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SELF-REPORTED ADHERENCE TO PHYSICAL ACTIVITY FOR CANCER SURVIVORS: AN UPDATE FROM THE 2015 NHIS DATABASE

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THESIS

A thesis submitted in partial fulfillment of the

requirements for the degree of Master of Science in the

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ABSTRACT OF THESIS

SELF-REPORTED ADHERENCE TO PHYSICAL ACTIVITY FOR CANCER SURVIVORS: AN UPDATE FROM THE 2015 NHIS DATABASE

Cancer is the second leading cause of death in America. It's been suggested that regular physical activity (PA) can improve health outcomes in cancer survivors. An estimate from BRFSS data (2009) suggested that 47% of all cancer survivors met recommended guidelines and that this estimate was not different from the population at large (48%). Several factors were examined from these BRFSS data to determine whether subgroups of survivors existed who might benefit from interventions aimed at improving their PA status. The purpose of this investigation was to obtain more recent estimates of adherence to established PA guidelines for cancer survivors. Data from 2015 NHIS were obtained from the CDC website. Of the survivors, 40% met PA guidelines. Additionally, 79% were 54 years or older, more likely to be female (60%), predominantly white (80%), with more than 2 comorbidities (41%), and with some form of functional limitation (66%). Compared to a study based on 2009 BRFSS data, an even smaller proportion of survivors met PA guidelines in this study. This might be due to differences in age distributions and no limitation of the analysis according to time since diagnosis. Targeted interventions to increase activity in cancer survivors continue to be warranted.

KEYWORDS: Physical Activity, Cancer Survivors, NHIS 2015, Self-Reported, Clinical Trials, Chronic illness"

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Chapter I: Introduction

Cancer is the second leading cause of death in America closely following cardiovascular disease (1). It's estimated that by the end of the year 2017, there will be approximately 600,000 cancer deaths, and over 1.5 million new cases in the Unites States (2). From a global perspective it's projected that by 2030, there will be 13 million cancer deaths and 21.6 million new cases per year. On a more positive note, as of 2016, of the total population in the United States, cancer survivors constitute 15.5 million (3). It's also worth noting that out of all cancer types, there is a 67% five-year relative survival rate with a median age of 65 at diagnosis. These facts regarding cancer mortality and cancer survivorship have prompted researchers to examine ways to decrease mortality rates by way of cancer screenings. While screenings are contributing to this goal, researchers have noted that the best way to prevent cancer and increase the rate of survival continues to be through lifestyle and environmental factor modifications (4,5). It has been observed that a relationship exists between these behavioral and environmental factors, and specific cancer types (6). Of the lifestyle factors, the one that is of major importance to this study, is adherence to physical activity.

For example, one follow-up study composed of 2,705 men was done by Kenfield et al., in which they evaluated physical activity and overall survival in post diagnosis prostate cancer (7). They found that there was a lower risk of all-cause mortality in men who were more physically active. Validating this point, they also found that those who walked more than 90 minutes a week at a vigorous pace had a 46% lower risk of all-cause mortality and those who invested in more than 180 minutes of vigorous activity per week increased their likelihood of survival by 49%. Their conclusion was that an appropriate amount of vigorous physical activity was associated with decreased overall mortality and prostate cancer diagnosis mortality. Another study from Richman et al. found similar results. They examined the effects of physical

activity and brisk walking after the diagnosis of prostate cancer in 1,455 men (8). Men who were actively walking at a brisk pace for at least 180 minutes a week had a 57% lower rate of progression of prostate cancer compared to those who walked at an easy pace for the same amount of minutes. They concluded that the intensity of their physical activity post diagnosis, may constrain or postpone the progression of prostate cancer. The results suggest that a behavioral risk factor such as physical activity plays a significant role in the lives in the advancement of cancer survivorship.

In 2014, a study was conducted using population-based data in order to observe whether a positive association existed between cancer survivors and adherence to physical activity (9). The study made use of 2009 BRFSS data estimated that 47% of all cancer survivors met recommended guidelines which was not different from the normal population (48%). Several factors were examined from these BRFSS data to determine whether there were subgroups of survivors who might benefit from interventions aimed at improving their physical activity status.

The purpose of this investigation was to obtain more recent estimates of adherence to established physical activity guidelines for cancer survivors and to determine whether there have been changes over time in distribution of socioeconomic status (SES), cancer diagnosis, comorbidity status, and functional limitation as well as other factors for those meeting PA guidelines. Such disparities, if found, could lead to more targeted intervention strategies to address non-adherence to PA.

Chapter II: Literature of Review

The overall goal of this chapter is firstly to establish the significance of the general field of study and, then identify a place where a new contribution could be made. The bulk of the chapter was on critically evaluating the different methodologies used in this field so as to identify the appropriate approach for investigating the research question(s). This literature review will be establishing four things. First, the historical context of cancer, cancer survivorship, and physical activity. Second, recommendations for physical activity in the healthy population as well as the cancer population. Third, if recommendations have been gathered for these populations, then determining whether they are adhering to the physical activity guidelines is important. Finally, this review will seek to provide justification for further investigations on physical activity adherence specifically in the cancer survivor population.

1. Establishing the Historical Context

1.1 History of Cancer Survivorship

The definition of a cancer survivor according to the American Cancer Society is anyone who has been diagnosed with cancer and has been alive from the time of diagnosis to the present day (3). The ACS's facts and figures for 2014-2015 articulates that approximately 14.5 million children and adult cancer survivors were alive in January 2014. This statistic included all cancer types with the exception of carcinoma in situ, basal cell and squamous cell skin cancers (these aren't recorded by registries). They estimate that by 2024 there will be a 4.5 million increase in the number of cancer survivors. These projected increases in cancer survivorship can be attributed to many things, one of which is physical activity. They state that PA is associated with increased overall survival and yet certain individual health status characteristics like unhealthy BMI values is consistently correlated with poorer overall survival.

Historically speaking, cancer has become the second leading cause of death in the Unites States (1). To put it more in perspective, Torre et al. provided statistical evidence from 2012 using globocan estimates showing that approximately 14.1 million new cases of cancer are occurring as well as 8.2 million deaths in 2012 (10). They observed that over the course of history this epidemic has shifted into less developed countries which have accounted for about 57% of cases and 65% of cancer deaths worldwide. This author concluded that the cancer burden is expected to increase due to the growth and aging population as well as the adoption of unhealthy behavioral and lifestyle risk factors for cancer.

Another study recently done by siegel et al., estimated the number of new cancer diagnoses and deaths in the United States the years 2007 to 2011. Their compilation of data found that there was 1,658,370 new cancer cases (approximately 4,500 new cancer diagnosis each day), and 589,430 deaths were projected to occur in 2015 (approximately 1,600 deaths each day) (11). On a more positive note, they observed that trends in cancer survivorship has improved. The 5-year relative rate for all sites combined has increased 19% percent for whites and 23% percent among blacks. These facts are relative, and when considering specific cancer types such as lung and pancreatic cancers, the 5-year relative survival rate is up 18% and 7% correspondingly. Overall what has helped the survival rate go up over a 5 year span has been the advances in cancer screenings.

1.2 History of Physical Activity as a Factor in Cancer Survival

It's also important to evaluate the historical platform of physical activity and its effect on physical and mental health. Authors Penedo and Dahn evaluated the association between this effect by looking at cross-sectional, and longitudinal studies as well as randomized clinical trials (12). In these studies they specifically focused on chronic diseases such as cancer, obesity and cardiovascular disease in all age groups for males and females. The results

showed an increasingly strong support for exercise interventions having a positive effect on one's mental and physical health outcomes. Another article by Charles Corbin sought to inform the general public of the importance of physical activity for every individual. He explained the historical context of physical activity and the need for guidelines to be administered in order to inform populations of the importance of exercise. The author suggested that prior to the 1970's, physical activity was deemed less important from a medical and scientific point of view. In the early 1990's the American Heart Association teamed up with the American College of Sports Medicine (ACSM) to publish a paper identifying sedentary behavior as a major risk factor for Coronary artery disease. Now physical activity is looked at as a key component of reducing chronic diseases as well as early death through increased moderate activity. These findings continue influencing the ACSM to update guidelines for the general population as well as those with chronic diseases such as cancer and heart disease.

A meta-analysis was conducted to look at physical activity trials in cancer survivors. Speck et al., pointed out that prescribing physical activity to cancer patients is based on whether exercise during and after treatments was effective (improved health outcomes) (13). They methodically took controlled trials of physical activity interventions in cancer survivors for during and post treatment. They accumulated 82 studies and evaluated 60 outcomes. They did not include adverse events. The results from their analysis showed a very large effect of physical activity on post treatment (for upper and lower body strength). Moderate effects of physical activity was seen in breast cancer survivors in terms of fatigue and a small to moderate effect of PA during treatment was observed for PA level, aerobic fitness, muscular strength and functional quality of life. They concluded that PA is both helpful and effective for people who are in the post treatment phase of their survivorship. They however did say

caution is important when prescribing exercise to survivors. Cancer survivors having weakened immune systems, and therefore care should be given as to how much physical activity should be given as well as how intense the exercise should be.

Having an historical perspective on cancer survivorship and physical activity plays a major role in understanding both the severity of the disease, as well as the importance of pin-pointing behavioral risk factors that may help lower the rate of cancer mortality. Over the years, it has been established through research that physical activity is a major component to reducing the effects of chronic disease. Implementing this into the cancer survivors may be needed as this disease continues to have a devastating effect on the United States.

2 Establishing Research Recommendations for Physical Activity

2.1 Recommendations of Physical Activity for the Healthy Population

Physical activity has become a topic of discussion among many experts. The next step was to develop guidelines for the normal population to follow to keep them healthy and fit. Underwood et al., noted that it was the goal of these experts to provide recommendations for physical activity that relates to public health (14). While physical activity can be linked to increased health and quality of life, they concluded that physical inactivity has remained by and large a public health issue. The public has either ignored, not adhered to, or do not fully comprehend the requirements or those recommendations. This lack of adherence to these requirements motivated the addition of new guidelines by the ACSM panel of experts for healthy adults between 18-65 years old. They went on to suggest that the primary recommendations for healthy adults 18-65 years of age is to do moderate-intensity aerobic physical activity for a minimum of 30 min on five days each week (150 minutes total), or vigorous aerobic physical activity for 20 minutes on three days each week (60 minutes).

While the normal population should consider abiding by these recommendations, it should be

understood that not everyone can. Different factors affect one's ability to exercise or be active. Not everyone is normal or healthy enough to adhere to these guidelines. Many people have functional limitations that impairs a person's ability to be active (15). Others may have metabolic problems as well as unhealthy ranges of BMI which is associated with one's inability to be active (16). Another reason may be due to chronic diseases like cancer.

2.2 Recommendations of Physical Activity for the Cancer Population

Since the panel of experts from ACSM have developed guidelines for the healthy population, they also realized the need for publishing guidelines for those who are chronically ill. There are many publications in this realm of research. Rock et al., noted ACS's decision to convene a group of experts in helping the cancer survivor population understand more about how they can live a healthy lifestyle. These researchers went on to provide information recommending good food choice, physical activity, and dietary supplements to help improve their overall quality of life and outcomes from their disease and treatments (17). These experts comprised of those with expertise in nutrition, physical activity and cancer survivorship. In terms of physical activity, they observed that prospectively speaking, PA does indeed decreases the probability of a person being re-diagnosed with cancer. They showed statistically that meta-analysis have been done showing a 34% lower risk of breast cancer deaths, 41% lower risk of all-cause mortality and a 24% lower risk of breast cancer recurrence. In terms of implementing physical activity as a prescription. They viewed 78 exercise intervention trials that all showed physical activity improves one's quality of life which continued to be the case even after the intervention was concluded. They were guided by a panel of experts by the American College of Sports Medicine (ACSM) as well as the US Department of Health and Human services. These panels recommended that adults 18-64 should engage in at least 150 minutes per week of moderate intensity aerobic PA or 75 minutes per week of vigorous intensity aerobic exercise.

For those older than 65 years of age, they should follow the same guidelines as they are physically able to. They did state that these guidelines may be cancer specific. That is, some caner types may prevent survivors from being able to adhere to these recommendations completely.

Another study conducted by Wolin et al., highlighted the need to evaluate the risks and benefits of exercise based interventions for cancer survivors (18). As shown in the Wolin et al paper, the ACSM organized a team of clinicians, exercise physiologists, epidemiologists, behavioral sciences and exercise specialists to conduct this evaluation. They went on to describe that the ACSM has two main documents for physical activity for cancer survivors that they used for recommendations. The first one to consider is the 2008 physical activity guidelines for Americans which provided recommendations for types and amounts of physical activity. The second documents is the ACSM guidelines for exercise testing and prescription which was used to address safety issues. The first document, suggested that adults gained an increased health benefit when they engaged in at least 150 min/week of moderate-intensity activity or 75 min/week of vigorous-intensity activity. This also would apply to older adults. The only exception to the rule is for those older adults (who are cancer survivors) that can't perform physical activity at this level (they are required to be as active as they are able). They concluded by stating that cancer survivors are already at increased risk for other chronic diseases and therefore physical activity which is safe for most cancer survivors will gain many health benefits.

Another study by Schmitz et al., also published a document that focused on physical activity guidelines for cancer survivors. In 2010, they noted that there were approximately 12 million survivors. This panel of experts that helped publish this paper concluded that physical activity guidelines would be beneficial as it was both safe and improved physical functioning during

and after treatments (19). Continued by showing that the ACSM assembled a panel of experts that took the ACSM physical recommendations for healthy adults and modified them to fit the specific population of cancer survivors, which is defined by the National Coalition for Cancer Survivorship as "time of diagnosis until the end of life". This team of experts took the PA recommendations for healthy adults from ACSM and American Heart Association as well as the guidelines from 2008 US Department of Health and Human Services (20), to create these guidelines for Cancer Survivors. The US Department of Health and Human Services provided recommendations of overall volume of weekly activity as 150 minutes of moderate-intensity exercise or 75 minutes of vigorous-intensity exercise. These guidelines are specific to chronic conditions which the ACSM panel agreed was appropriate of Cancer Survivors.

As can be seen in the references above, each of these publications view the ACSM as the gold standard for physical activity guidelines for the healthy population and those with chronic diseases. Therefore it's important to use them as a final reference. The ACSM and specifically Geoffrey and Patricia (the authors), developed and published a book entitled ACSM'S Exercise Management for Persons With Chronic Diseases and Disabilities 4th Edition (21). In their book, they provide recommendations for PA as being moderate intensity exercise for ≥ 150 minutes or ≥ 75 minutes of vigorous activity. Any exercise below the minimum amount for moderate or vigorous activity was considered sedentary.

Major steps have been made not only to meet the needs of the healthy population, but also the needs of those with chronic disease. The gold standard for physical activity guidelines is the ACSM. It is also the understanding of many experts that ACSM'S guidelines of moderate intensity exercise for ≥ 150 minutes or ≥ 75 minutes of vigorous activity is appropriate and should be adhered to.

3 Cancer Survivors and Being Adherent to Physical Activity

While guidelines have been established for physical activity. The question often pondered is whether people adhere to them or not. Published facts and figures that have already been discussed in the review regarding cancer mortality and cancer survivorship has motivated researchers to look at physical activity to see if adhering to PA guidelines is associated or not to overall cancer survivorship. Most of the research in this area is done analyzing data using survey data. Nayak et al. for example did a study using Behavioral Risk Factor Surveillance Survey (BRFSS) data from 2009. This paper attempted to look at self-reported physical activity among middle aged cancer survivors in the United States to controls. They focused on identifying correlates of adherence to PA to see if exercise adherence was associated to health related quality of life (9). They analyzed their data using multivariable logistic regression. They found that cancer survivors and control subjects had similar rates of PA adherence.

They looked at the population based estimates and found that only 47% of cancer survivors in the U.S. adhered to physical activity guidelines. Of these 47%, their cancer types included: Breast, Bladder, Cervical, Colon, Melanoma and Prostate. Demographic and medical factors contributed to being independently associated with this sedentary lifestyle. They also found that PA adherence was positively correlated with health related quality of life. They concluded that the majority of cancer survivors did not meet the PA recommendations stated by the American College of Sports Medicine. Evidence suggests therefore that interventions are needed to target physical activity among cancer survivors who are sedentary.

Another study conducted by Kwon et al., looked at the comparison between cancer survivors and non- cancer subjects in terms of their physical activity adherence. This study used 2009 data from BRFSS in order to conduct a secondary analyses (22). They looked at six different

cancer types for survivors, (prostate, female breast, colon, cervix, endometrium and ovary). These subjects were between the ages of 40-79. They measured physical activity levels in terms of weekly moderate to vigorous activity. They found that on average, prostate cancer survivors reported having participated in 20 min per week more compared to non-cancer male survivors. There wasn't any difference between physical activity levels between colon, breast or ovary cancer survivors vs. non-cancer survivors. Overall it was found that a high proportion of the people who answered the survey questions also met the physical activity guidelines. They concluded by observing that there was a higher level of physical activity adherence in prostate cancer survivors and lower physical activity adherence in cancer survivors of cervical and endometrial cancers compared to their gender and age matched healthy populations.

In 2002, Jones and Courneya compiled research for the purpose of offering an inclusive valuation of the exercise preferences of cancer survivors. What they found was that approximately 84% of participants favored having exercise counseling during their cancer experience (23). In terms of the methodological approach, 98% wanted to do recreational exercise, 81% preferred walking, 57% unsupervised exercise, and 56% desired moderate-intensity physical activity. Their conclusion from their results was that cancer survivors are more likely to be active if reassured that exercise programs are beneficial as well as safe. Thus, slowly and gradually increasing their level of intensity is both helpful and key. More recently, in 2014, a study done by Su et al., sought to validate the Taiwanese version of the Physical Activity Scale for the Elderly (PASE-T) and be able to assess physical activity in Taiwanese cancer survivors. They took 127 cancer survivors and assessed their physical activity using PASE-T, a version of the MD Anderson Symptom Inventory (MDASI-T), Karnofsky performance status (KPS) and an actigraph (24). They found the test-retest reliability of PASE-

T to be acceptable and its validity was significantly associated with MDASI-T scores as well as the KPS scores. They found that KPS, fatigue, and age were high predictors of their physical activity. They concluded that PASE-T is a good and valid instrument used to measure the physical activity levels of Taiwanese patients. They suggested that this scale could be helpful in the measure of physical activity levels in cancer survivors and may assist the quality of care in oncology.

Evidence suggests that those who are more adherent to ASCM'S guidelines for physical activity will benefit more than those who don't. For example, one study composed of 2,705 men was done on a follow-up study by Kenfield et al. (7). They found that there was a lower risk of all-cause mortality in men who were more physically active. They also found that those who walked more than 90 minutes a week at a vigorous pace had a 46% lower risk of all-cause mortality and those who invested in more than 180 minutes of vigorous activity per week increased their likelihood of survival by 49%. They concluded that appropriates amount of vigorous physical activity was associated with decreased overall mortality and prostate cancer diagnosis mortality.

Richman et al. observed similar results to Stacey Kenfield's research. In examining the effects of physical activity and brisk walking after the diagnosis of prostate cancer in 1,455 men (8), they found that men who were actively walking at a brisk pace for at least 180 minutes a week had a 57% lower rate of progression compared to those who walked at an easy pace for the same amount of minutes.

They concluded that the intensity of their physical activity post diagnosis, may constrain or postpone the progression of prostate cancer. The results suggest that a behavioral risk factor such as physical activity plays a significant role in the lives in the advancement of cancer survivorship.

It's apparent from different studies that have been conducted using national databases that adherence to physical activity among cancer survivors is not as prevalent as it could be. There are many factors that could be at the forefront, but it's a problem nonetheless. Out of the total population, 47% who were cancer survivor from 2009 adhered to physical activity but 53% failed to exercise regularly. Overall cancer survivors did not meet the guidelines for physical activity and it appears that interventions are needed to monitor and push for more physical activity in this population. It should also be pointed out, that while a select few cancer types were the focus of attention, it would be appropriate to include other cancer types. While it is also true that national databases like NHIS or BRFSS rely on self-reported data, this does give us a reasonable estimation of where the cancer survivor population is in terms of physical activity adherence. Looking at those trends from year to year may help researchers decide if this particular risk factor (physical inactivity) is improving, getting worse, or staying the same from year to year. It also worth mentioning, that on a national level, survey questions help determine the PA adherence of subjects, however, to get a better overall view of adherence to PA, specific instruments may lend a hand to facilitate a better view of where cancer survivors are in terms of adherence.

4 Justification for Further Investigation on Physical Activity Adherence for Cancer Survivors

For cancer survivors, the importance of understanding behavioral risk factors and the significant effect these elements have on individuals is vital. One of these risk factors previously discussed, is physical inactivity. Coups and Ostroff took NHIS data from the year 2000 and studied the prevalence of some of these behavioral risk factors (physical inactivity being one of them) on 32,346 adults (6). They measured physical inactivity as those who did not report engaging in 20 or more minutes of vigorous activity three or more times per week,

or 30 minutes or more of moderate exercise five or more days a week. What they found was that there were few differences in age-stratified behavioral risk factor prevalence between cancer survivors and non-cancer controls. With regards to physical inactivity, it was considered high across the cancer types. When comparing 18-39 year olds to those aged 65 or older, they found some differences in terms of physical inactivity. They found that the older group had a higher prevalence rate of physical inactivity than the younger population. In conclusion they determined that there is a heavy need to provide a systemic behavioral risk factor assessment as well as interventions for cancer survivors. They have found that while the research is growing in this area, there is still little attention being paid to these behavioral risk factors which could truly help provide better quality of life and health promoting lifestyles to the cancer survivor population.

Underwood et al., analyzed 2009 BRFSS data and focused their attention on demographic characteristics and health behaviors among cancer survivors. The subjects ≥ 18 years of age. They found that 15.1% of the survivors were current cigarette smokers, 27.5% were obese and 31.5% were not engaging in physical activity. Additionally, the majority of this population are not receiving recommended preventive care. What they found was that in the past 30 days, approximately 32% had not invested any time to physical activity. They also found that the highest proportion of these survivors who were physically inactive lived in the south (34.3%) followed by the Midwest (32.5%), Northeast (31.3%), and West (25.5%). In their discussion they noted that approximately 1 out of 3 cancer survivors in the US did not engage in physical activity during the past 30 days. They also found 30-60% decrease in mortality rates for breast cancer recurrence with moderate physical activity, and a 50-60% decrease in risk for colorectal cancer recurrence, cancer-specific death, or overall mortality from regular exercise after their diagnosis. They concluded that there are still barriers insuring cancer

survivors receive appropriate care at the conclusion of their treatment plan. Some of the responsibility may be on the health-care providers, lack of follow-up by the medical care team, and overall lack of knowledge of the survivors regarding appropriate healthy lifestyle (behavioral risk factors).

5 Summary of Literature Review

In conclusion, historical evidence suggests that extensive research has focused on improving physical and mental health. Specifically, the implementation of published guidelines for physical activity has been established as the gold standard. Even more impressive are the expert's motivation to not only reach out to the general healthy population, but also to those plagued by chronic illness. While research is being done in many areas, cancer is a prominent focus right now among scientists who are seeking to find a cure. Screenings have certainly played an integral part of in slowing down the cancer epidemic, however there are also behavioral risk factors that contribute to this role. One of the factors is physical activity. In order to see if physical activity adherence is associated with the survivorship of cancer subjects, analyses are needed. Thankfully, an easy way to keep track of physical activity adherence to guidelines in cancer survivors is by utilizing national databases that capture cancer diagnoses and one's adherence to physical activity.

In conducting this review of literature, it is apparent, that while some studies have been done to observe ones adherence to physical activity guidelines in the cancer population, more is needed. Adherence continues to be a problem in this population, and having updates each year or every other year is important. Looking at trends to see if the cancer survivors in the United States are increasing or decreasing their physical activity may help researchers decide if more interventions are need.

This review has also shed light on other needs in this area of research. It's helpful to have

these national databases to get population estimates. However, to truly understand whether there is a problem of adherence to physical activity, more clinical trials are needed to provide evidence to oncologists that there is a need to prescribe physical activity to cancer patients and survivors (25). While research has been done in the area of updates from national databases are needed as well as more studies in clinical trials to provide more concrete evidence that exercise interventions are needed to improve the lives of cancer survivors.

Chapter III: Methods

Data were obtained from the 2015 National Health Information Survey (NHIS) (26) from the CDC website. This cross-sectional survey is given annually and is conducted in the homes of a probability sample of the non-institutionalized population living in the United States. The core questionnaires are divided into four major categories (household, family core, child core, adult core).

Of particular interest in the core questionnaires were questions concerning cancer history, diagnoses and physical activity level. The NHIS survey included subjects 18 years of age and older with any cancer diagnosis. For this report, all cancer types were included with the exception of non-melanoma skin cancers (because cancer registries do not record these cancer types) (3). For the purpose of this study, cancer diagnoses were re-classified into 10 broad organ groups (within those organ groups were specific cancers of organ systems). Subjects were classified according to PA status as either ''Having met PA guidelines", "Insufficient but some activity" or "Inactive". These categorizations were based on specific guidelines provided by the American College of Sports Medicine (ACSM). In their book written specifically for persons with chronic diseases and disabilities, they provide recommendations for PA as being moderate intensity exercise for ≥ 150 minutes or ≥ 75 minutes of vigorous activity (21). Any exercise below the minimum amount for moderate or vigorous activity was considered sedentary. Therefore, "having met physical activity" was defined in this study as moderate PA ≥ 150 minutes or vigorous PA at ≥ 75 minutes. The term "insufficient but some activity" was defined as >1 but < 150 minutes of moderate exercise and >1 but < 75 minutes of vigorous exercise. These subjects have not been grouped with those who are sedentary for two reasons. First, the variable "time since diagnoses" is not available in the survey, and therefore subjects who might be on treatment and dealing with adverse effects are also being

included in the study. This 3-level measure for PA status was analyzed for bivariate associations using the Rao-Scott first- order chi-square test (9) and for multivariable associations using survey-weighted generalized logits regression modeling (9). The two sets of logits that were modeled included the logit of adherent or sufficiently active versus inactive (but not sufficiently) versus inactive. Covariates of interest included age, gender, race, education level, cancer type, functional status, comorbidity index status, and obesity status. Income was also available in the NHIS data but was not used because nearly 20% of the income levels were found to be missing. Additionally, education level has been used as a reasonable proxy for income when accounting for socio-economic characteristics in analyses (9). Both the bivariate and multivariable analyses accounted for the complex survey sampling that was conducted to generate the NHIS data. Data were analyzed using SAS V9.4 with SAS survey data procedures SURVEYFREQ and SURVEYLOGISTIC being utilized.

Chapter IV: Results

From the 2015 NHIS data, it is estimated that there are nearly 15 million cancer survivors (excluding non-melanoma skin cancers) in the US. Compared to population estimates from 2009 BRFSS data, which found that 47% of all cancer survivors met recommended guidelines; the NHIS data showed that there was a 7% absolute decrease (40%) in adherence to these guidelines (Figure 1). NHIS data also showed that 21% were insufficiently active compared to 40% for BRFSS 2009 data, and that there was a 27% absolute decrease in those who were inactive from NHIS data (39%), compared to those who were sedentary in the BRFSS data (12%).

The majority of cancer survivors were females (60%), middle aged or older (89%), white (80%) with an education level of high school or less (39%) compared to non-cancer control subjects (Table 1). Accordingly, 66% of these subjects had a functional limitation status (FLS) which was defined by Sternfeld et. al. as a "restriction in the physical (or mental) performance of tasks required for independent living, and is a precursor of disability" (16) This compares to 33% with functional limitation in the control group. One of the factors that plays a significant role in FLS is BMI (27). These subjects were characterized by a BMI of 25.0-39.9 (33%), which is defined by NIH as being overweight (28), but the distribution of BMI was not much different than the controls. Education levels were similar between cancer survivors and controls as well (39% with ≤ HS compared to 37% respectively). The percentage with greater than two comorbidities was 41% in cancer survivors compared to only 15% in the controls. When looking at cancer survivors and the three levels of physical activity, NHIS data showed that 40% met PA guidelines (Table 2) compared to 50% for controls ($p<0.0001$).

Table 2 provides analyses for cancer survivors of the bivariate associations between physical activity levels and relevant covariates of interest. Those who were inactive were more likely

to be older (p=0.044), non-white (p=0.049), have no more than a high school education (p<0.0001), have a functional limitation (p<0.0001), have had a diagnosis of gastrointestinal cancer (p=0.0001), lung cancer (p-0.0003), gynecologic cancer (p=0.0552), have increased BMI (p=0.0001), and have at least one or more comorbid condition (p=0.0001) than the two groups with at least some activity. There were no significant bivariate associations between physical activity level and sex as well as the specific cancer types of urinary, blood/lymph, breast, head & neck, melanoma, prostate/testis, and all other remaining types.

Multivariable analyses of the two sets of odds of being 'more' physically active compared to inactivity were also conducted and reported in Table 3. The adjusted odds of being sufficiently active compared to being inactive were greater in Whites compared to African Americans (aOR=1.81, p=0.0153), greater in those with higher education levels (aOR=2.02; p<0.0001 in those with associate degrees or higher compared to <= high school and aOR=1.74; p=0.0046 in those with some college compared to <= high school), those with no functional limitations (aOR=4.0, p<0.0001), and in those with no comorbidities compared to those with more than 2 (aOR=1.69, p=0.0213). The adjusted odds of being insufficiently active compared to those who were inactive were greater in those with no functional limitations (aOR=1.61, p=0.0100). Borderline significant adjusted odds of this type were found for those with Associate degrees or higher compared to those with HS diploma or less (aOR=1.45, p=0.0607), those who were underweight (aOR=1.92, p=0.0699), and those with no comorbidities compared to those with 1-2 comorbidities (aOR=1.49, p-0.0954). There were no significant differences in adjusted odds of either type for age or gender.

Chapter V: Discussion

This assessment of physical activity level in cancer survivors using 2015 NHIS data is important for several reasons. From 2009 BRFSS data, Nayak, et. al. found no difference in adherence to physical activity between cancer survivors and controls (9). Our data indicated that there was indeed a difference between cancer survivors and controls ($p<0.0001$) with only 40% of the survivors havingmet guidelines compared to 50% for the controls. This argues for the continued need for interventions aimed at increasing physical activity levels in cancer survivors.

Analysis results from NHIS 2015 data also provide a useful update to the extent that they allow for a comparison to results based on 2009 BRFSS data (9). When comparing the two, it was found that an even smaller proportion of cancer survivors actually met PA guidelines (40%) compared to the 2009 BRFSS data (where 47% met guidelines). In addition (Figure 1), this study found a greater percent of survivors who were sedentary (39%) compared to the Nayak study using 2009 BRFSS data (12%).

There may be several reasons for these differences between this study and the Nayak study. There were unadjusted differences in age distribution, although this study included a broader range of ages, whereas the 2009 BRFSS data included only ages 45-64 years. Secondly, our analysis was not limited based on time since diagnosis effectively including those who were possibly undergoing treatment for their cancer at the time of the survey. The 2009 BRFSS analysis included only those that were 1 year out from their diagnosis date at the time of that survey. Therefore, the overall rate of adherence reported here may be lower due to limitations on physical activity because of ongoing treatment for cancer. Yet another possible explanation for the difference in adherence rates could be due to differences in types of cancers included in the two studies. The 2009 BRFSS data included only 6 cancer types;

whereas, our study included 10 types with an “other category” capturing even more types which were less commonly reported.

From the 2015 NHIS data, it was observed that the majority of cancer survivors were female (60%), age 54 and older (79%), were white (80%), with an associate degree or higher (42%). Approximately half of the subjects had functional limitations. Forty-two percent made greater than $50K and 41% reported having had more than two comorbidities. Thirty-three percent were in the overweight category for BMI (24.9-29.9).). These characteristics found from this study are similar to those of other population based studies (29,30) that have examined physical activity in cancer survivors.

Of the cancer survivors who were “sufficiently active”, breast was the highest (28.1%), followed by prostate (18%) and gynecologic cancer (12.4%). They were 54 or older, female (59%) and white (83%). These survivors also predominantly had an Associate degree or higher with no functional limitation status. These survivors also were primarily in the healthy BMI range of (18.5-24.9) (36%).

It is particularly interesting to note that the majority of cancer survivors who met PA guidelines were 54 years of age or older. In a study of breast cancer survivors younger age was found to be positively associated with adherence to vigorous physical activity (31). However, other studies which focused on breast cancer survivors found that age was not a significant predictor of adherence to PA (32,33). The odds ratio for age in each of these two studies was found to be 1.01 and 0.99 respectively implying that there is a mere 1% increase (or decrease) in the odds of adhering to PA recommendations. The polytomous logistic regression model used in our study, did not reveal age as a significant factor in terms of whether cancer survivor was more or less likely to be adherent (table 3).

This polytomous logistic regression model did however show that there were other factors in

our study that were associated with physical activity adherence. These included, (race, education level, functional limitation status, and presence of comorbidities). For example, African American were less likely to be adherent compared to whites, having a high school education or less resulted in decreased odds of being adherent as did having any functional limitation or greater than two comorbidities. Other studies show comparable findings. A study conducted on endometrial cancer survivors found that younger subjects who reported a higher BMI level possessed lower physical function (34). This particular study concluded that interventions using exercise and weight loss may be useful to target this specific population of survivors. Another study from Nayak et al. observed that when looking specifically at gynecologic cancer survivors, 55% did not adhere to physical activity recommendations and 38% reported functional impairment (15). This study also demonstrated that survivors with functional impairment were less likely to meet guidelines, or to be somewhat active compared with those who did not have impairments. Clearly, cancer survivors with functional impairment or limitations need to be targeted with interventions consisting of some type of prescribed exercise regimes.

This study has several strengths and limitations. In terms of strengths, this study should serve as a helpful update to the Nayak paper given that we have included multiple age groups, a functional limitation variable, and a wider variety of cancer types. Having an overall broader perspective of the population in terms of age as well as type of cancer is important.

In terms of limitations, NHIS data collected in the year 2015 did not contain reliable data for time since diagnoses. Data were captured in some cases as time lapsed in years or months since diagnosis (with no indication of the unit of time being used), and in some cases a date of diagnosis was provided.

Therefore, unlike the Nayak study, we were not able to exclude subjects who may have been

undergoing treatment for their cancer. This may have caused our estimated proportion of adherence to physical activity guidelines to be biased downward. As Courneya et al. observed in a study on colorectal cancer survivors, cancer treatment negatively effects one's ability to be adherent to exercise especially those on multiple treatments (35). A second limitation is that our results are based on self- reported survey data which can lead to recall bias. The survey was also cross-sectional in nature allowing only for estimation of magnitudes of association as opposed to estimating causal relationships. Yet another limitation found in our study was that stage of cancer at diagnosis was not measured in the NHIS survey. Accounting for stage as potential confounder or mediator when assessing associations between cancer survivor status and physical activity, especially among those who may have been undergoing treatment at the time of survey administration, would likely be important in the analysis. Targeted interventions to increase activity in cancer survivors continue to be warranted overall, but especially in those with less than a high school education, having more than 2 comorbidities, and having functional limitations as well as those diagnosed with gastrointestinal, gynecologic, and lung cancer. The question remains, if there is high prevalence of physical inactivity in cancer survivors, then what interventions will help? Irwin et al. suggested that there may be many factors related to non- adherence. For instance, the oncologist may be hesitant to prescribe exercise possibly due to the lack of evidence-based findings that demonstrate benefits from it (25) or perhaps due to the belief that it may not be safe for cancer patients to prescribe to it. As Courneya et al. observed in a multicenter randomized controlled, there were no adverse events that occurred when applying aerobic and resistance activity to breast cancer patients (36). Therefore, increased physician involvement in prescribing PA may create more adherence. Additionally, much of the evidence that exists to link favorable outcomes in cancer survivors to physical activity stems

from survey data. More clinical trials in this area are needed in order to provide stronger evidence of the need for PA in cancer survivors.

Existence of evidence from such trials might lead physicians to prescribe exercise programs to their patients.

Modifications to patient health behavior involving exercise and possibly physician practice patterns toward recommendations for exercise could potentially close the gap leading to more favorable health outcomes after a diagnosis of cancer. While exercise is important for every individual, some need more guidance than others in reaching the goal of being adherent to physical activity recommendations.

Table 1. (*Distributions Between Cancer Survivors and Non-Cancer Controls: NHIS 2015)*

Table 1 Distributions Between Cancer Survivors and Non-Cancer Controls : National Health Information Survey 2015				
Characteristic	**Cancer Survivors[1]**		**Non-Cancer Controls**	
	Sample size = 2396	**Population Estimate 14,989,840 (100%)**	**Sample size= 31243**	**Population Estimate 227,233,413(100%)**
Age				
[18-45)	235	1,674,227 (11%)	13715	111,024,360 (49%)
[45-54)	218	1,476,220 (10%)	4737	37,023,109 (16%)
54+	1943	11,839,393 (79%)	12791	79,185,944 (35%)
Sex				
Male	924	5,931,701 (40%)	14131	110,828,311 (49%)
Female	1472	9,058,139 (60%)	17112	116,405,102 (51%)
Race/Ethnicity				
White	1832	12,051,516 (80%)	19002	145,174,496 (64%)
African American	254	1,216,033 (8%)	4203	27,157,721 (12%)
Hispanic	193	1,093,014 (7%)	5393	36,635,526 (16%)
Other	117	629,277 (4%)	2645	18,265,670 (8%)
Education level				
<=HS	975	5,909,604 (39%)	12,055	84,163,071 (37%)
Some College	478	2,762,662 (18%)	6,086	44,575,537 (20%)
>=Associate degree	930	6,262,449 (42%)	12,969	97,280,853 (43%)
DK/Refused	13	55,125 (0.4%)	133	1,213,952 (0.5%)
Annual Income				
<$25K	641	2,877,462 (24%)	7051	35,736,392 (19%)
$25K-$50K	555	3,306,032 (28%)	7122	45,985,750 (25%)
>$50K	728	5,706,906 (48%)	11,743	103,511,917 (56%)
Body Mass Index				
<18.5	122	727,179 (5%)	1624	12,382,221 (6%)
[18.5, 24.9]	698	4,456,643 (30%)	9962	74,333,983 (33%)
[24.9, 29.9]	783	4,904,562 (33%)	10,245	73,894,647 (33%)
[30.9, 39.9]	652	3,966,954 (26%)	7,891	56,174,126 (25%)
40+	141	934,502 (6%)	1496	10,318,283 (5%)
# Comorbidities				
None	383	2,578,197 (17%)	14,376	113,113,480 (50%)
1-2	988	6,273,037 (42%)	11,296	79,535,540 (35%)
>2	1025	6,138,606 (41%)	5,571	34,584,393 (15%)
Any Functional Limitation?				
Yes	1634	9,853,773(66%)	11,625	75,645,780 (33%)
No	758	5,108,910 (34%)	19,603	151,507,729(67%)
Physical Activity Levels (PA08_3R)				
Sufficiently Active	853	5,843,242 (40%)	14,767	110,886,315 (50%)
Insufficiently Active	486	3,099,822 (21%)	6,086	44,664,729 (20%)
Inactive	1017	5,766,915 (39%)	9,937	67,929,188 (30%)

Table 2 *(US Cancer Survivors According to Physical Activity Levels: NHIS 2015)*

Table 2 US Cancer Survivors according to Physical Activity levels: National Health Information Survey 2015							
Characteristics	**sufficiently Active (150 + min/wk)**		**Insufficiently Active (<150 min/wk)**		**Inactive (No activity)**		**PValue[1]**
	Sample Size	**Population Estimate**	**Sample Size**	**Population Estimate**	**Sample Size**	**Population Estimate**	
Age							
[18-45)	112	791658 (13.5%)	43	328671 (10.6%)	69	431105 (7.5%)	0.044
[45-54)	82	555948 (9.5%)	53	355566 (11.5%)	81	560649 (9.7%)	
54+	659	4495636 (76.9%)	390	2415585 (77.9%)	867	4775161 (82.8%)	
Sex							
Female	511	3459152 (59.2%)	302	1899465 (61.3%)	637	3540531 (61.4%)	0.69
male	342	2384090 (40.8%)	184	1200357 (38.7%)	380	2226384 (38.6%)	
Race/Ethnicity							
White	680	4862037 (83.2%)	380	2519271 (81.3%)	746	4481789 (77.7%)	0.049
African American	65	3231143 (5.53%)	44	233925 (7.55%)	134	599510 (10.4%)	
Hispanic	65	400708 (6.86%)	38	209068 (6.74%)	89	474845 (8.23%)	
Other	43	257354 (4.40%)	24	137558 (4.44%)	48	210771 (3.65%)	
Education level							
<=HS	228	1520846 (26%)	194	1217750 (39.3%)	534	3041053 (52.7%)	0.0001
Some College	168	1010152 (17.3%)	101	581768 (18.8%)	195	1052672 (18.3%)	
>=Associate degree	455	3292056 (56.3%)	189	1293166 (41.7%)	279	1645391 (28.5%)	
Functional Limitation Status							
Yes	416	2,717,166 (47%)	358	2,228,475 (72%)	832	4,736,392 (82%)	<0.0001
No	437	3,126,076 (53%)	127	865,874 (28%)	185	1,030,523 (18%)	
Cancer Type							
Urinary	45	301,480 (5.2%)	30	178083 (5.7%)	62	419892 (7.3%)	0.3430
Blood/Lymph	48	407673 (7%)	39	245168 (8%)	62	317138 (5.5%)	0.3785

Table 2 (Continued)

Breast	230	1640907 (28.1%)	122	786222 (55.4%)	256	1332697 (23.1%)	0.1714
Gynecological	122	725915 (12.4%)	78	459760 (14.8%)	166	1017727 (17.6%)	0.0552
Gastrointestinal	78	461237 (7.9%)	67	418662 (13.5%)	155	935350 (16.2%)	0.0001
Head & Neck	54	336897 (5.8%)	24	175002 (5.6%)	52	344728 (5.9%)	0.9825
Lung	24	114973 (1.9%)	14	74333 (2.4%)	67	318789 (5.5%)	0.0003
Melanoma	94	579478 (9.9%)	43	260320 (8.4%)	69	448861 (7.8%)	0.4503
Prostate/Testis	145	1053834 (18%)	74	515664 (16.6%)	156	905794 (15.7%)	0.5857
Other	69	538823 (9.2%)	36	223547 (7.2%)	88	475391 (8.2%)	0.6257
Body Mass Index							
<18.5	28	176932 (3%)	19	113353 (3.7%)	60	337522 (5.9%)	0.0001
[18.5, 24.9]	315	2165989 (37.1%)	115	732813 (23.6%)	260	1509446 (26.2%)	
[24.9, 29.9]	286	2077910 (35.6%)	188	1059953 (34.2%)	301	1701688 (11.629.5%)	
[30.9, 39.9]	195	1204693 (20.6%)	133	972792 (31.4%)	316	1730594 (30%)	
40+	29	217718 (3.7%)	31	220911 (7.1%)	80	487665 (8.5%)	
# Comorbidities							
None	207	1388616 (23.8%)	71	536688 (17.3%)	99	615452 (10.7%)	0.0001
1-2	404	2885097 (49.4%)	184	1032633 (33.3%)	385	2245813 (38.9%)	
>2	242	1569529 (26.9%)	231	1530501 (49.4%)	533	2905650 (50.4%)	

Table 3. *(Polytomous Logistic Regression Results: Outcome is Adherence to Physical Activity Recommendations (Adherent, insufficiently Active, Inactive); Assessing Associations with Selected Factors found in NHIS 2015)*

Table 3. Polytomous Logistic Regression Results : Outcome is Adherence to Physical Activity Recommendations (Adherent, Insufficiently Active, Inactive); Assessing Associations with Selected Factors found in the National Household Interview Survey 2015				
Characteristic	**Adherent vs Inactive**		**Insufficiently Active vs Inactive**	
	Adjusted OR (95% CI)	**p-value**	**Adjusted OR (95% CI)**	**p-value**
Age				
[18-45)	1.76 (0.89, 3.45)	0.1018	1.22 (0.59, 2.52)	0.5998
[45-54)	Reference		Reference	
54+	1.26 (0.78, 2.02)	0.3481	0.83 (0.50, 1.40)	0.4895
Sex				
Female	Reference		Reference	
Male	1.01 (0.78, 1.30)	0.9399	0.97 (0.74, 1.28)	0.8456
Race/Ethnicity				
White	Reference		Reference	
African American	0.55 (0.34, 0.89)	0.0153	0.69 (0.42, 1.13)	0.1414
Hispanic	0.89 (0.56, 1.40)	0.6143	0.76 (0.45, 1.29)	0.3101
Other	1.08 (0.57, 2.04)	0.8096	1.22 (0.66, 2.25)	0.5239
Education level				
<=HS	0.575 (0.39, 0.84)	0.0046	0.77 (0.50, 1.19)	0.2403
Some College	Reference		Reference	
>=Associate degree	2.02 (1.47, 2.76)	<0.0001	1.45 (0.98, 2.14)	0.0607
Functional Limitation Status				
Yes	0.25 (0.18, 0.35)	<0.0001	0.62 (0.44, 0.89)	0.0100
No	Reference		Reference	
Body Mass Index				
<18.5	0.53 (0.27, 1.06)	0.0719	0.52 (0.25, 1.06)	0.0699
[18.5, 24.9]	1.19 (0.86, 1.64)	0.2877	0.71 (0.45, 1.11)	0.1278
[24.9, 29.9]	1.28 (0.90, 1.82)	0.1666	1.03 (0.71, 1.49)	0.8764
[30.9, 39.9]	Reference		Reference	
40+	0.71 (0.39, 1.30)	0.2597	0.77 (0.42, 1.42)	0.4048
# Comorbidities				
None	Reference		Reference	
1-2	1.09 (0.70, 1.72)	0.6950	0.67 (0.41, 1.07)	0.0954
>2	0.59 (0.38, 0.92)	0.0213	0.81 (0.48, 1.36)	0.4239

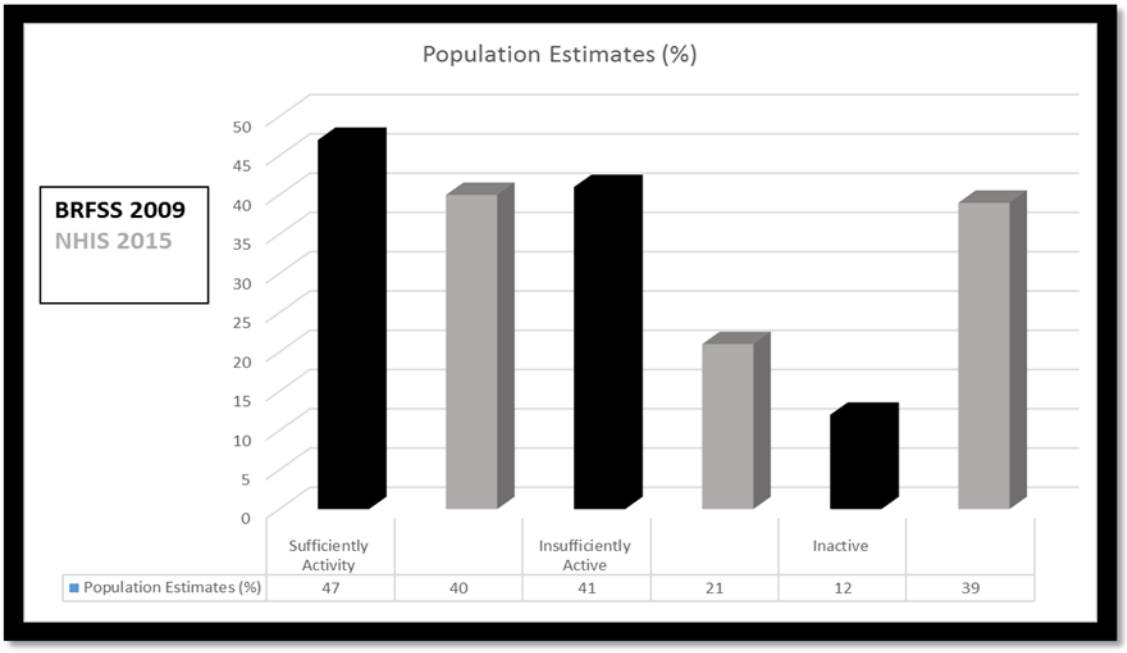

Figure 1*(Population Based Estimates comparing BRFSS data from 2009 to NHIS data 2015)*

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