantly lower depression scores on the PROMIS subscale (46.7, 95% CI: 45.8-47.5) compared to the group that reported no PA (49.4, 95% CI: 48.7 – 50.2) and 0 to < 150 minutes of PA group (49.2, 95% CI: 48.4-50.0; $p < .001$; Beebe-Dimmer et al., 2020). Cancer survivors who reported at least 150 minutes per week of physical activity reported experiencing significantly fewer depressive symptoms compared to survivors who reported less than 150 minutes of physical activity per week or no physical activity throughout the week.

Light physical activity or breathing exercises are recommended for lung cancer survivors to improve breathing capacity to help maintain the capacity to achieve activities of daily living (Michaels, 2016). To further study the effectiveness of physical activity in lung cancer survivors, Chen et al. (2015) studied the effects a home-based walking program had on depression. Participants ($N = 116$, 64.2 ± 10.9 years) were assigned to either the home-based walking group ($N = 58$) or the control group ($N = 58$). The intervention consisted of a 12-week home-based, moderate-intensity walking program, which included three 40-minute sessions per week and weekly activity counseling. Depression was measured using the Hospital Anxiety and Depression Scale at baseline, three months, and six months from the beginning of the intervention. The intervention group significantly improved their depression scores from baseline (5.7 ± 3.6) to month three (4.9 ± 3.1; $p = .001$) and month six (4.4 ± 3.9; $p = .035$). This study shows the impact of walking 120 minutes at a moderate intensity per week on depressive symptoms in lung cancer survivors. Walking at a moderate pace, even below physical activity guidelines, benefits lung cancer survivors' depressive symptoms.

With cancer survivors having an elevated prevalence of depression compared to the general population, there is a growing need to help relieve depressive symptoms. Previous research has successfully identified physical activity as one means to improve depressive symptoms in cancer survivors.

**Stress.** Cancer diagnosis and treatment can be a traumatic and stressful experience. Stress is commonly experienced among cancer patients and is typically associated with a higher burden of symptoms (Arnaboldi et al., 2017). Higher levels of stress among cancer patients also tend to be linked to more symptoms related to depression and anxiety (Liu et al., 2017). Stress may play a mediating role and one of the factors that may lead to depression and anxiety (Liu et al., 2017). Liu et al. (2017) studied the association between perceived stress and symptoms of depression and anxiety among 198 ovarian cancer survivors (55.7 ± 9 years). Most participants were diagnosed with either stage three or four cancer (72.7%), and 93.4% of participants received chemotherapy, surgery, or a combination (Liu et al., 2017). Results showed that perceived stress was significantly correlated with symptoms of depression ($r = .71$, $p < .01$) and symptoms of anxiety ($r = .66$, $p < .01$). This study explains that cancer survivors who experience a significant amount of stress may also experience symptoms of anxiety and depression. Physical activity can play a prominent role in helping cancer survivors suppress stress, anxiety, and depressive symptoms (Liu et al., 2016; Rogers et al., 2017).

Stress can negatively affect cancer survivors' mental health and ultimately lead to depression (Han, 2017). Due to stress impacting cancer survivors' mental well-being, it is important to understand the effect of physical activity on reducing stress. Phillips et al. (2015) studied the association between self-reported physical activity levels and perceived stress in breast cancer survivors. Participants ($N = 1348$; 56.3 ± 9.3 years) completed a survey that inquired about physical activity levels, measured with the Godin Leisure-Time Exercise Questionnaire, and stress, measured with the Perceived Stress Scale. Women who reported maintaining (12.3 ± 7.1) or increasing physical activity (12.0 ± 6.3) post-diagnosis reported significantly lower levels of perceived stress compared to women who reported decreasing physical activity post-diagnosis (14.4 ± 7.3, $p < .001$). These results are encouraging for cancer survivors because physical activity levels may not have to be increased to experience stress-related benefits. Decreasing physical activity, however, may result in increased perceived stress post-diagnosis.

With researchers confident that an adequate amount of physical activity can lower stress among cancer survivors, it is also important to understand the impact stress has on cancer survivors' symptom burden throughout survivorship if adequate physical activity levels are not achieved. Mazor et al. (2019) studied the effects of stress on cancer survivors' symptom burden. In this study, 623 participants (60.1 ± 11.2 years) with varying cancer diagnoses breast cancer (55.7%), ovarian cancer (8.7%), colon cancer (8.0%), lung cancer (3.0%), and other malignancies (24.6%) answered questionnaires to assess any relationship stress has on symptom burden. The researchers utilized the Perceived Stress Scale (PSS) and the Memorial Symptom Assessment Scale (MSAS) to measure stress and symptom burden, respectively. The mean PSS score for participants was 17.3 ± 8.9, and the mean MSAS score was 9.1 ± 5.2 (Mazor et al., 2019a). A higher score on the PSS was associated with a higher symptom burden, with stress accounting for 6.9% of the higher symptom burden variance. Stress is a mediating factor for how cancer survivors experience the symptoms of cancer and their cancer treatment, even years after treatment. Cancer survivors with elevated stress levels may also experience a higher symptom burden throughout survivorship. Lowering stress via physical activity will not only lead to lower stress, but it will also lead to a lower symptom burden.

Previous research has shown that a common barrier for cancer survivors to becoming physically active is their dislike of a gym environment (Hefferon et al., 2013). To help cancer survivors avoid a gym-based setting, Lengacher et al. (2018) introduced a mobile mindfulness-based stress reduction program for cancer survivors, including walking, meditation, and yoga. The researchers gave the participants ($N$ = 13, 57 ± 9 years) an iPad, which contained six weekly sessions with a duration of two hours per session that could be accessed at any time throughout the week. Participants' stress was measured using the Perceived Stress Scale (PSS) at baseline and again at week six. Perceived stress was significantly lower at the six-week follow-up (9.1 ± 4.8) compared to baseline (14.3 ± 7.7; $p < .004$) (Lengacher et al., 2018). This pilot study showed the effectiveness of a mobile mindfulness-based stress reduction program in cancer survivors that could be performed at their convivence for two hours throughout the week. Although this is an explorative study, it demonstrates new, accessible ways for cancer survivors to become active and lower their perceived stress.

With the impact that stress can have on cancer survivors (Liu et al., 2017a), cancer survivors must have effective ways to lower stress. Amritanshu et al. (2017) studied the effects of long-term yoga practices on stress in cancer survivors. Participants in the yoga group had more than six months of yoga experience in the last year ($N$ = 27, 51.2 ± 11.0 years), and the no yoga group were individuals who attended less than three yoga sessions in the previous year ($N$ = 25, 53.1 ± 10.4 years). This cross-sectional study inquired about participants' stress at one-time point using the Perceived Stress Scale. Participants in the yoga group reported significantly lower stress (19.2 ± 5.2) compared to the group that did not regularly perform yoga (33.9 ± 5.9; $p < .001$) (Amritanshu et al., 2017). Thus, cancer survivors who regularly perform yoga experienced significantly less stress than survivors who did not regularly perform yoga.

**Health-Related Quality of Life (HRQOL).** Due to the growing cancer survivor population, assessing health-related quality of life in survivors has had a growing importance. Health-related quality of life (HRQOL) is a concept that focuses on a person's life satisfaction by assessing areas such as physical, mental, emotional, and social functioning (Torrance, 1987). Cancer survivors tend to have lower health-related quality of life than the general population (Annunziata et al., 2018a). Annuziata et al. (2018) compared the long-term quality of life among cancer survivors and the general population. Long-term cancer survivors (5+ years from their cancer diagnosis, who completed treatment) were recruited, along with individuals from the general population ($N$ = 392; 68.8 ± 17.6 years). The researchers measured the participants' health-related quality of life using the SF-36. The eight aspects of quality of life measured with the SF-36 are physical functioning, role-physical limitation, bodily pain, general health, vitality, social functioning, role emotional limitations, and mental health (Ware & Gandek, 1998). Each index is scored on a 0 to 100 scale, with a higher score associated with better functioning in that respective section (Ware & Gandek, 1998). Mean differences between cancer survivors and the general population were found to be statistically significant for physical functioning (mean difference = -17.6, $p < .001$), role-physical limitation (mean difference = -4.1, $p = .049$), bodily pain (mean difference = -13.5, $p < .001$), general health (mean difference = -17.19, $p < .001$), vitality (mean difference = -10.2, $p < .001$), social functioning (mean difference = -11.1, $p < .001$), role emotional limitations (mean difference = 10.4, $p < .001$), and mental health (mean difference = 19.1, $p < .001$). This study demonstrates that long-term cancer survivors reported significantly lower health-related quality of life scores than their general population counterparts.

Breast cancer survivors' health-related quality of life may be diminished during the post-treatment transitional period due to a considerable amount of psychological distress during this time (Paraskevi, 2012). To assess if physical activity impacts health-related quality of life, Shin et al. (2017) conducted a study among breast cancer survivors ($N$ = 231, 48.1 ± 8.4 years) who were at least six months post-treatment. The researchers used the Quality-of-Life Questionnaire

Core 30 (QLQ-C30) and Quality of Life Questionnaire Breast Cancer Module 23 (QLQ-BR23) to assess quality of life. Next, physical activity was assessed using a detailed questionnaire asking about the top three physical activities they perform and the frequency and duration. Their survey found that their participants engaged in 33.7 ± 29.9 MET-hours of physical activity per week. Results from the study showed increasing scores of physical functioning ($p$ = .01) and decreasing scores of fatigue ($p$ = .02) were associated with increased physical activity levels in participants who had stage one breast cancer (Shin et al., 2017a). With women who had stage two and three cancer, the most active women showed lower fatigue scores than the least active women ($p$ = .001) (Shin et al., 2017a). Their study suggests that the most physically active individuals had lower fatigue and higher physical functioning, which are strongly related to health-related quality of life.

Similarly, Phillips et al. (2015) studied the association between self-reported physical activity levels and health-related quality of life in breast cancer survivors ($N$ = 1348; 56.3 ± 9.3 years). Physical activity and health-related quality of life were measured using the Godin-Leisure Time Exercise Questionnaire and the Functional Assessment of Cancer Therapy-Breast (FACT-B). Women who reported maintaining or increasing physical activity post-diagnosis reported higher physical well-being scores (24.3 ± 3.8 & 25.0 ± 3.2 vs. 22.5 ± 4.9; $p$ < .001), functional well-being (22.3 ± 5.1 & 22.9 ± 4.7 vs 20.8 ± 5.6; $p$ < .001), breast cancer concerns (26.4 ± 5.7 & 26.7 ± 5.2 vs 24.0 ± 6.2; $p$ < .001), and overall health-related quality of life (115.2 ± 18.4, 116.9 ± 20.1 vs 107.2 ± 20.1; $p$ < .001) compared to women who reported decreasing physical activity post-diagnosis. Women who maintained or increased their activity level after cancer-diagnosis showed significantly higher life satisfaction than women who decreased their physical activity levels. Thus, findings show that physical activity is one approach to increasing health-related quality of life among cancer survivors.

In a similar study, Gopalakrishna et al. (2017) investigated physical activity patterns and associated health-related quality of life in bladder cancer survivors. Researchers sent a survey, including the Functional Assessment of Cancer Therapy Bladder (FACT-BL) and the International Physical Activity Questionnaire (IPAQ), to measure participants' ($N$ = 472; 73.9 ± 9.9 years) quality of life and physical activity levels, respectively. These findings show that those who had physical activity levels that classified as moderate-high had an adjusted OR (95% CI) of 2.27 compared to people who classified under low-moderate had an OR (95% CI) of 1.21 (Gopalakrishna et al., 2017a). This cross-sectional study suggests that bladder cancer survivors that are more physically active have a higher perceived health-related quality of life.

Previous research has shown that women who experience upper limb disabilities have a lower quality of life than women who do not experience these symptoms (Chrischilles et al., 2019). Upper limb disability is a common side effect from treatment, with 30-74% of breast cancer survivors experiencing some form of should or arm disability (Chrischilles et al., 2019; Kramer et al., 2019). Due to the high prevalence of this disability, specific interventions focused on upper limb mobility are important to improve survivors' quality of life (Chrischilles et al., 2019). Mirandola et al. (2018) assessed the impact of adapted physical activity on upper limb disability and quality of life in breast cancer survivors. One hundred and twelve breast cancer survivors (56.8 ± 10.2 years) participated in an adapted physical activity program to reduce shoulder and arm complications. The adapted physical activity (APA) program was a total of eight weeks, and participants answered questionnaires assessing their quality of life and back and shoulder pain pre- and post-intervention, along with a fitness test assessing the mobility and range of motion (ROM) of their shoulder and arm. At the 1.5-year evaluation, twenty participants completed an assessment to assess the effectiveness of the APA. Post APA, participants experienced a significant increase in shoulder ROM, mobility, and low back flexibility. These significant improvements were seen in extension (43.9 ± .3 standard error of the mean (SEM) vs. 44.9 ± .1 SEM; $p = .001$), flexion (148.1 ± 2.3 SEM vs. 163 ± 1.9 SEM; $p < .001$), external rotation (65.1 ± 1.9 SEM vs. 74.6 ± 1.7 SEM; $p < .001$), abduction (144 ± 3.1 SEM vs. 162.5 ± 2.4 SEM; $p < .001$), shoulder mobility (16.6 ± .9 SEM vs. 11.9 ± .8 SEM; $p < .001$), and sit and reach (10.8 ± .9 SEM vs. 7.9 ± .9 SEM; $p < .001$) scores. Physical and mental scores for quality of life, measured with the SF-12, were significantly higher post-intervention compared to baseline (physical = 43.1 ± .6 vs. 40.6 ± .7; mental = 44.3 ± .9 vs. 40.8 ± 1.0; $p < .001$). For the women who participated in the 1.5-year follow-up, there were no significant ($p = .073$) improvements compared to post-intervention scores or even their baseline scores ($p = .24$). This study is important to the current literature because it shows that improving flexibility in breast cancer survivors can improve physical and quality of life, as well as ROM, mobility, and flexibility. These outcomes are possible for breast cancer survivors, but they may not persist long term if they do not adhere to the program.

To test the effects that physical activity levels from pre-to post-diagnosis have on quality of life, Anguinaga et al. (2018) conducted a cross-sectional study looking at the effects of physical activity on psychological well-being outcomes in breast cancer survivors ($N = 387$; 57.7 ± 9.6 years) from pre-diagnosis to post-treatment survivorship. Participants completed a survey that inquired about diagnosis date, treatment type, physical activity levels pre-and post-diagnosis, and quality of life. Participants were categorized based on their physical activity levels pre-and post-diagnosis into low-active maintainers, increasers, decreases, and high-active maintainers.

Findings showed that high-active maintainers reported significantly ($p < .01$) higher quality of life compared to the low-active maintainers and the group that decreased physical activity (27.1 ± .60 vs. 24.2 ± .60 vs. 23.0 ± .97). Participants who increased their physical activity levels after diagnosis reported significantly ($p < .02$) lower depressive symptoms compared to the participants who decreased their physical activity levels after diagnosis (26.8 ± .81 vs. 22.9 ± .97; $p < .02$). Cancer survivors who maintained a high activity level or increased their activity level after their cancer diagnosis reported a higher quality of life than participants who continued to be inactive or decreased their activity.

Knowing that cancer survivors have a lower health-related quality of life post-diagnosis compared to the general population, interventions to improve quality of life are necessary (Annunziata et al., 2018), Brown et al. (2018) conducted a randomized dose-response trial of aerobic exercise to improve colon cancer survivors' health-related quality of life. Participants (64% < 60 years, 62% women) in the intervention group were randomly assigned to either the low-dose (150 minutes/week; 50-70% age-predicted maximum heart rate) or the high-dose (300 minutes/week; 50-70% age-predicted maximum heart rate) group. The researchers utilized the SF-36 and the FACT-C to measure health-related quality of life at baseline and six months post-intervention. Participants in the low-dose group showed significant ($p = .014$) improvements in physical functioning (.1 ± 3.1) on the SF-36 and significantly ($p = .031$) improved their score on the FACT-C (2.1 ± 2.3). Participants in the high-dose group significantly ($p < .0001$) improved on the physical functioning (3.8 ± 3.4), role-physical (14.4 ± 10.8, $p = .035$), general health (7.1 ± 3.8, $p = .011$), vitality scale (12.1 ± 3.8, $p = .025$) and the FACT-C (2.7 ± 2.5, $p = .004$). Both groups' health-related quality of life improved significantly. The high-dose group showed significant improvements in multiple categories on the SF-36 compared to one category for the low-dose group, indicating a dose-response relationship between aerobic activity and improved health-related quality of life. Engaging in at least 300 minutes of moderate aerobic activity may provide additional benefits to cancer survivors' health-related quality of life compared to engaging in 150 minutes per week.

Although adult survivors of childhood cancer are long removed from cancer treatment, they are still at an increased risk for poor quality of life due to emotional and mental health (Ness et al., 2017). To study potential mediators to increase quality of life, Zhang et al. (2018) studied lifestyle factors in adult survivors of childhood cancer who are members of the St. Jude lifetime cohort study. Participants ($N$ = 2480, 54.7% male) were at least ten years post-cancer diagnosis and continuously reported comprehensive health questionnaires and clinical assessments at St. Jude Children's Research Hospital. Physical activity and health-related quality of life were measured using the National Health and Nutrition Examination Survey Physical Activity Questionnaire and the SF-36, respectively. Results demonstrated that cancer survivors meeting the physical activity guidelines had higher health-related quality of life in both physical and mental health domains (PCS $\beta = 3.1$, $p < .0001$; MCS $\beta = .48$, $p < .002$) compared to inactive participants (Zhang et al., 2018). This study illustrates that adult survivors of childhood cancer who reported higher physical activity levels also reported higher HRQOL scores. Increasing physical activity is beneficial for adult survivors of childhood cancer to raise their health-related quality of life.

With many studies reporting physical activity subjectively, Patsou et al. (2018) studied cancer survivors' physical activity levels and the impact on quality of life while measuring physical activity subjectively and fitness levels objectively. Physical activity and fitness levels were measured using the IPAQ and $VO_2$max test, respectively. Quality of life was assessed using the European Organization for Research and Treatment of Cancer. The metabolic equivalent of task (MET) associated with the $VO_2$ max test was found to be significantly positively correlated with QOL-physical EORTC30 ($r = .64$, $p < .001$), role EORTC30 ($r = .62$, $p < .001$), emotional EORTC30 ($r = .49$, $p < .001$), cognitive EORTC30 ($r = .42$, $p < .001$), and social EORTC30 ($r = .42$; $p < .001$) (Patsou et al., 2018). The correlation between the IPAQ and the $VO_2$max test was .91 ($p < .01$), indicating that the $VO_2$ max test was an accurate way to measure participants' fitness and an accurate estimate for how physically active participants were. This study shows that cancer survivors who were more physically active and had a higher $VO_2$ max also reported higher QOL scores on multiple subscales of the EORTC-QOL30 than less active cancer survivors.

Because African-American cancer survivors experience lower health-related quality of life than Caucasian survivors, it is important to understand the role physical activity can have on quality of life in this vulnerable population (Matthews et al., 2012). Beebe-Dimmer et al. (2020) conducted a study with the Detroit Research on Cancer Survivors (ROCS) cohort to examine physical activity and quality of life in African-American cancer survivors ($N = 1137$, female = 58%). Annually, participants updated researchers on their current physical activity level and health-related quality of life. Physical activity and health-related quality of life are measured using the IPAQ-SF and Functional Assessment of Cancer Therapy – General (FACT-G). Participants' physical activity levels categorized them into the "no reported physical activity" group, "0 to < 150 min of physical activity" group, or the "≥ 150 minutes of physical activity" group. Participants in the ≥ 150 minutes of physical activity group reported significantly higher scores on the FACT-G (85.6, 95% CI: 83.9 – 87.2; $p < .001$) compared to the group that reported no PA (74.3, 95% CI: 72.8 – 75.8) and 0 to < 150 minutes of PA group (78.5, 95% CI: 76.9 –

80.0) (Beebe-Dimmer et al., 2020). African-American cancer survivors who report at least 150 minutes per week of physical activity have a significantly higher quality of life than members who report less than 150 minutes of physical activity per week.

The YMCA's LIVESTRONG program has been implemented at certain locations to provide cancer survivors with a specific physical activity program. Irwin et al. (2017) conducted a study to see the LIVESTRONG program's impact on participants' (*N* = 186, 59.3 ± 10.4 years) physical activity levels and quality of life. An interview administered questionnaire along with the FACT-G assessed physical activity and quality of life, respectively. At the end of the three-month program, 71% of the LIVESTRONG program participants reported engaging in at least 150 minutes of activity per week, while only 26% of the control group reported that amount of physical activity. Participants in the LIVESTRONG program reported a mean increase of 127 ± 126 minutes/week compared to the control group, with a mean reduction of 5.8 ± 6 minutes/week in their physical activity over the three months. Also, participants who were less than 3.6 years from diagnosis reported significant improvements to their quality of life scores post-program (2.3, 95% CI: -.2-4.6; $p = .03$) compared to participants less than 3.6 years from diagnosis in the control group (-1.8, 95% CI: -4.7-1.0). The LIVESTRONG program increased cancer survivors' physical activity levels across the three-month program and significantly increased quality of life in cancer survivors who were less than 3.6 years from diagnosis. Cancer survivors can utilize the LIVESTRONG program to increase their physical activity and improve their quality of life.

Previous literature has shown that physical activity has a plethora of benefits for cancer survivors. The benefits that have been highlighted throughout this section are improved fatigue levels, maintaining or achieving a healthy body weight, improved sleep quality, improved anxiety and depression, and an overall improved health-related quality of life. Despite the benefits that physical activity can provide cancer survivors, there is an insufficient amount of cancer survivors experiencing these benefits and meeting the physical activity guidelines.

**Physical Activity Prescription.** One way to promote physical activity among varying populations is a physical activity prescription**.** Physical activity prescriptions have been implemented in previous research to improve patients' physical activity levels. This section aims to provide the current literature on the effectiveness of a physician's physical activity prescription.

To test the effectiveness of a physician's physical activity prescription, Grandes et al. (2009) conducted a randomized trial that involved investigating the effectiveness of physical activity prescriptions by physicians to their patients ($N$ = 4317; 20-80 years). The researchers used the 7-Day Physical Activity Recall (PAR), which showed that the group that was prescribed physical activity ($N$ = 2248) increased physical activity by 18 minutes per week (95% CI: 6-31 minutes) or 1.3 MET-h/wk (95% CI: .4-2.2 MET-h/wk). The proportion of individuals meeting the minimum physical activity guidelines was 3.9% higher in the group that received a physical activity prescription. When excluding outliers, there seemed to be a more considerable improvement, showing an increase of 24 min/wk (95% CI: 9-39 min/wk), 1.7 MET-h/wk (95% CI: .6-2.7 MET-h/wk), and 4.4% (95% CI: 1.6%-7.5%) meeting physical activity recommendations (Grandes et al., 2009). Patients who received a physical activity prescription were more likely to meet physical activity guidelines than patients who did not receive a physical activity prescription.

Similarly, Yaman et al. (2018) investigated the effect of an exercise prescription from physicians on quality of life. Participants ($N$ = 179; 57.7 ± 5.1 years) were randomized into either the intervention group ($N = 69$), which received an exercise prescription, or a control group ($N = 110$). The exercise prescription had a balance of endurance, balance, flexibility, and strength training. Endurance was prescribed 3-5 days/week, and strength, balance, and flexibility were prescribed 2-3 days/week. Healthcare providers gave participants a new prescription each month based on how they performed the previous month. Six months following the exercise prescription, the intervention group significantly improved in physical functioning (81.7 ± 11.9 vs. 84.9 ± 12.1; $p < .005$), physical role function (86.2 ± 32.2 vs. 80.9 ± 33.3; $p < .005$), body pain (26.1 ± 22.3 vs. 31.4 ± 22.9; $p < .005$), mental health (57 ± 8.1 vs. 52.9 ± 10.4; $p < .005$), vitality (53.9 ± 11.9 vs. 52.1 ± 12.3; $p < .005$), and emotional role function (74.9 ± 41.4 vs. 63.9 ± 42.9; $p < .005$) compared to the control group who did not receive a prescription (Yaman & Atay, 2018a). A physical activity prescription from a physician has been shown to have a small effect on physical activity levels and improve several aspects of quality of life.

To assess the impact of a healthcare provider's physical activity prescription among patients during preventative care visits, researchers assigned participants ($N = 24$, 57 ± 10 years) to intervention groups that included a written prescription only (PO; $N = 16$), written prescription, and exercise toolkit (PT; $N = 10$), or written prescription and active living guide (PALG; $N = 15$). Follow-up questionnaires were completed at month one and month three to track physical activity levels. The researchers implemented the aerobic center longitudinal study questionnaire to assess physical activity. Data analysis showed that the PT group increased their physical activity level from baseline (3.0 ± 1.1) to month 3 (4.8 ± .4; $p = .01$), while the other two groups did not increase their physical activity over the three months (Josyula & Lyle, 2013a). Results from this study may provide insight that a written physical activity prescription may not be enough to raise an individual's physical activity level. A written prescription and exercise toolkit, consisting of resistance bands and directions, significantly ($p$ = .01) improved participants' physical activity levels and proved to be more beneficial than a written exercise prescription.

Similarly, Rodjer et al. (2016) investigated the effects of a physical activity prescription on individuals' physical activity levels for two years. Participants ($N$ = 146, 55 ± 11 years) completed a survey at six, twelve, and twenty-four months which inquired about their physical activity level via Saltin-Grimby Physical Activity Level Scale (SGPALS). The regular healthcare provider used the physical activity on prescription (PAP) method, which consists of a written physical activity prescription, a referral to a PAP coordinator (typically a physiotherapist) who conducted a patient-centered interview. At six ($p < .001$) and twelve months ($p < .01$), there was a significant improvement in self-reported physical activity while the control group did not change (M6 $p$ = .41, M12 $p$ = .74) (Rödjer et al., 2016). At baseline, twenty-two participants reported sedentary behavior, while only eleven participants reported sedentary behavior at twenty-four months. Of those eleven participants, two reported engaging in MVPA, and nine reported engaging in light physical activity at the twenty-four-month follow-up. This study demonstrates that a physical activity prescription that includes a patient-centered interview significantly improved participant's physical activity levels up to twelve months but did not show sustained results at twenty-four months. This method may improve physical activity levels for up to a year but not for more extended periods. This method may influence cancer survivors to become active, but more research is needed for sustaining physical activity levels.

Physical activity is an effective method to help prevent and alleviate symptoms from metabolic syndrome, an epidemic that affects roughly 20% of Western countries' population (Golbidi et al., 2012). Lundqvist et al. (2017) conducted a study examining if a physical activity on prescription (PAP) is an effective method to increase physical activity among participants with metabolic risk factors. The PAP included a dialogue with the participant based on motivational interviewing to focus on behavior change, and then each participant was given a written prescription of physical activity. Participants' physical activity was reported using two different measures. First, a scoring system was used in which 30 minutes of moderate-intensity physical activity per day resulted in one point, and 20 minutes of vigorous-intensity physical activity results in 1.7 points. An inadequate physical activity level is classified as a value less than five. Secondly, the IPAQ was used to assess physical activity over the participants last seven days. Participants' ($N$ = 368, 57.4 ± 10.9 years) physical activity was estimated to be low at baseline, with 36% of participants reporting sedentary behavior according to the IPAQ, and 80% reported physical activity levels equivalent to a 30-minute brisk walk per week or less as their total amount of physical activity. At the six month follow up, 270 participants (73%, $d$ = 1.17) increased their physical activity level from inadequate to sufficient according to the point system used, and 153 participants (42%) improved their physical activity levels from inadequate to sufficient according to the ACSM guidelines (Lundqvist et al., 2017). Most participants in this study improved their physical activity levels to meet guidelines, even at the six-month follow-up. The physical activity on prescription method effectively improved most individuals' physical activity levels at the six-month follow-up period.

Physical activity prescriptions have been shown to increase physical activity levels and quality of life in the general population and populations with metabolic risk factors (Lundqvist et al., 2017; Rödjer et al., 2016; Yaman & Atay, 2018b). Although it has been effective in other populations, there is little data to provide evidence of a physical activity prescription's effectiveness among cancer survivors.

**Conclusion**

Cancer survivors may experience many adverse side effects from cancer treatment such as fatigue, negative impacts on body weight, poor sleep quality, anxiety, and depression, leading to a lowered health-related quality of life. Engaging in regular physical activity is one strategy that cancer survivors can use to alleviate cancer treatment's negative consequences. Cancer survivors may not be active because of the numerous barriers they face. One way to encourage cancer survivors to become physically active is through a healthcare providers' physical activity prescription. If a healthcare provider's physical activity prescription is effective, cancer survivors may reap the benefits physical activity provides.

# Chapter III. Methods

This pilot exploratory study examined the relationship between a health providers' physical activity prescription and cancer survivors' physical activity levels. First, participants provided their demographics and health history. Then, participants provided if they have received a physical activity prescription from their healthcare provider and their current physical activity level. Lastly, participants provided information regarding their sleep quality, depression, anxiety, health-related quality of life, fatigue, and stress.

## Participants

For participants to be eligible for this study, they needed to be a cancer survivor at least 18 years of age and at least one-year post-cancer treatment. Cancer survivors younger than 18 or who have had cancer treatment within the last year were excluded from the study. Thirty-nine participants were recruited via social media.

## Data Collection Procedures

First, IRB approval was obtained for the survey that was administered to the participants. Participants completed an informed consent form before completing the survey. Participants then completed a Qualtrics questionnaire comprised of the questionnaires described below.

## Measures

Participants completed multiple subjective measures. A list of all subjective measures can be found in Table 1.

**Physical Activity Prescription.** To assess if participants received a physical activity prescription during treatment, they were asked a question that read "Did your healthcare provider prescribe you physical activity during cancer treatment?" If they answered "yes," then participants were asked "What type of activity was prescribed?

and the options to choose from were aerobic, resistance training, flexibility, or other. Participants were then asked, “What frequency of physical activity was prescribed?” followed by “What duration of physical activity was prescribed?” The same questions were asked for post-treatment physical activity prescription with the initial questions reading “Did your healthcare provider prescribe you physical activity post cancer treatment?

**Physical Activity Levels.** The International Physical Activity Questionnaire (IPAQ) was utilized to measure physical activity. The IPAQ was developed to measure health-related physical activity amongst populations between the ages of 15-69 years. Craig et al. (2003) conducted a reliability and validity study of the IPAQ (*N* = 1974). Data was collected over a 3 - to 7 - day period, which required participant contact on three separate occasions. The first session entailed completing the IPAQ and receiving an accelerometer that participants would wear over the next seven days. Up to one week later, participants completed the IPAQ a second time. Three days following the second visit, participants completed the IPAQ to complete the third visit's reliability component. The IPAQ short form was found to be a reliable (pooled [rho] = .76 (95% CI; .73-.77) and moderately valid measure (median rho = .30 (95% CI; .23-.36) (Craig et al., 2003). Categorical and continuous scoring was used to classify participants’ physical activity levels. Those classified as “High” amount of physical activity met one of the two criteria: Vigorous activity at least three days per week, accumulating a minimum of 1500 MET-minutes per week or seven days of any combination of walking, moderate-intensity, or vigorous activity. Moderately physically active participants met one of the three criteria: three or more days of vigorous activity that is at least 20 minutes per day, five or more days of moderate-intensity activity at least 30 minutes per day, or five or more days of any combination of walking, moderate, or vigorous-intensity activities. Lastly, participants who categorize as low did not meet the criteria for moderate or high physical activity. Lastly, if an individual does not meet the criteria for "high" or "moderate," they will be classified as performing "light" physical activity. To calculate MET-minutes 3.3 METs was used for light activity, 4.0 METs for moderate activity, and 8.0 METs was used for vigorous activity. The calculation for each score was calculated by using the MET level x minutes of activity x days per week.

**Sleep Quality.** The Pittsburgh Sleep Quality Index (PSQI) was utilized to measure sleep quality. The PSQI is a self-reported measure of quality of sleep, assessing sleep quality and disturbances over the previous month. The PSQI scores seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, sleep medication, and daytime dysfunction. Buysse et al. (1989) were the first to test the reliability and validity of the PSQI. Group one consisted of "good" sleepers, and group two consisted of "poor" sleepers. Among participants (50.9 ± 17.8 years), the seven component scores of the PSQI were found to have a reliability coefficient (Cronbach's alpha) of .83, indicating a high level of internal consistency (Buysse et al., 1989a). A global score of five was used as a cutoff to differentiate between poor sleep and good sleepers. A cutoff of five correctly identified 88.5% (131/148) of all patients and controls (kappa = .75; $p < .001$) (Buysse et al., 1989a). The scale has a total of nine questions. Questions one through four are free-response questions for the participant to answer, such as "When have you usually gone to bed?" and "When have you usually gotten up in the morning?" Questions five through nine are scored on a 0 to 3 scale, where a three reflects negatively experiencing a specific component of sleep three or more times per week. The highest possible score on the PSQI is a score of 21, which indicates the worst possible sleep quality, and the lowest score is a 0, which is the best possible score on this construct. A global sum of 5 or higher indicates "poor" sleep.

**Depression & Anxiety.** The Hospital Anxiety and Depression Scale (HADS) was used to measure depression and anxiety. The Hospital Anxiety and Depression Scale is a reliable and valid instrument to assess depression and anxiety. Initial research was conducted with participants from a medical outpatient clinic ($N$ = 100) who have experienced a wide variety of adverse health effects and illnesses. The depression ($r$ = .70) and anxiety ($r$ = .74) subscales were found to be valid measures that can accurately measure the severity of an individual's depression and anxiety levels. The reliability of the scale was measured by how accurately the subscale categorized symptoms of depression and anxiety. Of the 100 participants, there were 1% false positive, 1% false negatives for depression, and 5% false-positive, and 1% false negatives were experienced for the anxiety subscale. Each question was scored on a four-point scale (0-3), with a higher score indicating a less favorable outcome for the participant. Questions regarding anxiety and depression are scored separately, with each variable having a total score ranging from 0-21. A score of 0-7 is regarded as the normal range, a score between 8-10 is regarded as borderline abnormal, and a score between 11-21 is an abnormal case.

**Health-Related Quality of Life.** The SF-12 Short Form Health Survey was used to measure health-related quality of life. Based on cross-sectional surveys used by the National Survey of Functional Health Status (NSFHS) and the Medical Outcomes Study (MOS), the SF-12 Short Form Health Survey was found to have multiple R squares of .91 and .92 ($p$ < .01) in predicting the SF-12 physical component summary and SF-12 mental component summary scores, respectively (Ware et al., 1996). The physical (RV coefficient=.93) and the mental (RV coefficient=1.07) component summaries were valid measures for measuring the physical and mental aspects of quality of life. The survey is a measure of physical health, emotional health, mental health, and social health. The answer choices were coded from one to six for scoring purposes, with overall scores ranging from 12-72, with a higher score indicating a higher quality of life. For categorical scoring purposes the median score was calculated and participants above the median were categorized as “Good Quality of Life” and participants below the median score was classified as “Poor Quality of Life.” The 12-item subscale is a condensed version of the Medical Outcome Study 36 Item Short Item Short-Form Health Survey (SF-36). The scale measures the physical and mental health components of the American population.

**Fatigue.** The Patient-Reported Outcomes Measurement Information System (PROMIS) SF-7a was used to measure fatigue. Cella et al. (2010) developed and tested the PROMIS subscale. The 7-item fatigue short form was found to be reliable ($r$ = .91) and valid ($r$ = .76) for measuring an individual’s current fatigue levels. PROMIS-SF-7a was found to have a strong correlation ($r$ = .95) to the FACIT-Fatigue scale and the SF-36 Vitality Scale ($r$ = .89) (Cella et al., 2010). Each question on the PROMIS-SF fatigue scale had answer choices ranging from one to five. The sum of the answer choices was calculated to score the short form. There were seven questions on the short form; the lowest score a participant can receive is a 7, and the highest score they could receive is 35. A higher score indicates that the participant is experiencing higher levels of fatigue. For categorical scoring purposes a score above 21 was considered “High” and a score below 21 was categorized as “Normal.”

**Stress.** The Perceived Stress Scale – 10 (PSS-10) was used to measure stress. The PSS was found to be a reliable ($r$ = .78) and moderately valid ($r$ = .39) subscale to measure perceived stress (Cohen, 1988). The PSS – 10 is a short scale of the original 14 – item scale. Each of the ten questions was rated on a five-point Likert type scale (0 = never to 4 = very often). Scores are summed with a higher score indicating greater amounts of stress. The maximum score is 40, and the minimum score is 0. For categorical scoring purposes a score from 0-13 was classified as "low stress", 14-26 was classified as "moderate stress", and 27-40 was classified as "high perceived stress" (Cohen, 1988).

**Table 1**

*List of Measurements*

| Measured Outcomes | Instruments/Measurements |
|---|---|
| Demographics | Demographics form |
| Health History | Health History Questionnaire |
| Physical Activity Levels | International Physical Activity Questionnaire |
| Sleep Quality | Pittsburgh Sleep Quality Index |
| Depression | Hospital Anxiety and Depression Scale |
| Anxiety | Hospital Anxiety and Depression Scale |
| Quality of Life | SF12 Short Form Health Survey |
| Fatigue | PROMIS-SF |
| Stress | Perceived Stress Scale-10 |

**Statistical Analysis**

Descriptive statistics were used for demographics and health history. An independent t-test was used to measure any differences in key continuous variables between the group that was prescribed physical activity versus the group that was not. A chi-square test was used determine if there was an association between the variables which were also scored categorically. A linear regression was used to predict if a physical activity prescription had an impact on the outcome measures. Another linear regression was conducted using a physical activity prescription and age to predict if there was an impact on the outcome measures. A third regression was used to predict if a physical activity prescription and time since cancer treatment had an impact on the outcome measures. Lastly, Cohen's d was used to measure the effect size a physical activity prescription had on the outcome measures. Statistical significance was set at $p < .05$ for the necessary statistical tests.

# Chapter IV. Results

## Recruitment

One-hundred thirteen individuals recorded responses on the Qualtrics survey. Of the 113 respondents, 61 were deemed insufficient due to a lack of responses. Thirteen individuals were removed due to missing data that pertained to the objective of the study. Thirty-nine individuals were deemed eligible for the current study.

## Participant Characteristics

**Table 2**

*Additional Descriptive Statistics of Participants*

| Variable | *N* | % |
|---|---|---|
| Marital Status | | |
| Married | 21 | 53.8 |
| Living as married | 1 | 2.6 |
| Widowed | 4 | 10.3 |
| Divorced | 3 | 7.7 |
| Never married/single | 10 | 25.6 |
| Household Income | | |
| <$15,999 | 4 | 10.3 |
| $16,000 to $24,999 | 3 | 7.7 |
| $25,000 to $34,999 | 3 | 7.7 |
| $35,000 to $49,999 | 3 | 7.7 |
| $50,000 to $74,999 | 6 | 15.4 |
| $75,000 and greater | 18 | 46.2 |
| Refuse to answer | 2 | 5.1 |

Data about participants' physical activity, sleep quality, depression, anxiety, quality of life, fatigue, and stress was collected from 39 participants. The reported mean age and BMI were 48.1 ± 17.9 years and 26.6 ± 6.0 kg/m$^2$, respectively. Most participants were female (*N* = 29, 74.4%) and Caucasian (*N* = 36, 92.3%). Participants also identified as Hispanic (*N* = 1, 2.6%), Asian (*N* = 1, 2.6%), and Native American (*N* = 1, 2.6%). Of the 39 participants, 19 (48.7%)

completed a bachelor's degree, 11 (28.2%) earned a graduate degree, 5 (12.8%) attended college or vocational school, and 4 (10.3%) earned a high school diploma or GED. Additional descriptive statistics can be found in Table 2.

### Participants' Cancer History

Of the 39 participants, 16 (41%) reported being diagnosed with breast cancer, 12 (30.8%) reported "other" (e.g., lymphoma, Non-Hodgkin's lymphoma, ovarian, stomach cancer), 5 (12.8%) reported leukemia, 3 (7.7%) reported kidney cancer, 2 (5.1%) reported prostate cancer, and 1 (2.6%) participant reported being diagnosed with endometrial cancer. Of the 39 participants, 19 (48.7%) reported being diagnosed with stage 1 cancer, 8 (20.5%) were diagnosed with stage 2, 3 (7.7%) were diagnosed with stage 3, 4 (10.3%) were diagnosed with stage 4, and 5 participants, (12.8%) did not report the stage of their diagnosis. Information on participants' cancer treatment can be found in Table 3, while additional information about the participants' cancer history can be found in Table 4.

**Table 3**

*Cancer Treatment*

| Treatment Type | N | % |
|---|---|---|
| Chemotherapy | 24 | 61.5% |
| Radiation Therapy | 24 | 61.5% |
| Surgery | 26 | 66.7% |
| Immunotherapy | 9 | 23.1% |
| Hormonal Therapy | 3 | 7.7% |
| Targeted Therapy | 4 | 10.3% |
| Other | 4 | 10.3% |

*Note.* Participants were instructed to select all cancer treatments they received.

**Table 4**

*Cancer History*

| Variable | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|
| Time since diagnosis (Months) | 118.8 | 102.2 | 16.0 | 396.0 |
| Time since last treatment (Months) | 97.0 | 96.1 | 12.0 | 389 |

## Physical Activity Prescriptions

Of the 39 participants, 12 (30.8%) participants reported being prescribed physical activity during cancer treatment by their healthcare provider. Next, 18 (46.2%) participants reported being prescribed physical activity post-cancer treatment by their healthcare provider. Ten (25.6%) participants reported receiving a physical activity prescription both during treatment and post-treatment, while sixteen (41%) participants reported that they did not receive a physical activity prescription at either time point.

## Physical Activity Prescription and Outcome Measures

During Cancer Treatment Physical Activity Prescription and Outcome Measures. The independent sample t-test showed no significant relationship between a healthcare providers' physical activity prescription during cancer treatment and MET-minutes ($p$ = .549), anxiety ($p$ = .382), depression ($p$ = .955), fatigue ($p$ = .416), sleep quality ($p$ = .415), stress ($p$ = .675), and health-related quality of life ($p$ = .451). Additional results from the independent sample t-test can be found in Table 5.

**Table 5**

*T-Test Results for During Cancer Treatment Physical Activity Prescription and Health Outcomes*

| Measures | Prescribed Physical Activity ($N$ = 12) | | Not Prescribed Physical Activity ($N$ = 23) | | $t$(35) | $p$ | Cohen's $d$ |
|---|---|---|---|---|---|---|---|
| | $M$ | $SD$ | $M$ | $SD$ | | | |
| MET-minutes | 2880.3 | 2159.0 | 2303.0 | 2903.0 | 0.605 | .549 | .216 |
| Anxiety | 10.0 | 2.3 | 9.1 | 3.1 | 0.887 | .382 | .316 |
| Depression | 3.6 | 2.7 | 3.7 | 3.7 | -.057 | .955 | -.020 |
| Fatigue | 15.1 | 4.5 | 17.7 | 5.2 | -1.44 | .157 | -.515 |
| Sleep Quality | 10.3 | 5.2 | 8.8 | 4.7 | .825 | .415 | .294 |
| Stress | 31.3 | 4.0 | 31.1 | 3.6 | .123 | .903 | .044 |
| Health-Related Quality of Life | 32.3 | 2.7 | 33.0 | 2.5 | -.763 | .451 | -.272 |

*Note.* $p < .05$

A chi-square test of independence showed no significant difference in MET-minutes reported between those who had and did not have physical activity prescribed by a healthcare provider. ($X^2$ (2, $N$ = 35) =.390, $p$ = .823). Additional findings from the chi-square test of independence showed no difference in anxiety ($X^2$(2, $N$ = 35) = 2.12, $p$ = .346), depression ($X^2$(2, $N$ = 35) = 1.28, $p$ = .527), fatigue ($X^2$(1, $N$ = 35) = .998, $p$ = .318), sleep quality ($X^2$(1, $N$ = 35) = .048, $p$ = .827), stress ($X^2$(1, $N$ = 35) = 2.36, $p$ = .125), and health-related quality of life ($X^2$(1,$N$ = 35) = .015, $p$ = .903) among those who did and did not receive a physical activity prescription by their healthcare provider.

A regression analysis revealed no significant association between a healthcare providers' physical activity prescription during cancer treatment on health outcomes. Further results from the regression analysis can be found in Table 6. Two additional regression analyses were conducted. First, a regression using a healthcare providers' physical activity prescription during cancer treatment and age was conducted to predict health outcomes, which revealed no significant relationships among health outcomes. Secondly, a regression using a healthcare providers' physical activity prescription during cancer treatment and participants time since treatment was conducted to predict physical activity and health outcomes, which revealed no significant relationships. Further results from these regression analyses can be found in Table 7 & 8, respectively.

**Table 6**

*Regression Coefficient for Physical Activity Prescription During Cancer Treatment (PATREATMENT) on Health Outcomes*

| Variable | *B* | *SE* | *t* | *p* | 95% CI |
|---|---|---|---|---|---|
| | | MET-minutes | | | |
| PATREATMENT | 0.00 | .000 | -.605 | .549 | [0,0] |
| $R^2$ | -.019 | | | | |
| | | Anxiety | | | |
| PATREATMENT | -.025 | .282 | 6.72 | .382 | [-.08, .03] |
| $R^2$ | -.006 | | | | |
| | | Depression | | | |
| PATREATMENT | .001 | .025 | .057 | .955 | [-.05, .05] |
| $R^2$ | -.030 | | | | |
| | | Fatigue | | | |
| PATREATMENT | 2.57 | 1.78 | 1.45 | .157 | [-1.0, 6.2] |
| $R^2$ | .031 | | | | |
| | | Sleep Quality | | | |
| PATREATMENT | -.014 | .017 | -.825 | .415 | [-.05, .02] |
| $R^2$ | -.009 | | | | |
| | | Stress | | | |
| PATREATMENT | -.163 | 1.32 | -.123 | .903 | [-2.9, 2.5] |
| $R^2$ | -.030 | | | | |
| | | Health-Related Quality of Life | | | |
| PATREATMENT | .025 | .032 | .763 | .451 | [-.04, .09] |
| $R^2$ | -.012 | | | | |

*Note. p < .05*

**Table 7**

*Regression Coefficient for Physical Activity Prescription During Cancer Treatment (PATREATMENT) and Age on Health Outcomes*

| Variable | *B* | *SE* | *t* | *p* | 95% CI |
|---|---|---|---|---|---|
| | | MET-minutes | | | |
| PATREATMENT | -602.7 | 934.6 | -.645 | .524 | [-2506.5, 1301.0] |
| Age | 40.3 | 26.2 | 1.54 | .133 | [-13.0, 93.7] |
| $R^2$ | .022 | | | | |
| | | Anxiety | | | |
| PATREATMENT | -.915 | 1.05 | -.876 | .388 | [-3.0, .06] |
| Age | .004 | .029 | .128 | .899 | [-.06, .06] |
| $R^2$ | -.037 | | | | |
| | | Depression | | | |
| PATREATMENT | .048 | 1.21 | .039 | .969 | [-2.4, 2.5] |
| Age | .033 | .034 | .978 | .335 | [-.04, .10] |
| $R^2$ | -.032 | | | | |
| | | Fatigue | | | |
| PATREATMENT | 2.57 | 1.80 | 1.43 | .164 | [-1.1, 6.2] |
| Age | -.003 | .051 | -.060 | .952 | [-.11, .10] |
| $R^2$ | .001 | | | | |
| | | Sleep Quality | | | |
| PATREATMENT | -1.44 | 1.75 | -.820 | .418 | [-5.0, 2.1] |
| Age | .022 | .047 | .478 | .636 | [-.07, .12] |
| $R^2$ | -.037 | | | | |
| | | Stress | | | |
| PATREATMENT | -.161 | 1.34 | -.021 | .905 | [-2.9, 2.6] |
| Age | -.003 | .038 | -.068 | .946 | [-.08, .07] |
| $R^2$ | -.062 | | | | |
| | | Health-Related Quality of Life | | | |
| PATREATMENT | .697 | .936 | .745 | .462 | [-1.2, 2.6] |
| Age | .015 | .026 | .565 | .576 | [-.04, .07] |
| $R^2$ | -.034 | | | | |

*Note.* $p < .05$

**Table 8**

*Regression Coefficient for Physical Activity Prescription During Cancer Treatment (PATREATMENT) and Time Since Treatment on Health Outcomes*

| Variable | *B* | *SE* | *t* | *p* | 95% CI |
|---|---|---|---|---|---|
| | | MET-minutes | | | |
| PATREATMENT | -721.9 | 965.9 | -.747 | .461 | [-2688.6, 1246.3] |
| Time since treatment | 4.63 | 4.77 | .972 | .338 | [--5.1, 14.3] |
| $R^2$ | .039 | | | | |
| | | Anxiety | | | |
| PATREATMENT | -.894 | 1.058 | -.845 | .404 | [-3.05, 1.3] |
| Time since treatment | -.001 | .005 | -.115 | .909 | [-.011, .01] |
| $R^2$ | .024 | | | | |
| | | Depression | | | |
| PATREATMENT | -.109 | 1.23 | -.089 | .930 | [-2.61, 2.39] |
| Time since treatment | .006 | .006 | .945 | .352 | [-.007, .018] |
| $R^2$ | .027 | | | | |
| | | Fatigue | | | |
| PATREATMENT | 2.44 | 1.82 | 1.35 | .188 | [-1.3, 6.2] |
| Time since treatment | .004 | .009 | .428 | .671 | [-.01, .02] |
| $R^2$ | .065 | | | | |
| | | Sleep Quality | | | |
| PATREATMENT | .008 | .009 | .927 | .361 | [-.01, .03] |
| Time since treatment | -1.67 | 1.75 | -.955 | .347 | [-5.24, 1.89] |
| $R^2$ | .046 | | | | |
| | | Stress | | | |
| PATREATMENT | -1.03 | 1.55 | -.665 | .514 | [-4.27, 2.21] |
| Time since treatment | .012 | .008 | 1.54 | .139 | [-.004, .027] |
| $R^2$ | .114 | | | | |
| | | Health-Related Quality of Life | | | |
| PATREATMENT | .571 | .939 | .608 | .547 | [-1.3, 2.5] |
| Time since treatment | .004 | .005 | .941 | .354 | [-.005, .014] |
| $R^2$ | .044 | | | | |

*Note. $p < .05$*

Post-Treatment Physical Activity Prescription and Outcome Measures. The independent sample t-test showed no significant differences in MET-minutes ($p$ = .896), anxiety ($p$ = .400), depression ($p$ = .510), fatigue ($p$ = .413), sleep quality ($p$ = .984), stress ($p$ = .924), and health-related quality of life ($p$ = .435) between receiving a healthcare providers' physical activity prescription post-cancer treatment and not receiving a prescription post-cancer treatment. . Further results from the independent sample t-test can be found in Table 9.

**Table 9**

*T-test results for Post-Cancer Treatment Physical Activity Prescription and Health Outcomes*

| Measures | Prescribed Physical Activity ($N$ = 18) | | Not Prescribed Physical Activity ($N$ = 21) | | $t$(39) | $P$ | Cohen's $d$ |
|---|---|---|---|---|---|---|---|
| | $M$ | $SD$ | $M$ | $SD$ | | | |
| MET-minutes | 2475.4 | 1928.9 | 2366.4 | 3040.9 | 0.131 | .896 | .042 |
| Anxiety | 9.8 | 2.4 | 9.0 | 3.8 | 0.852 | .400 | .274 |
| Depression | 3.9 | 3.5 | 3.2 | 3.1 | 0.665 | .510 | .214 |
| Fatigue | 16.2 | 4.9 | 17.6 | 5.6 | -.827 | .413 | -.266 |
| Sleep Quality | 9.2 | 3.7 | 9.2 | 5.5 | 0.021 | .984 | .007 |
| Stress | 31.1 | 3.3 | 31.0 | 3.8 | .096 | .924 | .031 |
| Health-Related Quality of Life | 32.9 | 3.0 | 32.1 | 2.9 | 0.789 | .435 | .254 |

*Note.* $p < .05$

A chi-square test of independence showed that there was no significant differences in physical activity categories between receiving and not receiving a healthcare provider physical activity prescription post-cancer treatment ($X^2$, (2, $N$ = 39) =.167, $p$ = .920). Further, no significant group differences were found among health outcomes such as anxiety ($X^2$(2, $N$ = 39) = 1.49, $p$ = .475), depression ($X^2$(2, $N$ = 39) = .027, $p$ = .987), fatigue ($X^2$(1, $N$ = 39) = 1.81, $p$ = .178), sleep quality ($X^2$(1, $N$ = 39)=.014, $p$ = .907), stress ($X^2$(1, $N$ = 39)=.803, $p$ = .370), and health related quality of life ($X^2$(1, $N$ = 39)=1.29, $p$ = .256).

The regression analysis findings revealed no significant association between a healthcare providers' physical activity prescription post-cancer treatment on health outcomes. Further results from the regression analysis can be found in Table 10. Two additional regression analyses were conducted. First, a regression analysis utilizing a healthcare providers' physical activity prescription post-cancer treatment and age was conducted to predict health outcomes, which also revealed no significant relationships among health outcomes. Next, a regression using a healthcare providers' physical activity prescription post-cancer treatment and participants time since treatment was conducted to predict physical activity and health outcomes, which revealed no significant relationships. Further results from these regression analyses can be found in Table 11 & 12, respectively.

**Table 10**

*Regression Coefficient for Physical Activity Prescription Post-Cancer Treatment (PAPOST) on Health Outcomes*

| Variable | *B* | *SE* | *t* | *p* | 95% CI |
|---|---|---|---|---|---|
| | | MET-minutes | | | |
| PAPOST | -109.0 | 831.9 | -.131 | .896 | -1794.6, 1576.6 |
| $R^2$ | -.027 | | | | |
| | | Anxiety | | | |
| PAPOST | -.881 | 1.03 | -.852 | .400 | [-3.0, 1.2] |
| $R^2$ | -.007 | | | | |
| | | Depression | | | |
| PAPOST | -.698 | 1.05 | -.665 | .510 | [-2.8, 1.4] |
| $R^2$ | -.015 | | | | |
| | | Fatigue | | | |
| PAPOST | 1.40 | 1.69 | .827 | .413 | [-2.0, 4.8] |
| $R^2$ | -.008 | | | | |
| | | Sleep Quality | | | |
| PAPOST | -.032 | 1.53 | -.021 | .984 | [-3.1, 3.1] |
| $R^2$ | -.027 | | | | |
| | | Stress | | | |
| PAPOST | -.111 | 1.15 | -.096 | .924 | [-2.5, 2.2] |
| $R^2$ | -.027 | | | | |
| | | Health-Related Quality of Life | | | |
| PAPOST | -.746 | .945 | -.789 | .435 | [-2.7, 1.2] |
| $R^2$ | -.010 | | | | |

*Note.* $p < .05$

**Table 11**

*Regression coefficient for Physical Activity Prescription Post-Cancer Treatment (PAPOST) and Age on health outcomes.*

| Variable | *B* | *SE* | *t* | *p* | 95% CI |
|---|---|---|---|---|---|
| | | | MET-minutes | | |
| PAPOST | 226.5 | 898.8 | .252 | .802 | [-1596.4, 2049.4] |
| Age | 25.1 | 25.4 | .988 | .330 | [-26.4, 76.6] |
| $R^2$ | -.027 | | | | |
| | | | Anxiety | | |
| PAPOST | -1.53 | 1.09 | -1.39 | .172 | [-3.8, .70] |
| Age | -.048 | .031 | -1.56 | .127 | [-.11, .01] |
| $R^2$ | .081 | | | | |
| | | | Depression | | |
| PAPOST | -.475 | 1.15 | -.415 | .681 | [-2.8, 1.6] |
| Age | .017 | .032 | .516 | .609 | [-.05, .08] |
| $R^2$ | .019 | | | | |
| | | | Fatigue | | |
| PAPOST | 1.31 | 1.85 | .707 | .484 | [-2.4, 5.1] |
| Age | -.007 | .052 | -.128 | .899 | [-.11, .10] |
| $R^2$ | -.036 | | | | |
| | | | Sleep Quality | | |
| PAPOST | .220 | 1.67 | .132 | .896 | [-3.2, 3.6] |
| Age | .019 | .047 | .399 | .693 | [-.08, .11] |
| $R^2$ | .004 | | | | |
| | | | Stress | | |
| PAPOST | -.342 | 1.26 | -.271 | .788 | [-2.9, 2.2] |
| Age | -.017 | .036 | -.485 | .631 | [-.09, .06] |
| $R^2$ | -.048 | | | | |
| | | | Health-Related Quality of Life | | |
| PAPOST | -1.10 | 1.02 | -1.08 | .290 | [-3.2, .98] |
| Age | -.026 | .029 | -.914 | .367 | [-.09, .03] |
| $R^2$ | .039 | | | | |

*Note.* $p < .05$

**Table 12**

*Regression Coefficient for Physical Activity Prescription Post-Cancer Treatment (PAPOST) and Time Since Treatment on Health Outcomes*

| Variable | *B* | *SE* | *t* | *p* | 95% CI |
|---|---|---|---|---|---|
| | | | MET-minutes | | |
| PAPOST | -209.59 | 831.71 | -.252 | .802 | [-1896.4, 1477.2] |
| Time since treatment | 5.19 | 4.37 | 1.19 | .243 | [-3.68, 14.05] |
| $R^2$ | .038 | | | | |
| | | | Anxiety | | |
| PAPOST | -.957 | 1.05 | -.914 | .367 | [-3.08, 1.17] |
| Time since treatment | .004 | .006 | .708 | .483 | [-.007, .015] |
| $R^2$ | .033 | | | | |
| | | | Depression | | |
| PAPOST | -.816 | 1.05 | -.776 | .443 | [-2.96, 1.32] |
| Time since treatment | .006 | .006 | 1.09 | .279 | [-.005, .017] |
| $R^2$ | .044 | | | | |
| | | | Fatigue | | |
| PAPOST | 1.26 | 1.71 | .740 | .464 | [-2.2, 4.7] |
| Time since treatment | .007 | .009 | .765 | .449 | [-.01, .03] |
| $R^2$ | .034 | | | | |
| | | | Sleep Quality | | |
| PAPOST | -.141 | 1.55 | -.091 | .928 | [-3.3, 2.9] |
| Time since treatment | .006 | .008 | .693 | .493 | [-.01, .02] |
| $R^2$ | .013 | | | | |
| | | | Stress | | |
| PAPOST | -.394 | 1.65 | -.239 | .814 | [-3.83, 3.04] |
| Time since treatment | .10 | .008 | 1.25 | .224 | [-.006, .026] |
| $R^2$ | .066 | | | | |
| | | | Health-Related Quality of Life | | |
| PAPOST | -.898 | .931 | -.965 | .341 | [-2.79, .989] |
| Time since treatment | .008 | .005 | 1.60 | .118 | [-.002, .018] |
| $R^2$ | .082 | | | | |

*Note.* $p < .05$

# Chapter V. Discussion

With the cancer survivorship population predicted to rise in the United States from 16.9 million survivors in 2019 to 21.7 million survivors by 2029 and 26.1 million by 2040, it is critical to understand the role physical activity plays among cancer survivors (NIH, 2019). Regular physical activity is associated with numerous health benefits for cancer survivors such as reduced fatigue (Aguiñaga et al., 2018a), improved sleep quality (Rogers et al., 2017), reduced anxiety (Phillips & McAuley, 2015), reduce depressive symptoms (Rogers et al., 2017), reduced stress (Phillips & McAuley, 2015), and improved quality of life (Gopalakrishna et al., 2017b). Despite the known benefits, nearly 82% of cancer survivors do not meet ACSM physical activity guidelines (Wiskemann et al., 2018). One promising strategy to promote physical activity in the general population is a physical activity prescription. Patient-centered physical activity prescriptions are effective for increasing physical activity and multiple aspects of quality of life (Josyula & Lyle, 2013b; Lundqvist et al., 2017; Rödjer et al., 2016). Although physical activity prescriptions have been effective in non-cancer populations, there is little evidence of physical activity prescriptions' effectiveness among cancer survivors. This study's purpose was to compare physical activity levels between cancer survivors who were prescribed physical activity by their healthcare provider and those who were not. We hypothesized that cancer survivors who received a physical activity prescription post-treatment would report higher physical activity levels than survivors who did not.

## During Cancer Treatment

**Physical Activity.** Twelve participants (34%) reported receiving a physical activity prescription from their healthcare provider during their cancer treatment. Participants who received a prescription were not significantly more active than those who did not ($p$ = .549, $d$ =

.216). Both groups reported mean MET-minute levels above the minimum requirement for meeting aerobic physical activity guidelines (Prescribe*d* = 2880.3 ± 2159.0, Not Prescribe*d* = 2303.0 ± 2903.0; Ainsworth et al., 2011), which is unexpected within the survivorship population (Wiskemann et al., 2018). Studies demonstrating the effectiveness of physical activity prescriptions in non-cancer survivor populations have typically had sedentary participants or participants not meeting physical activity guidelines (Lundqvist et al., 2017; Rödjer et al., 2016). Our sample size's baseline physical activity levels exceed the recommended weekly Met-minute value, which is one explanation why the prescription may not have been effective in increasing physical activity.

**Anxiety.** When cancer survivors are physically active and meeting physical activity guidelines, previous studies (Chen et al., 2015; Patsou et al., 2018; Rogers et al., 2017) have illustrated that cancer survivors' anxiety levels are significantly lower than sedentary cancer survivors. There was no significant difference in anxiety scores between the group prescribed physical activity during treatment and the group that was not ($p$ = .382, $d$ = .316). Participants who reported receiving a prescription during treatment did not report engaging in significantly more physical activity than participants that did not receive a prescription, so we do not expect to find significantly different anxiety scores based on these findings**.** Participants' anxiety levels were classified as 'borderline abnormal,' which could be associated with the COVID-19 pandemic (Czeisler, 2020). Previous literature (Chen et al., 2015; Patsou et al., 2018; Rogers et al., 2017) suggests participants with activity levels meeting physical activity guidelines would not report anxiety scores this high, and with the increase in anxiety disorders and symptoms due to the pandemic, it is a likely explanation for the higher than expected anxiety levels.

**Depression.** Participants reported 'normal' depression scores (Prescribe*d* = 3.6 ± 2.7, Not Prescribe*d* = 3.7 ± 3.7), with no significant difference between the two groups ($p$ = .955, $d$ = -.020). Participants in both groups reported physical activity levels that exceed physical activity guidelines, which previous literature has shown reduces depression in cancer survivors (Aguiñaga et al., 2018a; Beebe-Dimmer et al., 2020)**.** With high physical activity levels and low depression scores, we would not anticipate a significant difference between groups based on our results. Previous literature (Aguiñaga et al., 2018a; Beebe-Dimmer et al., 2020) demonstrates physical activity has a significant impact on depression scores when cancer survivors have higher initial depression scores and lower initial physical activity levels (Aguiñaga et al., 2018a; Beebe-Dimmer et al., 2020)**.**

**Fatigue.** Participants who received a physical activity prescription during cancer treatment did not report significantly lower fatigue scores than those who did not receive a prescription ($p$ = .157). Although the results were not significant, there was a moderate effect size ($d$ = .515), indicating the potential for a significant difference if we had a larger sample size (Sullivan & Feinn, 2012)**.** Previous studies (Aguiñaga et al., 2018a; Shin et al., 2017b) have shown that physical activity has effectively reduced fatigue among cancer survivors when participants are initially inactive, become active, or begin to reach physical activity guidelines. Since both groups exceeded guidelines (>600 MET-minutes), this could explain why there was no significant difference in fatigue scores.

**Sleep Quality.** According to the Pittsburgh Sleep Quality Index, a global score over five indicates poor sleep quality (Buysse et al., 1989b)**.** Participants in both groups, on average, reported poor sleep quality (Prescribe*d* = 10.3 ± 5.2, Not Prescribe*d* = 8.8 ± 4.7), with no significant difference from one another ($p$ = .415, $d$ = .294). The current body of literature demonstrates that cancer survivors can experience poor sleep quality years after diagnosis and treatment as a late or long-term effect (Strollo et al., 2020). Strollo et al. (2020) illustrated that 20% of cancer survivors nine years post-diagnosis reported poor sleep quality, 51% reported high sleep disturbance, and 28% reported using sleeping medication. Conflicting data (Armbruster et al., 2018a; Brown, Cespedes Feliciano, et al., 2018) suggests that cancer survivors who meet physical activity guidelines should experience better sleep quality than inactive cancer survivors, so these findings differ from previous literature with our active pool of cancer survivors who are experiencing poor sleep quality. With this data collected during the COVID-19 pandemic, the pandemic was potentially causing participants to experience worse sleep quality than they would have experienced otherwise (Huang & Zhao, 2020; Marelli et al., 2020)

**Stress.** Despite if participants received a physical activity prescription during cancer treatment or not, both groups experienced high-stress levels (Prescribe$d$ = 31.3 ± 4.0, Not Prescribe$d$ = 31.1 ± 3.6) and did not report significantly different stress levels ($p$ = .903, $d$ = .044). Stress levels this high for cancer survivors who meet physical activity guidelines defy past literature (Liu et al., 2016; Mazor et al., 2019), suggesting that active cancer survivors should experience lower stress levels. A potential explanation for high-stress levels despite high physical activity levels is the data collection period. The data was collected during the initial months of the COVID-19 pandemic, which has seen a spike in psychological distress and stress levels for people across the country, potentially impacting the results (Salari et al., 2020).

**Health-Related Quality of Life.** Participants did not report significantly different health-related quality of life whether they received a physical activity prescription or not ($p$ = .451. $d$ = -.272). Previous literature (Gopalakrishna et al., 2017b; Phillips & McAuley, 2015) illustrates cancer survivors who are physically active and meeting physical activity guidelines should experience better health-related quality of life than inactive cancer survivors (Gopalakrishna et al., 2017b; Phillips & McAuley, 2015). Both groups reported physical activity levels above the Met-minute level for meeting physical activity guidelines (> 600 MET-minutes), so we would not anticipate the groups having different health-related quality of life scores. Health-related quality of life was measured using the SF12 Short Form Health Survey with a maximum score of 72, with a higher score indicating a higher quality of life. Participants' scores may have been impacted by COVID-19, which has negatively impacted several aspects of health-related quality of life (Czeisler, 2020; Marelli et al., 2020; Xiong et al., 2020).

**Post-Cancer Treatment**

**Physical Activity.** Eighteen (46%) participants reported receiving a physical activity prescription from their healthcare provider post-cancer treatment. Participants who received a prescription were not more active than those who did not ($p$ = .896, $d$ = .042). Both groups reported physical activity levels above physical activity guidelines (Prescribe*d* = 2475.4 ± 1928.9, Not Prescribed = 2366.4 ± 3040.9), which is uncommon among the survivorship population (Wiskemann et al., 2018). The higher than anticipated physical activity levels in both groups are potential reasons why there was no significant difference in physical activity levels. Previous literature (Lundqvist et al., 2017; Rödjer et al., 2016) has illustrated the effectiveness of physical activity prescriptions in sedentary or inactive populations. Participants' activity levels already exceeding guidelines is a potential explanation for why there was no significant difference between the groups. Participants high physical activity levels is unusual based on previous literature, that expresses that about 82% of cancer survivors do not meet physical activity guidelines (Wiskemann et al., 2018). It is recommended to reach 500-1000 MET-minutes per week for health benefits and participants who received a physical activity prescription post-treatment reported 2475 ± 1928 MET-minutes and participants that did not receive a prescription reported a mean of 2366 ± 3040 MET-minutes per week. Participants in this study exceeded the physical activity recommendations, which is unusual since there is not a high percentage of survivors meeting physical activity guidelines (Wiskemann et al., 2018).

**Anxiety.** Prior research (Chen et al., 2015; Patsou et al., 2018; Rogers et al., 2017) has demonstrated a decrease in cancer survivors' anxiety levels when they increase their physical activity levels or are meeting physical activity guidelines. Both groups exceeded physical activity guidelines; therefore, there was no significant difference between participants who received a prescription and those that did not ($p$ = .400, $d$ = .274). Both groups were classified as 'borderline abnormal,' which contradicts previous research for cancer survivors above the threshold for meeting physical activity guidelines (Patsou et al., 2018; Rogers et al., 2017). A rationale for the higher-than-expected anxiety levels is that they can be attributed to the COVID-19 pandemic, which has caused an increase in anxiety and anxiety disorders (Czeisler, 2020; Salari et al., 2020). This is to be believed based on cancer survivors anxiety levels in previous studies, pre COVID-19 pandemic. Previous studies have shown that cancer survivors who have been physically active for 3 & 6 months reported scores on the Hospital Anxiety and Depression Scale of 5.6 ± 3.4 5.8 ± 3.9, respectively (Rogers et al., 2017). Additional studies have found that cancer survivors who maintained, increased, or decreased physical activity post-treatment reported anxiety on the Hospital Anxiety and Depression Score of 5.0 ± 3.6, 5.2 ± 3.9, and 5.1 ± 3.3, respectively. Previous research has shown that physically active cancer survivors typically categorize as "Normal" on the Hospital Anxiety and Depression Scale. Our findings classified participants as “Borderline Abnormal” which may have been influenced from the COVID-19 pandemic (Czeisler, 2020).

**Depression.** Whether participants received a physical activity prescription or not, there was no significant difference in participants depression scores ($p$ = .510, $d$ = .214). Participants were categorized as ‘normal,’ a total score ranging from 0-7 (Prescribe*d* = 3.9 ± 3.5, Not Prescribed = 3.2 ± 3.1). Prior research (Aguiñaga et al., 2018a; Beebe-Dimmer et al., 2020) demonstrates that participants who have high physical activity levels or are meeting physical activity guidelines have lower depression scores than sedentary or inactive cancer survivors. Participants’ physical activity exceeding the threshold for meeting physical activity guidelines and the classification of ‘normal’ depression scores are two possible explanations why there was no significant difference between groups. Previous literature (Rogers et al., 2017) pre COVID-19 suggest that physically active cancer survivors report “Normal” depression scores, which our results also indicate. Since the results agree with previous literature, pre-COVID-19, the pandemic did not affect depression score for our participants.

**Fatigue.** Participants who received a prescription post-cancer treatment did not report significantly lower fatigue scores than participants who did not receive a prescription ($p$ = .413, $d$ = -.266). Prior studies (Aguiñaga et al., 2018a; Shin et al., 2017b) have demonstrated the effect of physical activity on reducing cancer survivors’ fatigue levels. With both groups reporting physical activity levels above the requirement for meeting physical activity guidelines (> 600 Met-minutes), they would likely have similar fatigue scores. Our participants reported “Normal” fatigue scores, with those who were prescribed reporting 16.2 ± 4.9, and those that did not receive a prescription reported 17.6 ± 5.6. On the PROMIS SF-7a the maximum score is 35, with a higher score indicating higher levels of fatigue. Previous literature (Irwin et al., 2017; Pugh et al., 2020) has also found that physically active cancer survivors report “Normal” fatigue levels when meeting physical activity guidelines.

**Sleep Quality.** Both groups reported poor sleep quality (Prescribe*d* = 9.2 ± 3.7, Not Prescribe*d* = 9.2 ± 5.5), classified as a score over five on the Pittsburgh Sleep Quality Index (Buysse et al., 1989b). Participants who received a physical activity prescription did not report significantly better sleep quality than participants that did not receive a prescription ($p$ = .984, $d$ = .007). Previous studies (Strollo et al., 2020) have illustrated that poor sleep quality and sleep disturbance are late and long-term effects of cancer treatment, with about one in five survivors experiencing poor sleep quality and more than half of survivors experiencing sleep disturbance nine years post-diagnosis. Cancer survivors’ poor sleep quality is well documented (Armbruster et al., 2018a; Brown et al., 2018), even when they are physically active. Armbruster et al. (2018) found that physically active cancer survivors reported poor sleep quality with an average score of 6.2 ± 3.2 on the PSQI when a score over five indicates poor sleep quality. Similarly, Rogers et al. (2017) found that participants reported poor sleep quality after a six-month physical activity intervention with a score of 7.3 ± 3.8, with a score over five indicating poor sleep quality. In this current study, our participants reported exceeding physical activity guidelines as well as poor sleep quality, which agrees with the past literature pre COVID-19.

**Stress.** Participants that received a physical activity prescription did not report significantly lower stress levels than participants that did not ($p$ = .924, $d$ = .031), and both groups reported high-stress levels (Prescribed = 31.1 ± 3.3, Not Prescribe*d* = 31.0 ± 3.8). These findings conflict with previous data (Liu et al., 2016; Mazor et al., 2019), which suggests that cancer survivors who meet physical activity guidelines should experience lower stress levels. An explanation of why these findings conflict with previous literature is that the data was collected during the COVID-19 pandemic, which has caused a spike in psychological distress and stress levels for those affected (Xiong et al., 2020). Previous studies (Amritanshu et al., 2017; Phillips et al., 2015) pre COVID-19 indicate that physically active cancer survivors report lower stress levels than we found in the current study. Amritanshu et al. (2017) found that active cancer survivors and those who completed yoga reported stress levels of 19.2 ± 5.2, with a maximum score of 35 with a higher score indicating more stress. Phillips et al. (2015) also indicated that physically active cancer survivors that maintained or increased their physical activity levels post-treatment reported stress scores of 12.3 ± 7.1, and 12.0 ± 6.3, respectively. Participants in this current study reported higher stress levels than previous literature, despite our participants' high physical activity levels, which can be attributed to the COVID-19 pandemic.

**Health-Related Quality of Life.** Participants who received a physical activity prescription did not report significantly higher health-related quality of life than those that did not receive a prescription ($p$ = .435, $d$ = .254). Previous literature (Gopalakrishna et al., 2017b; Phillips & McAuley, 2015) expresses that cancer survivors who meet physical activity guidelines should experience higher health-related quality of life than sedentary or inactive cancer survivors. Participants in either group did not report high health-related quality of life scores, the prescription group reported a mean of 32.9 ± 3.0, and the non-prescription group reported a mean of 32.1 ± 2.9. A higher score on the SF12 indicates a higher quality of life, with the maximum score being 72. With several aspects of health-related quality of life being negatively affected by COVID-19 (Czeisler, 2020; Marelli et al., 2020; Xiong et al., 2020), it is possible the pandemic negatively affected participants' health-related quality of life. Previous literature (Brown, et al., 2018; Phillips & McAuley, 2015) that has studied the impact physical activity has on health-related quality of life prior to the COVID-19 pandemic indicated participants had a higher health-related quality of life than the results from this study found. Brown et al. (2018) categorized cancer survivors by how physically active they were, and results showed that the control group reported a score of 115.2 ± 18.9, the low physical activity group reported 113.1 ± 13.7, and the high physical activity group reported a mean score of 109.6 ± 14.0 on the Functional Assessment of Cancer Therapy-Colorectal (FACT-C). The FACT-C has a total score of 144, with a higher score indicating a higher quality of life. Phillips et al (2015) also reported cancer survivors' quality of life as it pertained to their physical activity levels and results showed that survivors that decreased their physical activity levels post-treatment reported a health-related quality of life score of 107.2 ± 20.1, survivors that maintained their activity level reported 115.2 ± 18.4, and those that increased their physical activity levels reported a mean score of 116.9 ± 20.1. The researchers used the Functional Assessment of Cancer Therapy-Breast (FACT-B) which has a total score of 148 with a higher score indicating a higher quality of life. Participants from the current study who received a physical activity prescription post-treatment reported a health-related quality of life score of 32.9 ± 3.0 and participants that did not receive a prescription reported a health-related quality of life score of 32.1 ± 2.9 with a total score of 72. Compared to previous literature our participants reported lower than expected health-related quality of life scores which may have been influenced by the COVID-19 pandemic.

**Strengths, Limitations and Future Research**

One strength of the study was that this is one of the first studies addressing the effectiveness of physical activity prescriptions in cancer survivors. The effectiveness of physical activity prescriptions has been studied in other populations (Lundqvist et al., 2017; Rödjer et al., 2016; Yaman & Atay, 2018b), but there is little to no data demonstrating the effectiveness in cancer survivors.

This study had several limitations. As of 2019, there were 16.9 million cancer survivors in the United States (NIH, 2019), and this study only had 39 participants. This small sample size is not representative of the survivorship population in the United States and may have been why some of the analyses were not significant. Furthermore, our sample consisted of primarily female (74.4%), Caucasian (92.3%), and high socioeconomic status (46.2%) participants. With such a homogenous sample, the findings cannot be generalized for all cancer survivors but primarily to Caucasian women during the COVID-19 pandemic. Future studies should gather a more representative sample of the survivorship population, or at least a more diverse group of participants, such as Non-Caucasians and low socioeconomic status survivors. This is important for future research because previous literature demonstrates Non-Caucasian (Hair et al., 2014) and low socioeconomic status survivors are less active and are more likely to think physical activity will not benefit them through survivorship (Naik et al., 2016).

Another limitation of the study is the meaning of the word ‘prescription.’ “Prescription” was not defined in the questions that asked if they were prescribed physical activity, which may have led to some confusion about what the question was explicitly asking. For example, participants may not have understood if the prescription meant their healthcare provider spoke to them about physical activity in general, specific recommendations, or if they received a written prescription. Previous literature (Lundqvist et al., 2017; Rödjer et al., 2016; Yaman & Atay, 2018b) has illustrated that written physical activity prescriptions are most effective in increasing physical activity levels, and we are unsure what type of prescription our participants received. This potential confusion may have led to participants incorrectly answering the question. Future research should be more specific when inquiring about what a physical activity prescription is and identify what type of prescription participants received (e.g., oral, written). For example, the question could read “Which best describes your experience regarding a physical activity prescription post-cancer treatment” with answer choices ranging from “I received a written, specific, physical activity prescription,” “I received an oral, specific physical activity prescription,” “My healthcare provider told me I should be active, but not a specific prescription,” and “My healthcare provider did not prescribe me physical activity nor recommend it to me.”

Another limitation related to the physical activity prescription was that the analyses did not focus on comparing the differences between groups that did receive a physical activity prescription during treatment, post-treatment, or at both time points. This could have been beneficial to test for any differences between participants who received a physical activity prescription during one time point only (treatment and post-treatment), and at both time points. This would help determine if the amount of times a cancer survivor receives information promoting physical activity increases the likelihood of being active post-treatment.

An additional limitation is the potential for a response bias. Individuals who were more physically active may have been more inclined to take and complete the survey or they could have potentially reported a higher amount of physical activity than they were currently engaging in as part of a social desirability bias (Brenner & Delamater, 2014). The impact of either or both of these factors would impact the findings and limit the generalizability of the findings to all cancer patients.

A unique limitation to this study was the data collection period. Data was collected from June 2020 to September 2020, during the COVID-19 pandemic. The COVID-19 pandemic could have potentially impacted physical activity levels (Nienhuis & Lesser, 2020) and several health-related components measured (Czeisler, 2020; Marelli et al., 2020; Xiong et al., 2020). Future research should try to understand the potential confounding variables that may influence participants' physical activity levels or health-related components that are being measured. If future research is conducted during the COVID-19 pandemic, researchers should understand the pandemic could impact their results.

Lastly, participants cancer history varied greatly. Time since diagnosis ranged from 16 months to 369 months, and the time since the last treatment ranged from 12 months to 389 months. With there being such an extensive range, it is hard to fully understand how cancer and the treatment they received is affecting them, if at all. Future research should include participants who were diagnosed or completed treatment within a closer timeframe to each other to better understand how physical activity is impacting their survivorship experience, compared to the wide variability in this study.

**Public Health Implications**

With the survivorship population at an all-time high and continuing to rise (Siegel et al., 2019), it is crucial cancer survivors understand the role physical activity can have in alleviating adverse effects or challenges from treatment. With cancer survivors experiencing multiple adverse effects from treatment, being physically active is a known method to mitigate the adverse effects of treatment (Aguiñaga et al., 2018; Gopalakrishna et al., 2017; Phillips & McAuley, 2015; Rogers et al., 2017). Although these effects are present from physical activity, a small amount of survivors are experiencing the benefits, with studies suggesting about 82% of cancer survivors are inactive and not meeting physical activity guidelines (Wiskemann et al., 2018). With most cancer survivors not experiencing the potential benefits of physical activity, it is important to find ways to influence cancer survivors to become more physically active. One way that has been beneficial in increasing physical activity in other populations is a physical activity prescription.

The results from this study show that participants who received a physical activity prescription during or post-cancer treatment did not report higher physical activity levels than those who did not receive a prescription. Research (Rödjer et al., 2016; Yaman & Atay, 2018) demonstrates that patient-centered written physical activity prescriptions or a written prescription with an activity toolkit effectively increases physical activity levels in non-cancer populations; it would be valuable to know what type of prescriptions participants received. Both groups reported physical activity levels exceeding the threshold for meeting physical activity guidelines, which may have been a by-product of the sample collected. Previous literature illustrates that individuals who are Caucasian and of high socioeconomic status are already physically active, which is one reason the prescription may have been ineffective. Since most cancer survivors are not meeting physical activity guidelines (Wiskemann et al., 2018), more research needs to be done to study physical activity prescriptions' effectiveness in a diverse sample. An oral prescription, recommendation, or encouragement is ineffective in increasing physical activity levels (Lundqvist et al., 2019), so healthcare providers should follow previous research and give a written physical activity prescription or an exercise toolkit to their patients when they are encouraging or prescribing them physical activity.

**Conclusion**

Cancer survivors face many challenges following cancer treatment such as anxiety (Smith et al., 2016), depression (Smith et al., 2016), fatigue (Tabrizi & Alizadeh, 2017), poor sleep quality (Lowery-Allison et al., 2018), stress (Liu et al., 2017), leading to a decreased quality of life (Shin et al., 2017b). Physical activity has proven to be an effective method to alleviate these negative consequences of cancer treatment. With almost 82% of cancer survivors not meeting physical activity guidelines (Wiskemann et al., 2018), research focused on improving cancer survivors physical activity levels are necessary.

This study focused on the effectiveness of a physical activity prescription post-cancer treatment on physical activity levels. Although this study did not demonstrate the effectiveness of a physical activity prescription in cancer survivors, some variables may have influenced the results, such as COVID-19 and not specifying which type of prescription each participant received. Due to cancer survivors experiencing adverse effects of treatment and cancer survivors having low physical activity levels, it is essential future research focuses on ways of improving cancer survivors' physical activity levels, such as a physical activity prescription.

## References


Abar, L., Sobiecki, J. G., Cariolou, M., Nanu, N., Vieira, A. R., Stevens, C., Aune, D., Greenwood, D. C., Chan, D. S. M., & Norat, T. (2019). Body size and obesity during adulthood, and risk of lympho-haematopoietic cancers: An update of the WCRF-AICR systematic review of published prospective studies. *Annals of Oncology*, *30*(4), 528–541. https://doi.org/10.1093/annonc/mdz045

Adams, S. C., DeLorey, D. S., Davenport, M. H., Fairey, A. S., North, S., & Courneya, K. S. (2018). Effects of high-intensity interval training on fatigue and quality of life in testicular cancer survivors. *British Journal of Cancer*, *118*(10), 1313–1321. https://doi.org/10.1038/s41416-018-0044-7

Aguiñaga, S., Ehlers, D. K., Cosman, J., Severson, J., Kramer, A. F., & McAuley, E. (2018a). Effects of physical activity on psychological well-being outcomes in breast cancer survivors from prediagnosis to posttreatment survivorship. *Psycho-Oncology*, *27*(8), 1987–1994. https://doi.org/10.1002/pon.4755

Aguiñaga, S., Ehlers, D. K., Cosman, J., Severson, J., Kramer, A. F., & McAuley, E. (2018b). Effects of physical activity on psychological well-being outcomes in breast cancer survivors from prediagnosis to posttreatment survivorship. *Psycho-Oncology*, *27*(8), 1987–1994. https://doi.org/10.1002/pon.4755

Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., Meckes, N., Bassett, D. R., Tudor-Locke, C., Greer, J. L., Vezina, J., Whitt-Glover, M. C., & Leon, A. S. (2011). 2011 Compendium of Physical Activities: A second update of codes and MET values. *Medicine and Science in Sports and Exercise*, *43*(8), 1575–1581. https://doi.org/10.1249/MSS.0b013e31821ece12

Amritanshu, R. R., Rao, R. M., Nagaratna, R., Veldore, V. H., Usha Rani, M. U., Gopinath, K. S., & Ajaikumar, B. S. (2017). Effect of Long-term Yoga Practice on Psychological outcomes in Breast Cancer Survivors. *Indian Journal of Palliative Care*, *23*(3), 231–236. https://doi.org/10.4103/IJPC.IJPC_93_17

Annunziata, M. A., Muzzatti, B., Flaiban, C., Gipponi, K., Carnaghi, C., Tralongo, P., Caruso, M., Cavina, R., & Tirelli, U. (2018a). Long-term quality of life profile in oncology: A comparison between cancer survivors and the general population. *Supportive Care in Cancer*, *26*(2), 651–656. https://doi.org/10.1007/s00520-017-3880-8

Annunziata, M. A., Muzzatti, B., Flaiban, C., Gipponi, K., Carnaghi, C., Tralongo, P., Caruso, M., Cavina, R., & Tirelli, U. (2018b). Long-term quality of life profile in oncology: A comparison between cancer survivors and the general population. *Supportive Care in Cancer*, *26*(2), 651–656. https://doi.org/10.1007/s00520-017-3880-8

Armbruster, S. D., Song, J., Gatus, L., Lu, K. H., & Basen-Engquist, K. M. (2018a). Endometrial cancer survivors' sleep patterns before and after a physical activity intervention: A retrospective cohort analysis. *Gynecologic Oncology*, *149*(1), 133–139. https://doi.org/10.1016/j.ygyno.2018.01.028

Armbruster, S. D., Song, J., Gatus, L., Lu, K. H., & Basen-Engquist, K. M. (2018b). Endometrial cancer survivors' sleep patterns before and after a physical activity intervention: A retrospective cohort analysis. *Gynecologic Oncology*, *149*(1), 133–139. https://doi.org/10.1016/j.ygyno.2018.01.028

Arnaboldi, P., Riva, S., Crico, C., & Pravettoni, G. (2017). A systematic literature review exploring the prevalence of post-traumatic stress disorder and the role played by stress and traumatic stress in breast cancer diagnosis and trajectory. *Breast Cancer (Dove Medical Press)*, *9*, 473–485. https://doi.org/10.2147/BCTT.S111101

Beebe-Dimmer, J. L., Ruterbusch, J. J., Harper, F. W. K., Baird, T. M., Finlay, D. G., Rundle, A. G., Pandolfi, S. S., Hastert, T. A., Schwartz, K. L., Bepler, G., Simon, M. S., Mantey, J., Abrams, J., Albrecht, T. L., & Schwartz, A. G. (2020). Physical activity and quality of life in African American cancer survivors: The Detroit Research on Cancer Survivors study. *Cancer*, *126*(9), 1987–1994. https://doi.org/10.1002/cncr.32725

Bevilacqua, L. A., Dulak, D., Schofield, E., Starr, T. D., Nelson, C. J., Roth, A. J., Holland, J. C., & Alici, Y. (2018). Prevalence and predictors of depression, pain, and fatigue in older- versus younger-adult cancer survivors. *Psycho-Oncology*, *27*(3), 900–907. https://doi.org/10.1002/pon.4605

Bower, J. E. (2014a). Cancer-related fatigue: Mechanisms, risk factors, and treatments. *Nature Reviews. Clinical Oncology*, *11*(10), 597–609. https://doi.org/10.1038/nrclinonc.2014.127

Bower, J. E. (2014b). Cancer-related fatigue: Mechanisms, risk factors, and treatments. *Nature Reviews. Clinical Oncology*, *11*(10), 597–609. https://doi.org/10.1038/nrclinonc.2014.127

Boyes, A. W., Girgis, A., D’Este, C., & Zucca, A. C. (2011). Flourishing or floundering? Prevalence and correlates of anxiety and depression among a population-based sample of adult cancer survivors 6months after diagnosis. *Journal of Affective Disorders*, *135*(1–3), 184–192. https://doi.org/10.1016/j.jad.2011.07.016

Brenner, P., & Delamater, J. (2014). Social Desirability Bias in Self-reports of Physical Activity: Is an Exercise Identity the Culprit? *Social Indicators Research*, *117*. https://doi.org/10.1007/s11205-013-0359-y

Brown, J. C., Cespedes Feliciano, E. M., & Caan, B. J. (2018). The evolution of body composition in oncology—epidemiology, clinical trials, and the future of patient care: Facts and numbers. *Journal of Cachexia, Sarcopenia and Muscle*, *9*(7), 1200–1208. https://doi.org/10.1002/jcsm.12379

Brown, J. C., Damjanov, N., Courneya, K. S., Troxel, A. B., Zemel, B. S., Rickels, M. R., Ky, B., Rhim, A. D., Rustgi, A. K., & Schmitz, K. H. (2018). A randomized dose-response trial of aerobic exercise and health-related quality of life in colon cancer survivors. *Psycho-Oncology*, *27*(4), 1221–1228. https://doi.org/10.1002/pon.4655

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989a). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989b). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Caan, B. J., Meyerhardt, J. A., Kroenke, C. H., Alexeeff, S., Xiao, J., Weltzien, E., Feliciano, E. C., Castillo, A. L., Quesenberry, C. P., Kwan, M. L., & Prado, C. M. (2017). Explaining the Obesity Paradox: The Association between Body Composition and Colorectal Cancer Survival (C-SCANS Study). *Cancer Epidemiology, Biomarkers & Prevention: A Publication of the American Association for Cancer Research, Cosponsored by the*

*American Society of Preventive Oncology*, *26*(7), 1008–1015. https://doi.org/10.1158/1055-9965.EPI-17-0200

Campbell, K. L., Winters-Stone, K. M., Wiskemann, J., May, A. M., Schwartz, A. L., Courneya, K. S., Zucker, D. S., Matthews, C. E., Ligibel, J. A., Gerber, L. H., Morris, G. S., Patel, A. V., Hue, T. F., Perna, F. M., & Schmitz, K. H. (2019). Exercise Guidelines for Cancer Survivors: Consensus Statement from International Multidisciplinary Roundtable. *Medicine & Science in Sports & Exercise*, *51*(11), 2375–2390. https://doi.org/10.1249/MSS.0000000000002116

Campbell, P. T., Newton, C. C., Newcomb, P. A., Phipps, A. I., Ahnen, D. J., Baron, J. A., Buchanan, D. D., Casey, G., Cleary, S. P., Cotterchio, M., Farris, A. B., Figueiredo, J. C., Gallinger, S., Green, R. C., Haile, R. W., Hopper, J. L., Jenkins, M. A., Le Marchand, L., Makar, K. W., … Limburg, P. J. (2015). Association between body mass index and mortality for colorectal cancer survivors: Overall and by tumor molecular phenotype. *Cancer Epidemiology, Biomarkers & Prevention : A Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology*, *24*(8), 1229–1238. https://doi.org/10.1158/1055-9965.EPI-15-0094

*Cancer Facts & Figures 2019 | American Cancer Society*. (n.d.). Retrieved August 31, 2019, from https://www.cancer.org/research/cancer-facts-statistics/all-cancer-facts-figures/cancer-facts-figures-2019.html

Chen, H.-M., Tsai, C.-M., Wu, Y.-C., Lin, K.-C., & Lin, C.-C. (2015). Randomised controlled trial on the effectiveness of home-based walking exercise on anxiety, depression and cancer-related symptoms in patients with lung cancer. *British Journal of Cancer*, *112*(3), 438–445. https://doi.org/10.1038/bjc.2014.612

Chen, Hui-Mei, Cheung, D. S. T., Lin, Y.-Y., Wu, Y.-C., Liu, C.-Y., Lin, K.-C., Lin, Y.-J., & Lin, C.-C. (2020). Relationships of exercise timing with sleep, fatigue and rest–activity rhythms of lung cancer patients in Taiwan: An exploratory study. *European Journal of Cancer Care*, *n/a*(n/a), e13233. https://doi.org/10.1111/ecc.13233

Chrischilles, E. A., Riley, D., Letuchy, E., Koehler, L., Neuner, J., Jernigan, C., Gryzlak, B., Segal, N., McDowell, B., Smith, B., Sugg, S. L., Armer, J. M., & Lizarraga, I. M. (2019). Upper extremity disability and quality of life after breast cancer treatment in the Greater Plains Collaborative clinical research network. *Breast Cancer Research and Treatment*, *175*(3), 675–689. https://doi.org/10.1007/s10549-019-05184-1

Cohen, S. (1988). Perceived stress in a probability sample of the United States. In *The social psychology of health* (pp. 31–67). Sage Publications, Inc.

Corbett, T., Groarke, A., Walsh, J. C., & McGuire, B. E. (2016). Cancer-related fatigue in post-treatment cancer survivors: Application of the common sense model of illness representations. *BMC Cancer*, *16*. https://doi.org/10.1186/s12885-016-2907-8

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F., & Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*(8), 1381–1395. https://doi.org/10.1249/01.MSS.0000078924.61453.FB

Cramp, F., & Byron-Daniel, J. (2012). Exercise for the management of cancer-related fatigue in adults. *The Cochrane Database of Systematic Reviews*, *11*, CD006145. https://doi.org/10.1002/14651858.CD006145.pub3

Czeisler, M. É. (2020). Mental Health, Substance Use, and Suicidal Ideation During the COVID-19 Pandemic—United States, June 24–30, 2020. *MMWR. Morbidity and Mortality Weekly Report*, *69*. https://doi.org/10.15585/mmwr.mm6932a1

D, C., W, R., A, S., N, R., B, R., S, Y., D, A., R, B., D, B., S, C., K, C., R, D., D, D., Jf, F., R, G., Ea, H., Js, L., P, P., D, R., … undefined. (2010). The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005-2008. *Journal of Clinical Epidemiology*, *63*(11), 1179–1194. https://doi.org/10.1016/j.jclinepi.2010.04.011

George, G. C., Iwuanyanwu, E. C., Anderson, K. O., Yusuf, A., Zinner, R. G., Piha-Paul, S. A., Tsimberidou, A. M., Naing, A., Fu, S., Janku, F., Subbiah, V., Cleeland, C. S., Mendoza, T. R., & Hong, D. S. (2016). Sleep quality and its association with fatigue, symptom burden, and mood in patients with advanced cancer in a clinic for early-phase oncology clinical trials. *Cancer*, *122*(21), 3401–3409. https://doi.org/10.1002/cncr.30182

Gjerset, G. M., Kiserud, C. E., Loge, J. H., Fosså, S. D., Wisløff, T., Gudbergsson, S. B., Oldervoll, L. M., & Thorsen, L. (2019). Changes in fatigue, health-related quality of life and physical activity after a one-week educational program for cancer survivors. *Acta Oncologica*, *58*(5), 682–689. https://doi.org/10.1080/0284186X.2018.1562210

Golbidi, S., Mesdaghinia, A., & Laher, I. (2012). Exercise in the Metabolic Syndrome. *Oxidative Medicine and Cellular Longevity*, *2012*. https://doi.org/10.1155/2012/349710

Gopalakrishna, A., Longo, T. A., Fantony, J. J., Harrison, M. R., & Inman, B. A. (2017a). PHYSICAL ACTIVITY PATTERNS AND ASSOCIATIONS WITH HEALTH-RELATED QUALITY OF LIFE IN BLADDER CANCER SURVIVORS. *Urologic Oncology*, *35*(9), 540.e1-540.e6. https://doi.org/10.1016/j.urolonc.2017.04.016

Gopalakrishna, A., Longo, T. A., Fantony, J. J., Harrison, M. R., & Inman, B. A. (2017b). PHYSICAL ACTIVITY PATTERNS AND ASSOCIATIONS WITH HEALTH-RELATED QUALITY OF LIFE IN BLADDER CANCER SURVIVORS. *Urologic Oncology*, *35*(9), 540.e1-540.e6. https://doi.org/10.1016/j.urolonc.2017.04.016

Grandes, G., Sanchez, A., Sanchez-Pinilla, R. O., Torcal, J., Montoya, I., Lizarraga, K., & Serra, J. (2009). Effectiveness of Physical Activity Advice and Prescription by Physicians in Routine Primary Care: A Cluster Randomized Trial. *Archives of Internal Medicine*, *169*(7), 694–701. https://doi.org/10.1001/archinternmed.2009.23

Hair, B., Hayes, S., Tse, C., Bell, M., & Olshan, A. (2014). Racial Differences in Physical Activity among Breast Cancer Survivors: Implications for Breast Cancer Care. *Cancer*, *120*(14), 2174–2182. https://doi.org/10.1002/cncr.28630

Han, M. A. (2017). Stress and Depressive Symptoms in Cancer Survivors and Their Family Members: Korea Community Health Survey, 2012. *International Journal of Environmental Research and Public Health*, *14*(9). https://doi.org/10.3390/ijerph14090999

Hefferon, K., Murphy, H., McLeod, J., Mutrie, N., & Campbell, A. (2013). Understanding barriers to exercise implementation 5-year post-breast cancer diagnosis: A large-scale qualitative study. *Health Education Research*, *28*(5), 843–856. https://doi.org/10.1093/her/cyt083

Holland, J. C., Andersen, B., Breitbart, W. S., Buchmann, L. O., Compas, B., Deshields, T. L., Dudley, M. M., Fleishman, S., Fulcher, C. D., Greenberg, D. B., Greiner, C. B., Handzo, G. F., Hoofring, L., Hoover, C., Jacobsen, P. B., Kvale, E., Levy, M. H., Loscalzo, M. J., McAllister-Black, R., … Freedman-Cass, D. A. (2013). Distress Management. *Journal of* *the National Comprehensive Cancer Network*, *11*(2), 190–209. https://doi.org/10.6004/jnccn.2013.0027

Hollen, P. J., Msaouel, P., & Gralla, R. J. (2015). Determining issues of importance for the evaluation of quality of life and patient-reported outcomes in breast cancer: Results of a survey of 1072 patients. *Breast Cancer Research and Treatment*, *151*(3), 679–686. https://doi.org/10.1007/s10549-015-3420-5

Huang, Y., & Zhao, N. (2020). Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 outbreak in China: A web-based cross-sectional survey. *Psychiatry Research*, *288*, 112954. https://doi.org/10.1016/j.psychres.2020.112954

Inhestern, L., Beierlein, V., Bultmann, J. C., Möller, B., Romer, G., Koch, U., & Bergelt, C. (2017a). Anxiety and depression in working-age cancer survivors: A register-based study. *BMC Cancer*, *17*. https://doi.org/10.1186/s12885-017-3347-9

Inhestern, L., Beierlein, V., Bultmann, J. C., Möller, B., Romer, G., Koch, U., & Bergelt, C. (2017b). Anxiety and depression in working-age cancer survivors: A register-based study. *BMC Cancer*, *17*. https://doi.org/10.1186/s12885-017-3347-9

Irwin, M. L., Cartmel, B., Harrigan, M., Li, F., Sanft, T., Shockro, L., O'Connor, K., Campbell, N., Tolaney, S. M., Mayer, E. L., Yung, R., Freedman, R. A., Partridge, A. H., & Ligibel, J. A. (2017). Effect of the LIVESTRONG® at the YMCA exercise program on physical activity, fitness, quality of life and fatigue in cancer survivors. *Cancer*, *123*(7), 1249–1258. https://doi.org/10.1002/cncr.30456

Iyengar, N. M., Kochhar, A., Morris, P. G., Morris, L. G., Zhou, X. K., Ghossein, R. A., Pino, A., Fury, M. G., Pfister, D. G., Patel, S. G., Boyle, J. O., Hudis, C. A., & Dannenberg, A. J. (2014). Impact of Obesity on the Survival of Patients with Early Stage Squamous Cell

Carcinoma of the Oral Tongue. *Cancer*, *120*(7), 983–991. https://doi.org/10.1002/cncr.28532

Jones, J. M., Olson, K., Catton, P., Catton, C. N., Fleshner, N. E., Krzyzanowska, M. K., McCready, D. R., Wong, R. K. S., Jiang, H., & Howell, D. (2016). Cancer-related fatigue and associated disability in post-treatment cancer survivors. *Journal of Cancer Survivorship: Research and Practice*, *10*(1), 51–61. https://doi.org/10.1007/s11764-015-0450-2

Josyula, L., & Lyle, R. (2013a). Health Care Provider Physical Activity Prescription Intervention. *American Journal of Health Education*, *44*(3), 162–168. https://doi.org/10.1080/19325037.2013.779903

Josyula, L., & Lyle, R. (2013b). Health Care Provider Physical Activity Prescription Intervention. *American Journal of Health Education*, *44*(3), 162–168. https://doi.org/10.1080/19325037.2013.779903

Kenzik, K. M., Demark-Wahnefried, W., Ganz, P. A., Colditz, G., Rock, C. L., & Rogers, L. Q. (2018). Changes in Body Mass Index and Physical Activity Predict Changes in Vitality During a Weight Loss Trial in Breast Cancer Survivors. *Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine*, *52*(12), 999–1009. https://doi.org/10.1093/abm/kay004

Kessels, E., Husson, O., & van der Feltz-Cornelis, C. M. (2018a). The effect of exercise on cancer-related fatigue in cancer survivors: A systematic review and meta-analysis. *Neuropsychiatric Disease and Treatment*, *14*, 479–494. https://doi.org/10.2147/NDT.S150464

Kessels, E., Husson, O., & van der Feltz-Cornelis, C. M. (2018b). The effect of exercise on cancer-related fatigue in cancer survivors: A systematic review and meta-analysis. *Neuropsychiatric Disease and Treatment*, *14*, 479–494. https://doi.org/10.2147/NDT.S150464

Kramer, N., Ramjith, J., & Shamley, D. (2019). Prevalence of shoulder morbidity after treatment for breast Cancer in South Africa. *Supportive Care in Cancer*, *27*(7), 2591–2598. https://doi.org/10.1007/s00520-018-4540-3

Lengacher, C. A., Reich, R. R., Ramesar, S., Alinat, C. B., Moscoso, M., Cousin, L., Marino, V. R., Elias, M. N., Paterson, C. L., Pleasant, M. L., Rodriguez, C. S., Wang, H.-L., Kip, K. E., Meng, H., & Park, J. Y. (2018). Feasibility of the mobile mindfulness-based stress reduction for breast cancer (mMBSR(BC)) program for symptom improvement among breast cancer survivors. *Psycho-Oncology*, *27*(2), 524–531. https://doi.org/10.1002/pon.4491

Liu, C. L., Liu, L., Zhang, Y., Dai, X. Z., & Wu, H. (2017a). Prevalence and its associated psychological variables of symptoms of depression and anxiety among ovarian cancer patients in China: A cross-sectional study. *Health and Quality of Life Outcomes*, *15*(1), 161. https://doi.org/10.1186/s12955-017-0738-1

Liu, C. L., Liu, L., Zhang, Y., Dai, X. Z., & Wu, H. (2017b). Prevalence and its associated psychological variables of symptoms of depression and anxiety among ovarian cancer patients in China: A cross-sectional study. *Health and Quality of Life Outcomes*, *15*(1), 161. https://doi.org/10.1186/s12955-017-0738-1

Liu, Y., Wheaton, A. G., Chapman, D. P., Cunningham, T. J., Lu, H., & Croft, J. B. (2016). Prevalence of Healthy Sleep Duration among Adults—United States, 2014. *MMWR.*

*Morbidity and Mortality Weekly Report*, *65*(6), 137–141. https://doi.org/10.15585/mmwr.mm6506a1

Lowery-Allison, A. E., Passik, S. D., Cribbet, M. R., Reinsel, R. A., O'Sullivan, B., Norton, L., Kirsh, K. L., & Kavey, N. B. (2018). Sleep problems in breast cancer survivors 1-10 years posttreatment. *Palliative & Supportive Care; Cambridge*, *16*(3), 325–334. http://dx.doi.org/10.1017/S1478951517000311

Lundqvist, S., Börjesson, M., Larsson, M. E. H., Cider, Å., & Hagberg, L. (2019). Which patients benefit from physical activity on prescription (PAP)? A prospective observational analysis of factors that predict increased physical activity. *BMC Public Health*, *19*(1), 482. https://doi.org/10.1186/s12889-019-6830-1

Lundqvist, S., Börjesson, M., Larsson, M. E. H., Hagberg, L., & Cider, Å. (2017). Physical Activity on Prescription (PAP), in patients with metabolic risk factors. A 6-month follow-up study in primary health care. *PLoS ONE*, *12*(4). https://doi.org/10.1371/journal.pone.0175190

Maliniak, M. L., Patel, A. V., McCullough, M. L., Campbell, P. T., Leach, C. R., Gapstur, S. M., & Gaudet, M. M. (2018). Obesity, physical activity, and breast cancer survival among older breast cancer survivors in the Cancer Prevention Study-II Nutrition Cohort. *Breast Cancer Research and Treatment*, *167*(1), 133–145. https://doi.org/10.1007/s10549-017-4470-7

Marelli, S., Castelnuovo, A., Somma, A., Castronovo, V., Mombelli, S., Bottoni, D., Leitner, C., Fossati, A., & Ferini-Strambi, L. (2020). Impact of COVID-19 lockdown on sleep quality in university students and administration staff. *Journal of Neurology*, 1–8. https://doi.org/10.1007/s00415-020-10056-6

Matthews, A. K., Tejeda, S., Johnson, T. P., Berbaum, M. L., & Manfredi, C. (2012). Correlates of Quality of Life among African American and White Cancer Survivors. *Cancer Nursing*, *35*(5), 355–364. https://doi.org/10.1097/NCC.0b013e31824131d9

Mazor, M., Paul, S. M., Chesney, M. A., Chen, L.-M., Smoot, B., Topp, K., Conley, Y. P., Levine, J. D., & Miaskowski, C. (2019a). Perceived stress is associated with a higher symptom burden in cancer survivors. *Cancer*, *125*(24), 4509–4515. https://doi.org/10.1002/cncr.32477

Mazor, M., Paul, S. M., Chesney, M. A., Chen, L.-M., Smoot, B., Topp, K., Conley, Y. P., Levine, J. D., & Miaskowski, C. (2019b). Perceived stress is associated with a higher symptom burden in cancer survivors. *Cancer*, *125*(24), 4509–4515. https://doi.org/10.1002/cncr.32477

Michaels, C. (2016). The importance of exercise in lung cancer treatment. *Translational Lung Cancer Research*, *5*(3), 235–238. https://doi.org/10.21037/tlcr.2016.03.02

Mishra, S. I., Scherer, R. W., Snyder, C., Geigle, P., & Gotay, C. (2015). The Effectiveness of Exercise Interventions for Improving Health-Related Quality of Life From Diagnosis Through Active Cancer Treatment. *Oncology Nursing Forum*, *42*(1), E33–E53. https://doi.org/10.1188/15.ONF.E33-E53

Mitchell, A. J., Ferguson, D. W., Gill, J., Paul, J., & Symonds, P. (2013). Depression and anxiety in long-term cancer survivors compared with spouses and healthy controls: A systematic review and meta-analysis. *The Lancet. Oncology*, *14*(8), 721–732. https://doi.org/10.1016/S1470-2045(13)70244-4

Naik, H., Qiu, X., Brown, M. C., Eng, L., Pringle, D., Mahler, M., Hon, H., Tiessen, K., Thai, H., Ho, V., Gonos, C., Charow, R., Pat, V., Irwin, M., Herzog, L., Ho, A., Xu, W., Jones,

J. M., Howell, D., & Liu, G. (2016). Socioeconomic status and lifestyle behaviours in cancer survivors: Smoking and physical activity. *Current Oncology*, *23*(6), e546–e555. https://doi.org/10.3747/co.23.3166

Nelson, S. H., Marinac, C. R., Patterson, R. E., Nechuta, S. J., Flatt, S. W., Caan, B. J., Kwan, M. L., Poole, E. M., Chen, W. Y., Shu, X., & Pierce, J. P. (2016). Impact of very low physical activity, BMI, and comorbidities on mortality among breast cancer survivors. *Breast Cancer Research and Treatment*, *155*(3), 551–557. https://doi.org/10.1007/s10549-016-3694-2

Ness, K. K., Howell, C. R., & Bjornard, K. L. (2017). Frailty and quality of life in adult survivors of childhood cancer. *Expert Review of Quality of Life in Cancer Care*, *2*(2), 79–85. https://doi.org/10.1080/23809000.2017.1300507

Nienhuis, C. P., & Lesser, I. A. (2020). The Impact of COVID-19 on Women's Physical Activity Behavior and Mental Well-Being. *International Journal of Environmental Research and Public Health*, *17*(23). https://doi.org/10.3390/ijerph17239036

Orre, I. J., Fosså, S. D., Murison, R., Bremnes, R., Dahl, O., Klepp, O., Loge, J. H., Wist, E., & Dahl, A. A. (2008). Chronic cancer-related fatigue in long-term survivors of testicular cancer. *Journal of Psychosomatic Research*, *64*(4), 363–371. https://doi.org/10.1016/j.jpsychores.2008.01.002

Paraskevi, T. (2012). Quality of life outcomes in patients with breast cancer. *Oncology Reviews*, *6*(1). https://doi.org/10.4081/oncol.2012.e2

Park, Y., Peterson, L. L., & Colditz, G. A. (2018). The Plausibility of Obesity Paradox in Cancer. *Cancer Research*, *78*(8), 1898–1903. https://doi.org/10.1158/0008-5472.CAN-17-3043

Patsou, E. D., Alexias, G. T., Anagnostopoulos, F. G., & Karamouzis, M. V. (2018). Physical activity and sociodemographic variables related to global health, quality of life, and psychological factors in breast cancer survivors. *Psychology Research and Behavior Management*, *11*, 371–381. https://doi.org/10.2147/PRBM.S170027

Phillips, S. M., & McAuley, E. (2015). *Supportive Care in Cancer*, *23*(1), 159–167. https://doi.org/10.1007/s00520-014-2346-5

*Physical Activity and Cancer Fact Sheet*. (2017, February 3). [CgvArticle]. National Cancer Institute. https://www.cancer.gov/about-cancer/causes-prevention/risk/obesity/physical-activity-fact-sheet

Pugh, G., Below, N., Fisher, A., Reynolds, J., & Epstone, S. (2020). Trekstock RENEW: Evaluation of a 12-week exercise referral programme for young adult cancer survivors delivered by a cancer charity. *Supportive Care in Cancer*. https://doi.org/10.1007/s00520-020-05373-5

Rafie, C., Ning, Y., Wang, A., Gao, X., & Houlihan, R. (2018, November 9). *Impact of physical activity and sleep quality on quality of life of rural residents with and without a history of cancer: Findings of the Day and Night Study*. Cancer Management and Research. https://doi.org/10.2147/CMAR.S160481

Rödjer, L., Jonsdottir, I. H., & Börjesson, M. (2016). Physical activity on prescription (PAP): Self-reported physical activity and quality of life in a Swedish primary care population, 2-year follow-up. *Scandinavian Journal of Primary Health Care*, *34*(4), 443–452. https://doi.org/10.1080/02813432.2016.1253820

Rodriguez, J. L., Hawkins, N. A., Berkowitz, Z., & Li, C. (2015). Factors Associated with Health-Related Quality of Life Among Colorectal Cancer Survivors. *American Journal of Preventive Medicine*, *49*(6), S518–S527. https://doi.org/10.1016/j.amepre.2015.08.007

Rogers, L., Courneya, K., Oster, R., Anton, P., Robbs, R., Forero, A., & Mcauley, E. (2017a). Physical Activity and Sleep Quality in Breast Cancer Survivors: A Randomized Trial. *Medicine & Science in Sports & Exercise*, *49*(10), 2009–2015. https://doi.org/10.1249/MSS.0000000000001327

Rogers, L., Courneya, K., Oster, R., Anton, P., Robbs, R., Forero, A., & Mcauley, E. (2017b). Physical Activity and Sleep Quality in Breast Cancer Survivors: A Randomized Trial. *Medicine & Science in Sports & Exercise*, *49*(10), 2009–2015. https://doi.org/10.1249/MSS.0000000000001327

Rogers, L. Q., Courneya, K. S., Anton, P. M., Verhulst, S., Vicari, S. K., Robbs, R. S., & McAuley, E. (2017). Effects of a multicomponent physical activity behavior change intervention on fatigue, anxiety, and depressive symptomatology in breast cancer survivors: Randomized trial. *Psycho-Oncology*, *26*(11), 1901–1906. https://doi.org/10.1002/pon.4254

Rossi, A., Garber, C. E., Kaur, G., Xue, X., Goldberg, G. L., & Nevadunsky, N. S. (2017). Physical activity-related differences in body mass index and patient-reported quality of life in socioculturally diverse endometrial cancer survivors. *Supportive Care in Cancer*, *25*(7), 2169–2177. https://doi.org/10.1007/s00520-017-3622-y

Salari, N., Hosseinian-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., Mohammadi, M., Rasoulpoor, S., & Khaledi-Paveh, B. (2020). Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: A systematic review and meta-analysis. *Globalization and Health*, *16*(1), 57. https://doi.org/10.1186/s12992-020-00589-w

Savina, S., & Zaydiner, B. (2019a). Cancer-Related Fatigue: Some Clinical Aspects. *Asia-Pacific Journal of Oncology Nursing*, *6*(1), 7–9. https://doi.org/10.4103/apjon.apjon_45_18

Savina, S., & Zaydiner, B. (2019b). Cancer-Related Fatigue: Some Clinical Aspects. *Asia-Pacific Journal of Oncology Nursing*, *6*(1), 7–9. https://doi.org/10.4103/apjon.apjon_45_18

Shachar, S. S., & Williams, G. R. (2017). The obesity paradox in cancer – moving beyond BMI. *Cancer Epidemiology, Biomarkers & Prevention : A Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology*, *26*(1), 13–16. https://doi.org/10.1158/1055-9965.EPI-16-0439

Sheehan, P., Denieffe, S., Murphy, N. M., & Harrison, M. (2020). Exercise is more effective than health education in reducing fatigue in fatigued cancer survivors. *Supportive Care in Cancer*. https://doi.org/10.1007/s00520-020-05328-w

Shin, W., Song, S., Jung, S.-Y., Lee, E., Kim, Z., Moon, H.-G., Noh, D.-Y., & Lee, J. E. (2017a). The association between physical activity and health-related quality of life among breast cancer survivors. *Health and Quality of Life Outcomes*, *15*. https://doi.org/10.1186/s12955-017-0706-9

Shin, W., Song, S., Jung, S.-Y., Lee, E., Kim, Z., Moon, H.-G., Noh, D.-Y., & Lee, J. E. (2017b). The association between physical activity and health-related quality of life among breast cancer survivors. *Health and Quality of Life Outcomes*, *15*. https://doi.org/10.1186/s12955-017-0706-9

Siegel, R. L., Miller, K. D., & Jemal, A. (2019). Cancer statistics, 2019. *CA: A Cancer Journal for Clinicians*, *69*(1), 7–34. https://doi.org/10.3322/caac.21551

Smith, A. B., Butow, P., Olver, I., Luckett, T., Grimison, P., Toner, G. C., Stockler, M. R., Hovey, E., Stubbs, J., Turner, S., Hruby, G., Gurney, H., Alam, M., Cox, K., & King, M. T. (2016). The prevalence, severity, and correlates of psychological distress and impaired health-related quality of life following treatment for testicular cancer: A survivorship study. *Journal of Cancer Survivorship: Research and Practice*, *10*(2), 223–233. https://doi.org/10.1007/s11764-015-0468-5

Sparano, J. A., Wang, M., Zhao, F., Stearns, V., Martino, S., Ligibel, J. A., Perez, E. A., Saphner, T., Wolff, A. C., Sledge, G. W., Wood, W. C., Fetting, J., & Davidson, N. E. (2012). Obesity at Diagnosis Is Associated With Inferior Outcomes in Hormone Receptor-Positive Operable Breast Cancer. *Cancer*, *118*(23), 5937–5946. https://doi.org/10.1002/cncr.27527

*Statistics—Office of Cancer Survivorship*. (n.d.). Retrieved September 8, 2019, from https://cancercontrol.cancer.gov/ocs/statistics/statistics.html

*Statistics—Office of Cancer Survivorship*. (2019, September 8). https://cancercontrol.cancer.gov/ocs/statistics/statistics.html

Strollo, S. E., Fallon, E. A., Gapstur, S. M., & Smith, T. G. (2020). Cancer-related problems, sleep quality, and sleep disturbance among long-term cancer survivors at 9-years post diagnosis. *Sleep Medicine*, *65*, 177–185. https://doi.org/10.1016/j.sleep.2019.10.008

Sullivan, G. M., & Feinn, R. (2012). Using Effect Size—Or Why the P Value Is Not Enough. *Journal of Graduate Medical Education*, *4*(3), 279–282. https://doi.org/10.4300/JGME-D-12-00156.1

TABRIZI, F. M., & ALIZADEH, S. (2017). Cancer Related Fatigue in Breast Cancer Survivors: In Correlation to Demographic Factors. *Mædica*, *12*(2), 106–111.

Tarasenko, Y. N., Miller, E. A., Chen, C., & Schoenberg, N. E. (2017). Physical activity levels and counseling by health care providers in cancer survivors. *Preventive Medicine*, *99*, 211–217. https://doi.org/10.1016/j.ypmed.2017.01.010

Thraen-Borowski, K. M., Trentham-Dietz, A., Edwards, D. F., Koltyn, K. F., & Colbert, L. H. (2013). Dose-response relationships between physical activity, social participation, and health-related quality of life in colorectal cancer survivors. *Journal of Cancer Survivorship: Research and Practice*, *7*(3), 369–378. https://doi.org/10.1007/s11764-013-0277-7

Torrance, G. W. (1987). Utility approach to measuring health-related quality of life. *Journal of Chronic Diseases*, *40*(6), 593–603. https://doi.org/10.1016/0021-9681(87)90019-1

Tuyan İlhan, T., Uçar, M. G., Gül, A., Saymaz İlhan, T., Yavaş, G., & Çelik, Ç. (2017). Sleep quality of endometrial cancer survivors and the effect of treatments. *Turkish Journal of Obstetrics and Gynecology*, *14*(4), 243–248. https://doi.org/10.4274/tjod.59265

Ware, J. E., & Gandek, B. (1998). Overview of the SF-36 Health Survey and the International Quality of Life Assessment (IQOLA) Project. *Journal of Clinical Epidemiology*, *51*(11), 903–912. https://doi.org/10.1016/S0895-4356(98)00081-X

Ware, J., Kosinski, M., & Keller, S. D. (1996). A 12-Item Short-Form Health Survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care*, *34*(3), 220–233. https://doi.org/10.1097/00005650-199603000-00003

*Weight Gain*. (2012, February 10). Cancer.Net. https://www.cancer.net/coping-with-cancer/physical-emotional-and-social-effects-cancer/managing-physical-side-effects/weight-gain

Wiskemann, J., Foo, W., WInkels, R. M., Bluthmann, S. M., Mama, S. K., Calo, W., Lengerich, E., Segel, J., & Schmitz, K. H. F. (2018). Pennsylvania Cancer Survivors And Their Adherence To The ACSM Physical Activity Guideline: 1099 Board #4 May 31 8: 00 AM - 10: 00 AM. [Abstract]. *Medicine & Science in Sports & Exercise*. https://doi.org/10.1249/01.mss.0000535928.34563.86

Xiong, J., Lipsitz, O., Nasri, F., Lui, L. M. W., Gill, H., Phan, L., Chen-Li, D., Iacobucci, M., Ho, R., Majeed, A., & McIntyre, R. S. (2020). Impact of COVID-19 pandemic on mental health in the general population: A systematic review. *Journal of Affective Disorders*, *277*, 55–64. https://doi.org/10.1016/j.jad.2020.08.001

Yaman, H., & Atay, E. (2018a). The effect of exercise prescription of primary care physician on the quality of life in patients. *London Journal of Primary Care*, *10*(4), 93–98. https://doi.org/10.1080/17571472.2018.1464731

Yaman, H., & Atay, E. (2018b). The effect of exercise prescription of primary care physician on the quality of life in patients. *London Journal of Primary Care*, *10*(4), 93–98. https://doi.org/10.1080/17571472.2018.1464731

Yi, J. C., & Syrjala, K. L. (2017). Anxiety and Depression in Cancer Survivors. *The Medical Clinics of North America*, *101*(6), 1099–1113. https://doi.org/10.1016/j.mcna.2017.06.005

Zhang, F. F., Hudson, M. M., Huang, I.-C., Bhakta, N., Ness, K. K., Brinkman, T. M., Klosky, J., Lu, L., Chen, F., Ojha, R. P., Lanctot, J. Q., Robison, L. L., & Krull, K. R. (2018).

Lifestyle factors and health-related quality of life in adult survivors of childhood cancer: A report from the St. Jude Lifetime Cohort Study. *Cancer*, *124*(19), 3918–3923. https://doi.org/10.1002/cncr.31647

# APPENDIX A

**EAST CAROLINA UNIVERSITY**
**University & Medical Center Institutional Review Board**
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** ·
rede.ecu.edu/umcirb/

## Notification of Amendment Approval

From: Biomedical IRB
To: Brian Maloney
CC: Bhibha Das
Date: 5/20/2020
Re: Ame1_UMCIRB 20-000318
UMCIRB 20-000318
The Effects of a Healthcare Providers' Prescription of Physical Activity on Cancer Survivors Physical Activity Levels

Your Amendment has been reviewed and approved using expedited review on 5/19/2020. It was the determination of the UMCIRB Chairperson (or designee) that this revision does not impact the overall risk/benefit ratio of the study and is appropriate for the population and procedures proposed.

Please note that any further changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must adhere to all reporting requirements for this study.

If applicable, approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

| Document | Description |
| --- | --- |
| Additonal survey questions - Maloney - 5.19.20.docx(0.02) | Surveys and Questionnaires |
| Demographics&HH. Maloney-5.17.20.doc(0.02) | Surveys and Questionnaires |
| Recruitment script 5.17.20.docx(0.02) | Recruitment Documents/Scripts |

For research studies where a waiver of HIPAA Authorization has been approved, each of the waiver criteria in 45 CFR 164.512(i)(2)(ii) has been met. Additionally, the elements of PHI to be collected as described in items 1 and 2 of the Application for Waiver of Authorization have been determined to be the minimal necessary for the specified research.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

## APPENDIX B

You are being invited to participate in a **research** study titled *"The Impact of a Healthcare Providers' Prescription of Physical Activity on Cancer Survivors Physical Activity Levels"* being conducted by Brian Maloney, a graduate student at East Carolina University in the Kinesiology department. The goal is to survey 50 individuals via online surveys. The survey will take approximately 15 minutes to complete. It is hoped that this information will assist us to better understand the impact a healthcare providers' physical activity prescription has on physical activity levels post cancer treatment. Your responses will be kept confidential and no data will be released or used with your identification attached. Your participation in the research is **voluntary**. You may choose not to answer any or all questions, and you may stop at any time. There is **no penalty for not taking part** in this research study. Please call Brian Maloney at 704-345-8003 for any research related questions or the University & Medical Center Institutional Review Board (UMCIRB) at 252-744-2914 for questions about your rights as a research participant

**APPENDIX C**

## Demographics & Health History

1. What is your age? ____ ____ years

2. What is your race/ethnicity? (check one)

| | | |
|---|---|---|
| ____ 1. African-American | ____ 3. Hispanic | ____ 5. Native American |
| ____ 2. Non-Hispanic white | ____ 4. Asian | ____ 6. Other |

3. What is your sex? (check one)

____ 1. Female
____ 2. Male
____3. Other

4. What is your weight? _______lbs.

5. What is your height? _______ ________inches

6. Which best reflects your highest level of education? (check one)

____ 1. Did not complete high school
____ 2. Graduated from high school or earned GED
____ 3. Attended college or vocational school
____ 4. Earned a college degree (Bachelor's)
____ 5. Earned a graduate degree (Masters, Doctoral, Professional)
____ 6. Don't know/refused

7. Which best describes your marital status? (check one)

____ 1. Married
____ 2. Living as married
____ 3. Widowed
____ 4. Divorced
____ 5. Never married/single
____ 6. Separated
____ 7. Don't know/refused

8. Which best describes your household income in the past year? (check one)

____ 1. < $15,999

____ 2. $16,000 to $24,999
____ 3. $25,000 to $34,999
____ 4. $35,000 to $49,999
____ 5. $50,000 to $74,999
____ 6. $75,000 and greater
____ 7. Don't know/refused

9. If you are from the United Stated please write the zip code you live in. If you are from outside of the United States, please specify which country you live in. ___

10. Have you seen a change in your professional responsibilities post-COVID-19?
_____1. Yes
_____2. No
Is there anything else you'd like to add?
_______________________________________

11. Have you seen a change in your personal responsibilities post-COVID-19?
_____1. Yes
_____2. No
Is there anything else you'd like to add?
________________________________________

12. Are you more physically active post-COVID-19?
_____1. Yes
_____2. No
Is there anything else you'd like to add?
________________________________________

**Cancer History**

13. What type of cancer were you initially diagnosed with?
____ 1. Breast
____ 2. Lung
____ 3. Prostate
____ 4. Colon and rectal
____ 5. Melanoma
____ 6. Bladder
____ 7. Kidney
____ 8. Endometrial
____ 9. Leukemia
____ 10. Pancreatic
____ 11. Thyroid
____ 12. Liver
____ 13. Other: ______________

14. What stage of cancer were you initially diagnosed with?

____1. Stage 1
____ 2. Stage 2
____3. Stage 3
____4. Stage 4

15. How long has it been since your initial diagnosis? _______months

16. How long has it been since your last cancer treatment? _______months

17. What type of cancer treatment did you receive? (Select all that apply)

______ Chemotherapy ______ Radiation therapy______ Surgery ______ Immunotherapy

______ Hormonal Therapy _______ Targeted Therapy _____________________Other (Please specify)

**Pre-Cancer Diagnosis**

18. Did your healthcare provider prescribe you physical activity prior to your cancer diagnosis?
______ Yes ______ No (Go to question 22)

19. If you answered yes to #18, what type of activity was prescribed?

______ Aerobic (i.e. walking, biking, swimming, etc.) _______ Resistance training
______ Both

20. If you answered yes to #18, what intensity of physical activity was prescribed?

____ 1. Low Intensity (Walking)
____ 2. Moderate Intensity (Walking at a brisk pace)
____ 3. High Intensity (Jogging or running)
____ 4. Intensity Not Prescribed/Do Not Know

21. What duration of physical activity was prescribed? (In minutes) ___________

22. Were you physically active before your cancer diagnosis?
_____ Yes _____ No (Go to question 25)

23. If you answered yes to #22, what type of activity did you engage in? (Please select all that apply)

______ Aerobic (i.e. walking, biking, swimming, etc.) _______ Resistance training
______ Flexibility ________ Other (Please specify)

24. If you answered yes to #22, what intensity of physical activity did you engage in?

____ 1. Low Intensity (Walking)
____ 2. Moderate Intensity (Walking at a brisk pace)
____ 3. High Intensity (Jogging or running)
____ 4. Do Not Know

25. If you answered yes to #22, On average, how many days per week were you physically active?

______ 1-2 days ______ 3-4 days _____ 5+ days

## During Cancer Treatment

26. Did your healthcare provider prescribe you physical activity during cancer treatment?
_____Yes ____ No

27. What type of activity was prescribed? (Please select all that apply)
______ Aerobic (i.e. walking, biking, swimming, etc.) _______ Resistance training
______ Flexibility ______ Other (Please specify)

28. What frequency of physical activity was prescribed?

______ Days per Week (Aerobic) ______ Days per Week (Resistance Training)

______Frequency Not Prescribed ______ Do not know

29. What duration of physical activity was prescribed? (In minutes) ___________

## Post Cancer Diagnosis

30. Did your healthcare provider prescribe you physical activity post cancer treatment?
_____ Yes _____ No (end of questionnaire)

31. If you answered yes to #20, what type of activity was prescribed? (Please select all that apply)

______ Aerobic (i.e. walking, biking, swimming, etc.) _______ Resistance training
______ Flexibility ______ Other (Please specify)

32. If you answered yes to #20, what frequency of physical activity was prescribed?

______ Days per Week (Aerobic) ______ Days per Week (Resistance Training)

______Frequency Not Prescribed/Do Not Know

33. If you answered yes to #20, what intensity of physical activity was prescribed?

____ 1. Low Intensity (Walking)
____ 2. Moderate Intensity (Walking at a brisk pace)
____ 3. High Intensity (Jogging or running)
____ 4. Intensity Not Prescribed/Do Not Know

34. What duration of physical activity was prescribed? (In minutes) ___________

# International Physical Activity Questionnaire

## INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

   _____ **hours per day**
   _____ **minutes per day**

   ☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

   _____ **days per week**

   ☐ No moderate physical activities → ***Skip to question 5***

SHORT LAST 7 DAYS SELF-ADMINISTERED version of the IPAQ. Revised August 2002.

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

   _____ **hours per day**
   _____ **minutes per day**

   ☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

   _____ **days per week**

   ☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

   _____ **hours per day**
   _____ **minutes per day**

   ☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

   _____ **hours per day**
   _____ **minutes per day**

   ☐ Don't know/Not sure

# The Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions. During the past month,

1. When have you usually gone to bed?

2. How long (in minutes) has it taken you to fall asleep each night?

3. When have you usually gotten up in the morning?

4. How many hours of actual sleep do you get at night? (This may be different than the number of hours you spend in bed)

| 5. During the past month, how often have you had trouble sleeping because you... | Not during the past month (0) | Less than once a week (1) | Once or twice a week (2) | Three or more times week (3) |
|---|---|---|---|---|
| a. Cannot get to sleep within 30 minutes | | | | |
| b. Wake up in the middle of the night or early morning | | | | |
| c. Have to get up to use the bathroom | | | | |
| d. Cannot breathe comfortably | | | | |
| e. Cough or snore loudly | | | | |
| f. Feel too cold | | | | |
| g. Feel too hot | | | | |
| h. Have bad dreams | | | | |
| i. Have pain | | | | |
| j. Other reason(s), please describe, including how often you have had trouble sleeping because of this reason(s): | | | | |
| 6. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep? | | | | |
| 7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity? | | | | |
| 8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done? | | | | |
| | Very good (0) | Fairly good (1) | Fairly bad (2) | Very bad (3) |
| 9. During the past month, how would you rate your sleep quality overall? | | | | |

Add the seven component scores together ______ **Global PSQI Score** ______ Buysse, D.J., Reynolds III, C.F., Monk, T.H., Berman, S.R., & Kupfer, D.J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric

practice and research. *Journal of Psychiatric Research*, *28*(2), 193-213.

# Hospital Anxiety and Depression

## Hospital Anxiety and Depression Scale (HADS)

**Tick the box beside the reply that is closest to how you have been feeling in the past week.**
**Don't take too long over you replies: your immediate is best.**

| D | A | | D | A | |
|---|---|---|---|---|---|
| | | **I feel tense or 'wound up':** | | | **I feel as if I am slowed down:** |
| | 3 | Most of the time | 3 | | Nearly all the time |
| | 2 | A lot of the time | 2 | | Very often |
| | 1 | From time to time, occasionally | 1 | | Sometimes |
| | 0 | Not at all | 0 | | Not at all |
| | | | | | |
| | | **I still enjoy the things I used to enjoy:** | | | **I get a sort of frightened feeling like 'butterflies' in the stomach:** |
| 0 | | Definitely as much | | 0 | Not at all |
| 1 | | Not quite so much | | 1 | Occasionally |
| 2 | | Only a little | | 2 | Quite Often |
| 3 | | Hardly at all | | 3 | Very Often |
| | | | | | |
| | | **I get a sort of frightened feeling as if something awful is about to happen:** | | | **I have lost interest in my appearance:** |
| | 3 | Very definitely and quite badly | 3 | | Definitely |
| | 2 | Yes, but not too badly | 2 | | I don't take as much care as I should |
| | 1 | A little, but it doesn't worry me | 1 | | I may not take quite as much care |
| | 0 | Not at all | 0 | | I take just as much care as ever |
| | | | | | |
| | | **I can laugh and see the funny side of things:** | | | **I feel restless as I have to be on the move:** |
| 0 | | As much as I always could | | 3 | Very much indeed |
| 1 | | Not quite so much now | | 2 | Quite a lot |
| 2 | | Definitely not so much now | | 1 | Not very much |
| 3 | | Not at all | | 0 | Not at all |
| | | **Worrying thoughts go through my mind:** | | | **I look forward with enjoyment to things:** |
| | 3 | A great deal of the time | 0 | | As much as I ever did |
| | 2 | A lot of the time | 1 | | Rather less than I used to |
| | 1 | From time to time, but not too often | 2 | | Definitely less than I used to |
| | 0 | Only occasionally | 3 | | Hardly at all |
| | | | | | |
| | | **I feel cheerful:** | | | **I get sudden feelings of panic:** |
| 3 | | Not at all | | 3 | Very often indeed |
| 2 | | Not often | | 2 | Quite often |
| 1 | | Sometimes | | 1 | Not very often |
| 0 | | Most of the time | | 0 | Not at all |
| | | | | | |
| | | **I can sit at ease and feel relaxed:** | | | **I can enjoy a good book or radio or TV program:** |
| | 0 | Definitely | 0 | | Often |
| | 1 | Usually | 1 | | Sometimes |
| | 2 | Not Often | 2 | | Not often |
| | 3 | Not at all | 3 | | Very seldom |

Please check you have answered all the questions

Scoring:
Total score: Depression (D) ___________ Anxiety (A) ______________
0-7 = Normal
8-10 = Borderline abnormal (borderline case)
11-21 = Abnormal (case)

After completing this survey if you feel you are expecting thoughts or symptoms of depression and/or anxiety, we encourage you to utilize resources provided by the Anxiety and Depression Association of America.
https://adaa.org

# SF-12 Short Form Health Survey

This questionnaire asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities.

Please answer every question by checking one box. If you are unsure about how to answer a question, please give the best answer you can.

1. In general, would you say your health is:

| Excellent | Very good | Good | Fair | Poor |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

| | Yes Limited a lot | Yes Limited a little | No Not limited at all |
|---|---|---|---|
| 2. **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling or playing golf | ☐ | ☐ | ☐ |
| 3. Climbing **several** flights of stairs | ☐ | ☐ | ☐ |

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

| | Yes | No |
|---|---|---|
| 4. **Accomplished less** than you would like | ☐ | ☐ |
| 5. Were limited in the **kind** of work or other activities | ☐ | ☐ |

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

| | Yes | No |
|---|---|---|
| 6. **Accomplished less** than you would like | ☐ | ☐ |
| 7. Didn't do work or other activities as **carefully** as usual | ☐ | ☐ |



8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

| Not at all | A little bit | Moderately | Quite a bit | Extremely |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the past 4 weeks:

| | All of the time | Most of the time | A Good bit of the time | Some of the time | A little of the time | None of the time |
|---|---|---|---|---|---|---|
| 9. Have you felt calm and peaceful? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 10. Did you have a lot of energy? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 11. Have you felt down-hearted and blue? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

12. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?

| All of the time | Most of the time | Some of the time | A little of the time | None of the time |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

## Fatigue - Short Form 7a

**Please respond to each question by marking one box per row.**

**In the past 7 days…**

| | | Never | Rarely | Sometimes | Often | Always |
|---|---|---|---|---|---|---|
| FATEXP20 | How often did you feel tired?................ | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| FATEXP5 | How often did you experience extreme exhaustion?........................................... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| FATEXP18 | How often did you run out of energy?................................................... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| FATIMP33 | How often did your fatigue limit you at work (include work at home)?.............. | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| FATIMP30 | How often were you too tired to think clearly?.................................................... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| FATIMP21 | How often were you too tired to take a bath or shower?....................................... | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 4 | ☐ 5 |
| FATIMP40 | How often did you have enough energy to exercise strenuously?........................... | ☐ 5 | ☐ 4 | ☐ 3 | ☐ 2 | ☐ 1 |

## Perceived Stress Scale

| | Never | Almost Never | Sometimes | Fairly Often | Very Often |
|---|---|---|---|---|---|
| In the last month, how often have you been upset because of something that happened unexpectedly? | | | | | |
| In the last month, how often have you felt that you were unable to control the important things in your life? | | | | | |
| In the last month, how often have you felt nervous and "stressed"? | | | | | |
| In the last month, how often have you felt confident about your ability to handle your personal problems? | | | | | |
| In the last month, how often have you felt that things were going your way? | | | | | |
| In the last month, how often have you found that you could not cope with all the things that you had to do? | | | | | |
| In the last month, how often have you been able to control irritations in your life? | | | | | |
| In the last month, how often have you felt that you were on top of things? | | | | | |
| In the last month, how often have you been angered because of things that were outside of your control? | | | | | |
| In the last month, how often have you felt difficulties were piling up so high that you could not overcome them? | | | | | |