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EXAMINING THE IMPACT OF DIABETIC STATUS ON MULTIPLE OUTCOMES AMONG
CANCER SURVIVORS

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ABSTRACT OF THE DISSERTATION

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Context: Among cancer survivors, multi-morbidity is common, with the majority of survivors co-managing at least one additional condition alongside their cancer care needs. A co-diagnosis of diabetes, a heterogeneous group of metabolic disorders, occurs in 16-29% of all cancer survivors. Both diabetes and cancer place considerable stress on the individuals and populations affected by these conditions. Research has identified multiple factors associated with better outcomes for specific cancers and diabetes when considered separately; however, there is a need to develop a holistic understanding of the impact of co-managing these conditions. Additionally, health disparities for cancer and diabetes among specific racial and socioeconomic groups for mortality and several health-related outcomes have persisted for decades. This study was guided by Link and Phelan's theory of 'fundamental causes,' a social epidemiological theory that aims to identify the fundamental social causes of health inequalities by exploring four key relationships between socioeconomic status and health outcomes. According to the theory of 'fundamental causes' theory socioeconomic disparities in health are rooted in unequal resource distribution which positions those with more resources in a better position to adopt behaviors that will benefit their health. Guided by this theoretical framework, this dissertation examines the impact of social factors on co-managing diabetes and cancer on multiple risk factors and disease outcomes. The overall goal of this dissertation is to examine the impact of social factors and diabetic status on

multiple outcomes in a nationally representative sample of cancer survivors, as articulated in the three specific aims below.

Specific Aims: The aims of this dissertation were to: (1) identify factors associated with the co-occurrence of diabetes and cancer and factors known to be associated with higher risks for poor outcomes (i.e., obesity and physical inactivity); (2) examine differences in self-assessed health (i.e., proxy for mortality), physical and mental quality of life between diabetic cancer survivors and non-diabetic survivors; and (3) examine differences in multiple psychosocial outcomes for diabetic cancer survivors and non-diabetic cancer survivors.

Design, Setting and Patients: All aims of this study utilize data from the U.S. Medical Expenditures Panel Survey Household Component (MEPS-HC) and the supplemental self-administered survey “Experiences with Cancer” collected from 2011-2012. The study sample is restricted to non-institutionalized civilians who reported having a diagnosis of cancer during their lifetime who completed the supplemental questionnaire. Cases of non-melanoma skin cancers were excluded. Study subjects were stratified based on a comorbid diagnosis of diabetes compared to non-diabetic cancer survivors.

Descriptive, cross-sectional analyses were conducted to characterize the study populations for all three aims. For Aim 1, a series of nested multivariate logistic regressions were constructed to examine predictors associated with co-occurring diabetes and cancer. Bivariate analyses explored significance of cancer site and co-morbid chronic conditions. Chi-square analyses were analyzed to identify differences between groups on lifestyle and preventive health behaviors. Multivariate logistic regression models were specified to examine the impact of social factors on obesity, physical inactivity and likelihood of complex multi-morbidity. For Aim 2, a series of nested, multivariate logistic regressions were constructed to examine predictors of increased mortality, measured by proxy using self-assessed health. Additionally, a hierarchical multivariate regression model was specified to examine the impact of social factors and diabetic status on physical and mental functioning. Physical and mental functioning were measured using

the subscales for the SF-12. For Aim 3, multivariate regression models were specified to assess factors associated with psychosocial variables including: non-specific psychological distress measured by the Kessler Index; depression measured by the Patient Health Questionnaire-2; mental health functioning measured by the SF-12 mental health composite; and cancer related worries measured by two single-item measures assessing chance of recurrence and fears about recurrence. For a subset of the study sample, longer-term cancer survivors, a logistic model was specified to identify factors that are associated with clinically relevant levels of psychological distress.

Results: Aim 1 of this dissertation showed that the following are risk factors for the co-occurrence of diabetes and cancer: (1) survivors with a high school education had 1.63 greater odds [CI 1.03-2.50, $p=0.04$] and those with less than a high school education had 3.15 [CI: 1.75-5.69, $p<0.001$] greater odds than survivors with bachelor's degrees or higher; (2) African American/black survivors had 2.05 greater odds [CI: 1.18-3.55, $p=0.001$] than Caucasian/White survivors; and (3) survivors aged 55-less than 65 had 12.28 greater odds [CI: 1.60-94.28], aged 65-less than 75 had 10.19 greater odds [CI: 1.31-79.39, $p=0.03$]; aged 75 and older had 7.79 greater odds [CI: 0.97-62.22, $p=0.05$] than survivors aged 18-39 years old. Female survivors had 37% lower odds [CI: 0.41-0.97, $P=0.04$] of diabetic status compared to male survivors; and survivors 10 or more years out from treatment had a 43% lower odds [0.33-0.98, $P=0.04$] of diabetic status compared to recently diagnosed survivors. Diabetic cancer survivors had 48% lower odds of meeting physical activity recommendations [CI: 0.34-0.80, $p=0.003$] and 73% lower odds of meeting weight recommendations [CI: 0.16-0.48, $p<0.001$] compared to non-diabetic cancer survivors, controlling for social and cancer related variables. Diabetic cancer survivors had 186% [CI: 1.84-4.45, $p<0.001$] greater odds of having five or more chronic conditions compared to non-diabetic survivors. Examinations of differences in physical health (Aim 2) revealed that being diabetic was associated with 1.71% greater odds of reporting poor/fair health holding all else constant ($p<0.001$) compared to non-diabetic survivors; however,

no differences in mental health were found. The results of Aim 3 demonstrated that diabetic status was not significantly associated with any of the psychosocial outcomes examined; however, physical functioning was associated with lower non-specific distress ($B=-0.14$, $p<0.001$) and depression ($B=-0.05$, $p<0.001$), and increased mental health functioning ($B=0.155$, $p<0.001$).

Conclusions: The research in this dissertation confirmed that race and educational disparities exist in the prevalence of co-morbid diabetes among cancer survivors and the mechanisms underlying these disparities warrants further study. Further, diabetic cancer survivors were less likely to engage in protective health behaviors (i.e., meeting physical activity recommendations and maintaining healthy weight) and were at higher risk for complex multi-morbidity compared to non-diabetic survivors. Diabetic cancer survivors had poorer health and poorer health related quality of life compared to non-diabetic cancer survivors. While diabetic status alone was not shown to be associated with psychosocial health outcomes compared to non-diabetic cancer survivors, poorer physical health was shown to be related to poorer psychosocial adjustments. Research to identify individual and contextual level barriers are needed develop prevention strategies that may help mitigate the excess risk of the co-management of diabetes and cancer. Future research is needed to distinguish the components of the diabetic cancer survivorship phenomenon that are issues of inequity versus issues of disparate outcomes based on biological differences associated with race/ethnicity.

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INTRODUCTION

There are 15.5 million cancer survivors living in the U.S. as of January 1, 2016 (Miller et al., 2016). By 2040, estimates project that more than 26.1 million survivors will reside in the U.S. and may require long-term care (Bluethmann, Mariotto, & Rowland, 2016). Two factors account for the cancer survivor populations' growth. First, advanced age is a common risk factor for many cancers (Bluethmann et al., 2016). Second, as of 2010 the first wave of the 'baby boom' generation (i.e., those born between 1946-1964) have begun to reach retirement age causing a surge of older Americans termed "the silver tsunami" (Bluethmann et al., 2016). Due to this association with aging, cancer survivors figure prominently among the 25% of the population with multiple chronic conditions that consume a majority (65%) of the total health care resources in the U.S. (Anderson, 2012; Soni, 2009). For example, Per Edwards et al. (2014), comorbid diabetes occurs in approximately 16% of cancer survivors and is one of the most prevalent co-occurring chronic conditions during the post-treatment phase of cancer care. Despite enormous investments in health care, cancer care still urgently needs strategies to eliminate cancer health disparities and manage patients with multiple chronic conditions in a planned, proactive, and cost-effective manner (Thorpe & Howard, 2006).

Following acute cancer treatment completion (i.e., either single therapy or multi-modal therapy administered and no evidence of cancer remains in the body) there are no coordinated strategies to assist patients. Therefore, the present design of the health care system expects patients to navigate its complexities to meet their long-term medical and psychosocial needs (Hewitt, Greenfield, Stovall, & National Cancer Policy Board (U.S.). Committee on Cancer Survivorship: Improving Care and Quality of Life., 2006). Researchers are exploring best practices in transitional care processes to improve the interfaces between oncology and primary care (Earle & Ganz, 2012a; Oeffinger & McCabe, 2006a; Taplin & Rodgers, 2010). Most current

approaches rely heavily on patient skills to broker communications, largely ignoring patients who may lack the knowledge, skills or access to support to be effective in this role (Hudson, Miller, Hemler, McClinton, et al., 2012).

Cancer survivors with co-morbid chronic conditions may be particularly at risk for poor coordination when they face such transitions (Beckjord et al., 2008; Earle & Neville, 2004; O'Malley et al., 2014). The transitional care system needs strategies to identify and assess those cancer survivors who have the ability to navigate the care system independently versus those who are in need of more support. An in-depth understanding of the challenges that confront specific groups at higher risk for poor health outcomes is needed, specifically during periods of transitional care (Casillas & Ayanian, 2011). Therefore, it is apparent that data to inform care strategies for cancer survivors managing complex co-morbidities (e.g., diabetes) are lacking, especially for patients in lower socioeconomic status (SES) groups that are historically associated with poorer cancer outcomes (Casillas & Ayanian, 2011).

Therefore, three papers that comprise this dissertation investigate a contextualized understanding of cancer survivors' experience of long-term care through an exploration of the relationships between diabetic status, socioeconomic status and multiple disease outcomes. The goals of the first paper is: (a) to identify risk factors of co-occurring diabetes and cancer; and (b) to identify factors related with co-occurrence and high risk for behaviors associated with poorer outcomes (i.e., healthy weight management, sedentary lifestyle, etc. The second paper examines the effect of diabetic status and flexible resource availability on mortality, and on physical and mental health functioning. The third paper in this dissertation explores the impact of diabetic status on multiple psychosocial outcomes, specifically generalized psychological distress, mental health functioning, depression and cancer-related worries. Further, this study identifies risk and protective factors associated with each of the psychosocial outcomes. Additionally, the third study identifies risk factors that contribute to clinically relevant levels of distress in the long-term survivor subpopulation. Lastly, the final chapter of this dissertation synthesizes the findings

across the three papers and describes the implications of these findings for both clinical practice and health policy. Additionally, the next steps of this research agenda are discussed in the final chapter.

Empirical Background

Diabetes.

Diabetes mellitus is a heterogeneous group of metabolic disorders where blood glucose levels are above normal ranges (Harris, 1995). It is a complex, chronic condition that is typically diagnosed based on fasting plasma glucose (greater than or equal to 126 mg/dL), hemoglobin A1C (greater than or equal to 6.5%) blood tests, or clinical presentation with hyperglycemia or hyperglycemic crisis (American Diabetes Association, 2014). There are four classifications of diabetes: type I (i.e., insulin deficient or dependent), type II diabetes (i.e., adult onset, non-insulin dependent, insulin resistance), diabetes secondary to other conditions (e.g., genetic causes, drug and chemical induced, etc.), and gestational diabetes (diagnosed during pregnancy) (Harris, 1995). Type II diabetes, is treated and managed through diet, physical activity, and medications to lower blood glucose levels (Centers for Disease Control and Prevention, 2014). Additionally, cardiovascular risk factors, such as hypertension, hyperlipidemia, and tobacco use are important contributors to achieving glycemic control (Centers for Disease Control and Prevention, 2014). Complications of living with diabetes includes hypoglycemia and hyperglycemic crises, increased blood pressure and cholesterol, blindness and eye problems, kidney disease, and amputations (Centers for Disease Control and Prevention, 2014). Further, due to cardiovascular risks associated with diabetes, cardiac events and stroke risk are higher among diabetics, with recovery from each having higher morbidity and mortality rates for diabetics (Centers for Disease Control and Prevention, 2014).

The prevalence and incidence of diabetes has increased in recent decades (Burke et al., 1999; Fox et al., 2006; Geiss et al., 2006) with the incidence of diabetes diagnosis increasing 41%

from 4.9 to 6.9 per 1000 population from 1997 to 2003 (Geiss et al., 2006). Increasing diabetes prevalence remains consistent with the obesity prevalence trends among U.S. adults. Obesity prevalence has risen steadily from 1960-1994 (from 12.8-22.5%), and continued to rise from 1990-2000 and 2009-2010 reaching 17.8% (An, 2014). Diabetes was historically associated with adults, while type 1 diabetes was more commonly associated with children; however, diagnoses of type II diabetes among people under 30 have increased alarmingly (Alberti et al., 2004). Rates of diabetes increased dramatically each year from 1990-2008, but have leveled off between 2008-2012 for the general population (Geiss, Wang, Cheng, & et al., 2014). Obesity disproportionately affects specific subpopulations, and in the past decade, the highest rate of obesity prevalence increases occurred in African American women (Bhupathiraju & Hu, 2016; Wang, Beydoun, Liang, Caballero, & Kumanyika, 2008). It follows that specific subpopulations, specifically non-Hispanic blacks and Hispanics rates of diabetes continues to increase at a faster rates that the non-Hispanic white adult population (Geiss et al., 2014). A growing body of literature hypothesizes that the health disparities in cancer outcomes by race and ethnicity are in part explained by disparities in obesity and its associated comorbidity burden (Schmitz et al., 2013) (Bach et al., 2002; Haynes & Smedley, 1999; Tammemagi, Nerenz, Neslund-Dudas, Feldkamp, & Nathanson, 2005). Therefore, this dissertation explores how these shared risks for disease outcomes may be associated with social risk factors in a national sample of cancer survivors.

Diabetes is the comorbid illness of focus in the present study due to the known SES disparities in outcomes (Heisler, Smith, Hayward, Krein, & Kerr, 2003b; Selby et al., 2007), the complex, but clear self-management recommendations for patients (Haas et al., 2013), and the establishment of best practices for diabetes management in primary care (American Diabetes Association, 2014). The four consistently endorsed and measured diabetes self-management behaviors are: dietary choices; exercise behaviors; medication usage; and blood glucose self-testing (Glasgow, Hampson, Strycker, & Ruggiero, 1997; Haas et al., 2013; Norris, Engelgau, & Venkat Narayan, 2001). Patient self-management among diabetics reduces risks of multiple long-

term consequences (The Diabetes Control and Complications Research Group, 1993). Diabetic self-management behaviors include four behaviors, each is supported by the highest level of evidence (i.e., level of evidence rated “A” indicating clear evidence from well conducted, generalizable randomized controlled trials) (American Diabetes Association, 2014). Decades of research have focused on strategies to empower and educate diabetics to achieve and glycemic control, with one systematic review including over 70 studies on this subject alone between 1980-1999 (Norris, Engelgau, & Narayan, 2001). Although many studies report improvements initially, sustaining the interventions effects over time has been problematic (Norris, Lau, Smith, Schmid, & Engelgau, 2002).

Cancer.

Cancer is a heterogeneous group of diseases characterized by uncontrolled cellular growth that can spread throughout the body if left untreated (American Cancer Society, 2015). Advances in cancer screening, detection, diagnosis, treatment, and supportive care have increased cancer survival rates (American Cancer Society, 2015). For all cancers diagnosed 2004-2010, the five-year relative survival rate was 68%, up from 48% in 1975-1977 (American Cancer Society, 2015). Current estimates suggest that nearly 15.5 million cancer survivors are living in the U.S (Miller et al., 2016). By 2022, due to demographic shifts particularly among the aging, de Moor et al. (2013) expect the number of cancer survivors to surge to 18.2 million. By 2040, Bluethmann et al. (2016) project the population of cancer survivors will reach 26.1 million. In the next decade, long-term survivors (i.e., those five or more years post diagnosis) will account for 11.9 million cancer survivors (de Moor et al., 2013).

The large and increasing population of adult cancer survivors presents new challenges in the delivery of health care services. In the aftermath of a cancer diagnosis, survivors face a variety of complex physical, psychological, spiritual, and social challenges (Hewitt et al., 2006). Survivors are at risk for late effects of their disease and treatment, secondary cancers, alterations in fertility, impairments in cognitive function, employment and insurance consequences, and

early death (Baker, Denniston, Smith, & West, 2005; Neglia et al., 2001; Robison et al., 2005; Schag, Ganz, Wing, Sim, & Lee, 1994; Short, Vasey, & Tunceli, 2005; Stewart et al., 2001; van Dam et al., 1998). Moreover, cancer survivors are at risk of dying at higher rates from ‘non cancer’ causes when compared to the general population, due to increased morbidity and disability and long term treatment effects (Brown, Brauner, & Minnotte, 1993; Ganz, 2001).

For long-term survivors, integration of cancer survivorship care into multi-morbidity care in primary care settings is an option, though this is not the current practice. A population based study found that only a third of long term cancer survivors continued to seek care from physicians whose specialties are related to their original cancer after 5 years of survival, and trends indicate that oncologists visits decline over time among long term cancer survivors (Pollack, Adamache, Ryerson, Ehemann, & Richardson, 2009). Despite patient reservations about primary care leadership for follow-up cancer survivorship care, (Hudson, Miller, Hemler, Ferrante, et al., 2012) it has been shown that over time declining numbers of cancer survivors continue to see their oncology providers regularly for follow-up (Oeffinger & McCabe, 2006c; Oeffinger & Wallace, 2006). Moreover, current estimates suggest that by 2020 the annual demand for oncology visits will surpass the capacity of trained oncologists from 9.4 to 15.0 million visits (Erikson, Salsberg, Forte, Bruinooge, & Goldstein, 2007), which will likely increase the need for primary care practices to provide survivor care. Both health system and provider roles are being re-examined to test new approaches to enhance care transitions, particularly those communication strategies and tools that adjust surveillance patterns for cancer survivors based on their risk profiles (Earle, 2006; Hewitt & Ganz, 2006).

In contrast to the well-established and researched self-management practices for diabetes care, self-management for cancer survivors was only recently operationalized for the different phases of cancer care (McCorkle et al., 2011). In a recent review, McCorkle et al. (2011) found 16 intervention studies that focus on teaching cancer patients self-management skills throughout the cancer experience. Unlike interventions for diabetes where nearly all focus is on the sole

outcome of glycemic control, cancer self-management interventions focus on myriad of outcomes including symptom management, psychological adjustment, lifestyle changes, and quality of life (McCorkle et al., 2011). During the phase after cancer treatment described self-management behaviors included; 1) engaging in routine follow-up visits with oncology team; 2) understanding the signs and symptoms of cancer recurrence; 3) adjusting to the long-term health, social and psychological impact of cancer and its treatment; 4) re-establishing new routines; 5) dealing with psychological distress; and 6) adopting healthy lifestyle behaviors (McCorkle et al., 2011).

Countries with strong primary care foundations have integrated cancer survivorship care into primary care systems and evidence suggests these strategies are acceptable to patients and effective at detecting cancer recurrence (Grunfeld et al., 2006; Wattchow et al., 2006). The prevalence of cancer survivorship among the aging population and the associated comorbidity burdens suggest that integration into multi-morbidity models of care are needed (Nekhlyudov, O'Malley D, & Hudson, 2017). However, there is a dearth of evidence to inform practice level change and policy interventions for this population.

Diabetes and Cancer.

The relationship between diabetes and cancer is important to consider. Diabetes can impact each phase of the cancer continuum including cancer prevention, treatment, survivorship, and end-of-life (Vigneri, Frasca, Sciacca, Pandini, & Vigneri, 2009a). Diabetic patients have an increased risk for many cancers, including: bladder (Larsson, Orsini, Brisman, & Wolk, 2006); breast (Larsson, Mantzoros, & Wolk, 2007); colorectal (Larsson, Orsini, & Wolk, 2005); endometrial (Friberg, Orsini, Mantzoros, & Wolk, 2007); kidney (Lindblad et al., 1999; Washio et al., 2007); liver (El-Serag, Hampel, & Javadi, 2006); non-Hodgkin's lymphoma (Mitri, Castillo, & Pittas, 2008); and pancreatic (Huxley, Ansary-Moghaddam, De González, Barzi, & Woodward, 2005). However, diabetics have a decreased incidence of prostate cancer (Kasper & Giovannucci, 2006) when compared to non-diabetic men. Despite increased risk for a cancer diagnosis in diabetics' lifetime, they have lower rates of cancer screenings compared to non-

diabetics (Beckman et al., 2001; Marshall, Cowell, Campbell, & McNaughton, 2010). During treatment, anti-cancer therapies and supportive care drugs routinely administered during the cancer treatment phase may exacerbate pre-existing diabetes or initiate the onset of a new diabetes diagnosis in some patients (Vigneri et al., 2009a). Further, poor glycemic control during and after treatment is associated with increased morbidity and mortality among diabetic survivors (Barone et al., 2008; Vigneri et al., 2009a). Despite higher risk for many types of cancers, the need to adjust standard anti-cancer therapies and supportive care medications, and poorer survival outcomes there have been no systematic studies to describe the unique needs and survivorship experience of the diabetic cancer survivors to date. Therefore, several co-variables warrant consideration to explain diabetic cancer survivors' health outcomes. These include potentially later diagnoses due to lower screening rates, unfavorable treatment response due to modified treatments, and glycemic control throughout the treatment experience and beyond.

Cancer Survivors: An Aging Population.

The parallel growth of the aging population and increasing length of cancer survival times will give rise to a large population of cancer survivors over the age of 65. By 2020 it is expected that two-thirds of the cancer survivor population will be both over the age of 65 and living beyond the 5-year survival time point (Parry, Kent, Mariotto, Alfano, & Rowland, 2011). Generally, cancer is an illness associated with aging, but the age distribution of cancer survivors varies widely by cancer type (DeSantis et al., 2014). An important driver in the surging numbers of older cancer survivors is that the incidence of the most commonly diagnosed cancers (i.e., breast, prostate, and colorectal) increases substantially among those over 60 years old (American Cancer Society, 2015). Nearly half of all cancer survivors (46%) are over the age of 70, and estimates suggest that only 5% of survivors are under the age of 40 (DeSantis et al., 2014). Most prostate cancers survivors (62%) are over the age of 70 years old. Among breast cancer survivors, nearly 72% (2.3 million women) are over the age of 60 years old (DeSantis et al., 2014).

With respect to psychosocial adjustments, adults diagnosed with cancer later in life tend to fare better psychologically than younger cancer survivors (Bellizzi & Rowland, 2007; Deimling, Bowman, Sterns, Wagner, & Kahana, 2006; Rowland & Bellizzi, 2014). In part, this is attributed to older adults having lower expectations for functional recovery, and they are more accepting of having less control over their general health (Brandtstadter & Renner, 1990; Rowland & Bellizzi, 2014). Further, from a developmental life course perspective, illness is an anticipated part of growing older whereas, in earlier life stages major illness is disruptive to the multiple roles and expectations individuals have for themselves (Bellizzi, Mustian, Palesh, & Diefenbach, 2008; Brandtstadter & Renner, 1990).

Older adults are far more likely to experience negative impacts to their physical and social domains of quality of life by a cancer diagnosis (Bellizzi & Rowland, 2007). In one study, cancer-related factors (i.e., continuing cancer related symptoms and stage of cancer at diagnosis) have been shown to modestly predict increased functional limitations in a sample of longer-term older breast, prostate and colorectal cancer survivors (Deimling, Sterns, Bowman, & Kahana, 2007). Further, comorbid health conditions have a greater effect on physical functioning. Survivors with more comorbidities were also more likely to have unresolved cancer symptoms (Deimling et al., 2007). Home health care recipients over the age of 65 with breast, prostate and colorectal cancers, reported a high prevalence of comorbid conditions (60.8%, 75%, and 70.5%, respectively) (Koroukian, Murray, & Madigan, 2006). The conditions with the highest prevalence were hypertension, cardiovascular disease, diabetes, and arthritis (Koroukian et al., 2006). Geriatric syndromes (e.g., urinary incontinence, dementia) and disabilities were most prevalent in prostate cancer survivors (51% and 45.4%, respectively) and lowest in breast cancer survivors (34.7% and 24.7%). Among this sample there were a small proportion at each extreme: survivors reporting no comorbidities, disabilities or geriatric syndromes (26.4% breast, 12% prostate, 14% colorectal) and survivors reporting at least one in each category simultaneously (11.7% breast, 24.7% prostate, and 15.7% colorectal)(Koroukian et al., 2006).

Among the estimated 29.1 million people in the U.S. living with diabetes, the distributions by age group are 4.4 million ages 20-44; 13.4 million ages 45-64; and, 11.2 million ages 65 and older (Centers for Disease Control and Prevention, 2014). There is complexity among each of these age groups associated with the nature of type II diabetes and the requirements of self-management and other competing health and social needs. Among the younger age group, a cross-sectional analysis of National Health and Nutritional Examination Survey (NHANES) from 2005-2010 found persons diagnosed with type II diabetes at a younger age are associated with poorer glycemic control than those diagnosed at a later age (Berkowitz, Meigs, & Wexler, 2013). Further, although younger diabetics in this sample reported fewer comorbidities, they were less likely to report good health (Berkowitz et al., 2013). Additionally, another study also using NHANES data (from 2002-2010) and Behavioral Risk Factor Surveillance System (BRFSS) survey data (2000, 2004 and 2008) evaluated the control of individual or combined risk factors for microvascular and macrovascular complications and adherence to preventive practices (e.g., screenings, glucose monitoring and vaccination use) and benchmarked results against performance standards (Ali, Bullard, & Gregg, 2013). Findings suggest that younger adults with diabetes were less likely to meet the recommendations treatment and preventive practices than older adults and these showed no improvement over time (Ali et al., 2013). Another national longitudinal focused only on those over age 65 (between 1991-2004), which found an association between patients newly diagnosed type II diabetes and increased risks of morbidity and mortality when compared to their age matched controls who did not have diabetes (Bethel, Sloan, Belsky, & Feinglos, 2007).

Mortality.

Cancer ranks second and diabetes ranks seventh as the leading causes of death in the U.S. (American Cancer Society, 2015; Centers for Disease Control and Prevention, 2011). Not surprisingly, the effects of having both conditions simultaneously increases overall mortality rates, with diabetic cancer survivors more likely to die as a result of their cancers than non-

diabetic cancer survivors (Vigneri et al., 2009a). For example, having comorbid diabetes and breast cancer is associated with a 24% increased mortality risk from cancer compared to non-diabetic breast cancer survivors (Larsson et al., 2006). Compared to the mortality risk of diabetic breast cancer patients, the mortality risk is slightly higher among diabetic colorectal patients, which is associated with a 26% increased mortality risk from cancer when compared to non-diabetic patient outcomes (Larsson et al., 2005). Additionally, although diabetics have a decreased incidence of prostate cancer (Kasper & Giovannucci, 2006), once diagnosed, overweight men with hyperinsulinemia have a higher likelihood dying from their cancer (Ma et al., 2008). Biologically, the reasons for higher rates of mortality among diabetic cancer survivors must be better understood to develop better medical interventions for this population (Vigneri, Frasca, Sciacca, Pandini, & Vigneri, 2009o). However, currently, socially, the burdens of both cancer and diabetes disproportionately affect specific populations, therefore, explorations in care processes and psychosocial support of the post-acute phase of cancer care may provide valuable insights to inform strategies to address these disparate outcomes for patients' with diabetes.

Physical Health and Mental Health.

Initial population based investigations of cancer survivors have focused on describing the characteristics of this population to inform approaches to their care. Generally, cancer survivors without any other chronic conditions were more likely to report fair or poor health, psychological disability, and functional limitations when compared to aged matched controls with no history of cancer (Hewitt, Rowland, & Yancik, 2003; Keating, Norredam, Landrum, Huskamp, & Meara, 2005; Ness, Wall, Oakes, Robison, & Gurney, 2006; Sweeney et al., 2006). Cancer survivors with additional chronic conditions were much more likely to report poor health and greater levels of disability than people without a cancer history, another chronic disease history or among people with a cancer history alone (Hewitt et al., 2003).

In a study of long-term cancer survivors, mental health outcomes were reported as similar to non-cancer controls (Keating et al., 2005); however, a robust literature documents inconsistent

and wide-ranging estimates of depression and anxiety among the cancer survivor population (Stein, Syrjala, & Andrykowski, 2008). Further, there is an incomplete understanding of how the demands of managing a complex comorbid illness along with the long-term psychological sequelae following cancer impacts psychological health (Bellizzi et al., 2008). A meta-analysis of 70 studies across 14 countries estimated the prevalence for depression (all types) at 24.7%, depression or adjustment disorder at 31.6%, and any mood disorder at 38.2% of the population of survivors in oncologic and hematological settings (Mitchell et al., 2011). In a community-based sample of long-term survivors one-third of respondents reported cancer-related worries (worries about recurrence, second cancers, and cancer symptoms), and these worries were predictive of depression and anxiety (Deimling et al., 2006).

Data suggests that survivors who have additional physical illnesses report poorer overall health, but there is inconsistency about the impact of cancer on mental health. Research that provides further insights into the relationships between the mental health impact of cancer and other comorbid illnesses could help guide care.

Preventive Health Services Use and Lifestyle Behaviors.

Two recommended strategies to mitigate the longer-term effects of a cancer diagnosis are the consistent patient engagement in preventive health services and the uptake of protective lifestyle behaviors. One study described cancer survivors engagement in preventive screenings and lifestyle behaviors (e.g., smoking, exercise, alcohol consumption) in comparison to non-cancer controls (Bellizzi, Rowland, Jeffery, & McNeel, 2005; Findley & Sambamoorthi, 2009). This longitudinal study found in a nationally representative that a majority (78%) of the cancer survivors surveyed (n=1,801) had a routine physical examination in the past year, 66% had a dental check-up in the previous year and 54% had received a flu vaccination (Findley & Sambamoorthi, 2009). Additionally, 20% of cancer survivors reported smoking, 37% reported having a weight in the 'normal range' based on body mass index (BMI) values, and 52% reported engaging in moderate-vigorous physical activity three or more times per week (Findley &

Sambamoorthi, 2009). Further, this study found that survivors with diabetes were more likely to engage in clinical preventive services than non-diabetic cancer survivors; however, survivors with diabetes were less likely to report healthy lifestyle practices than their non-diabetic counterparts (Findley & Sambamoorthi, 2009). Another study found that people with a history of cancer reported similar smoking and alcohol consumption behaviors as those without a cancer history; however, cancer survivors were more physically active than the general population (Bellizzi et al., 2005). This study also found that female cancer survivors were more likely to adhere to mammography and cervical cancer screening recommendations than women in the general population. Therefore, it appears survivors sub optimally engage in protective health behaviors and further research to explore explanations and variations among cancer survivor uptake would inform intervention strategies.

Distress.

The National Comprehensive Cancer Network defines cancer related distress as “a multifactorial unpleasant emotional experience of a psychological (i.e., cognitive, behavioral, emotional), social, and/or spiritual nature that may interfere with the ability to cope effectively with cancer, its physical symptoms, and its treatment” (Holland, Greenberg, & Hughes, 2015, p. 2). In a landmark report from the Institute of Medicine (Adler & Page, 2008) the widespread failure to adequately screen for and intervene with patients experiencing distress was documented and it was recommended that routine screening of all cancer patients be adopted as the ‘sixth vital sign’ (Bultz & Johansen, 2011). One population health study analyzing data from 10 states found that approximately (n=8,055) 12% of survivors had ‘frequent’ episodes mental health distress in the past 30 days (Poghosyan, Darwish, Kim, & Cooley, 2016). Distress research on specific cancer sites (Chambers et al., 2015; Mao et al., 2014; Russell et al., 2015; Zabora, BrintzenhofeSzoc, Curbow, Hooker, & Piantadosi, 2001), age groups (i.e., adolescents and young adults) (Kaul et al., 2016; Zebrack et al., 2014), cancer progression (Enzinger, Zhang, Schrag, & Prigerson, 2015), temporal point post-cancer diagnosis (e.g., one year post diagnosis, five years

beyond, etc.) (Deimling et al., 2017; Dupont, Bower, Stanton, & Ganz, 2014; Russell et al., 2015), treatment modality (Mao et al., 2014; Rusiewicz et al., 2008), and treatment setting (Jacobsen et al., 2005) yielded wide variations in distress figures among survivors. The overall prevalence of distress has been reported to range from 29.6% (gynecological) to 43.4% (lung), with approximately 36.4% reporting distress scores suggestive of psychiatric morbidity (Fallowfield, Ratcliffe, Jenkins, & Saul, 2001; Zabora et al., 2001).

The relationship between comorbidity and psychological distress in cancer survivors is an emerging research area. Among early stage breast cancer patients the ‘multiple-hit hypothesis’ for developing cardiovascular disease (CVD) provides an explanation of how cascading of ‘insults’ increases CVD risks among breast survivors (Jones, Haykowsky, Swartz, Douglas, & Mackey, 2007). According to this hypothesis, cancer and CVD share similar clinical pathways. Therefore, patients enter the breast cancer diagnosis and treatment phases with elevated risk for CVD. Elevated risk for CVD increases from the use of cardio-toxic treatments that diminish cardiac reserve. Cardiac reserve is then further depleted when survivors are unable to maintain health body weights or activity levels while recovering from cancer treatments (Jones et al., 2007). This initial hypothesis was expanded beyond breast cancer survivors to other populations of cancer survivors and during this refinement of the hypothesis psychological distress was added to one of the possible ‘insults’ that diminish cardiac reserves (Schoormans, Pedersen, Dalton, Rottmann, & van de Poll-Franse, 2016).

Research illustrated how distress negatively affected cardiovascular risk among the general population, which prompted the addition of distress as an ‘insult’ to cardiac reserves. The risk of distress and CVD occurs through behavioral mechanisms, such as poorer diet and increased smoking, and physiologically through neuroendocrine and platelet activation (Rozanski, Blumenthal, & Kaplan, 1999). More information is needed to understand how comorbidity, specifically diabetic comorbidity contributes to the distress response among cancer survivors.

Depression.

The presence of type II diabetes doubles and Type I diabetes triples the odds of a comorbid depression diagnosis (Anderson, Freedland, Clouse, & Lustman, 2001b; Roy & Lloyd, 2012). Consistently depression has been shown to be associated with complication from diabetes (de Groot, Anderson, Freedland, Clouse, & Lustman, 2001). Generally, women are more likely to have a diagnosis of depression than men are, and depression rates are higher in women who are diabetic (Roy & Lloyd, 2012). Among diabetics, patients with higher depression severity are less adherent to diet and medication regimens, have poorer physical and mental health functioning, and have higher overall health care costs (Ciechanowski, Katon, & Russo, 2000). Though diabetes and depression are clearly interrelated, the exact nature and causal pathways of this relationship remains unclear (Roy & Lloyd, 2012). In a meta-analysis of longitudinal studies reporting depression at baseline and CVD at follow-up found that a clinical diagnosis of major depressive disorder was an independent risk factor for developing CVD (Van der Kooy et al., 2007).

Depression is common among cancer patients (median prevalence estimated between 15-29%), and is three to five times greater among cancer survivors than in the general population (Miller, Ancoli-Israel, Bower, Capuron, & Irwin, 2008; Raison & Miller, 2003; Rooney et al., 2011). A recent systematic review found that the prevalence of depression varied widely based on the cancer type and diagnostic tool used to identify depression, reporting prevalence mean rates that ranged from 3-31% (Krebber et al., 2014). Generally, prevalence rates of depression are highest during the treatment phase of cancer and remain elevated in the first year of diagnosis but taper off over time (Krebber et al., 2014). A study that compared rates for major depressive disorder between long-term cancer survivors and individuals without cancer histories found no significant differences in prevalence rates; however, they may have greater impairment in their home, work or social lives (Pirl et al., 2014). Despite elevated rates of depression among cancer

survivors and diabetics when studied separately, more evidence about the cumulative effect of diabetes and cancer would inform better strategies to care provision.

Race.

Cancer related health disparities have persisted for ethnic/racial minorities for decades, in part, due to an unequal burden of comorbid illnesses (Bach et al., 2002; Haynes & Smedley, 1999; Tammemagi et al., 2005). Compared to Caucasian/white-Americans, African-American males have a 15% higher incidence rates for all cancers combined (prostate, lung, colorectal, kidney and pancreas) and are more likely to die as a result of a diagnosis (DeSantis, Naishadham, & Jemal, 2013). Whereas, African-American women are estimated to have a 6% lower incidence of breast cancer than Caucasian/white-American women do overall, yet mortality rates among African-American women remain higher (DeSantis et al., 2013). A recent population-based study of cancer survivors between the ages of 40-84 years old found that African-American women have the highest rates of chronic disease comorbidity (76%) followed by African-American men (70.6%). These findings suggest that the compound impact of cancer and comorbidity among African-Americans is a significant contributor to poorer survival outcomes (Ogle, Swanson, Woods, & Azzouz, 2000; Tammemagi et al., 2005). The persistent disparities in mortality raises questions about the how the role of biology, social and health system factors contribute to these outcomes.

Similarly, in the U.S. the estimated prevalence of type II diabetes (age adjusted) among those over 20 years old demonstrate the disproportionately burden among members of racial/ethnic minority groups. The proportions of diabetics by race/ethnicity groups are: 7.6% non-Hispanic whites; 9.0% Asian American; 12.8 % Hispanic; 13.2 % non-Hispanic blacks; and 15.9% American Indians/Alaska Natives (Centers for Disease Control and Prevention, 2014). A translational study investigating patient factors associated with vascular disease risk factors in “well managed” population (i.e., those who received at least five of the seven recommended care processes in the past 12 months) found that controlling for care African Americans had poorer

glycemic control that whites (Selby et al., 2007). In this study, medical, socioeconomic, psychosocial, and behavioral factors were independently associated with glycemic control, but did not sufficiently explain differences in control by race and socioeconomic status (Selby et al., 2007). An observational study in Veteran Affairs (VA) facilities found some discrepancies between African American/black and Caucasian patients for some diabetes care processes and intermediate outcomes but not for treatment intensity when glycemic control was poor (Heisler et al., 2003b). In this study, both groups were found to receive similar hemoglobin A1C tests and foot examinations. Yet, some care processes (i.e., dilated eye examination and low density lipoprotein (LDL) checked in past two years) were less likely among African Americans even after controlling for a variety of other potential covariates (i.e., patient age, education, income, insulin use, diabetes self-management, duration, severity, comorbidities, and health services utilization) (Heisler, Smith, Hayward, Krein, & Kerr, 2003a).

A recent study compared racial differences in diabetes prevalence using national data (National Health Interview Survey, NHIS) with Exploring Health Disparities in Integrated Communities-Southwest Baltimore (EHDIC-SWB) a urban racially integrated community sample to discern if prevalence outcomes were similar when African American/black and white Americans live in similar social conditions (LaVeist, Thorpe, Galarraga, Bower, & Gary-Webb, 2009). While differences racial differences in African Americans having diabetes when compared to whites was greater in the national data set (OR: 1.61, 95% CS: 1.26-2.04), results from the EHDIC-SWB reported similar odd of having diabetes between African Americans and whites (OR: 1.07, 95% CS: 0.71-1.58) living in similar social environments (LaVeist et al., 2009).

Socioeconomic status.

The relationship between cancer and socioeconomic status is complex; a myriad of factors including access to health care, screening utilization, behavioral risk, and occupational hazards strongly influence cancer incidence and are also associated with SES. In the U.S., cancer incidence in specific cancer sites is associated with lower SES, including lung, colorectal,

cervical (Clegg et al., 2009), oral (Johnson, McDonald, & Corsten, 2008), and liver (Shebl, Caporamos, Graubard, McGlynn, & Altekruse, 2012). While cancer incidence for other sites including breast, prostate, skin (Clegg et al., 2009), and thyroid (Li, Du, Reitzel, Xu, & Sturgis, 2013) are associated with higher SES. In general, cancer incidence for sites that are associated with behavioral risk factors (i.e., tobacco use, alcohol, diet, intravenous drug use, and sexually transmitted infections) tend to be associated with lower SES groups (Boscoe et al., 2014).

In high-income countries, occupying a low socioeconomic position based on having a low income, low level of education or low status occupation, is strongly associated with risk of type II diabetes (Agardh, Allebeck, Hallqvist, Moradi, & Sidorchuk, 2011). A nationally representative study in the U.S. found that living below the poverty level was associated with twice the diabetes-related mortality risk compared to those in higher income levels, and only 25% of this additional risk associated with lower SES could be explained by adjusting other covariates (Saydah & Lochner, 2010). In the U.S., during 1971-2002, diabetes prevalence disparities widened for low education and income groups (Kanjilal et al., 2006). Another nationally representative study found that survivors with a low incomes and comorbid conditions were more likely to have poorer physical functioning and quality of life (Short & Mallonee, 2006). Low socioeconomic status is associated with delays in diabetes diagnosis (Karter, Ferrara, Darbinian, Ackerson, & Selby, 2000), poor glycemic control (Selby et al., 2007), higher rates of diabetes-related complications (Karter et al., 2002), and emergency room visits and hospitalizations (Bazargan, Johnson, & Stein, 2003; Booth & Hux, 2003).

Few studies examine the contextual factors that inhibit or protect cancer survivors to engage in protective health behaviors. In a recent study of breast cancer survivors, mental and physical health-related quality of life outcomes differed according to income, educational, and job type, with survivors' belonging to higher SES groups reporting better physical and mental health (Ashing-Giwa & Lim, 2009). Additionally, this study findings suggest that socioecological stress (i.e., housing situation, neighborhood, use of public services, violence exposure, and relations

with the police) was the strongest predictor influencing physical and mental quality of life among breast cancer survivors (Ashing-Giwa & Lim, 2009). Further explorations into these contextual factors that affect physical and emotional health among cancer survivors are needed, particularly, approaches to identify and understand the burdens faced by cancer survivors in high socioecological stress environments (e.g., members of low SES groups) whose challenges include managing other comorbid conditions.

Conceptual Foundations and Theoretical Framework

Theory of ‘Fundamental Causes.’

The theory of ‘fundamental causes’ aims to explain the ongoing and historical persistence of health inequities, and why associations between SES and mortality continue even after conditions change that should have improved health across the population (Link & Phelan, 1995; Phelan, Link, & Tehranifar, 2010). According to theory of ‘fundamental causes,’ the root of persistent SES disparities is the unequal resources distribution positioning those with more flexible resources (i.e., money, power, prestige, social networks) in a more advantageous position to adopt protective behaviors and to adapt to avoid risk of disease and death (Link & Phelan, 1995). The theory of ‘fundamental causes’ assumes that flexible resources operate at both the individual and contextual levels, contributing to health behavior outcomes through additive and interactive relationships (Phelan et al., 2010). Thereby, social conditions are the negative drivers of individual behaviors that are risk factors, such as maintaining a healthy diet, not smoking, and exercising regularly. Additionally, social conditions operate at contextual levels. The health delivery system, for example, is a context where access barriers exist and similar quality and types of care and providers are limited for specific subpopulations.

The theory of ‘fundamental causes’ arose in response to an abundance of evidence developed by epidemiologists that identified proximate risk factors for specific diseases (Link & Phelan, 1995). Proponents of theory of ‘fundamental causes’ argue that focusing on proximate,

individual risk factors, resonates with the Western ideology of personal responsibility and works to shift attention away from the underlying social conditions that are the actual causes of the risk factors (Eckersley, 2006; Link & Phelan, 1995). Empirical support of the ‘fundamental cause’ theory provides evidence that demonstrates how once strategies to improve health problems caused by specific diseases are known, these benefits are experienced disproportionately by higher status members of society. From a ‘fundamental cause’ perspective, individually based-risk factors (i.e., diet, exercise, and smoking) are inadequate to understand population health risks because the evidence produced is devoid of context. A contextualized lens accounts for the social conditions that are associated with known risk behaviors for particular diseases, therefore shifting the analytic emphasis from individually based behaviors to the contexts that produce and reinforce these behaviors (Link & Phelan, 1995). According to Link & Phelan’s (1995) theory, the social conditions are the causes of these risks not the individual behaviors themselves and thereby the social conditions are termed the ‘fundamental causes’ of the medical conditions.

Much of the empirical support for the ‘fundamental causes’ theory have been illustrated through the health disparities among cancer survivor populations. The central thesis of the ‘fundamental causes’ theory was tested and supported using the National Longitudinal Mortality Study data in an analysis of the impact of SES on less preventable deaths (situations where little is known about prevention and treatment) compared to preventable deaths. Based on this study, socioeconomic differences were less strongly associated with mortality for less preventable deaths where evidence to guide prevention and treatment are limited (Phelan, Link, Diez-Roux, Kawachi, & Levin, 2004). Additional support was later provided for the ‘fundamental causes’ theory in the Tehranifar et al. (2009) study which demonstrated a similar phenomenon. In this study the outcomes of cancers by racial and ethnic group were compared between the specific cancers classified into three groups based on amenability to cancer treatment (i.e., typically amenable, partly amenable, seldom amenable) and found Caucasians/whites consistently had

better outcomes in typically amenable to treatment cancers compared to African Americans (Tehranifar et al., 2009).

Among both diabetics and cancer survivors, the role of smoking provides an example how a social factors can be ‘a risk of risks’ that cascades into several negative health consequences. Smoking is associated with increased mortality for both diabetics and cancer survivors, and demonstrates how access to resources (i.e., preventive care, smoking cessation resources) and social networks influence both the initiation and continuation of a behavior that has an eventual impact on mortality (Cockerham, Hamby, & Oates, 2017). Despite decreases in smoking behavior in the general population, disparities persist among members of lower socioeconomic groups and racial/ethnic minorities (Agaku, King, Dube, Centers for Disease, & Prevention, 2014; Haiman et al., 2006). Smoking is well established as a risk factor for many types of cancer and the development of type II diabetes (Pan, Wang, Talaei, Hu, & Wu, 2015; Stewart & Wild, 2014). A recent review found that the relative risk for type II diabetes was 1.37 for current smokers compared to non-smokers (Pan et al., 2015). Further, there are multiple mechanisms of how smoking impacts health for cancer and diabetes in addition to increased prevalence (Cockerham et al., 2017). For example, smoking affects cancer outcomes even in instances where smoking is not associated with the cause of the cancer itself (e.g., breast and prostate cancer). Yet smoking behavior was associated with increase relative risk of death compared to non-smokers (relative risk, 1.3; 95% CI, 1.2 to 1.5; relative risk, 1.4; 95% confidence interval [CI], 1.2 to 1.7, respectively)(Carter et al., 2015).

The theory of ‘fundamental causes’ challenges the approach of researching medical conditions that focus on identifying “connection of social conditions to single disease via single mechanisms at single points in time,” because this approach produces fragmented understandings of the overall impact of social conditions on health (Link & Phelan, 1995). Link and Phelan (1995) define social conditions as ‘factors that involve a person’s relationship to other people’ including factors race, socioeconomic status as well as social support, stressors of a social nature

(i.e., job loss, spousal death, etc.). There is much evidence about the role of social conditions and health, however two issues—the direction of causation and the mechanism that explain the observed relationships remains contentious (Link & Phelan, 1995). Further, Link and Phelan's (1995) theory challenges the characterization of social causes as proxies for real causes and argue that the social conditions are the starting points in the causal chain that eventually lead to the proximal risk factors. The social factors that contribute to poorer outcomes among lower SES populations when coping with the cumulative effect of the diabetes and cancer survivorship co-morbidity cluster have not yet been explored empirically (Casillas & Ayanian, 2011). More specificity to elucidate the social and intermediate mechanisms through which the compound effects of cancer survivorship and diabetes contribute to poorer morbidity and mortality among lower SES groups would inform strategies to reduce health disparities (Bach et al., 2002; Tammemagi et al., 2005).

The empirical support for the 'fundamental cause' theory evaluates four essential relationships between diseases and socioeconomic status. These relationships are that: (1) SES is related to multiple disease outcomes; (2) SES is related to multiple risk factors for disease and death; (3) resources position people in higher SES with a health advantage; and (4) the association between SES and mortality is duplicated over time with the replacement of intervening mechanisms (e.g., infections, diseases) with the emergence of new mechanisms (e.g., smoking, diet/exercise)'fundamental causes' (Phelan et al., 2010). This study's aims explore the first three relationships outlined above among diabetic cancer survivors. For both diabetes and cancer, when separately assessed, health disparities among minorities and SES disadvantaged groups have persisted for decades this study uses this explanatory theory to elucidate the mechanisms of these disparities (Bach et al., 2002; Heisler et al., 2003b; Selby et al., 2007; Tammemagi et al., 2005).

Thus far, research has mainly focused on the identification of proximate risk factors that place groups of survivors at risk for poorer outcomes, rarely attending to other health issues and

the influence of socioecological factors on these outcomes and behaviors (Earle & Ganz, 2012c; Earle & Neville, 2004; Hewitt et al., 2003; McCorkle et al., 2011; Parry et al., 2011). As a result, proposed patient interventions emphasize individual behavior change (Speck, Courneya, Mâsse, Duval, & Schmitz, 2010) and self-management (McCorkle et al., 2011) without accounting for patient level capacity due to individual and contextual factors. Health system level interventions focus on corrective measures to improve known fragmentation between the different levels of care (Taplin & Rodgers, 2010), but focus primarily on the communication between primary care and oncology regardless of how involved in patients care and the complexity of their care needs (Earle & Ganz, 2012c).

The theory of ‘fundamental causes’ emphasizes the need to contextualize risk factors and argues that this is done by a) using an interpretive lens to discern why risk and protective behaviors/factors manifest for specific people in specific contexts and b) identifying the social conditions where proximate factors are related to medical conditions (Link & Phelan, 1995). The rationale for contextualizing risk factors is that the impact of changing individual behavior may be limited if the process and context that produce these behaviors are poorly understood. In the last decade, there have been considerable advances in our understanding of cancer survivors as a population; however, limited evidence is available from these investigations about survivors who are co-managing other complex illnesses.

Pearlin’s Stress Model.

The diagnosis, treatment and ongoing management of diabetes and cancer is both a stressful life events and chronic stressors. Pearlin (1989) argued that the “structural context of people’s lives are not extraneous to the stress process but fundamental to that process (p. 242).” In his seminal work, Pearlin cautioned against identifying stressful events while ignoring other indicators of chronic hardships. Chronic stressors are enduring problems that people must manage over time. Pearlin (1989) described the convergence of life events and chronic stressors as potentially occurring in three ways: (1) a life event to give rise to a chronic strain; (2) chronic

strains can give way to a life event; and; and (3) life events and chronic strains can provide meaning contexts for each other. Therefore, the characterization of an illness as an acute life event overlooks the continuing circumstances in which an illness emerges in the first place, and ignores the more subtle impacts of an illnesses treatment and management over time. Pearlin's Stress Model provides a useful framework that describes how the psychosocial impact of cancer has shifted historically, with earlier emphasis primarily concerned with acute management of a terminal illness toward an emerging conceptualization of cancer as a chronic illness that needs to be managed over time (McCorkle et al., 2011).

Pearlin's stress process model provides a psychosocial framework to conceptualize the how individuals cope with the diagnoses and management of cancer and diabetes. A blended model of Pearlin (1989) Stress Process Model and Link and Phelan (1995)'s theory of 'fundamental causes' guides the analysis of aim 3 of this study, where the outcomes of interest are psychosocial indicators. Guided by the stress process model, the main independent variable, the illness burden (cancer alone vs. cancer and diabetes), was conceptualized as primary stressors. Financial stressors are conceptualized as a 'secondary stressors' and includes financial sacrifice due to cancer and health insurance status (Drentea & Reynolds, 2014). Pearlin (1989) and Link and Phelan's (1995) models were blended in the conceptualization of flexible resources and mediators. In the stress process model factors such as social support and intrapsychic resources were characterized as mediators, the analytic model used for this analysis conceptualizes these factors as 'flexible resources' that can be used to mitigate the effects of both the primary and secondary stressors to understand how these impact psychosocial outcomes.

Overview of Dissertation

This dissertation follows a three-paper format, whereby each aim represents a specific paper presented herein. Each of the aims was constructed to investigate specific aspects of the essential relationship(s) (Phelan, Link, & Tehranifar, 2010) of Link and Phelan's (1995) theory of 'fundamental causes' as it relates to the potential for health disparities during cancer survivorship.

Each aim presented below includes the research questions and/or aim and the specific essential relationship(s) of the theory of ‘fundamental causes/’

The first aim of this dissertation was to identify factors associated with the co-occurrence of diabetes and cancer and factors known to be associated with higher risks for poor outcomes (e.g., obesity and physical inactivity) (see Paper 1). The first research question in this study explored the social factors that were predictive of diabetic status among cancer survivors. This research question investigates the ‘fundamental cause’ empirical relationships that: (1) SES is related to multiple risk factors for disease and death and (2) resources positions people in a higher SES in a better position to avoid disease. The second research question in paper 1 investigates how diabetic status and social factors predict adherence to recommendation known to reduce health risk for diabetics and cancer survivors. This investigates the ‘fundamental cause’ relationship that: SES is related to multiple risk factors for disease and death and resources position people with a higher SES in better position to adopt protective behaviors to avoid disease and death. Paper 1 also investigates how diabetic status and social factors relate to complex multi-morbidity. This research questions evaluates the essential relationship of how SES relates to multiple disease outcomes and how SES relates to multiple risk factors for disease and death.

The second aim of this dissertation was to examine the differences in self-assessed health (i.e., proxy for mortality), physical and mental quality of life between diabetic cancer survivors and non-diabetic survivors. This study investigates three research questions: (1) What is the effect of diabetic status on the likelihood of reporting poor/fair health among cancer survivors; (2) What is the effect of diabetic status on general physical health among cancer survivors; (3) What is the effect of diabetic status on mental health among cancer survivors? This investigation will further examine the ‘fundamental causes’ relationships of how social factors are related to multiple disease outcomes and multiple risk factors related to disease and death.

The third paper (aim 3), examined the differences in multiple psychosocial outcomes for diabetic cancer survivors and non-diabetic cancer survivors. This paper aimed to: (1) explore the

effect of diabetic status on cancer survivors' non-specific psychological distress, depression, mental health functioning and cancer related health worries; (2) examine how internal and flexible resources predict multiple psychosocial outcomes; and (3) identify factors that are associated with clinically relevant non-specific psychological distress in longer term survivors.

The goal of this investigation was to explore both how social factors relate to multiple risk factors and how resource availability relates to survivors' adjustment to primary and secondary health stressors. This paper examines the 'fundamental causes' empirical relationships, that low SES groups may be a 'risk of risks' due to the known association of psychosocial conditions and physical health issues.

The final chapter synthesizes the findings across the three papers, and describes these studies contributions understandings of health disparities among cancer survivors. Additionally, this chapter includes a discussion of the implications of these finding for both clinical practice and health policy.

MANUSCRIPT 1**DETERMINANTS AND CORRELATES OF DIABETIC STATUS IN A POPULATION OF
CANCER SURVIVORS**

by

DENALEE M. O'MALLEY

Manuscript 1 of 3 of a dissertation entitled:

**EXAMINING THE IMPACT OF DIABETIC STATUS ON MULTIPLE OUTCOMES
AMONG CANCER SURVIVORS**

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Graduate Program in Social Work

Written under the direction of

Patricia A. Findley

ABSTRACT

Purpose: Using the ‘fundamental causes’ theory of socioeconomic disparities in health this study identifies factors associated with comorbid diabetes among cancer survivors. This study explores the impact of diabetic status on cancer survivors’ use of preventive health services and adherence to lifestyle recommendations. Additionally, this study explores the relationship of diabetic status and complex multi-morbidity in a population of cancer survivors.

Methods: A retrospective, cross-sectional analysis using data from the 2011 Medical Expenditures Panel Experiences with Cancer survey (n=743) was conducted. Cancer site, chronic disease correlates, preventive health service use, and adherence to lifestyle behaviors were explored using Chi-square analyses. Nested logistic models were specified to examine the social, demographic and cancer-related factors on likelihood of diabetic status and the association of diabetic status on adherence to physical activity and weight management recommendations. Multivariate logistic regression models were also specified to explore the association of comorbid diabetes and high levels of multi-morbidity (i.e., five or more chronic conditions).

Results: The following factors were identified as risk factors for co-occurring diabetes and cancer: (1) survivors a high school educations had 63% greater odd [CI 1.03-2.50, p=0.04] and those with less than a high school education had 215% [CI: 1.75-5.69, p<0.001] greater odds than survivors with bachelor’s degrees or higher; (2) African American/black survivors had 105% greater odds [CI: 1.18-3.55, p=0.001] than Caucasian/white survivors; and (3) survivors aged 55-less than 65 had 1128% greater odds [CI: 160-94,28], aged 65-less than 75 had 919% [CI:1.31-79.39, p=0.03] greater odds; aged 75 [CI: 0.97-62.22, p=0.05] and older had 679% greater odds than survivors aged 18-39 years old. Female survivors had a 37% lower odds [CI: 0.41-0.97, P=0.04] of diabetic status compared to male survivors; and survivor 10 or more years out had a 43% lower odds [0.33-0.98, P=0.04] of diabetic status compared to recently diagnosed survivors. Diabetic cancer survivors had 48% lower odds of meeting physical activity recommendations [CI: 0.34-0.80, p=0.003] and 73% lower odds of meeting weight recommendations [CI: 0.16-0.48,

p<0.001] compared to non-diabetic cancer survivors, controlling for social and cancer related variables. Diabetic cancer survivors had 186% [CI: 1.84-4.45, p<0.001] greater odds of having five or more chronic conditions compared to non-diabetic survivors.

Conclusion: Education and race were found to be related to the development of co-morbid diabetes among cancer survivors. Diabetic cancer survivors were less likely to meet physical activity and weight recommendations compared to non-diabetic cancer survivors; and were found to have a much higher likelihood of complex multi-morbidity. Therefore, survivorship models that aim to mitigate the long-term risks associated with the cancer should account for the social determinants and shared clinical pathways found in the diabetic subpopulation of cancer survivors.

Introduction

Approximately 15.5 million cancer survivors reside in the U.S. (Miller et al., 2016). Diabetes is one of the most prevalent comorbid conditions in cancer survivors, with estimated rates ranging from 16-29% of survivors having comorbid diabetes (Bluethmann et al., 2016; Edwards et al., 2014). Diabetes influences each phase of the cancer control continuum. Diabetics are at elevated risk for bladder (Larsson et al., 2006), breast (Larsson et al., 2007), colorectal (Larsson et al., 2005), endometrial (Friberg et al., 2007), kidney (Lindblad et al., 1999; Washio et al., 2007), liver (El-Serag et al., 2006), non-Hodgkin's lymphoma (Mitri et al., 2008), and pancreatic cancers (Huxley et al., 2005). Despite elevated risks, diabetics have lower screening rates for several types of cancer (Beckman et al., 2001; Felsen, Piasecki, Ferrante, Ohman-Strickland, & Crabtree, 2011; Garcia-Jimenez et al., 2016; Marshall et al., 2010; Zhao, Ford, Ahluwalia, Li, & Mokdad, 2009). Cancer treatments can induce new diagnoses of type II diabetes and may aggravate symptoms of diabetes (Chowdhury, 2010; Vigneri et al., 2009a). Further diabetes increases the morbidity and mortality for several cancers (Barone et al., 2008; Larsson et al., 2006; Peairs et al., 2011; Vigneri et al., 2009a).

Cancer health disparities have persisted for specific racial and socioeconomic groups and due to disproportionate burdens of comorbidity among specific subpopulations (Bach et al., 2002; Haynes & Smedley, 1999; Schmitz, Agurs-Collins, Neuhouser, Pollack, & Gehlert, 2014; Tammemagi et al., 2005). Cancer incidence and mortality vary by race and ethnicity in the U.S. (DeSantis et al., 2016; Siegel et al., 2015). Type II diabetes also varies by race and ethnicity in the U.S., with the age-adjusted prevalence much higher in specific racial and ethnic groups. Current proportion of type II diabetes by race/ethnic group are: 7.6% non-Hispanic whites, 9.0% Asian American, 12.8 % Hispanic, 13.2 % non-Hispanic blacks and 15.9% American Indians/Alaska Natives (Centers for Disease Control and Prevention, 2014). The relationship between cancer and socioeconomic status is also complex. Cancer incidence for breast, prostate and skin (Clegg et al., 2009), and thyroid (Li et al., 2013) cancers are associated with higher

socioeconomic status; however, for cancer sites associated with behavioral risk factors (i.e., tobacco use, alcohol, diet, intravenous drug use, and sexually transmitted infections) tend to be associated with lower SES groups (Boscoe et al., 2014).

The theory of ‘fundamental causes’ is a social epidemiologic theory that seeks to explain the historical persistence of inequities in health, the association between socioeconomic status and mortality that continue even after conditions changes that should improve health across the population (Link & Phelan, 1995; Phelan et al., 2010). Based on the theory of ‘fundamental causes’ the root of socioeconomic differences is the unequal distribution of resources which position those in more advantageous positions with the ability to adapt behaviors more readily to avoid risks of disease and death (Link & Phelan, 1995). Therefore, differential risk of obesity and diabetic status in specific subpopulations of cancer survivors may contribute to health disparities during cancer survivorship. Specifically, social factors may determine who is more likely to have diabetic comorbidity, to adapt protective strategies to both prevent this comorbidity cluster and may mitigate the joint risk once both conditions present. Therefore, this study aims to: (1) identify the social factors predictive of diabetic status among cancer survivors; (2) explore how social factors contribute to adherence to recommendations common to both cancer survivors and diabetics; and (3) examine the relationship between diabetic cancer survivor statuses with complex multi-morbidity. Based on the ‘fundamental causes’ theory it is hypothesized that cancer survivors with lower socioeconomic status (i.e., lower educational levels, members of ethnic/minority groups, and lower income groups) would be more likely to have a comorbid diagnosis of diabetes and less likely to engage in protective health behaviors. Therefore, individuals with lower socioeconomic status would also be more likely to have complex comorbidity.

Methods

Study Design and Data Source.

The Medical Expenditures Panel Survey Household Component (MEPS-HC) is a survey administered by the Agency for Healthcare Research and Quality of a nationally representative sample of non-institutionalized individuals from 15,000 selected civilian households across the United States (*Medical Expenditures Panel Survey-Household Component*). Using an overlapping panel design, collecting data at five time-points over 2.5 years, the MEPS-HC collects detailed information on each member of the household about demographics, charges and payments, medical conditions, employment, health status, health insurance, and health care utilization. In 2011-2012, two panels of the MEPS-HC oversampled for adult cancer survivors over 18 years old, who answered ‘yes’ to the question, “have you ever been told by a doctor or other health professional that you have a cancer or malignancy of any kind?” During these years, the supplemental questionnaire ‘Experiences with Cancer’ was fielded to assess: characteristic of cancer treatment and status, financial aspects, health care experiences and psychosocial impacts of cancer (Yabroff et al., 2012). The MEPS-HC response rate was 54.9% and MEPS Experiences with Cancer survey response rate was 90%. Therefore, the overall response rate was 72.45%. This study used a retrospective, cross-sectional study design.

Study Population.

There were 2,145 respondents from the MEP-HC were diagnosed with cancer over the age of 18 years old. Of these respondents, 1,591 completed the MEPS Experiences with Cancer. Cases of non-melanoma skin cancers and skin cancers unknown (n=386) and those with incomplete data (n=462) were excluded from the study sample.

Measures.

Outcome Measures.

There are three main outcomes measures in this study. Two outcomes, diabetic status and complex multi-morbidity, were constructed using the MEPS-HC medical condition data that was collected for all priority conditions. MEPS collects comorbidity data for select priority conditions, including: diabetes, hypertension, any heart disease (coronary artery disease, angina, history of heart attack, or other heart disease), stroke, emphysema, chronic bronchitis, arthritis, high cholesterol, and asthma. Priority condition data were collected at each time point. Priority conditions were assessed at baseline, from the question: “have you (or the reference household member) been told by a health professional that you (or the reference household member) has the <reference condition>.” At subsequent data collection points, the household respondents were asked: “During the past 12 months have you been told by a health professional you were diagnosed,” with the reference condition. Responses were coded as: yes, no, not ascertained, don’t know, refused, and inapplicable. All respondents that reported to have a diagnosis of diabetes as a priority condition were included in the diabetic status group. A ‘complex multi-morbidity’ outcome variable was constructed from priority condition data, first the number of conditions were counted per case, then dichotomized (i.e., between zero and four or five or more conditions) (Note: diabetic status was not included in this count as it is either the independent variable of interest or the outcome variable). Assessment of adherence to physical activity recommendation included a single yes/no question “do you currently spend half hour or more in moderate to vigorous physical activity at least five times a week?” Adherence to the weight recommendation for cancer survivors was assessed using the body mass index (BMI) based on the Centers for Disease definition of overweight and obesity. The BMI variable was constructed by the MEPS data center as a continuous variable; but was recoded and analyzed as a categorical variable. BMIs within the 18.5 through 24.9 (inclusive) range were coded as “normal weight” all

other categories: underweight (BMI <18.5); overweight (BMI in 25.0-29.9 range, inclusive); and overweight (BMI greater than or equal to 30) were coded as “not meeting weight guideline” (Centers for Disease Control and Prevention, 2015a).

Independent Variables.

Social Factors.

The main independent variables of interest were social factors, which included income status, education, race/ethnicity, and insurance status. Income consisted of three groups: negative income or poor (less than 100 to less than 200% of FPL); middle income (200% to 400% FPL); and high income (greater than or equal to 400%). Initially collected as a continuous variable for years of education, for these analysis three categories for level of education were constructed: less than a high school, high school degree or some college, and a bachelor's degree or higher. Race/ethnicity were assessed using six categories: Non-Hispanic Caucasian/white, African American/black, American Indian/Alaska Native, Asian, Native American/Pacific Islander, and multiple races reported. Hispanic ethnicity was assessed separately. For this analysis race and ethnicity were recoded into five categories: Non-Hispanic Caucasian/white, African American/black, Asian, Hispanic/Latino and 'other' for all categories with less than ten respondents (i.e., American Indian/Alaska Native, Native Hawaiian/Pacific Islander, multiple races). Insurance status was assessed as public, private or no insurance.

Demographics.

Demographic factors including gender (male vs. female), age, and marital status of respondents were reported by the household respondent for the MEPS-HC. Exact age was calculated for all participants from their date of birth as of 12/31/2011 and constructed into five categories to (18-39, 40-54, 55-64, 65-74, and 75+). Age was top coded at 85 years old. Marital status was measured using the following categories: married, widowed, divorced/separated, or

never married. The categories of divorced/separated were combined for the purposes of this analysis because of the conceptual similarities and small sample sizes.

Cancer variables.

Cancer variables were drawn from the supplemental survey. Time since cancer treatment was measured using the following categories: less than one year to less than three years; between three years but less than five years; between five years but less than ten years; ten or more years post-treatment; or never received treatment. Recurrent cancer was assessed (no recurrence vs. cancer returned). Cancer remission status was measured using three categories: not cancer free; in remission; and does not know cancer status. Cancer site was assessed from the MEPS-HC, for all people who responded ‘yes’ to having had a diagnosis of cancer they were asked what type of cancer was diagnosed options included bladder, blood, bone, brain, breast, cervical, colon, esophageal, gall bladder, kidney, larynx, leukemia, liver, lung, lymphoma, melanoma, mouth, muscle, other, ovary, pancreas, prostate, rectum, skin (non-melanoma), skin (unknown type), stomach, testis, throat, thyroid, and uterus.

Preventive Service Use and Lifestyle Factors.

Frequency of dental check-up was initially assessed: twice a year or more; once a year; less than once a year; never go to the dentist. This was dichotomized into two groups survivors who visited a dentist at least once a year and those who go less than a year or not at all. Routine physical was assessed with the question, ‘how long ago was your last routine check-up’ with response options including: within the last year; within past two years; three years; five years; or never. This was also dichotomized into two groups: survivors who had an annual physical within the last year and those who had had their last check-up over a year ago or never. Time since last flu shot was assessed as: within last year; within the past two, three, five years or never. Flu shot utilization was dichotomized into two groups: those who had a flu shot in past year and those who

had had one beyond that time period or not at all. Current smoking status was assessed (response: yes or no).

Statistical Analyses

Social factors, demographics, cancer and comorbidity variables were presented overall and by diabetic status with frequencies and percentages (Table 1). Pearson's χ^2 statistics were used to test for differences in distributions of cases by cancer site (Figure 1), preventive services uses (Figure 2), lifestyle factors (Figure 3), and priority conditions (Figure 4) by diabetic status. In a series of hierarchical multivariate logistic regression models, each set of covariates was added to the models to estimate the probability of: being diagnosed with co-morbid diabetes (Table 2); meeting recommendations for physical activity (Table 3); and meeting the weight management recommendations (Table 4). In a multiple logistic regression model the adjusted association of each covariate was estimated for the probability of having a high burden of comorbidity (i.e., five or more chronic conditions) (Table 5). All estimates were weighted to account for the MEPS complex survey design and survey non-response using STATA 14 (StataCorp, 2015). (Note: this analysis was weighted at the person-level; the survey logistic procedures were used to account for complex survey design).

Results

Table 1 presents frequencies and percentages of selected demographic, medical/health, and access characteristics of the sample (n=743). There were more women (62%) and over half of the sample was over 65 years old, with 28% between the ages of 65-74 years old, and slightly fewer over the age of 75 years old (24%). A majority of the sample (54%) was married, with slightly over one-fifth who were divorced or separated (22%), fewer were widowed ((17%), or never married (8%).

Income distribution was similar, with nearly one-third in the low income (34%) and high-income (36%) groups, and slightly less than one-third in the middle-income group (30%). Over

three-quarters of the sample were Non-Hispanic whites (77%), less than a third identified as African American/black (12%), fewer identifying as Hispanic/Latino (7%), Asian (2%) or other/mixed race (2%). Most survivors were insured either privately (62%) or publically (31%).

The distribution survivors' cancer sites by diabetic status are presented in Figure 1. Fifty-eight percent of the cases represented in the sample are from the most prevalent cancers among men and women in the U.S. (i.e., breast, prostate, melanoma, uterine, colon) (Miller et al., 2016). Notably, more cases of cervical cancer cases were observed (n=70) than would be expected (i.e., cervical cases represent 1.89% of overall cancer survivors; however 9.42% were observed in the sample). A majority of survivors' cancers were in remission (86%), though some respondents were not currently in remission (7%) and others were unaware of their current cancer status (7%). Among those in the 'early' phases of survivorship, most were in the one to three years post treatment phase (22%), followed by those three to five years out from treatment (13%). Over half of the sample were 'longer-term' survivors, those who are five years beyond treatment with the majority in the 10 years out from treatment group (35%). Fewer survivors were between five and ten years out from treatment (22%). Some respondents received no treatment at all (8%). Few respondents reported having had a cancer recurrence (6%). Most respondents reported having between three and four additional comorbid conditions in addition to their cancer history (43%), fewer had between zero and two conditions (36%), five or more conditions (22%).

Table 2 presents the results from the nested series logistic models that predict the probability of being diagnosed with diabetes on social factors. Controls were added successively for demographics (Model 2) and cancer-related factors (Model 3). Education and race remain consistently and strongly significant across all models. Considering social factors alone, the odds of having comorbid diabetes were highest for survivors with lower levels of education (model 1: OR: 1.58; 95% CI: 1.00-2.49 for high school; OR: 3.28; 95% CI: 1.87-5.76) and for African Americans (model 1: OR: 2.08; 95% CI: 1.23=3.50). Therefore, the 'fundamental causes' hypothesis that cancer survivors with social factors indicative of lower socio-economic status

would be more likely to have a diagnosis of co-morbid diabetes was supported. Including demographics and cancer variables had little effect on the odds ratios for high school education, less than high school education and African American/black race. In all models the odds of having comorbid diabetes for cancer survivors were not statistically significant for income level or insurance status.

Exploratory analysis of preventive service use (Figure 2) and lifestyle factors (Figure 3) were analyzed to identify differences between non-diabetic cancer survivors and diabetic survivors. There were significant differences for all preventive health services—annual physical, dental check-up and flu shot in the last year. More diabetic cancer survivors had physicals and flu shots (92%; 71%, respectively) in the past year than non-diabetics (86%; 59%, respectively) year ($p=0.05$; $p=0.008$, respectively). But, fewer diabetic survivors (45%) had annual dental visits than non-diabetic survivors (64%) ($p<0.001$). For modifiable lifestyle factors both meeting the recommendation for physical activity and normal weight were strongly significantly different between diabetic and non-diabetic cancer survivors. Only 45% of non-diabetic cancer survivors were meeting recommendation for the exercising moderate/vigorously five time per week, compared to 30% of diabetic survivors ($p<0.001$). Among non-diabetic survivors 36% were in the recommended weight range, but only 13% of diabetics met that recommendation ($p<0.001$). Due to the strength of the significance for modifiable lifestyle factors, a series of nested logistic regression models to examine whether social, demographic and cancer related factors explained some of the association between diabetic status and meeting lifestyle recommendations (Tables 3 and 4). Successive controls were added for diabetic status (Model 1); social factors (income, education, race/ethnicity, insurance status, in Model 2); demographic factors (gender, age, marital status, in Model 3); and cancer variables (time since treatment, recurrence, and cancer status, in Model 4).

After adjusting for social factors, demographic factors and cancer variables the differences in diabetic status for meeting physical activity and healthy weight recommendations

persisted. Diabetic cancer survivors had 48% lower odds [CI: 0.34-0.80, $p=0.003$] of meeting physical activity recommendations and 73% lower odds [CI: 0.16-0.48, $p<0.001$] of meeting recommendations for maintaining a healthy weight. The strength of the associations between diabetic status and these recommendations was not diminished by adding controls for social factors, demographics, and cancer related variables. African American cancer survivors had 49% lower odds [CI: 0.30-0.86, $p=0.01$] of meeting physical activity recommendations compared to Caucasian/white cancer survivors. Female cancer survivors had 30% lower odds [CI: 0.50-0.98, $p=0.04$] of meeting physical activity recommendations compared to male survivors. For healthy weight management, Asian survivors had 5.04 times the odds [CI: 1.63-15.58, $p=0.005$] of maintaining a healthy weight compared to Caucasian survivors. Female survivors had 1.79 times the odds [CI: 1.22-2.63, $p=0.003$] of maintaining healthy weight compared to male survivors. Therefore, the ‘fundamental causes’ hypothesis was supported for who was at greater ‘risk of risks,’ with African American survivors reporting much lower odd of meeting physical activity recommendations. Further, survivors over the age of 75 years old had 2.67 greater odds [CI: 1.17-6.10, $p=0.02$] of having a weight in the normal range compared to survivors between the ages of 18-39 years old. Survivors who are three to five years out from treatment had 1.84 greater odds [CI: 1.02-3.30, $p=0.04$] of having weight in normal range compared to survivors who are one to three years out. Survivors who were never treated had 63% lower odds [CI: 0.16-0.86, $p=0.02$] of meeting normal weight recommendations compared to survivors who were one to three years from treatment. Survivors who were in remission had 55% lower odds and survivors who did not know their remission status had 71% lower odds of meeting the weight recommendations compared to survivors who currently had active cancer.

Descriptive analyses of priority conditions indicated that complex multi-morbidity (5+ conditions) was much more common in diabetic cancer survivors (40%) compared to non-diabetic survivors (18%). Many of these chronic conditions share clinical pathways for diabetes and cancer and physical activity and health weight recommendations are pivotal aspects of

disease prevention. Thus, bivariate analyses to identify associations between additional comorbidities and the relationship to diabetic status were explored (Figure 4). Strongly significant differences ($p < 0.001$) were found for most priority conditions (i.e., congestive heart failure, angina, heart attack, other heart disease, any heart disease, hyperlipidemia and asthma), stroke ($p = 0.003$) and hypertension ($p = 0.03$) were also significant, with the only non-significant exceptions being emphysema, chronic joint pain, and depression. A logistic regression model was specified to identify additional factors associated with complex multi-morbidity (Table 5). Diabetic cancer survivors had 186% greater odds [95% CI: 1.84-4.45, $p < 0.001$] of complex multi-morbidity compared to non-diabetics. Age was significantly associated with complex multi-morbidity with survivors between ages 55-64 having 1,286% greater odds; between ages 65-74 having 1007% greater odds and survivors over the age of 75 having 1,588% greater odds of having five or more priority conditions compared to survivors between 18-39 years old. Survivors who did not know their remission status were also 189% higher odds of having complex multi-morbidity.

Discussion

Empirical support for the ‘fundamental causes’ hypothesis evaluates four essential relationships between diseases and socioeconomic status. First, it must be established that socioeconomic status is related to multiple disease outcomes (Phelan et al., 2010). In this study, education and race were found to be related to the development of co-morbid diabetes among cancer survivors. Second, socioeconomic status must be related to multiple risk factors for disease and death (Phelan et al., 2010). These findings suggest that diabetic cancer survivors are less likely to meet physical activity and weight recommendations compared to non-diabetic cancer survivors and were found to have a much higher likelihood of complex multi-morbidity. Third, resources should be shown to position people in a higher socioeconomic status at a health advantage (Phelan et al., 2010). Based on the present study’s findings the likelihood of diabetic cancer survivor status was associated with having access to less resources (e.g., education) and

being of the African American/black race. Being a diabetic cancer survivor was strongly and significantly associated with a lower probability of adopting the protective health behaviors of exercising five or more times weekly or maintaining a healthy weight. In addition to diabetic status, African American race was also associated with lower odds of meeting physical activity recommendations compared to Caucasian/white cancer survivors. Therefore, this study is consistent with the growing body of literature that hypothesizes that the health disparities by race and ethnicity are in part explained by disparities in obesity and comorbidity burden (Schmitz et al., 2013) (Bach et al., 2002; Haynes & Smedley, 1999; Tammemagi et al., 2005).

The fourth and final empirical requirement to support the ‘fundamental causes’ theory is that the association between socioeconomic status and mortality is duplicated over time with the replacement of intervening mechanisms (e.g., infections, disease) with the emergence of new mechanisms (e.g., smoking, diet/exercise) (Phelan et al., 2010). Basically, this contends that proposed solutions are failing to address the fundamental problem—which is there remain inequities in resource distribution and this manifests as increased health risks among those with fewer resources. The findings of this study suggest that the proposed and piloted models of survivorship care across the country may need reassessment if they aim to be responsive to the needs of survivors with fewer resources. Since the landmark report, From Cancer Patient to Cancer Survivor: Lost in Transition (Hewitt & Ganz, 2006) models of cancer survivorship have been implemented across the country (Halpern et al., 2015). Most of these models implemented are extensions of oncologic care and rely heavily on cancer-related professionals (Campbell et al., 2011; Grant, Economou, Ferrell, & Bhatia, 2007; Halpern et al., 2015). Further, these survivorship models have not consistently reported the proportion of non-white survivors who have access to these innovative new care models being studied (Surbone & Halpern, 2016) (Halpern et al., 2015). Studies have also shown that African American survivors, in particular want additional information to guide follow-up care and desire care plans that address comorbidities in detail (Ashing-Giwa et al., 2013; O'Malley et al., 2016).

This study suggests the strong need to revisit the approach of current care models, and the need to move from a ‘comorbidity’ frame to a complex ‘multi-morbidity’ framing of the health status of cancer survivors. Comorbidity is defined as “any distinct additional clinical entity that has existed or that may occur during the clinical course of a patient who has the index disease under study” (Feinstein, 1970, p. 456-457). A major criticism of the concept of “comorbidity” was articulated in the past decade, as comorbidity conceptualizations assume an index disease perspective, where one disease or condition is central when in reality this is often ambiguous. In contrast, multi-morbidity encompasses multiple, potentially overlapping medical and psychosocial conditions, and is arguably a more patient centered approach than the traditional single disease paradigm (Boyd & Martin Fortin, 2010; van den Akker, Buntinx, & Knottnerus, 1996). In the present study, 65% of the survivors had three or more conditions. Among diabetic cancer survivors, 40% had five or more conditions. With the baby-boomer generation, those individuals born 1946-1964, currently reaching retirement age the numbers of survivors with complex multi-morbidity will surge (Bluethmann et al., 2016). For other, non-cancer conditions the comorbidity framework has been challenged both as it applies to care and its contribution in the generation of knowledge that informed disease specific guidelines (Boyd & Martin Fortin, 2010; Fortin, Dubois, Hudon, Soubhi, & Almirall, 2007). Despite this, the lens of co-morbidity is currently being utilized to develop cancer-site specific guidelines to inform primary care survivorship models cancers to inform primary care (Cohen et al., 2016; El-Shami et al., 2015; Skolarus et al., 2014). In parallel, primary care systems are being transformed to be responsive to multi-morbidity (Tinetti, Fried, & Boyd, 2012); this disconnect must be addressed to enhance primary care integration (Nekhlyudov et al., 2017).

This study has important limitations to consider. First, this study relies on a comorbidity conceptualization of diabetic status to demonstrate the impact of cumulative health risks due to social factors; however, also acknowledges the limitations of this conceptualization. Additionally, cancer site was not controlled in the logistic models due to limited sample sizes; but

socioeconomic status and diabetic status is known to be more strongly associated with specific cancer sites. Data used to assess exercise and weight/height were self-reported and therefore potentially subject to social desirability bias. Further, despite the lens of health disparities analysis, the diversity of the sample was limited in important ways. According to the Census Report (Humes, Jones, & Ramirez, 2011), 17% of the U.S. population was of Hispanic origin in 2010 and 4.7% Asian; however, only 7% of the study sample identified as Hispanic/Latino and 2% Asian. Caucasian/whites represented 77% of the sample; however, the census population of 2010 suggests that 63.7% of the U.S. population was Caucasian/white. . Additionally, Link and Phelan (1995) initially conceptualized ‘flexible resources’ to include social networks, prestige, income and status related benefits not captured by the use of income, race/ethnicity and educational variables available for analysis in this study. Despite these limitations, this study presents illuminates the complexities of cancer survivorship for groups underrepresented in currently implemented cancer survivorship models—longer term survivors and racial/ethnic minorities. Based on the findings presented here, further inquiry is warranted to develop care strategies responsive to multi-morbidity among cancer survivors, as well as, target interventions to prevent the cumulative health risks associated with social factors.

In conclusion, the framing of the ‘cancer survivorship’ care challenge determines when and how we involve different members of the health care and social system to intervene. There may be points of entry for more intensive roles for community based care, both primary care and social work. This study contributes to the emerging literature that is evaluating the connections of obesity, race and ethnicity on cancer survivorship (Schmitz et al., 2013). While cancer survivorship model development emphasizes what should be done and how should be involved in post-treatment care, given the shared clinical and social pathways it may be as important to consider potential interventions earlier in the causal chain to mitigate poor health outcomes.

Tables and Figures for Manuscript #1

Table 1

Description of the Study Sample of Cancer Survivors

	All (n=743)		Non Diabetic Cancer Survivors (n=607)		Diabetic Cancer Survivors (n=136)	
	N	Percentage/Mean (SD)	N	Percentage/Mean (SD)	N	Percentage/Mean (SD)
Socioeconomic						
Income						
Low income	253	34.05	198	32.62	55	40.44
Middle income	226	30.42	184	30.31	42	30.88
High income	264	35.53	225	37.07	39	26.68
Education						
< High School	105	14.13	69	11.37	36	26.47
High school or some college	418	56.26	341	56.18	77	56.62
Bachelors or higher	220	29.61	197	32.45	23	16.91
Race/Ethnicity						
Non-Hispanic White	569	76.58	480	79.08	89	65.44
AA/Black	91	12.25	63	10.38	28	20.59
Hispanic/Latino	52	7.00	40	6.59	12	8.82
Asian	16	2.15	13	2.14	3	2.21
Other	15	2.02	11	1.81	4	2.94
Insurance type						
No insurance	43	5.79	35	5.77	8	5.88
Any private	468	62.99	385	63.43	83	61.03
Public only	232	31.22	187	30.81	45	33.09
Demographics						
Gender						
Female	459	61.78	389	64.09	70	48.53
Male	284	38.22	218	35.914	66	51.47
Age						
18-39	45	6.06	44	7.25	1	.74
40-54	142	19.11	121	19.93	21	15.44
55-64	175	23.55	135	22.24	40	29.41
65-74	205	27.59	164	27.02	41	30.15
74-85	176	23.69	143	23.56	33	24.26
Marital Status						
Married	399	53.70	327	53.87	72	52.94
Widowed	124	16.69	99	16.31	25	18.38
Divorced/ separated	160	21.53	128	21.09	32	25.53
Never married	60	8.08	53	8.73	7	5.15
Cancer & Comorbidity						
Last Treatment						
< 1-3 years ago	164	22.07	126	20.76	38	27.94
3-5 years ago	96	12.92	79	13.01	17	12.50
5-10 years ago	165	22.21	133	21.91	32	23.53
10+ years ago	262	35.26	223	36.74	39	28.68
Not treated	56	7.54	46	7.58	10	7.35

Recurrence						
No recurrence	697	93.81	570	93.90	127	93.38
Cancer returned	46	6.19	37	6.10	9	6.62
Remission						
Not cancer free	50	6.73	40	6.59	10	7.35
No evidence of cancer	638	85.87	522	86	116	85.29
Doesn't know if cancer free	55	7.40	45	7.41	10	7.35
No. Conditions						
0-2	265	35.67	249	41.02	16	11.76
3-4	316	42.53	250	41.19	66	48.53
5 or more	162	21.80	108	17.79	54	39.71

Figure 1

Description of Cases by Cancer Site and Diabetic Status

Cancer Site	Total	Non-Diabetic Cancer Survivor	Diabetic Cancer Survivor	χ^2	P-value
Breast	160	137	23	2.11	NS
Prostate	129	103	26	1.26	NS
Melanoma	60	52	8	1.08	NS
Uterine	52	42	10	0.72	NS
Colon	51	36	15	4.52	0.03*
Cervix	70	61	9	0.37	NS
Lung	31	23	8	1.22	NS
Lymphoma	30	25	5	0.06	NS
Bladder	24	20	4	0.04	NS
Thyroid	23	18	5	0.19	NS
Kidney	22	16	6	1.22	NS
Ovarian	19	14	5	1.88	NS
Leukemia	10	8	2	0.02	NS

Note: Shaded cells represent the 5 most prevalent cancer sites for men and women in 2016 survivorship statistics (Miller et al., 2016).

Cancer sites with more than 10 cases pictured above; those with less than 10 and other (non-specified) include: blood (1 case); bone (6 cases); brain (6 cases); esophagus (2 cases); larynx (4 cases); liver (3 cases); mouth (2 cases); muscle (3 cases); other (66 cases); pancreas (1 case); rectal (2 cases); stomach (7 cases); testis (6 cases) and throat (6 cases).

*p<.05

Currently evidence of disease					-	-	-	-	-
In Remission							1.50	0.64-3.52	0.35
Unk remission status							1.04	0.36-3.03	0.94

Figure 2

Preventive Service Use among Cancer Survivors by Diabetic Status

	All	Non-Diabetic		Diabetic		χ^2	p-value
		Less than yearly	Once a year	Less than yearly	Once a year		
Dental Check	739	215	388	75	61	17.68	<0.001
Annual Physical	729	85	508	11	125	3.77	0.05
Flu shot	737	246	355	38	97	7.02	0.008

Figure 3

Adoption of Protective Lifestyle Behaviors among Cancer Survivors by Diabetic Status

Behavior	All	Non-Diabetic		Diabetic		χ^2	p-value
		No	Yes	No	Yes		
Active 5+ times per week	739	332	271	96	40	10.98	0.001
Current Smoker	733	485	113	113	22	0.50	NS
BMI in Normal Range	734	382	217	118	17	28.34	<0.001

[illegible]

Recurred										0.62	0.31-1.23	0.17
Cancer Status												
Currently evidence of disease										-	-	-
In Remission										0.80	0.41-1.55	0.50
Unk remission status										0.82	0.35-1.91	0.65

[illegible]

Recurred										1.52	0.74-3.12	0.26
Cancer Status												
Currently evidence of disease										-	-	-
In Remission										0.45	0.21-0.95	0.037
Unk remission status										0.29	0.11--.75	0.010

Figure 4

Description of Priority Conditions among Cancer Survivors by Diabetic Status

Priority Conditions	All	Non-Diabetic	Diabetic	χ^2	p-value
Angina	49	27	22	24.81	<0.001
Any Chronic Bronchitis	57	40	17	5.48	0.02
Any Chronic joint pain	742	606	136	0.22	NS
Any Heart Disease	240	172	68	23.85	<0.001
Arthritis	386	302	84	6.42	0.01
Asthma	103	72	31	11.12	0.001
Congestive Heart Failure	107	67	40	30.43	<0.001
Depressed	92	71	21	1.44	NS
Heart Attack	74	50	24	10.97	0.001
Hyperlipidemia	385	276	109	53.51	<0.001
Hypertension	370	265	105	4.69	0.03
Other Heart Disease	180	129	51	15.98	<0.001
Stroke	78	54	24	9.06	0.003

Table 5

Logistic Regression Results to Identify Factors Associated with High Burden of Comorbidity (5+ Chronic Conditions) among Cancer Survivors

	OR	CI	p
Diabetic Status	2.86	1.84-4.45	<0.001
Income			
High (ref)	-	-	-
Middle	0.99	0.59-1.66	0.96
Low	1.40	0.82-2.37	0.22
Education			
College degree + (ref)	-	-	-
High school	1.12	0.72-1.73	0.62
< High school	1.24	0.69-2.23	0.48
Race/Ethnicity			
Caucasian/White	-	-	-
African American	0.96	0.54-1.69	0.88
Hispanic/Latino	0.59	0.24-1.45	0.25
Asian	0.54	0.11-2.59	0.44
Other race	0.42	0.08-2.25	0.31
Insurance Status			
No insurance (ref)	-	-	-
Private Insurance	0.81	0.32-2.07	0.66
Public only	1.46	0.56-3.77	0.44
Gender			
Male (ref)	-	-	-
Female	0.94	0.62-1.44	0.79
Age			
18-39 (ref)	-	-	-

40-54	4.61	0.57-37.23	0.15
55-64	13.86	1.78-107.87	0.01
65-74	11.07	1.42-86.52	0.02
75+	16.88	2.13-133.40	0.007
Marital Status			
Married (ref)	-	-	-
Widowed	1.2	0.70-2.05	0.50
Divorced or separated	1.06	0.64-1.77	0.82
Never married	1.25	0.55-2.81	0.60
Last Treatment			
1-3 years (ref)	-	-	-
3-5 years	0.75	0.36-1.54	0.43
5-10 years	1.36	0.77-2.40	0.30
10 or more years	1.17	0.68-2.02	0.56
Not treated	1.38	0.62-3.07	0.44
Recur History			
Never recurred	-	-	-
Recurred	1.28	0.59-2.79	0.53
Cancer Status			
Currently evidence of disease	-	-	-
In Remission	1.06	0.47-2.41	0.89
Unk remission status	2.89	1.10-7.55	0.03

MANUSCRIPT 2

EXAMINING THE IMPACT OF DIABETIC STATUS AND FLEXIBLE RESOURCE

AVAILABILITY ON PHYSICAL AND MENTAL HEALTH

AMONG CANCER SURVIVORS

by

DENALEE M. O'MALLEY

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Abstract

Purpose: This study examines the impact of diabetic status on mortality, physical and mental quality of life outcomes in cancer survivors. Using the ‘fundamental causes’ theory of socioeconomic disparities in health outcomes this study also aims to identify social risk factors for poorer health and mental health outcome among cancer survivors.

Methods: A retrospective, cross-sectional analysis using data from the 2011 Medical Expenditures Panel Experiences with Cancer survey (n=743) was conducted. A series of nested logistic regression models were specified controlling for factors known to contribute to poorer self-assessed physical health. Two hierarchical multivariate regression models were specified to examine the impact of diabetic status on physical and mental health functioning using composite scores from the SF-12. In all models, successively controls were added including demographics, socioeconomics, additional comorbidities, cancer and other health factors, and access to care.

Results: For physical health, the effect of diabetes on reporting fair/poor health decreases slightly (from OR 3.6 in Model 1 to 2.7 in Model 7) as covariates are added, remaining significant in the final model. In the final model, when compared to non-diabetic cancer survivors, being diabetic is associated with 1.71% greater odds of reporting poor/fair health holding all else constant ($p < 0.001$). In the final model, additional factors associated with increased odds of reporting fair/poor health included: young age (i.e., 18-39 years old) ($p = 0.03$), Hispanic ethnicity (0.04), reporting between three and four ($p = 0.001$) or five or more additional comorbidities ($p < 0.001$) and being depressed ($p < 0.001$). For mental health, the effect of diabetic status is significant in earlier models; however, the effect diminishes as additional factors are added.

Conclusion: These findings provide insights into the complex relationship between diabetes, cancer survivorship and physical and mental quality of life. Further, disproportionate distribution

of African Americans, those of lower socioeconomic status, and with less than a high school education had comorbid cancer and diabetes. Therefore, it is important for health care professionals to consider these implications on cancer survivorship models of care. Furthermore, this suggests that policy makers should consider the impact of social disparities that contribute to the development of a high cost, high-need multi-morbid cancer survivor population.

Introduction

Currently, there are an estimated 15.5 million cancer survivors living in the United States (Miller et al., 2016). Cancer survivors can be an expensive and complex population; many are among the 25% of the population with multiple chronic conditions that consume majority (65%) of the total health care resources in the U.S. (Anderson, 2012; Soni, 2009). Additional comorbidities among lung, breast, prostate, and colorectal cancer patients pose a significantly higher risk of mortality (Edwards et al., 2014). Furthermore, diabetes is a common comorbidity for survivors and it is estimated that these conditions co-occur in approximately 16 % of the cancer survivor population (Edwards et al., 2014). Diabetics are at an increased risk of developing bladder (Larsson et al., 2006), breast (Larsson et al., 2007), colorectal (Larsson et al., 2005), endometrial (Friberg et al., 2007), kidney (Lindblad et al., 1999; Washio et al., 2007), liver (El-Serag et al., 2006), non-Hodgkin's lymphoma (Mitri et al., 2008), and pancreatic (Huxley et al., 2005) cancers. The frequency of diabetes is higher among cancer survivors than among the general population (Stava et al., 2007). During treatment, anti-cancer therapies and supportive care drugs routinely administered during the cancer treatment phase can exacerbate pre-existing diabetes or initiate the onset of a new diabetes diagnosis in some patients (Vigneri et al., 2009a). Despite diabetics' elevated risk for many types of cancers, the need to adjust standard anti-cancer therapies and supportive care medications during treatment, and poorer survival outcomes, there is little evidence available to guide clinical or psychosocial care in this population.

Cancer related health disparities based on race and socioeconomic status have persisted for decades, and are attributed, in part to disproportionate rates of comorbid illness including diabetes among specific sub-populations (Bach et al., 2002; Haynes & Smedley, 1999; Tammemagi et al., 2005; Vigneri et al., 2009a). In a review of the state of the evidence of the relationship between cancer and diabetes, Giovannucci et al. (2010) provided an overview of shared risk factors. Advanced age is a risk factor for both type 2 diabetes and many cancers (Centers for Disease Control and Prevention, 2015c; Siegel & Jemal, 2015). Higher morbidity

and mortality among racial and ethnic minorities is also a shared characteristic of both conditions (Giovannucci et al., 2010). Compared to Caucasian/white Americans, African-American males have a 15% higher incidence rates for all cancers combined (prostate, lung, colorectal, kidney and pancreas) and are more likely to die as a result of a diagnosis (DeSantis et al., 2013). Whereas, African-American women are estimated to have a 6% lower incidence of breast cancer than Caucasian/white American women overall, yet mortality rates among African-American women remain higher (DeSantis et al., 2013). A recent population-based study of cancer survivors between the ages of 40-84 years old found that African-American women have the highest rates of chronic disease comorbidity (76%) followed by African-American men (70.6%). Prevalence data for cancer survivors dually diagnosed with diabetes and cancer are not available; however, general population data demonstrates the unequal burden of diabetes among racial and ethnic minorities. For example, with the percentage of age-adjusted population with diagnosed diabetes by race/ethnicity, as follows: 15.9% American Indians/Alaska Natives, 13.2 Non-Hispanic blacks, 12.8% Hispanics, 9.0% Asian Americans, 7.6% Non-Hispanic whites (Control & Prevention, 2014).

Several modifiable behavioral are risk factors for both diabetes and cancer, including being overweight or obese, poor diet, sedentary lifestyle, and tobacco use (Giovannucci et al., 2010). Obesity accounts for 90-95% of type 2 diabetes cases, and is a major risk factor for type 2 diabetes (Edelstein et al., 1997; Fox et al., 2006; Lee et al., 2002; Vazquez, Duval, Jacobs, & Silventoinen, 2007). Obesity is also a risk factor for many cancers (Garcia-Jimenez et al., 2016). Obese cancer survivors have poorer outcomes, with men and women having a 52 % and 62% (respectively) higher mortality rate compared to those who are a 'normal' weight (Calle, Rodriguez, Walker-Thurmond, & Thun, 2003; Calle, Thun, Petrelli, Rodriguez, & Heath, 1999). Use of tobacco products is also a shared risk factors for both diabetes and cancer (Giovannucci et al., 2010) elevated among those in lower socioeconomic strata and racial/ethnic minorities (Jha et al., 2006).

According to Link and Phelan's (1995) theory of 'fundamental causes,' the social conditions are the causes of these elevated risks not the individual behaviors themselves. Therefore, the social conditions are the 'fundamental causes' of these medical conditions. To ascertain if a social factor is a 'fundamental cause' of disease empirical support must demonstrate: 1) an association with access to specific resources that impact disease outcomes; 2) impact various medical conditions outcomes through multiple mechanisms; and 3) remain associated with poor outcomes even after intervening mechanisms for illness change over time (Link & Phelan, 1995). Evidence is needed to demonstrate social determinants that are associated with the shared burden of co-occurring diabetes and cancer and are therefore among the 'fundamental causes' of disparities in health outcomes (Link & Phelan, 1995; Phelan et al., 2010). Higher exposures to and use of tobacco products, prevalence of obesity, food insecurity, and inadequate physical activity are more common among socially disadvantaged groups (Ball, 2015; Centers for Disease Control and Prevention, 2013; Gan, Mannino, & Jemal, 2015; Hanson & Connor, 2014; Levine, 2011). Examining the social determinants of these behaviors rather than the behavior of individuals in prevention efforts may have the potential to improve outcomes for several negative health consequences downstream (Cockerham et al., 2017).

Clinical theories about the etiology of to the co-occurrence of diabetes and cancer and the underlying clinical mechanisms remain focused, for the most part, on the underlying biology of these medical conditions. For example, it is hypothesized that the cumulative impact of hyperglycemia--increase in adipose mass and inflammation that occurs among the obese--may be the pathway for common co-occurrence of diabetes and many cancer sites (Garcia-Jimenez et al., 2016). Additionally, the 'multiple-hit hypothesis' of elevated cardiovascular disease (CVD) post-cancer treatment among cancer survivors was developed and provides an explanatory framework of how cascading of 'insults' increases CVD risks among survivors (Jones et al., 2007). This hypothesis aims to explain that due to similar clinical pathways between many cancers and CVD, cancer patients enter the diagnosis and treatment phases with elevated risk for CVD. This can be

compounded by the use of cardio-toxic treatments, which diminish cardiac reserve and are further depleted when survivors are unable to maintain health body weights or activity levels while recovering (Jones et al., 2007). This initial hypothesis was expanded to include the impact of psychological distress as one of the additional ‘insults’ that diminish cardiac reserves (Schoormans et al., 2016). The recent addition of distress to the ‘multiple hit’ hypothesis represents a consideration of the mind-body connection. However, evidence supporting the theory of ‘fundamental causes’ may suggest that the multiple ‘insults’ that initiated the cascading effect for the subsequent cardiovascular disease or the cancer that precipitated it in the survivor population occurred much earlier and interventions to address these earlier ‘insults’ may be warranted.

Reviews of the evidence about diabetes and cancer are available (Giovannucci et al., 2010; Vigneri et al., 2009a) and descriptive studies of how comorbidity (broadly) and aging impact cancer survivors (Mao et al., 2007; Rowland & Yancik, 2006; Vissers et al., 2013). However, few studies have characterized the diabetic cancer survivor population to inform approaches to cancer survivorship care and how this might be better integrated into approaches to multi-morbidity care (Stava et al., 2007). Moreover, few studies have examined the impact of socioeconomic factors on cancer survivorship. In a study examining the impact of socioeconomic status and sociological stress among breast cancer survivors both were found to be significantly associated with poorer overall physical and mental health (Ashing-Giwa & Lim, 2009). Therefore, this research aims to contribute to the understanding of how multi-morbidity might influence the cancer survivorship experience, in effort to develop strategies to be responsive to the diabetic cancer survivor population. Further, this study aims to extend the application of the fundamental cause’s theory to examine how the flexible resource availability affects overall health and mental health in this population. Based on the ‘fundamental causes’ theory it is hypothesized that cancer survivors with fewer resources (i.e., survivors with lower education, members of specific racial and ethnic groups, and survivors with low incomes) would be more

likely to report poor/fair health, and report lower physical and mental health functioning. This study aims to address the following research questions: (1)

- What is the effect of diabetic status on likelihood of reporting poor/fair health among cancer survivors?
- What is the effect of diabetic status on general physical health among cancer survivors?
- What is the effect of diabetic status on general mental health among cancer survivors?

Methods

Study Design and Data Source.

A retrospective, cross sectional analysis of the U.S. Medical Expenditures Panel Survey Household Component (MEPS-HC) and the supplemental survey Experiences with Cancer collected from 2011-2012. The MEPS-HC is an ongoing survey administered annually by the Agency for Health Care Quality to a nationally representative sample of civilians and non-institutionalized individuals from 15,000 selected households across the United States (Yabroff et al., 2012). MEPS-HC collects detailed information on each person in the household including the following core content areas: demographics, charges and payments, medical conditions, employment, health status, health insurance, and health care utilization. In 2011, two panels of the MEPS-HC were oversampled for households with adult cancer survivors. Individuals who were diagnosed and treated with cancer over the age of 18 years old were administered the Experiences with Cancer survey which assessed the burden of cancer, financial aspects, health care experiences and psychosocial impacts of cancer. The MEPS Household Component response rate was 54.9% and MEPS Experiences with Cancer survey response rate was 90%. Therefore, the overall response rate was 72.45%.

Study Population.

A total of 2,145 respondents from the MEP-HC were diagnosed with cancer over the age of 18 years old. Of these respondents 1,591 completed the MEPS Experiences with Cancer. Cases of

non-melanoma skin cancers and skin cancers unknown (n=386) and those with incomplete data (n=462) were excluded from the study sample.

Outcome Measures.

There are three main outcomes measures in this study. The first is the single-item self-assessed health (SAH). Self-assessed health is predictive of mortality, hospitalization and high outpatient utilization (DeSalvo, Fan, McDonell, & Fihn, 2005). Patients' responses were collected as a categorical variable with five possible responses: excellent, very good, good, fair and poor. This variable was recoded into dichotomous variable collapsing original categories into "excellent/very good/good" and "fair/poor." The Short-Form Version 12, a registered trademark, was used to measure physical and mental health functioning (Ware Jr, Kosinski, & Keller, 1996). Two summary scores are based on all twelve items in the scale, however the composite scores for physical health and mental health weight items differently, see scoring manual for details (Ware Jr, Kosinski, Turner-Bowker, & B., 2002). The second analysis uses the physical health composite from the SF-12. In the third analysis, the SF-12 mental health composite score is the dependent variable.

Independent Variables.

Diabetic Status.

This variable was constructed from the MEPS-HC medical condition data collection where priority conditions are queried. Medical condition data is collected at each time point on the MEPS-HC survey. Questions about cancer and diabetes were only asked to individuals aged 18 years or older. For both at baseline, this question was asked, "Ever been told by a health professional" if they had the reference condition. In subsequent data collection points the household respondent was asked: "During the past 12 months have you been told by a health professional you were diagnosed," with the reference condition. Responses are coded as: yes, no,

not ascertained, do not know, refused and inapplicable. All respondents that were reported to have a diagnosis of diabetes, as a priority condition were included in the diabetic group.

Demographic characteristics.

Demographic factors included age, gender (male vs. female), and marital status of respondents were reported by the household respondent for the MEPS-HC. Exact age was calculated for all participants from their date of birth as of 12/31/2011 and constructed into five categories to (18-39, 40-54, 55-64, 65-74 and 75+). All respondents' ages are top coded at 85 years old. Marital status was measured using the following categories: married, widowed, divorced/separated or never married. Initially measured categorically, the categories of divorced/separated were combined for the purposes of this analysis because of the conceptual similarities and small sample sizes.

Socio-demographic and Socioeconomic characteristics.

Race/ethnicity was assessed using five categories: Non-Hispanic Caucasian/white, African American/black, American Indian/Alaska Native, Asian, Other/Mixed Race, and Hispanic/Latino. For this analysis race was recoded into five categories: Non-Hispanic Caucasian/white, African American/black, Asian, Hispanic/Latino and other due to small sample sizes. Education was collected as a continuous variable for years of education, from this three categories were constructed: less than a high school diploma, high school diploma or some college, and a bachelor's degree or higher. Poverty status consisted of three groups: negative or poor (less than 100 to less than 200% of FPL); middle income (200% to 400% FPL); and high income (greater than or equal to 400%).

Cancer Survivorship Variables.

Cancer survivorship variables we based on responses from the supplemental survey. Cancer status was measured using three categories: not cancer free, no evidence of cancer in the body, and does not know cancer status. Time since cancer treatment was measured as those who

were less than one year to less than three years, between three years but less than five years, between five years but less than ten years, ten or more years post-treatment, or never received treatment. Cancer recurrence was also assessed (no recurrence vs. cancer returned).

Priority conditions.

MEPS collects comorbidity data for select priority conditions, including: hypertension, any heart disease (coronary artery disease, angina, history of heart attack, or other heart disease), stroke, emphysema, chronic bronchitis, arthritis, high cholesterol, and asthma were assessed. Three categories of comorbidity were developed based on number of priority conditions (i.e., none to two, three-four, or five or more conditions).

Depression Status.

Depression was assessed using the summation scores of a self-reported measure, the Patient Health Questionnaire (PHQ-2) (Kroenke, Spitzer, & Williams, 2003). The variable (PHC242) is a summation of the values of two variables, which assessed the frequency of anhedonia and depressed mood in past two weeks. In this analysis, patients assessed at a three or above were coded “depressed” based on recommended cut scores for this screening measure (Kroenke et al., 2003; Lowe, Kroenke, Herzog, & Grafe, 2004).

Access variables.

Access variables assessed whether cancer survivors were born in the U.S. or in another country; whether they had a usual source of care; current insurance status and insurance status at the time of cancer treatment. Current insurance types assessed were public, private, or no insurance. Insurance status during cancer treatment was assessed by whether survivors were uninsured; had coverage or does not know insurance status.

Statistical Analyses.

Demographic and health profile of the sample were presented overall and by diabetic status with means and standard deviations (SDs) or frequencies and percentages depending on the

measurement scale for all variables (Table 1). A multi-level logistic regression model was estimated to identify factors associated with the probability of reporting lower self-assessed physical health (proxy for mortality). For this analysis, a series of nested logistic regression models were specified controlling for factors previously shown to contribute to poorer self-assessed physical health (Table 2).

Two separate series of hierarchical multivariate regression models were specified, which estimate the impact of diabetic status on physical and mental health functioning (Tables 3 & 4). Successively controls were added into the model for demographic factors (Model 2), socioeconomic factors (Model 3) cancer factors (Model 4), priority conditions (Model 5), depression status (Model 6), access variables (model 7). In the models testing the mental health functioning outcome, the same additive strategy was used though depression status (i.e., Model 6) was omitted. In multivariate models, patient factors were selected for inclusion in final regression analyses based on existing literature and bivariate associations with outcomes of interest.

All estimates were weighted to account for the MEPS complex survey design and survey non-response using STATA 14 (StataCorp, 2015) (Note: this analysis was weighted at the person-level; the survey logistic and survey regress procedures were used to account for complex survey design).

Results

Table 1 presents frequencies and percentages of selected demographic, medical/health, and access characteristics of the sample. The sample (n=743) included more women (62%) than men (38%). Over half of the sample were over 65 years old, with 28% between the ages of 65-74 years old, and slightly fewer over the age of 75 years old (24%). Over three-quarters of the sample were Non-Hispanic whites (77%), less than a third identified as African American/black (12%), fewer identifying as Hispanic/Latino (7%), Asian (2%) or other/mixed race (2%). More than half of the sample (54%) were married, slightly over one-fifth were divorced or separated

(22%), fewer were widowed ((17%), or never married (8%). Income distribution was similar with slightly over one-third in the low income (34%) and high-income (36%) groups, and slightly less than one-third in the middle-income group (30%). Most respondents were U.S. born (90%), had a usual source of care (90%), and were insured either privately (62%) or publically (31%). Most survivors had insurance during their cancer treatment (88%).

The majority of respondents cancers were currently in remission (86%), though some respondents were not currently cancer free (7%) and others were unaware of their current cancer status (7%). Over half of the sample was ‘longer-term’ survivors, those who are five years beyond treatment with majority in the ten years out from treatment group (35%), followed by those five to ten years out from treatment (22%). Among those in the ‘early’ phases of survivorship, most were in the one to three years post treatment phase (22%), followed by those three to five years out from treatment (13%). Some respondents received no treatment at all (8%). Few respondents reported having had a cancer recurrence (6%). Most respondents reported having between three and four additional comorbid conditions in addition to their cancer history (43%), fewer had between zero and two conditions (36%) or five or more conditions (22%).

Table 2 presents the results from the hierarchical logistic models that predict the probability of having poor/fair health status on being a diabetic cancers survivor, controlling to sets of variables in additive models. The first point to consider is that the probability of reporting fair/poor health decreases slightly (from OR 3.6 in Model 1 to 2.7 in Model 7) as covariates are added; and remains significant in the final model. In the final model, when compared to non-diabetic cancer survivors, being diabetic is associated with 1.71% greater odds of reporting poor/fair health holding all else constant ($p < 0.001$). Being a cancer survivor between the ages of 40-54 is associated with a change in odds of poor/fair health by a factor of 4.07 ($p = 0.03$) compared to those aged 18-39. Hispanic/Latino/a survivors were associated with a 155% greater odds ($p = 0.037$) of reporting poor/fair health compared to non-Hispanic white survivors. This finding supported the ‘fundamental causes’ hypothesis that specific subpopulations may be less

able to marshal resources to protect from negative health consequences. A 57% decrease in the odds ($p=0.004$) of poor/fair health was associated with survivors treated ten or more years ago compared to those treated between 1-3 years ago. A 76% decrease in the odds ($p=0.004$) of poor/fair health was associated with not being treated compared to those between 1-3 years out from treatment. Survivors reporting between three and four additional priority conditions were associated with a 155% increase in the odds ($p=0.001$) of reporting fair/poor health, compared to those with between zero and two additional comorbidities. Survivors with the most comorbidity were associated with a 586.5% increase in the odds ($p<0.001$) of reporting fair/poor health, compared to those with fewer comorbidities. Depressed survivors have 14.96 times greater odds ($p<0.001$) of reporting fair/poor health compared to non-depressed survivors.

Table 3 presents results from OLS models that regress physical health composite scores (range: 9.25-69.84) on diabetic status. The analysis presented here examine the full sample of cancer survivors and control for different sets of covariates. Model 2 controls for sociodemographic variables, model 3, adds controls for socioeconomic variables (race, education, income), model 4 adds controls for cancer treatment variables, model 5 adds comorbidity burden, model 6 adds depression status, and model 7 adds access to care variables.

In the final model (Table 3), the effect of diabetic status on physical health functioning remains strongly significant ($p<0.001$). Diabetic status is associated with a 4.20 decrease on physical health functioning compared to non-diabetic survivors. Greater lengths of time since treatment from were significant and positively associated with better physical functioning, with those who were more than 10 years out from treatment associated with 2.84 increase in physical functioning compared to those less than 1-3 years out ($p<0.01$). Additionally, the high-income group was positively and significantly associated with a 3.44 increase ($p<0.001$) in physical functioning compared to the low-income group. The positive association for income and increased physical health scores supported the hypothesis that survivors with more financial resources would be better positioned to protect themselves from negative health consequences. In

the final model, being a women was associated with a 2.12 decrease in physical health ($p<0.001$) compared to men. Additionally, survivors who were not treated for their cancer were associated with a 3.24 increase in physical functioning compared to survivors treated less than 1-3 years ago ($p<0.05$). Increasing age was negatively associated with physical health status in the anticipated direction with declines in physical functioning more pronounced in advanced age. Being a survivor in the 65-75 year old age group was negatively and significantly associated with a 5.79 decrease ($p<0.001$) and those in the 75 and older group associated with a 8.55 ($p<0.001$) decrease in physical functioning compared to the youngest group. Additional comorbidity was negatively significantly associated with physical health, as comorbidity burden increases were associated with decreases in physical functioning. Survivors who reported having five or more additional comorbidities were associated with a 10.78 decrease in physical functioning ($p<0.001$) compared to survivors with fewer (between zero and two) additional comorbidities. Survivors who were depressed were associated with a 7.64 decrease in physical functioning ($p<0.001$) compared to survivors who were not depressed.

Table 4 presents results from OLS models that regress mental health composite scores (4.55-68.68) on diabetic status. The analysis presented here examines the full sample of cancer survivors and control for different sets of covariates. Model two controls for sociodemographic variables, model three adds controls for socioeconomic variables (race, education, income), model four adds controls for cancer treatment variables, model five adds comorbidity burden, model six adds access to care variables.

The first point to consider in Table 4 is that across models one through six is that although the effect of diabetic status increases and becomes significant when sociodemographic controls are added, this effect quickly loses significance (in model 3) and the effect diminishes as covariates are added to the models. Results in the model six suggest that mental health scores are significantly associated with being over the age of 65, health status (i.e., poor, fair and good), and not being able to recall insurance status during cancer treatment. Additionally, models five and

six show how the effect of many of the demographic and socioeconomic status covariates that are significant in earlier models declines as comorbidity burden and health status are added to the model. With the exception of those in age categories for senior citizens, which remain relatively stable across the models, additional controls are added. In the model six, cancer survivors who are between the ages of 65-75 report on average 5.40 higher mental health scores than the young adult survivors (i.e., 18-39 years old). In this model, estimates for the oldest old report 7.49 higher score on average than the young adult survivors. The magnitude of coefficients for health status remain significant when the access-to care variables are added to the model and demonstrate significant decreases in mental health as reports of health status are less favorable ($p < 0.001$ for good, fair, and poor). The magnitude of the coefficient when health reported as “good” is an estimated reduction of 5.73 points on the mental health score compared to survivors reporting excellent health. Cancer survivors reporting fair health were associated with an estimated reduction of 12.24 on mental health score compared to survivors in excellent health, a little more than a one standard deviation decrease. Those reporting poor health were associated with an estimated reduction in mental health score nearly 1.5 times the standard deviation, associated with 16.78 decrease in scores than those in excellent health. For mental health, the ‘fundamental causes’ hypothesis that individuals with more resources would benefit from better mental health functioning was not supported by the data.

Discussion

There is dramatic room for improvement in cancer survivorship models of care, particularly when a holistic approach to long-term care is envisioned. This study provides insights about the role of diabetic status, socioeconomic indicators and comorbidity in patients diagnosed with and recovering from many different cancers. While previous studies have documented the elevated mortality risk for diabetic cancer survivors in the breast (Larsson et al., 2007), colorectal (Larsson et al., 2005), and prostate cancer (Kasper & Giovannucci, 2006) sites compared to non-diabetics; these findings suggest that in the broader cancer survivor population the impact of

diabetes should be considered a risk factor for overall poorer health and potentially higher mortality. It is important to consider that most of the survivors in the sample were at least five years out from treatment, and among non-diabetic survivors slightly less than a quarter reported poor/fair health compared to half of the diabetic cancer survivor population.

The American Cancer Society has released guidelines to guide primary care providers in the follow up care of survivors of colorectal (Resnick, Lacchetti, Penson, & American Society of Clinical, 2015), breast (Runowicz, Leach, Henry, Henry, Mackey, Cowens - Alvarado, et al., 2016), prostate (Skolarus et al., 2014), and head and neck (Cohen et al., 2016) cancers. These guidelines are comprehensive; however, many recommendations lack a strong evidence base on how care primary care providers should be prioritize areas of care (Nekhlyudov et al., 2017). These guidelines also provide little guidance about how care might consider comorbidities in cancer survivorship. This study's findings suggest a few areas may warrant prioritization. For example, depression was a strong predictive factor for lower physical quality of life and potentially a risk for mortality. The prevalence of depression among the general population is 6.7% in the U.S (National Institute of Mental Health, 2017). In the study population overall the depression rate was nearly twice that of the national average at 12.38% overall among survivors, with 11.7% non-diabetic survivors and 15.44% of diabetic survivors reporting depression. The U.S. Preventive Services Task Force recommends screening for depression in all adults over 18 years old (Siu et al., 2016), however, the guidelines about the effectiveness of primary care depression screening efficacy remains contentious with both Canada Task Force on Preventive Health Care (Canadian Task Force on Preventive Health Care et al., 2013) and the U.K. Quality and Outcome Framework not supporting screening for all adults (Thombs & Ziegelstein, 2014). Primary care practices that adopt prudent strategies of depression screening, should consider cancer survivors as a population in need of screening. Depression screening for diabetics is the standard of care (American Diabetes Association, 2014), as depression is associated with higher

risk of complications, poorer metabolic control, and all-cause mortality (Anderson, Freedland, Clouse, & Lustman, 2001a).

The integration of cancer survivorship into multi-morbidity models of primary care may be an area in need of further attention. Most of the survivors in this study's sample were at least 5 years out from treatment (57%) many were 10 years post treatment (35%). A population based study found that only a third of long term cancer survivors continued to seek care from physicians whose specialties are related to their original cancer after 5 years of survival and that use of oncologists continues to decline over time among long term cancer survivors (Pollack et al., 2009). Risk stratified approaches to cancer survivorship care are a promising model which have been recommended but not yet implemented (Nekhlyudov et al., 2017), as these approaches consider the impact of comorbidities on overall health (Hewitt et al., 2006; McCabe, Partridge, Grunfeld, & Hudson, 2013; Nekhlyudov et al., 2017). In these proposed models, patients with substantial comorbidity would be considered high-risk and extensive primary care integration, preferable by an 'oncogeneralist' (a primary care physician with training in oncology) would take place during treatment and survivorship phases of cancer care (Nekhlyudov et al., 2017). Results from the present study found that additional comorbidity was associated with overall poorer health and potential risk for mortality. Although diabetes was the independent variable of interest among diabetic cancer survivors nearly 50% had between three to four additional comorbidities, and 40% had five or more. Therefore, the finding may be applicable to patients with multi-morbidity for whom diabetes and cancer are two components of their constellation of medical concerns. It follows, that while diabetic status alone was not a significant predictor of overall mental health functioning, self-assessed poor health was associated with a dramatic decrease.

Profound differences were observed in the social factors that differed between the diabetic cancer survivor and non-diabetic cancer survivor groups. This study also found that social factors contributed to both physical health and mental health outcomes. Cancer survivors in the high-income group had significantly better physical health. Hispanics cancer survivors were

at an elevated risk for poor health. A larger percentage of African Americans were diabetic cancer survivors (20.59%) than non-diabetic survivors (20.59%). A larger percentage of low-income cancer survivors were diabetic (40.44%) than non-diabetic (32.62%). A larger percentage of survivors with less than a high school education (26.47%) were diabetic cancer survivors than non-diabetic cancer survivors (11.37%). These differences on which patients are at higher risk to become a diabetic cancer survivor in the first place, suggest that both prevention efforts and survivorship efforts need more proactive policy approaches that support prevention efforts. Given these disparate distributions based on the three key social factors, it is important to consider not only the social issues but also the care delivery contexts of these different groups. When considering the findings of the social impact of prevalence and risk factors found from this study, some potential mechanisms might be differential quality of care based delivered in clinical settings based on the socioeconomic status of the patient populations demonstrated in previous qualitative work (Lutfey & Freese, 2005). In this study, using a 'fundamental causes' lens an ethnographic assessment of two diabetic clinics was conducted, one clinic served primarily a high-SES patient and other primarily low-SES patients. The differences between the clinics organization included a more consistent staffing model, better continuity of care, and more educational resources in the high-SES clinic; in the low SES greater reliance on residents who were transitory was observed (Lutfey & Freese, 2005). Interview data from this study found that patients in the lower-SES clinics had fewer financial resources, had occupational constraints, were more likely to have constraints due to lack of social support (e.g., single motherhood, child care responsibilities), experienced longer wait times and the associated costs of time spent not working to attend clinic visits, and providers attributed non-compliance to lack of patient motivation, health literacy and practitioner biases (Lutfey & Freese, 2005). The observed differences in who becomes a diabetic cancer survivor may be a downstream effect of both social disparities writ large and disparities in the adequacy of the health services designed to intervene on behalf of low socioeconomic patients.

This study has important limitations to consider. In this analysis, cancer site was not controlled due to the limited sample size, and there are known differences in physical health and mortality based on cancer site (American Cancer Society, 2015; Duijts et al., 2014). Further, the data source does not assess cancer stage; therefore, cancer severity could not be controlled. To account for this patient self-report about cancer status of ‘in remission’ was assessed as a proxy. However, this does not account for differences in stage at presentation, which could not be assessed. Later stage cancer presentation is associated with poorer outcomes (Force et al., 2016; Moyer & Force, 2014; Siu, 2016). Diabetics have been shown to be more likely to present with later stage breast cancers (Peairs et al., 2011). Additionally, cancer treatment was not captured in this data set, therefore, the impact of the modification of treatments regimens on physical health could not be assessed (Peairs et al., 2011; Vigneri et al., 2009a). Additionally, the majority of the sample was non-Hispanic whites, which limited analytic assessment of interactions, based on race and the interaction of race and other social factors. These limitations notwithstanding, these findings provide preliminary support suggesting that social factors play an important role in cumulative risks of diabetic cancer survivors. Link and Phelan’s initial conceptualization of ‘flexible resources’ was more robust than was possible using the current data set as resources included social networks, occupational prestige, both economic and interpersonal resources. Future research that can broaden the scope of our understandings how different resource availability may mediate individual and population cumulative risks for diabetes, cancer and complex multi-morbidity are needed.

Tables and Figures for Manuscript #2

Tables 1

Description of the Study Sample of Cancer Survivors

	All (n=743)		Non Diabetic Cancer Survivors (n=607)		Diabetic Cancer Survivors (n=136)	
	N	Percentage/ Mean (SD)	N	Percentage/ Mean (SD)	N	Percentage/ Mean (SD)
Mortality (proxy)						
Good-Excellent	539	72.54	472	77.76	67	49.26
Poor/Fair	204	27.54	135	22.24	69	50.74
Physical Functioning (SF-12 Composite)	-	43.10 (12.16)	-	44.56 (11.82)	-	36.57 (11.53)
Mental Health (SF-12 Composite)	-	50.16 (10.44)	-	50.48 (10.36)	-	48.76 (10.74)
Depression Status						
Not Depressed	651	87.62	536	88.3	115	84.56
Depressed	92	12.38	71	11.7	21	15.44
Demographics						
Gender						
Female	459	61.78	389	64.09	70	48.53
Male	284	38.22	218	35.914	66	51.47
Age						
18-39 years	45	6.06	44	7.25	1	.74
40-54	142	19.11	121	19.93	21	15.44
55-64	175	23.55	135	22.24	40	29.41
65-74	205	27.59	164	27.02	41	30.15
74-85	176	23.69	143	23.56	33	24.26
Socioeconomic						
Race/Ethnicity						
Non-Hispanic White	569	76.58	480	79.08	89	65.44

African American/Black	91	12.25	63	10.38	28	20.59
Asian	16	2.15	13	2.14	3	2.21
Other/Mixed Race	15	2.02	11	1.81	4	2.94
Hispanic/Latino	52	7.00	40	6.59	12	8.82
Education						
< High school	105	14.13	69	11.37	36	26.47
High school/some college	418	56.26	341	56.18	77	56.62
Bachelors or higher	220	29.61	197	32.45	23	16.91
Marital Status						
Married	399	53.70	327	53.87	72	52.94
Widowed	124	16.69	99	16.31	25	18.38
Divorced/separated	160	21.53	128	21.09	32	25.53
Never married	60	8.08	53	8.73	7	5.15
Income						
Low income	253	34.05	198	32.62	55	40.44
Middle income	226	30.42	184	30.31	42	30.88
High income	264	35.53	225	37.07	39	26.68
Cancer & Comorbidity Burden						
Remission						
Not cancer free	50	6.73	40	6.59	10	7.35
No evidence of cancer	638	85.87	522	86	116	85.29
Doesn't know if cancer free	55	7.40	45	7.41	10	7.35
Last Treatment						
Less than 1-3 years ago	164	22.07	126	20.76	38	27.94
3-5 years ago	96	12.92	79	13.01	17	12.50
5-10 years ago	165	22.21	133	21.91	32	23.53
10+ years ago	262	35.26	223	36.74	39	28.68
Not treated	56	7.54	46	7.58	10	7.35

Recurrence						
No recurrence	697	93.81	570	93.90	127	93.38
Cancer returned	46	6.19	37	6.10	9	6.62
Number of priority Conditions						
0-2	265	35.67	249	41.02	16	11.76
3-4	316	42.53	250	41.19	66	48.53
5 or more	162	21.80	108	17.79	54	39.71
SRPH						
Excellent	51	6.86	49	8.07	2	1.47
Very Good	204	27.46	193	31.80	11	8.09
Good	284	38.22	230	37.89	54	39.71
Fair	165	22.21	112	18.45	53	38.97
Poor	39	5.25	23	3.79	16	38.97
Access variables						
Nativity						
Born outside U.S.	72	9.69	53	8.73	19	13.97
U.S. born	671	90.31	554	91.27	117	86.03
Usual Source of Care (USC)						
No USC	73	9.83	64	10.54	9	6.62
Have USC	670	90.17	543	89.46	127	93.38
Insurance type						
No insurance	43	5.79	35	5.77	8	5.88
Any private	468	62.99	385	63.43	83	61.03
Public only	232	31.22	187	30.81	45	33.09
Insurance during cancer treatment						
Not covered	70	9.42	58	9.54	12	8.82
Had coverage	654	88.02	534	87.97	120	88.24
Doesn't know	19	2.56	15	2.47	4	2.94

Ethnicity																	
Non-Hispanic White			1.00			1.00			1.00			1.00			1.00		
African American/Black			0.32	1.30	0.78:2.1 7	0.275	1.34	0.79:2.7 2	0.32	1.32	0.76:2.2 9	0.08	1.69	0.94:3.0 4	0.09	1.68	0.93:3.0 5
Asian			1.00	1.00	0.29:3.3 9	0.901	0.92	0.27:3.1 7	0.97	1.03	0.29:3.6 2	0.77	0.80	0.18:3.5 6	0.95	0.95	0.20:4.5 2
Other/Mixed Race			0.71	.79	0.22:2.8 7	0.763	0.81	0.21:3.1 0	0.95	0.96	0.22:4.1 0	1.00	1.00	0.18:5.7 0	0.93	1.08	0.19:6.1 7
Hispanic/Latino			0.06	1.84	0.96:3.5 4	0.117	1.75	0.88:3.5 2	0.03	2.16	1.06:4.4 1	0.03	2.44	1.12:5.3 2	0.04	2.55	1.06:6.1 7
Education																	
< High School			1.00			1.00			1.00			1.00			1.00		
High school/some college			0.01	.53	0.32:0.8 5	0.02	0.54	0.32:0.8 9	0.02	0.54	0.37:0.9 1	0.09	0.61	0.34:1.0 8	0.09	0.61	0.34:1.0 9
Bachelors or higher			0.00	.30	0.24:0.6 4	0.000	0.31	0.16:0.5 9	0.001	0.34	0.18:0.6 6	0.05	0.50	0.25:1.0 0	0.06	0.50	0.24:1.0 2
Income																	
Low			1.00			1.00			1.00			1.00			1.00		
Middle			0.01	0.56	0.37:0.8 5	0.014	0.58	0.38:0.8 9	0.11	0.69	0.77:1.0 9	0.78	0.93	0.56:1.5 3	0.95	0.98	0.59:1.6 5
High			0.00	0.40	0.24:0.6 4	0.001	0.44	0.27:0.7 3	0.01	0.51	0.31:0.8 5	0.21	0.70	0.40:1.2 2	0.41	0.78	0.43:1.4 0
Cancer Burden																	
Remission																	
Not cancer free						1.00			1.00			1.00			1.00		
No evidence of cancer						0.48	0.76	0.36:1.6	0.47	0.75	0.34:1.6 4	0.38	0.68	0.29:1.6 0	0.39	0.38	0.29:1.6 2
Doesn't know if cancer free						0.36	1.53	0.62:3.7 8	0.66	1.24	0.48:3.2 0	0.87	1.09	0.39:3.0 8	0.90	0.90	0.38:3.0 6
Last Treatment																	
< than 1-3 years ago						1.00			1.00			1.00			1.00		

3-5 years ago				0.29	0.71	0.38:1.3 3	0.38	0.75	0.40:1.4 3	0.12	0.57	0.29:1.1 5	0.08	0.52	0.26:1.0 7
5-10 years ago				0.27	0.74	0.46:1.2 7	0.21	0.70	0.40:1.2 2	0.20	0.67	0.37:1.2 2	0.21	0.68	0.37:1.2 4
10+ years ago				0.02	0.55	0.33:0.9 1	0.02	0.53	0.31:0.9 0	0.01	0.45	0.25:0.7 9	0.004	0.43	0.24:0.7 7
Not treated				0.06	0.48	0.22:1.0 4	0.03	0.40	0.18:0.9 0	0.005	0.25	0.10:0.6 5	0.004	0.24	0.09:0.6 3
Recurrence				1.00			1.00			1.00			1.00		
No recurrence				1.00			1.00			1.00			1.00		
Cancer returned				0.95	1.02	0.49:2.1 3	0.96	0.98	0.44:2.1 7	0.90	0.94	0.38:2.3 2	0.87	0.93	0.37:2.3 3
Comorbidity burden															
Number of priority Conditions															
0-2							1.00			1.00			1.00		
3-4							0.001	2.52	1.49:4.2 5	0.001	2.59	1.46:4.5 7	0.001	2.55	1.43:4.5 3
5 or more							0.000	7.17	3.98:12. 91	0.000	7.19	3.78:13. 70	0.000	6.86	3.58:13. 17
Depression status															
Not Depressed										1.00			1.00		
Depressed										0.000	14.61	7.73:27. 63	0.000	14.96	7.84:28. 56
Access variables															
Nativity															
Born outside U.S.													1.00		
U.S. born													0.51	1.29	0.60:2.7 9
Usual Source of Care (USC)															
No USC													1.00		

Have USC							0.53	1.28	0.60:2.7 4
Insurance type									
No insurance							1.00		
Any private							0.07	0.42	0.16:1.0 8
Public only							0.19	0.52	0.20:1.3 6
Covered during CA Rx									
Not covered							1.00		
Had coverage							0.72	0.88	0.42:1.8 3
Doesn't know							0.43	0.55	0.12:2.4 3
Explained Variance (R ²)	5%	7%	14%	15%	21%	31%	31%		

Table 3

Cross-sectional Ordinary Least Square Regression Models of Diabetic Status on Physical Health Status

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Cancer Survivor Type	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Non-Diabetic	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diabetic	- 7.9 6 ** *	1.12	-7.48 ***	1.08	-6.44 ***	1.07	-6.31 ***	1.07	-4.00 ***	1.02	-4.05***	0.99	-4.20***	1.00
Demographics														
Gender														
Men			-	-	-	-	-	-	-	-	-	-	-	-
Women			-2.28*	0.90	-1.50*	.90	-2.02*	0.91	-2.24**	0.84	-2.17**	0.82	-2.12**	0.82
Age														
18-39			-	-	-	-	-	-	-	-	-	-	-	-
40-54			-6.28 ***	1.93	-6.58 ***	1.88	-7.01 ***	1.86	-4.94**	1.77	-5.04**	1.72	-4.90**	1.73
55-64			-8.38 ***	1.91	-9.47 ***	1.87	-9.75 ***	1.87	-5.74**	1.80	-6.11***	1.75	-6.17***	1.77

65-74			-8.64 ***	1.92	-8.98 ***	1.88	-9.43 ***	1.88	-5.15**	1.83	-5.92***	1.78	-5.79***	1.82
74-85			-12.38 ***	2.02	-11.56 ***	1.98	-12.18 ***	1.99	-7.49***	1.92	-8.64***	1.88	-8.55***	1.91
Marital Status														
Married			-	-	-	-	-	-	-	-	-	-	-	-
Widowed			-4.85 ***	1.27	-3.65 **	1.25	-3.90**	1.24	-3.43**	1.16	-3.16**	1.12	-3.19**	1.13
Divorced/ separated			-2.85 **	1.06	-1.29	1.06	-1.37	1.05	-1.17	0.98	-0.86	0.95	-0.69	0.96
Never married			-1.49	1.60	-.66	1.58	-.51	1.58	-0.48	1.48	-0.10	1.43	0.06	1.45
Race/Ethnicity														
Non-Hispanic White			-	-	-	-	-	-	-	-	-	-	-	-
African American/ Black					1.11	1.28	1.05	1.28	1.40	1.20	0.88	1.16	0.96	1.17
Asian					1.95	2.78	2.41	2.76	2.25	2.58	2.61	2.50	2.27	2.59
Other/Mixed Race					1.32	2.87	1.15	2.86	-0.17	2.66	-0.27	2.58	0.07	2.60
Hispanic/ Latino					.77	1.63	0.93	1.68	0.13	1.57	0.27	1.52	-0.05	1.67

Education														
< High School					-	-	-	-	-	-	-	-	-	-
High school/some college					1.86	1.26	1.84	1.26	1.50	1.17	0.93	1.14	0.70	1.15
Bachelors or higher					3.58**	1.46	3.43*	1.46	2.24	1.36	1.05	1.33	0.71	1.36
Income														
Low					-	-	-	-	-	-	-	-	-	-
Middle					3.16**	1.02	2.95**	1.02	1.66	0.96	0.78	0.94	0.56	0.96
High					6.23***	1.08	5.69***	1.09	4.64***	1.02	3.70***	1.00	3.44***	1.05
Cancer Burden														
Remission														
Not cancer free							-	-	-	-	-	-	-	-
No evidence of cancer							0.46	1.75	0.65	1.64	0.70	1.59	0.56	1.59
Doesn't know if cancer free							-3.46	2.19	-1.88	2.04	-1.21	1.98	-1.21	1.99
Last Treatment														
< 1-3 years ago							-	-	-	-	-	-	-	-

Born outside U.S.											-	-	-	-
U.S. born													-1.14	1.41
Usual Source of Care (USC)														
No USC											-	-	-	-
Have USC													-0.24	1.34
Insurance type														
No insurance											-	-	-	-
Any private													-0.05	1.782
Public only													-1.10	1.82
Insured during Cancer Treatment														
Not covered											-	-	-	-
Had coverage													2.16	1.32
Doesn't know													1.43	2.59
Explained Variance (R ²)	6%	16%	22%	24%	34%	38%	39%							

*p<0.05 **p<0.01 ***p<0.001

Table 4

Cross-sectional Ordinary Least Square Regression Models of Diabetic Status on Mental Health Status

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Cancer Survivor Type												
Non-Diabetic	-	-	-	-	-	-	-	-	-	-	-	-
Diabetic	-1.72	.99	-2.06*	.97	-1.37	0.98	-1.52	0.98	1.12	0.94	0.98	0.93
Demographics												
Gender												
Men			-	-	-	-	-	-	-	-	-	-
Women			-.72	0.81	-0.11	0.82	-0.19	0.84	0.31	0.77	0.39	0.76
Age												
18-39			-	-	-	-	-	-	-	-	-	-
40-54			0.26	1.74	0.20	1.73	0.35	1.73	1.58	1.62	1.20	1.61
55-64			1.69	1.73	1.04	1.72	1.22	1.73	2.36	1.64	2.05	1.64
65-74			5.25**	1.73	5.16**	1.72	5.37**	1.74	5.50**	1.67	5.40***	1.69
74-85			6.22***	1.82	6.83***	1.82	6.98***	1.83	7.54**	1.74	7.49***	1.77
Marital Status												
Married			-	-	-	-	-	-	-	-	-	-
Widowed			-3.05**	1.15	-2.35*	1.14	-2.50*	1.15	-1.72	1.04	-1.88	1.05
Divorced/ separated			-1.24	0.96	-0.40	0.97	-0.40	0.97	-0.27	0.89	-0.11	0.89
Never married			-3.45*	1.44	-3.17*	1.45	-2.78	1.47	-2.61*	1.34	-	
Race/Ethnicity												
Non-Hispanic White			-	-	-	-	-	-	-	-	-	-
African American/ Black					0.88	1.17	0.97	1.19	1.49	1.08	1.67	1.08
Asian					1.33	2.55	1.74	2.55	2.53	2.33	3.09	2.40
Other/Mixed Race					0.61	2.63	0.43	2.64	-0.83	2.41	-0.18	2.42

Hispanic/ Latino					-0.50	1.50	-0.23	1.55	0.93	1.43	1.51	1.55
Education												
< High School					-	-	-	-	-	-	-	-
High school/some college					1.22	1.15	1.12	1.16	-0.43	1.08	-0.59	1.08
Bachelors or higher					3.50**	1.34	3.16*	1.35	0.75	1.25	0.38	1.26
Income												
Low					-	-	-	-	-	-	-	-
Middle					1.85*	0.94	1.88*	0.94	0.700	0.87	0.11	0.89
High					3.03**	1.00	2.89**	1.01	0.93	0.94	0.16	0.97
Cancer Burden												
Remission												
Not cancer free							-	-	-	-	-	-
No evidence of cancer							1.04	1.62	-0.00	1.49	-0.30	1.48
Doesn't know if cancer free							-2.4	2.02	-1.51	1.85	-1.36	1.85
Last Treatment												
< 1-3 years ago							-	-	-	-	-	-
3-5 years ago							-1.56	1.30	-1.68	1.19	-1.76	1.19
5-10 years ago							0.62	1.13	0.43	1.03	0.35	1.03
10+ years ago							-0.66	1.06	-1.33	0.97	-1.19	0.97
Not treated							-0.22	1.60	-1.76	1.47	-1.20	1.47
Recurrence												
No recurrence							-	-	-	-	-	-
Cancer returned							-0.46	1.60	-0.96	1.47	-0.58	1.47
Comorbidity burden												
No. of priority Conditions												
0-2									-	-	-	-
3-4									0.36	0.85	0.41	0.85
5 or more									1.72	1.08	2.03	1.08

Health Status												
Excellent									-	-		
Very good									-1.36	1.45	-1.51	1.45
Good									-5.62***	1.46	-5.73***	1.46
Fair									-12.20***	1.59	-12.24***	1.58
Poor									-17.54***	2.15	-16.78***	2.16
Access variables												
Nativity												
Born outside U.S.											-	-
U.S. born											0.55	1.30
Usual Source of Care (USC)												
No USC											-	-
Have USC											-0.95	1.25
Insurance type												
No insurance											-	-
Any private											1.77	1.65
Public only											-0.04	1.68
Insured during CA Rx												
Not covered											-	-
Had coverage											0.91	1.23
Doesn't know											-5.19*	2.39
Explained Variance (R ²)	<1%		6%		11%		12%		28%		29%	

*p<0.05 **p<0.01 ***p<0.001

MANUSCRIPT 3**EXAMINING THE IMPACT OF DIABETIC STATUS ON MULTIPLE PSYCHOSOCIAL
OUTCOMES AMONG CANCER SURVIVORS**

by

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Manuscript 3 of 3 of a dissertation entitled:

**EXAMINING THE IMPACT OF DIABETIC STATUS ON MULTIPLE OUTCOMES
AMONG CANCER SURVIVORS**

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Abstract

Background/Purpose: Cancer and diabetic status are related to several psychosocial outcomes when considered separately. This study examines the impact of diabetic status on multiple psychosocial outcomes (i.e., non-specific distress, mental health functioning, depression, and cancer-related thoughts) among cancer survivors. Further, this study explores factors that are associated with clinically significant levels of non-specific distress in a long-term (10 years beyond treatment) population of cancer survivors.

Methods: A retrospective, cross-sectional analysis using data from the 2011 Medical Expenditures Panel Survey (MEPS) Household Component Data and the Experiences with Cancer Survivorship Supplement (n=714) was conducted. Analysis was guided by Pearlin's Stress-Process model of individual coping and Link and Phelan's theory of 'fundamental causes,' and multivariate regression models were specified controlling for patient characteristics (demographic and psychosocial), and health and financial stressors. Psychosocial outcomes included the: (1) Kessler Index; (2) Patient Health Questionnaire-2 (PHS-2); (3) SF-12 mental health composite; and (4) two, single-item measures to assess chance of (CDR) and fears about disease recurrence (FDR).

Results: Diabetic status was not significantly associated with any of the psychosocial outcomes. Older age (i.e., 65-74 years old; 74 years and older, respectively) was a protective factor for non-specific distress (NSD) ($B=-2.18$, $p<0.01$; $B=-3.27$, $p<0.001$), with higher mental health functioning ($B=6.52$, $p<0.001$; $B=8.67$, $p<0.001$), lower depression ($B=-0.58$, $p<0.05$; $B=-0.98$, $p<0.001$); and lower CDR ($B=-0.52$, $p<0.01$; $B=-0.65$, $p<0.01$) and fewer FDR (NS; $B=-0.52$, $p<0.05$) compared to younger survivors. Physical functioning was associated with lower NSD ($B=-0.14$, $p<0.001$) and lower depression ($B=-0.05$, $p<0.001$), and higher mental health functioning ($B=0.155$, $p<0.001$). Having private insurance was associated with a decrease in

NSD ($B=-1.54$, $p<0.05$) compared to being uninsured. Increased FDR was associated with being a women ($B=0.31$, $p<0.01$) compared to men and having a social support during treatment ($B=0.39$, $p<0.0001$). Being ten years from treatment was associated with lower CDR ($B=-0.28$, $p<0.05$) and FDR ($B=-0.26$, $p<0.05$) compared to more recently treated survivors. Being African American ($B=-0.48$, $p<0.001$) and Hispanic ($B=-0.38$, $p<0.05$) was associated with lower perceptions for CDR than Caucasian/whites. Middle income was associated with lower NSD ($B=-0.90$, $p<0.05$) and depression scores ($B=-0.30$, $p<0.05$), whereas, high income was only associated with lower NSD ($B=-0.94$, $p<0.05$) compared low income. Making a financial sacrifice due to cancer was associated with increased NSD ($B=1.51$, $p<0.01$) and depression ($B=0.46$, $p<0.19$), more frequent FDR ($B=0.63$, $p<0.001$), decreased mental health functioning ($B=-3.13$, $p<0.05$).

Conclusions: Diabetic status has been shown to be associated with poorer physical health outcomes among survivors; however, being diabetic alone is not predictive of poorer psychosocial outcomes.

Introduction

There are 15.5 million cancer survivors living in the U.S. (Miller et al., 2016). Estimates suggest that diabetes co-occurs in 16% of the cancer survivor population, and is one of the most commonly occurring co-morbidities (Edwards et al., 2014). Diabetes can influence each phase of the cancer continuum including cancer prevention, treatment, survivorship, and end-of-life (Vigneri et al., 2009a). Diabetics are at increased risk of developing many cancers, including: bladder (Larsson et al., 2006), breast (Larsson et al., 2007), colorectal (Larsson et al., 2005), endometrial (Friberg et al., 2007), kidney (Lindblad et al., 1999; Washio et al., 2007), liver (El-Serag et al., 2006), non-Hodgkin's lymphoma (Mitri et al., 2008), and pancreatic (Huxley et al., 2005). During active cancer treatment diabetics may not receive standard therapies, because anti-cancer and supportive care therapies routinely used in cancer care may exacerbate diabetic symptoms (Vigneri et al., 2009a). The effect of having both cancer and diabetes increases overall mortality rates, with diabetic cancer survivors more likely to die because of their cancers than non-diabetic survivors (Vigneri et al., 2009a).

For cancer and diabetes, there are behavioral and social aspects that influence prevention, prevalence, chronic disease management as well as overall outcomes. Among cancer survivors, bio-behavioral and psychological influences including depression, psychological distress, and stressful life events are associated with disease progression and mortality (Chida, Hamer, Wardle, & Steptoe, 2008; Costanzo, Sood, & Lutgendorf, 2011). Among cancer survivors, the estimated prevalence of distress ranges have been estimated from 29.6% to 43.4%, depending on cancer site, with approximately 36.4% reporting distress scores suggestive of psychiatric morbidity (including depression) (Fallowfield et al., 2001; Zabora et al., 2001). Studies have shown that cancer survivors five years and beyond from cancer diagnoses are more likely to experience rates of serious psychological distress when compared to those without a cancer history (Hoffman,

McCarthy, Recklitis, & Ng, 2009). In the general population, the presence of type II diabetes doubles and type I diabetes triples the odds of a comorbid depression diagnosis (Anderson et al., 2001b; Roy & Lloyd, 2012). In the general population, while diabetes and depression are clearly interrelated, the exact nature and causal pathways of this relationship remains unclear (Roy & Lloyd, 2012). Further, there is a dearth of evidence examining the additive impact of diabetes and cancer survivorship on psychosocial outcomes.

Cancer related health disparities have persisted for decades and are attributed, in part to disproportionate rates of comorbid illness including diabetes among specific sub-populations (Bach et al., 2002; Haynes & Smedley, 1999; Tammemagi et al., 2005; Vigneri et al., 2009a). The ability to cope and mitigate risks in the face of cumulative stress from major illness or illnesses and the subsequent adjustments necessary to accommodate treatment and disease management may position specific individuals and groups at a disadvantage to rehabilitate from cancer. The adoption of protective health behaviors, such as weight management occur in a specific context, and social determinants are more widely acknowledged as the ‘fundamental causes’ of disparities in health outcomes (Link & Phelan, 1995; Phelan et al., 2010). For example, a diagnosis of depression is associated with a nearly 1.5 odds of developing obesity (Luppino et al., 2010). Obese cancer survivors have poorer outcomes, with men and women having a 52 % and 62% (respectively) higher mortality rate compared to those who are a ‘normal’ weight (Calle et al., 2003; Calle et al., 1999). Further, the ability to prevent the development of obesity or effectively implement weight loss strategies is contextually bound. Research on the emergence of ‘food deserts’ where nutritious food sources are scarce demonstrate that among lower socioeconomic neighborhoods with larger concentrations of racial and ethnic minorities healthy food is less available and often more expensive (Weaver et al., 2012).

Psychosocial issues are known to have an impact on patients’ ability to manage their health and ultimately, affect physical health. The role of psychological distress in cancer survivors as it relates to the development of subsequent co-morbid illness, particularly

cardiovascular disease is an emerging area of study. Distress has been shown to be related to cardiovascular risk factors among the general population, both through behavioral mechanisms, such as poorer diet and increased smoking and physiologically through neuroendocrine and platelet activation (Rozanski et al., 1999). Among cancer survivors in ongoing treatment coping style impacts informational preferences (Miller, 1995); while survivors post-treatment with higher fear about disease recurrence have been shown to desire more information to guide follow-up care (O'Malley et al., 2014).

Therefore, this study was undertaken to: (1) explore the effect of diabetic status on cancer survivors' non-specific psychological distress, mental health functioning, and cancer related health worries; (2) examine how internal and flexible resource availability predict non-specific psychological distress, mental health functioning, and cancer related health worries; and (3) identify the factors that are associated with clinically relevant non-specific psychological distress in long-term survivors (i.e., survivors 10 years out from treatment).

Conceptual Model

This analysis was guided by the conceptual model portrayed in Figure 1 derived from an integration of by Pearlin, Lieberman, Menaghan, and Mullan (1981)'s general stress model and Link and Phelan (1995) 'fundamental causes' theory. In this conceptualization, distress is the result of an array of specific and chronic stressors. The general stress paradigm (Pearlin, 1989) acknowledges the role of personal characteristics as chronic stressors (e.g., age and gender); therefore, these are entered as co-variates in the cancer and comorbidity distress relationship. Younger age has been associated with increased levels of distress among adult cancer survivors (Hoffman et al., 2009). The primary stressor was conceptualized as health burden, therefore, diabetic status, cancer status and other health related stressors are considered. Health-related stressors included additional comorbidities, cancer remission status, time since treatment, and physical functional disabilities. Pearlin's approach also specified secondary stressors that arise from the primary stressors. For this analysis, the focus was on financial secondary stressors

including insurance status and needing to make a financial sacrifice during acute cancer treatment. Financial toxicity post-cancer is now recognized as a major concern among survivors and has been found to be associated with mortality and distress (Zafar, 2016a). In the integration of Pearlin's approach (1989) and Link and Phelan's (1995) theory, the chronic stressor was re-conceptualization as 'flexible resources.' According to the theory of 'fundamental causes,' the root of persistent SES disparities is the unequal resource distribution positioning those with more flexible resources (i.e., money, power, prestige, social networks, etc.) in a more advantageous position to adopt protective behaviors and to adapt to avoid risk of disease and death (Link & Phelan, 1995). Therefore, socio-cultural resources (i.e., race, income, and education), self-appraisal of stress resilience, and social supports were seen as potential buffers from the primary and secondary stressors. In this model, the primary stressors are personal characteristics and health stressors and the secondary stressors are financial sacrifice, which are seen to contribute to non-specific psychological distress. Depression, mental health functioning and cancer-related health worries are seen as different manifestations of the stressors and resource availability.

Based on this conceptual model it was hypothesized that cancer survivors with higher primary and secondary stress burdens (i.e., due to increased health issues and having to make financial sacrifice) would be fare worse on psychosocial outcomes than those with lower levels of primary and secondary stress. Additionally, it was hypothesized that cancer survivors with less socio-cultural resources (i.e., low levels of education, low income, and members of underserved minority groups) would fare worse on psychosocial outcomes.

Methods

Study Design and Data Source.

A retrospective, cross sectional analysis of the U.S. Medical Expenditures Panel Survey Household Component (MEPS-HC) and the supplemental survey Experiences with Cancer collected from 2011-2012. The MEPS-HC is an ongoing survey administered annually by the

Agency for Health Care Quality to a nationally representative sample of civilians and non-institutionalized individuals from 15,000 selected households across the United States (Yabroff et al., 2012). MEPS-HC collects detailed information on each person in the household including the following core content areas: demographics, charges and payments, medical conditions, employment, health status, health insurance, and health care utilization. In 2011, two panels of the MEPS-HC were oversampled for households with adult cancer survivors. Individuals who were diagnosed and treated with cancer over the age of 18 years old were also administered the Experiences with Cancer survey which assessed the burden of cancer, financial aspects, health care experiences and psychosocial impacts of cancer. The MEPS Household Component response rate was 54.9% and MEPS Experiences with Cancer survey response rate was 90%. Therefore, the overall response rate was 72.45%.

Study Population.

A total of 2,145 respondents from the MEP-HC were diagnosed with cancer over the age of 18 years old. Of these respondents, 1,591 completed the MEPS Experiences with Cancer. Cases of non-melanoma skin cancers and skin cancers unknown (n=386) and those with incomplete data (n=491) were excluded from the study sample.

Outcome Measures.

There are five main outcomes measures in this study. The Kessler Distress Inventory (K-6) a validated measure of non-specific distress is the summation of six items self-reported items (Kessler & Neighbors, 1986). For the logistic model of clinically distressed was defined as those who had a score of 13 or above on the K-6. The mental health composite score was derived from the Short-Form 12 (SF-12), Version 2, a registered trademark, was used to measure mental health functioning (Ware Jr et al., 1996). The mental health composite score was constructed based on all twelve items with the weights applied for the mental health summary scores, see scoring manual for details (Ware Jr et al., 2002). Depression was measured using the Patient Health

Questionnaire-2, a validated two-item self-reported measure of depression (Kroenke et al., 2003; Ware Jr et al., 2002). Health-related worries were assessed using two, single-item measures from the Experiences with Cancer Supplement. Patient's perception of their chance of their cancer recurring was measured from a question that accesses, 'the chance that your cancer will come back or get worse in the next ten years.' Patient's fear of disease recurrence was measured with a single-item question, which inquired about the frequency, that they worry about their cancer returning.

Independent Variables.

Diabetic Status.

This variable was constructed from the MEPS-HC medical condition data collection where priority conditions are queried. Medical condition data is collected at each time point on the MEPS-HC survey. Questions about cancer and diabetes were only asked to individuals aged 18 years or older. For both at baseline, this question was asked, "Ever been told by a health professional" they had the reference condition. In subsequent data collection points the household respondent was asked: "During the past 12 months have you been told by a health professional you were diagnosed," with the reference condition. Responses are coded as: yes, no, not ascertained, do not know, refused and inapplicable. All respondents that were indicated to have a diagnosis of diabetes, as a priority condition were included in the diabetic group.

Demographic characteristics.

Demographic factors included age and gender (male vs. female) reported by the household respondent for the MEPS-HC. Exact age for all respondents was calculated from their date of birth as of 12/31/2011 and was constructed into five age categories (18-39, 40-54, 55-64, 65-75, and 75+). Age was top coded at 85 years old to protect respondents' confidentiality.

Financial Stressors.

Health insurance status was assessed using the following three categories: no insurance, any private insurance, or any public insurance. The financial impact of the cancer diagnosis was measured with a single-item from the Experiences with Cancer survey, which asked whether the respondent had to make a financial sacrifice due to their cancer diagnosis.

Health Stressors.

MEPs collects data for selected ‘priority conditions’ which include: hypertension, any heart disease (coronary artery disease, angina, history of heart attack, other heart disease), stroke, emphysema, chronic bronchitis, arthritis, high cholesterol, and asthma were assessed. Three categories of comorbidity were developed based on the number of priority conditions (i.e., none to two, three to four or more conditions). Time since cancer treatment was measured by the following temporal phases: one to three years, three to less than five years, five to less than ten years, 10 or more years post treatment and never received treatment. Physical functioning was assessed using the SF-12 composite score (Ware Jr et al., 1996). Current cancer remission status was assessed using three categories: active cancer; no evidence of cancer; unknown cancer remission status.

Socio-cultural Resources.

Race/ethnicity was assessed using five categories: Non-Hispanic Caucasian/white, African American/black, American Indian/Alaskan Native, Asian, Other/Mixed Race, and Hispanic/Latino. Within the MEPs data set poverty is coded into five categories based on the 2011 federal poverty level (FPL), which were collapsed into three categories: negative income or poor (< than 100% to < than 200% of the FPL), middle income (200-400% FPL, and high income (greater than or equal to 400% above FPL). Education was collected as a continuous variable for years of education, from this three categories were constructed: less than a high school degree, high school degree or some college, and a bachelor’s degree or higher.

Internal resources.

A single item assessed benefit finding of the cancer experience, in which the patient could either agree or disagree that the cancer experience made them stronger.

Social Supports.

A single item assessed the availability of a social support during the cancer experience on the Experiences with Cancer survey, which asked if the patient had a caregiver during or after cancer treatment. Additionally, marital status was measured using the following categories: married, widowed, divorced/separated, or never married. The categories of divorce/separated were combined because of small sample sizes and conceptual similarities.

Statistical Analyses.

Demographics, financial and health stressors, socio-cultural resources, internal resources, and social supports of the sample were presented overall and by diabetic status with means and standard deviations (SDs) or frequencies and percentages. Based on the conceptual model, regression equations were estimated to provide the relative strength of multiple factors, including: diabetic status, demographics, financial and health stressors, socio-cultural and internal resources, and social supports on general distress, mental health status, depression and cancer-related worries. The coefficients provided are the standardized regression coefficients (β) and standard errors to identify the net effects of each predictor on each respective outcome. The regression analysis also provides goodness-of-fit information (p -values and R^2).

Results

Table 1 presents the patient characteristics and descriptive statistics for the overall sample and by diabetic status. The sample included more women (61.34%) overall and in the non-diabetic cancer survivor group (63.78%), while the diabetic cancer survivor group had similar gender distribution (48.91% men vs. 51.09% women). Over half of the sample was over 65 years old, with 28% between the ages of 65-74 and 22% of the sample being over 74 years old.

Majority of the sample had some form of private insurance (62%), with only 31% of the sample relying solely on public health insurance and a small minority reporting having no insurance at all (6%). Approximately 9% of cancer survivors reported having to make a financial sacrifice as a result of their cancer diagnosis. The majority of the sample had multi-morbidity with 43% having between three and four additional priority conditions and 21% reporting five or more additional comorbidities.

Most of the sample are ‘longer term’ survivors, the largest group being those ten years out from treatment (34%), followed by those who are between 5-10 years from treatment (23%). More recently treated survivors represent 22% who are between years 1-3 years post-treatment, with 13% between years 3-5 post-treatment. Approximately 8% of cancer survivors received no treatment. Mean scores of physical functioning were 43.02 (SD=12.24), slightly higher among the non-diabetic cancer survivor group 44.52 (11.86), with lower scores among diabetic cancer survivors 37.72 (11.86). The majority of cancer survivors reported their cancer status as in remission (86%), the latter reporting currently active cancer (7%) or cancer status unknown (7%).

Most cancer survivors in the sample were Caucasian/white (75%), followed by African American/blacks (14%), Hispanic/Latinos (7%), Asian (3%), and other/mixed race (2%). Similar distributions of race/ethnicity were seen in the non-diabetics cancer survivor group to the general study sample; however, the diabetic cancer survivor group there were nearly 10% fewer Caucasians/white and slightly more than 20% African American/blacks. In the overall sample, slightly more than a third of the sample were in the low and high income groups (35% each), with a slightly smaller subset (30%) in the middle-income group. The diabetic cancer survivor group was comprised of 40% in the lower income group. Most of the sample had a high school degree or some college (56%), and nearly a third had a bachelor’s degree or higher. While only 14% of the overall sample reported having less than a high school education, 28% of diabetic cancer survivor group had less than a high school education. Most cancer survivors felt that the experience of cancer made them stronger (70%). Most survivors did not have a caregiver during

or after their cancer treatment (59%). Slightly over half were married (53%); nearly a quarter were divorced or separated (22%); with fewer widowed (17%) or never married (9%).

Table 2 provides the regression coefficients (beta), standard errors and related p-values for each of the psychosocial outcomes. Diabetic status was not significantly associated with any of the psychosocial outcomes. Looking first at NSD, older age (i.e., 65-74 years old; 74 years and older, respectively), having any private insurance ($B=-1.54$, $p<0.05$), physical functioning ($B=-0.14$, $p<0.001$), and reporting middle ($B=-0.90$, $p<0.05$) or high income ($B=-0.94$, $p<0.05$) were associated with protective benefits compared to reference categories for each respective factor. In NSD, the only factor identified that was associated with increased distress was reporting a financial sacrifice during the cancer experience ($B=1.51$, $p<0.01$). This model explains 29% of the variance in non-specific distress. Therefore, both socio-cultural resources (i.e., income and insurance) and primary (i.e., physical functioning) and secondary (i.e., financial sacrifice) stressors were related to NSD rates in the anticipated direction.

Next, in mental health functioning similar protective benefits were found among those in the older age groups (i.e., 65-74 years old; 74 years and older, respectively) ($B=6.52$, $p<0.001$; $B=8.67$, $p<0.001$) and for physical functioning ($B=0.155$, $p<0.001$). Again, in the mental health functioning group the only factor associated with decreased mental health functioning was financial sacrifice during the cancer experience ($B=-3.13$, $p<0.05$). This model explains 16% of the variance in mental health functioning. The hypothesized relationship for socio-cultural resources (i.e., race, income and education) was not supported for mental health functioning. However, primary (i.e., physical functioning) and secondary (i.e., financial sacrifices) stressors were found to be associated with mental health functioning in the anticipated directions.

Older age (i.e., 65-74 years old; 74 years and older, respectively) ($B=-0.58$, $p<0.05$; $B=-0.98$, $p<0.001$) and physical functioning ($B=-0.05$, $p<0.001$) were also protective benefits from depression. Additionally, reporting middle income was also associated with better depression scores ($B=-0.30$, $p<0.05$) compared to low income group members. For depression, the only

factor associated with additional risk was reporting making a financial sacrifice during the cancer experience ($B=0.46$, $p<0.01$). This model explains 24% of the variance in depression. The conceptual model's hypothesis for socio-cultural factors (i.e., income) and primary (i.e., physical functioning) and secondary (i.e., financial sacrifice) were supported in the anticipated directions for depression.

For cancer related health worries, older age (i.e., 65-74 years old; 74 years and older, respectively) was a protective benefit for CDR ($B=-0.52$, $p<0.01$; $B=-0.65$, $p<0.01$) and FDR (NS; $B=-0.52$, $p<0.05$) compared to younger survivors. However, physical functioning was not found to be significant for either cancer related worry outcome. Increased FDR was associated with being a women ($B=0.31$, $p<0.01$) compared to men and having a social support during treatment ($B=0.39$, $p<0.0001$). Being ten years from treatment was associated with lower CDR ($B=-0.28$, $p<0.05$) and FDR ($B=-0.26$, $p<0.05$) compared to more recently treated survivors. Being African American ($B=-0.48$, $p<0.001$) and Hispanic ($B=-0.38$, $p<0.05$) was associated with lower CDR than Caucasian/whites. Making a financial sacrifice due to cancer was associated with more frequent FDR ($B=0.63$, $p<0.001$). Therefore, the hypothesized direction for primary stressors (i.e., health burden and physical functioning) and socio-demographic factors were not supported by the data for either cancer-related worry; however, the secondary stressor (i.e., financial sacrifice) was significant for fear of disease recurrence only in the anticipated direction. The models explained 14% of the variance in chance of disease recurrence, and 16 percent of the variance in fear of disease recurrence.

Lastly, Table 3 provides the results of the logistic analysis for distressed longer-term cancer survivors. Survivors between the ages of 75-85 years old had 99% lower odds of reporting clinical distress compared to survivors in the age ranges 18-39 years old. Survivors who were members of the middle income had 93% lower odd and those in the high-income group had 95% lower odds of reporting clinical distress compared to survivors in the low-income group. Survivors who had made a financial sacrifice as a result of their cancer had 604% greater odds of

reporting clinical distress. This findings supports that the secondary stressor of having to make a financial sacrifice is associated with greater distress among survivors who are over ten years out from treatment.

Discussion

The findings provide a clear picture that while diabetic status alone is not an important indicator for psychosocial sequelae among cancer survivors, other primary and secondary stressors play a significant role in non-specific distress, mental health functioning, depression and cancer related worries. Age was a strong predictive factor all of the psychosocial outcomes, associated with lower distress, depression and cancer-related worries and greater overall mental health functioning. Gender was only found to be associated with increased worries about cancer recurrence. While the health stressor of interest, diabetic status, did not provide information about psychosocial outcomes alone, diabetics in the sample on average had larger co-morbidity burdens compared to non-diabetic survivors. The primary stressor of overall physical functioning was a better predictor of non-specific distress, depression and mental health functioning. Therefore, the overall impact on physical functioning resulting from cancer, diabetes and any other comorbidities present maybe a better indicator for potential psychosocial issues than a diagnosis of any specific disease. Primary stressors in the model, which included time since treatment and remission status were only significant predictors of cancer related worries. Among financial toxicity variables, having insurance was associated only with a decreased non-specific distress, while having made a financial sacrifice as the result of cancer was associated with increased distress, depression, fears of disease recurrence and lower mental health functioning. Among the flexible resource variables, the socio-cultural resource of income was a predictive factor for distress, with members of the middle and high-income groups reporting less distress compared to low income group members. Members of the middle-income group also reported less depression compared to lower income cancer survivors. African American and Hispanic cancer survivors reported significantly lower perceptions of chance of disease recurrence than

Caucasians/whites. The only psychosocial outcome that was associated with having social support during treatment was greater fear of recurrence worries compared to those who reported not relying on support.

The data presented also demonstrate that the impact of the secondary stressors of having to make a financial sacrifice and the flexible resource of income status remain salient predictors of clinically notable distress in survivors who are ten years or more from treatment. Interestingly, none of the primary stressors had an enduring effect of distress. In a landmark report from the Institute of Medicine (Adler & Page, 2008) the widespread failure to adequately screen for and intervene with patients experiencing distress was documented and it was recommended that routine screening of all cancer patients be adopted as the ‘sixth vital sign’ (Bultz & Johansen, 2011). Yet, the ability to intervene to mitigate the impact of high-out-of-pocket medical expenses remains limited. Cancer patients pay larger out-of-pocket costs than patients with other chronic illnesses, with recent estimates for non-elderly survivors spending on average a minimum of 20% of their incomes on out-of-pocket costs (Bernard, Farr, & Fang, 2011). Medicare recipients are not faring much better, with 50% of beneficiaries with cancer paying 10% of their income on out-of-pocket costs (Davidoff et al., 2013). In a sample of insured cancer survivors surveyed through a national copay assistance program, 42% of respondents reported a subjective ‘catastrophic’ financial burden and the impacts included 68% reducing leisure activities, 48% reducing spending on food or clothing and 46% used savings to pay out-of-pocket costs (Zafar et al., 2013). Financial toxicity has been found to be associated with poorer adherence to treatment (Neugut et al., 2011) and poorer health related quality of life among survivors in treatment and those with advanced cancer (De Souza, Yap, Hlubocky, & Daugherty, 2014).

The data presented also demonstrated that risk perception for cancer returning was lower among African Americans and Hispanics compared to Caucasians/whites; however, no significant differences were found for worries about cancer recurrence. This finding is consistent with an earlier study that also reported that African American survivors were less inclined to

worry about their cancer health (Deimling et al., 2006). Further exploration regarding the accuracy of risk perception in this population may be necessary given that mortality risk for racial minorities is substantially higher than among Caucasians; however, this is not translating into health related worries. (DeSantis et al., 2013). While other cultural factors, such as spirituality may account for these differences, inaccurate or uncertain risk perception has been shown to be related to cancer screenings (Waters, Kiviniemi, Orom, & Hay, 2016). Even in breast cancer, the most commonly studied cancer site, there remains no consensus on the best way to communicate recurrence risk to patients (Brewer, Richman, DeFrank, Reyna, & Carey, 2012). Moreover, health literacy issues impact risk perceptions based on presentation styles, and issues of numeracy may impact understanding (Hamstra et al., 2015) which may be compounded by the tendency of patients with lower literacy to ask fewer clarifying questions (Katz, Jacobson, Veledar, & Kripalani, 2007).

Notably, this study has important limitations to consider. In this analysis, cancer site was not controlled due to the limited sample size, and there have been variable reports of distress based on cancer sites (Zabora et al., 2001). The data source does not assess cancer stage, and therefore, cancer severity could not be controlled; however, patient self-report about cancer status of ‘in remission’ was assessed as a proxy and health status was also a co-variate in the analysis. The data used for this analysis were self-reported and cross-sectional, therefore, limiting the ability to assess causal relationships. Additionally, the majority of the sample was non-Hispanic whites. A systematic review reported that Hispanics reported more fear of disease recurrence more frequency consistently across studies, which was not supported by this analysis and may be a result of sampling bias (Koch, Jansen, Brenner, & Arndt, 2013). Earlier research has also reported that the effect of race on psychological distress is due to the role of socioeconomics; however, Kessler and Neighbors (1986) demonstrated that this effect was interactive replicating results across several epidemiological studies. In this analysis, due to small sample sizes for racial minorities groups exploring several interactions was not possible. Additionally, Link and Phelan

(1995) initially conceptualized ‘flexible resources’ to include social networks, prestige, income and status related benefits not captured by the use of income, race/ethnicity and educational variables available for analysis in this study. The ‘financial sacrifice’ variable is a subjective variable, and provides some insights about how an individuals need to use resources as a result of a health stressor. Yet, it does not capture the reasons underlying why a sacrifice was necessary, which may provide valuable insights about differential impacts on households and family systems coping with a major illness.

The relationship between financial toxicity, distress and the impact on physical health is an area in need of further research, as recent studies have shown relationships between financial toxicity and mortality. Ramsey et al. (2016) compared mortality outcomes in a propensity matched sample of cancer survivors who had and who had not declared bankruptcy and found a consistent positive relationship between cancer survivors who declared bankruptcy and an increased risk of mortality risk (that varied in magnitude by cancer site). Currently three factors are being considered for further explanations about the mechanism between financial toxicity and outcomes: (1) poorer subjective well-being; (2) impairments to health related quality of life, and (3) inadequate standards of care (Zafar, 2016a). Another potential area that warrants further exploration is the relationship of stress related to financial toxicities’ impact on subsequent cardiovascular risk. The ‘multiple-hit hypothesis’ for developing cardiovascular disease (CVD) was developed and provides an explanation of how cascading of ‘insults’ increases CVD risks among breast survivors (Jones et al., 2007). This initial hypothesis was expanded beyond breast cancer survivors to other populations of cancer survivors and to include the impact of psychological distress as one of the additional ‘insults’ that diminish cardiac reserves (Schoormans et al., 2016). Distress has been shown to be related to cardiovascular risk factors among the general population, both through behavioral mechanisms, such as poorer diet and increased smoking and physiologically through neuroendocrine and platelet activation (Rozanski et al., 1999).

In conclusion, there appears a need to create interventions to address financial toxicity of cancer diagnosis and treatment given the clear impact on mortality; however, effective models of cost containment utilized in other countries (Canada, most European and Middle Eastern countries) are illegal in the United States (Kantarjian, Fojo, Mathisen, & Zwelling, 2013a). Specifically, many other countries governments negotiate the costs of drug prices with pharmaceutical companies, as a result the costs for standard cancer therapies are much lower. It is unclear if the Affordable Care Act had an appreciable impact on financial toxicity among the insured (Zafar, 2016a). However, given the results of the 2016 election, it is uncertain if the Affordable Care Act (ACA) will be repealed which may lead to a surge among the uninsured in the future. An assessment of the potential impact of modification or repeal of the ACA, was recently conducted using National Health Interview Survey data, which assessed three groups whose future health insurance status maybe in jeopardy: (1) adults with incomes below 400% federal poverty levels, (2) those who are covered through Medicaid due to disability but not Social Security eligible; and Medicaid enrolled adults or adults in families who did not receive disability income (Karaca-Mandic, Jena, & Ross, 2017). Adults in these three groups who were more likely to become uninsured through a policy change were more likely to be less educated, minorities, poor, unemployed and had significantly higher rates of self-assessed ‘poor’ health (Karaca-Mandic et al., 2017). Therefore, anticipated policy changes forecast a surge among an uninsured highly vulnerable population. This coupled with continued, unrestricted inflation of the costs of cancer drugs shouldered by cancer survivors, and experienced as financial toxicity could potentially lead to devastating consequences of preventable increases in cancer-related mortality.

Tables and Figures for Manuscript 3

Table 1

Description of the Study Sample of Cancer Survivors

	All (n=714)		Non Diabetic Cancer Survivors (n=577)		Diabetic Cancer Survivors (n=137)	
	N	Percentage/ Mean (SD)	N	Percentage/ Mean (SD)	N	Percentage/ Mean (SD)
Non-specific distress (0-24)	-	4.11 (4.58)	-	3.86 (4.51)	-	5.15 (4.72)
Mental Health (SF-12 Composite) (0-68.68)	-	50.02 (10.29)	-	50.30 (10.16)	-	48.86 (10.80)
PHQ-9	-	0.99 (1.53)	-	0.90 (1.51)	-	1.33 (1.58)
Chance of Recurrence	-	1.50 (1.09)	-	1.51 (1.07)	-	1.45 (1.16)
Fear of Recurrence	-	2.34 (1.19)	-	2.31 (1.15)	-	2.46 (1.31)
Demographics						
Age						
18-39	42	5.88	41	7.11	1	0.73
40-54	143	20.03	119	20.62	24	17.52
55-64	168	23.53	131	22.70	37	27.01
65-74	198	27.73	156	27.04	42	30.66
74-85	163	22.83	130	22.53	33	24.09
Gender						
Male	276	38.66	209	36.22	67	48.91
Female	438	61.34	368	63.78	70	51.09
Financial Stressors						
Insurance type						
No insurance	43	6.02	34	5.89	9	6.57
Any private	443	62.04	362	62.74	81	59.12
Public only	228	31.93	181	31.37	47	34.31
Financial Sacrifice due to Cancer						

No	650	91.04	527	91.33	123	89.78
Yes	64	8.96	50	8.67	14	10.22
Health Stressors						
No. of priority Conditions						
0-2	259	36.27	240	41.59	19	13.87
3-4	306	42.86	237	41.07	69	50.36
5 or more	149	20.87	100	17.33	49	35.77
Last Treatment						
< 1-3 years	159	22.27	121	20.97	38	27.74
3-5 years	90	12.61	73	12.65	17	12.41
5-10 years	163	22.83	129	22.36	34	24.82
10+ years	245	34.31	209	36.22	36	26.28
Not treated	57	7.98	45	7.80	12	8.76
Physical Functioning						
SF-12 Physical	-	43.02 (12.24)	-	44.52 (11.86)	-	36.72 (11.86)
Remission						
Not cancer free	47	6.58	37	6.41	10	7.30
No evidence of cancer	616	86.27	498	86.31	118	86.13
Doesn't know if cancer free	51	7.14	42	7.28	9	6.57
Socio-cultural resources						
Race/Ethnicity						
Non-Hispanic White	534	74.79	444	76.95	90	65.69
African American/Black	98	13.73	70	12.13	28	20.44
Asian	19	2.66	15	2.60	4	2.92
Other/Mixed Race	13	1.82	10	1.73	3	2.16
Hispanic/Latino	50	7.00	38	6.59	12	8.76
Income						
Low	251	35.15	196	33.97	55	40.15
Middle	214	29.97	169	29.29	45	32.85

High	249	34.87	212	36.74	37	27.01
Education						
< High school	100	14.01	61	10.57	39	28.47
High school/some college	399	55.88	324	56.15	75	54.74
Bachelors or higher	215	30.11	192	33.28	23	16.79
Internal resources						
Benefit finding from cancer experience						
No-cancer did not make me stronger	217	30.39	173	29.98	44	32.12
Yes-cancer made stronger	497	69.61	404	70.02	93	67.88
Social Supports						
Cancer caregiver						
No	424	59.38	346	59.97	78	56.93
Yes	290	40.62	231	40.03	59	43.07
Marital Status						
Married	378	52.94	303	52.51	75	54.74
Widowed	119	16.67	95	16.46	24	17.52
Divorced/separated	156	21.85	126	21.84	30	21.90
Never married	61	8.54	53	9.19	8	5.84

Table 2

Cross-sectional Ordinary Least Square Regression Models of Multiple Psychosocial Outcomes

	Non-specific Distress (n=714)		Mental Health functioning		Depression		Chance of Recurrence		Fears of Recurrence	
	β	SE	β	SE	β	SE	β	SE	β	SE
Primary Stressors										
Diabetic Status										
Non-Diabetic	-	-	-	-	-	-	-	-	-	-
Diabetic	0.20	0.41	0.02	0.99	0.07	0.14	0.04	0.11	0.15	0.11
Age										
18-39	-	-	-	-	-	-	-	-	-	-
40-54	-0.65	0.73	1.77	1.77	-0.17	0.25	-0.25	0.19	0.03	0.20
55-64	-1.17	0.74	3.42	1.80	-0.36	0.26	-0.56**	0.19	-0.18	0.21
65-74	-2.18**	0.75	6.52***	1.84	-0.58*	0.26	-0.52**	0.20	-0.29	0.21
74-85	-3.27***	0.80	8.67***	1.94	-0.98***	0.28	-0.65**	0.21	-0.52*	0.22
Gender										
Male	-	-	-	-	-	-	-	-	-	-
Female	0.33	0.34	-0.18	0.84	0.07	0.12	0.13	0.09	0.31**	0.10
Financial Stressors										
Insurance type										
No insurance	-	-	-	-	-	-	-	-	-	-
Any private	-1.54*	0.67	2.67	1.65	-0.25	0.23	0.07	0.18	-0.004	0.19
Public only	-1.03	0.70	1.67	1.72	-0.24	0.24	0.01	0.18	0.09	0.20
Financial Sacrifice due to Cancer										
No	-	-	-	-	-	-	-	-	-	-
Yes	1.51**	0.53	-3.13*	1.31	0.46**	0.19	-0.08	0.14	0.63***	0.15
Health Stressors										
No. of priority Conditions										
0-2	-	-	-	-	-	-	-	-	-	-
3-4	0.19	0.37	-0.63	0.91	0.01	0.13	0.09	0.10	0.02	0.11
5 or more	0.41	0.48	-1.29	1.17	0.05	0.17	0.08	0.13	0.15	0.14
Last Treatment										
< 1-3 years	-	-	-	-	-	-	-	-	-	-
3-5 years	0.95	0.53	-1.90	1.30	0.32	0.18	-0.03	0.14	-0.12	0.15
5-10 years	0.19	0.45	-0.53	1.11	0.15	0.16	-0.16	0.12	-0.19	0.13

10+ years	0.30	0.43	-0.95	1.05	0.10	0.15	-0.28*	0.11	-0.26*	0.12
Not treated	0.63	0.63	-1.20	1.55	0.41	0.22	-0.26	0.17	-0.38*	0.18
Physical Functioning										
SF-12 Physical	-0.14***	0.01	0.155***	0.04	-0.05***	0.01	-0.005	0.004	-0.003	0.004
Remission										
Not cancer free	-	-	-	-	-	-	-	-	-	-
No evidence of cancer	-0.78	0.65	0.79	1.59	-0.22	0.23	-0.91***	0.12	-0.54**	0.18
Doesn't know if cancer free	0.39	0.83	-2.16	2.03	0.12	0.29	-0.42	0.22	-0.10	0.23
Socio-cultural resources										
Race/Ethnicity										
Non-Hispanic White	-	-	-	-	-	-	-	-	-	-
African American/ Black	0.89	0.46	-0.50	1.14	-0.20	0.16	-0.48***	0.12	-0.03	0.13
Asian	0.56	0.94	0.16	2.29	0.11	0.32	-0.25	0.25	-0.23	0.26
Other/Mixed Race	-1.48	1.13	0.83	2.76	-0.45	0.39	-0.13	0.30	-0.17	0.32
Hispanic/Latino	0.23	0.64	-1.12	1.55	0.09	0.22	-0.38*	0.17	-0.31	0.18
Income										
Low	-	-	-	-	-	-	-	-	-	-
Middle	-0.90*	0.39	0.53	0.96	-0.30*	0.14	-0.06	0.13	0.09	0.11
High	-0.94*	0.43	1.16	1.06	-0.25	0.15	0.11	0.11	0.17	0.12
Education										
< High School	-	-	-	-	-	-	-	-	-	-
High school/some college	-0.13	0.48	0.16	1.18	-0.05	0.17	0.25*	0.13	0.63	0.14
Bachelors or higher	-0.52	0.56	1.79	1.38	-0.35	0.20	0.30*	0.15	0.12	0.16
Internal resources										
Benefit finding from cancer experience										
No-cancer did not make me stronger	-	-	-	-	-	-	-	-	-	-
Yes-cancer made stronger	-0.46	0.35	1.40	0.84	-0.02	0.12	0.09	0.09	0.08	0.10
Social Supports										
Cancer caregiver										
No	-	-	-	-	-	-	-	-	-	-
Yes	-0.54	0.31	-0.01	0.77	-0.02	0.12	0.10	0.08	0.39***	0.09

Marital Status										
Married	-	-	-	-	-	-	-	-	-	-
Widowed	0.60	0.47	-1.75	1.14	0.09	0.16	-0.02	0.12	-0.21	0.13
Divorced/ separated	0.41	0.40	-0.30	0.97	0.11	0.14	-0.12	0.10	-0.16	0.11
Never married	0.93	0.59	-2.03	1.43	0.30	0.20	0.01	0.15	-0.04	0.17
Explained Variance (R ²)	0.29		0.16		0.24		0.14		0.16	

*p<0.05 **p<0.01 ***p<0.001

Notes: All models run using cancer supplement weights.

Table 3

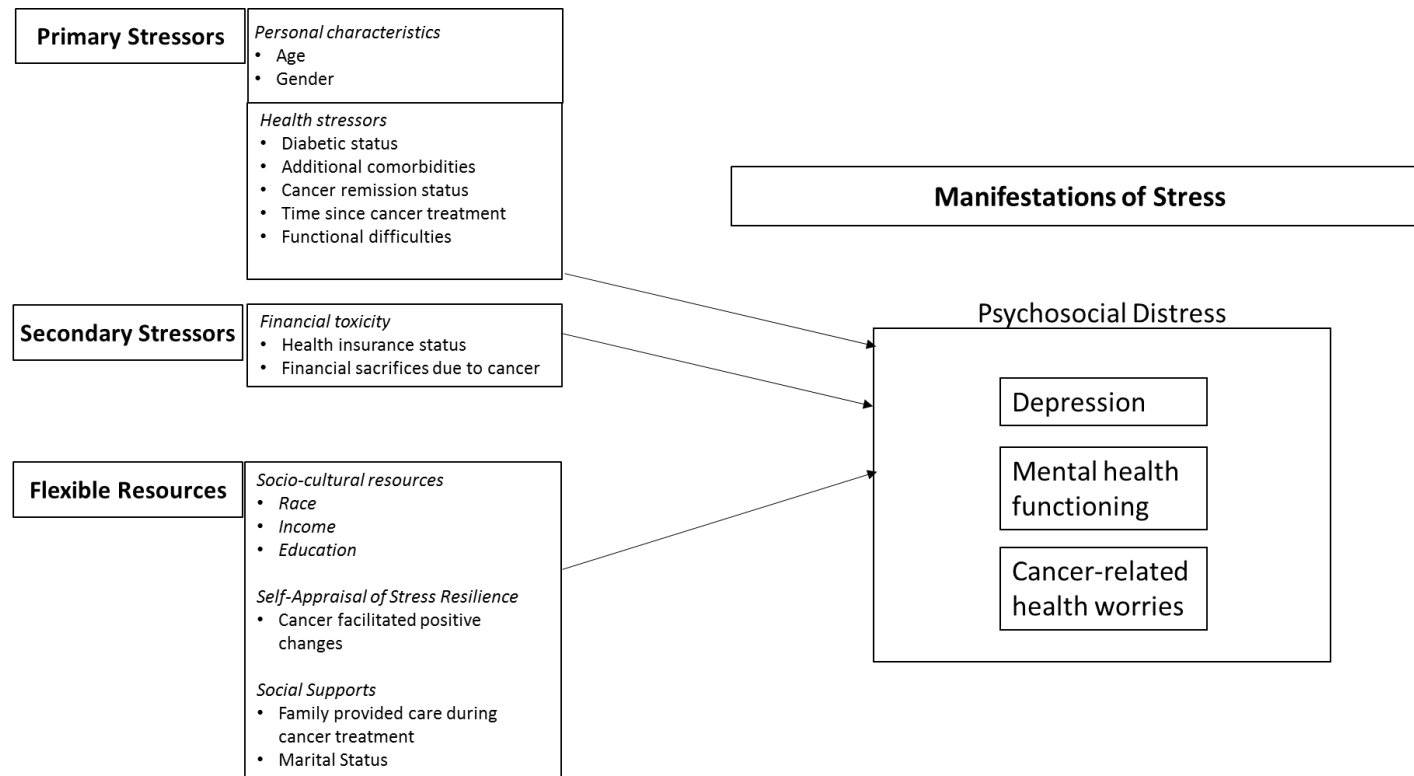
Logistic Model Results for Clinically Relevant Distress among Long-term Cancer Survivors

Variable	Sample Size (N=249)	% Distressed	Adjusted OR (95% CI)
Diabetic Status			
Diabetic	212	4.25	1 (Reference)
Non Diabetic	13	8.11	1.44 (0.16-13.07)
Age			
18-39	6	16.67	1 (Reference)
40-54	51	5.88	0.05 (0.002-1.28)
44-64	57	7.02	0.12 (0.006-2.43)
64-74	72	4.17	0.07 (0.003-1.56)
75-85	63	1.59	0.01 (0.0001-0.51)*
Sex			
Male	72	1.39	1 (Reference)
Female	177	6.21	3.29 (0.31-34.59)
Marital Status			
Married	122	4.10	1 (Reference)
Widowed	52	3.85	1.02 (0.97-10.67)
Divorced/Separated	52	7.69	0.30 (0.05-1.97)
Never Married	23	4.35	0.17 (0.01-3.34)
Education			
< High School	37	5.41	1 (Reference)

High School/GED/Some College	142	5.63	2.02 (0.244-16.64)
BA or higher	70	2.86	1.75 (0.11-27.70)
Income Level			
Low	81	12.35	1 (Reference)
Middle	74	1.35	0.07 (0.006-0.711)*
High	94	1.06	0.05 (0.004-0.54)*
Financial Sacrifices			
No financial sacrifices during cancer	224	3.57	1 (Reference)
Made financial sacrifices during cancer	25	16.00	7.04 (1.20-41.35)*
Insurance Type			
Uninsured	15	13.33	1 (Reference)
Any Private	158	2.53	0.17 (0.16-1.76)
Public Only	76	7.89	0.56 (0.05-5.90)
Priority Conditions			
0-2	93	4.30	1 (Reference)
3-4	101	3.96	0.96 (0.15-6.09)
5+	55	7.27	1.46 (0.19-11.33)

Figure 1

Integrated 'Fundamental Causes' and 'General Stress' Conceptual Model for Psychosocial Distress among Cancer Survivors



DISCUSSION AND CONCLUSIONS

Dissertation Summary

A review of the findings as they relate to the Link and Phelan's 'fundamental cause' theory.

The phenomenon of co-occurring diabetes among cancer survivors may contribute to health disparities among specific subpopulations of cancer survivors (See Figure 1, Summary of Findings). The aims of this dissertation were to: (1) identify social factors associated with the co-occurrence of diabetes and cancer and factors known to be associated with higher risks for poor outcomes (i.e., obesity and physical inactivity); (2) examine differences in self-assessed physical health (proxy for mortality), physical, and mental quality of life between diabetic cancer survivors and non-diabetic survivors; and (3) examine difference in multiple psychosocial outcomes between diabetic cancer survivors and non-diabetic survivors. The findings of this dissertation provide empirical evidence demonstrating that social factors maybe the 'fundamental causes' of persistent health disparities among lower socioeconomic cancer survivors. First, the identification of risks for the development of diabetes among cancer survivors provides support regarding the relationship between social factors and that have a negative impact on multiple disease outcomes for this population. The findings of this dissertation confirm that diabetic status is elevated among cancer survivors with less education and among African Americans compared to those with higher levels of education and Caucasians/whites, respectively. These findings also suggest, consistent with the results of other studies, that diabetic cancer survivors are less likely to engage in protective health behaviors like meeting physical activity recommendations and maintaining a healthy weight compared to non-diabetic cancer survivors (Findley & Sambamoorthi, 2009).

The second key relationship of the 'fundamental causes' theory, posits that social factors are related to multiple risk factors that are related to disease and death. Results from Aim 2, provide evidence that diabetic cancer survivors were more likely to report poor/fair health and had lower scores for overall physical health status compared to non-diabetic survivors. Patients who report poor/fair health are associated with higher mortality and greater health care utilization (DeSalvo et al., 2005). Therefore,

this finding is congruent with the growing body of evidence that has demonstrated elevated cancer mortality risk among diabetics (Barone et al., 2008; Larsson et al., 2006; Peairs et al., 2011; Vigneri et al., 2009a). Previous studies have also shown that being inactive, overweight and/or obese post-cancer is associated with poorer outcomes and higher comorbidity burden in another research study (Leach et al., 2015). In this study, diabetic cancer survivors were associated with higher levels of inactivity, not having weight in the 'healthy/normal' range. It follows that the findings of this dissertation also confirm that diabetic cancer survivors are more likely to have complex multi-morbidity (i.e., five or more conditions). Additionally, these findings suggest that survivors with complex multi-morbidity were substantially more likely to report poor/fair health. Moreover, cancer survivors who report poor/fair health are associated with reductions in overall mental health functioning. This study found no significant impact for diabetic status among several psychosocial variables. Yet, physical functioning and financial sacrifice played a significant role across several psychosocial domains. Increases in physical functioning among cancer survivors were associated with lower non-specific distress, lower rates of depression and increased mental health status. Whereas, financial sacrifice was associated with increases in non-specific distress, depression, more frequent fears of recurrence and decreased mental health status functioning.

The third empirical relationship needed to support the 'fundamental causes' theory describes how resource availability may enable specific populations to better adapt protective strategies. Results from Aim 2 and 3 of this dissertation identified income disparities associated with poorer physical and psychosocial health among cancer survivors. In this study, cancer survivors in the high-income group were associated with better physical health functioning and lower non-specific distress compared to cancer survivors in the low-income group. Further, Hispanic/Latino cancer survivors in the study sample were significantly more likely to report poor/fair health compared to Non-Hispanic whites. In the U.S., the Hispanic population is heterogeneous; however, overall substantial resource disparities between Hispanic/Latinos and Non-Hispanic whites (NHW) have been documented. For example, in 2010, in the general population 26.6% of Hispanics lived in poverty compared to 9.9% of non-Hispanic whites (DeNavas-Walt, Proctor, & Smith, 2011). Moreover, Hispanics/Latinos are much more likely to

be uninsured compared to NHWs and in 2010, approximately 31% of Hispanics were uninsured compared to 12% of NHWs. Due to access to care issues, Hispanics are less likely to be diagnosed at localized stages than NHWs for several types of cancers (Siegel et al., 2015).

There was an additional finding regarding the impact of resource availability during the acute cancer care phase and its impact on psychosocial functioning. In Aim 3, the impact of making a financial sacrifice during survivorship was found to be associated with several psychosocial consequences. Making a financial sacrifice during acute cancer treatment was associated with increased non-specific distress and depression, more frequent fears of disease recurrence and decreases in overall mental health functioning. Further, findings suggest that the impact of financial sacrifice during acute cancer survivorship may be associated with long-term psychosocial sequelae. Among survivors who were ten or more years of post-diagnosis, clinically significant psychosocial distress was associated with a financial sacrifice made during acute cancer care. This may be, in part, due to the issue escalating costs of cancer care, which are having an impact on patient health and well-being. This is recognized as a growing problem, which has prompted the American Society of Oncology's (ASCO) to develop the Cost of Care Task Force. The task force has recommended that discussions of costs of care be recognized as an important component of high quality cancer care, and that providers be trained and tools be developed to assist patients in decision-making processes that considers the financial implications (Meropol et al., 2009).

Practice Implications

The Institute of Medicine report, From Cancer Patient to Cancer Survivors: Lost in Transition (Hewitt et al., 2006) released recommendations that set the tone for much of the innovation around cancer survivorship model development seen in the past decade. This report provided the framework for the essential components of survivorship care, which included: (1) prevention of new and recurrent cancers and other impact of treatment; (2) surveillance for cancer metastasis, recurrence, and new cancers; assessment for development of emerging medical and psychosocial issues that resulted from cancer; (3) interventions focused on issues that developed

due to cancer and its treatment and; and (4) coordination of care between specialists and primary care (Hewitt et al., 2006). The recommendations for the development of survivorship care plans and the support of demonstration projects using interdisciplinary teams to pilot coordinated survivorship care have most notably shaped this landscape (Hewitt & Ganz, 2006).

Implementation projects and working groups were initiated by the Institute of Medicine to guide survivorship care plan refinement (Ganz & Hewitt, 2007; Parry, Kent, Forsythe, Alfano, & Rowland, 2013). The American College of Surgeon's has made the provision of survivorship care plans a requirement for cancer center accreditation, which was endorsed by the American Society of Clinical Oncology as a step toward the delivery of higher quality cancer care (Moy et al., 2011).

Shortly after the seminal cancer survivors report was released, a multi-level framework to address health disparities from a population framework was proposed by the National Cancer Institute's Centers for Population Health and Health disparities. This framework has yet to be applied to the issues of disparities found during cancer survivorship (Warnecke et al., 2008). Yet, this may be a useful framework to think about the fourth and final component of the 'fundamental causes' theory, which contends that the association between social factors and mortality is duplicated over time with the replacement of intervening factors and the emergence of new mechanisms. There remains a paucity of information to determine whether and how higher risk sub-populations, such as ethnic/racial minorities and cancer survivors who are of lower socioeconomic status have access to innovative survivorship care models.

Many of the contextual issues surrounding the organization and delivery of healthcare based on the socioeconomic characteristics of the population accessing clinics for diabetic care has been demonstrated previous work. Lutfey and Freese (2005) conducted a comparative case analysis that used a 'fundamental causes' theoretical lens examining how problem definition at both the individual and institutional setting was shaped contextually and how context mattered regarding how care was organized, what patient problems received attention and how health professionals viewed patient health

issues (Lutfey & Freese, 2005). Appreciable differences in how both the clinics in this study were staffed, care was structured and resources available to providers were observed based on the patient populations' socioeconomic status (Lutfey & Freese, 2005).

Despite widespread piloting of survivorship care models, there remains an absence of a standard of care for survivorship care delivery models (Halpern et al., 2015). Most of these models are an extension of the oncology models of care and rely strongly on the survivorship care plan as the link between specialty and oncology care (Campbell et al., 2011; Halpern et al., 2015). Unfortunately, no reliable information about how accessible cancer survivorship programs are to minority and underserved populations of cancer survivors in the U.S. are available (Surbone & Halpern, 2016). In recognition of contextual barriers (i.e., cultural/linguistic, race/ethnicity, insurance) impact care at the onset of a cancer diagnosis, patient navigation services have emerged as a method to reduce treatment delays for vulnerable populations (Vargas, Ryan, Jackson, Rodriguez, & Freeman, 2008). Given the nature of the access issues that have given rise to the standard use of patient navigations services for underserved patients it is reasonable to presume that many of these issues remain unresolved at the point of transitioning to post-acute cancer care.

Despite the reality that most cancer survivors separate from oncology care after a period of time and transition to primary care, efforts to build capacity beyond the oncology setting for survivorship care have been limited (Nekhlyudov et al., 2017). The chronic care model offers a framework to assess the various components of the healthcare and community systems and evaluate how survivorship models might evolve over time (Wagner, 2000; Wagner et al., 2001). Assessment and proposed interventions using Wagner's Expanded Chronic Care Model (CCM-E) might focused attention to the social determinants of health among the cancer survivor population across selected tenets of this model, including: self-management support, delivery system redesign, information systems, and strengthening of community action (Barr et al., 2003). There may be pivotal roles for clinical social work to support patient empowered and partner with community members to foster activation.

In the past decade, health reform have given rise to primary care practice redesign efforts informed by CCM-E, like the Patient Centered Medical Home, (PCMH) are being widely adopted by state and health systems with the aim to enhance quality of care and patient safety (Arrow et al., 2009; Berenson et al., 2008; Davis, Schoenbaum, & Audet, 2005). The PCMH model incorporates best practices in access, prevention, chronic disease management, care coordination, and patient responsiveness that integrates innovative health technology to enhance communication is the goal (Bodenheimer, Wagner, & Grumbach, 2002; Grumbach & Bodenheimer, 2002; Rosenthal, 2008). Within these models, there are envisioned roles for social workers in the areas of patient navigation, care coordination and behavioral health care treatment (Andrews, Darnell, McBride, & Gehlert, 2013). Patient centered medical homes are being adopted by federally qualified health centers who are responsible for caring for underserved populations. An assumption of the CCM-E model that may not hold among vulnerable cancer survivors is that patients have the necessary skills and ability to collaborate with the health care team, develop a plan of care and take action (Findley, 2014). The health care system is fragmented and health care teams in primary care are not yet prepared to deliver long term survivorship care, therefore improvements targeting the cancer survivor population must appreciate these challenges and confront them directly (McCorkle, Ercolano, Lazenby, Schulman-Green, et al., 2011). Efforts to disseminate relevant evidence to federally qualified health centers and to develop community responsive strategies might be best operationalized using a multi-disciplinary approach that includes health educators, social workers and nursing staff.

Population risk-based approaches to cancer survivorship care have been described in detail, but have yet to be operationalized (McCabe, Partridge, Grunfeld, & Hudson, 2013b; Nekhlyudov et al., 2017). In proposed models, five years after treatment ends patient risk level would be assessed based on cancer, comorbidity and degree of physician specialization to address the needs based on risk (Nekhlyudov et al., 2017). The promise of these models, theoretically, is that they stratify patients based on their acuity and match them to the level of care that can most adequately meet their needs, accounting for both cancer and multi-morbidity concerns. Thus far,

these models describe the distinction in roles between primary care providers and oncologists and the level of training necessary for primary care providers to assume a leadership role in the long term care of cancer survivors, without providing much input in the role and potential contributions of other health professionals on the care team. As much of the activities necessary for managing cancer survivorship, and particularly patients with other chronic conditions, extend beyond basic medical care to include behavioral and social factors further articulation of workforce development for social workers and other supportive care staff are needed. The potential for social work contribution to facilitate the adjustment, access community, and family and individuals' capacity to make and sustain behavior changes to mitigate risk of this population are vast.

Patient behaviors to support quality survivorship care include attendance to routine visits to the oncologist, learning and monitoring for recurrence, managing the late effects of cancer and its treatment, coping with psychological distress, resuming normal routines (e.g., return to work) and fulfilling social roles and obligations. Oncology social workers are the largest workforce that is responsive to the psychosocial needs of cancer survivors, and this care is often delivered through a multidisciplinary team based model (Zebrack, Walsh, Burg, Maramaldi, & Lim, 2008). Oncology social workers provide biopsychosocial assessment, supportive counseling, and case management to enhance cancer care. Additionally, oncology social workers frequently broker communications between health care professionals and patients and families about concerns and decision-making (Gehlert & Browne, 2011). Clinicians with counseling skills, particularly motivational interviewing and cognitive behavioral training, effectively empower patients and decrease distress during the treatment phase of care (Given et al., 2004; McCorkle, Ercolano, Lazenby, Schulman-Green, et al., 2011; Sikorskii et al., 2007). Due to social workers' counseling skills and philosophical orientation to foster social justice they are uniquely suited to meet the needs of potentially vulnerable cancer survivors as models of care are operationalized and expand into primary care (Findley, 2014; Wagner, 2000). There is currently a lack of evidence regarding

how to best integrate cancer survivorship models into existing CCM-E models; further research is needed to explore and expand these models and social workers potential roles within them. Social works' historical commitment to patient-centered care and the potential bridging functions between the medical system and social services could enhance care service delivery models during cancer survivorship; however, this potential remains untested as there is an insufficient empirical evidence base to support best practices for social work CCM-E integration (Allen, 2012).

There is clearly a role for social work to empower and support patients with adequately adjusting to the needed tasks of self-management and to assess barriers to achieving preventive health goals. The core skills of self-management include: problem-solving, decision making, resource utilization, forming patient-provider relationships, and taking action (Lorig & Holman, 2003). Currently the strongest evidence is available to identify potential intervention opportunities to support breast cancer survivorship. In an earlier study, a need for stronger information support among African American survivors and patients with more comorbidity to guide follow-up care was demonstrated (O'Malley et al., 2014). Not only would social workers be ideally suited to deliver health education in a culturally appropriate manner, social workers could also assess if patients accurately understand their health risks. Findings in Aim 3 suggest that despite poorer outcomes among Hispanics and African American cancer survivors these survivors were less likely to report that their cancer may return. In a recent study, a study of overweight and obese breast cancer survivors, patients described higher levels of cardiovascular risk; however, they did not accurately assess their long-term health risk (Christian, O'Malley, Barac, Miller, & Hudson, 2017). Ensuring patients understand their risks is important because inaccuracy about or uncertainty about risk perception has been shown to be related to lower levels of cancer screenings (Waters et al., 2016). Health literacy issues can affect patient perceptions of risk and presentation of information may need to be tailored based on issues of literacy, numeracy and linguistic barriers (Hamstra et al., 2015). Issues of embarrassment due to limited health literacy or

literacy in general may potentially interfere with patients' health seeking behaviors and could be an additional barrier to patients receiving the information they need (Katz et al., 2007).

Not only may patients not be accurately assessing their health risks, also, providers may not be delivering consistent health education messages about what health behaviors cancer survivors should address. For example, in a study of overweight and obese cancer survivors, despite the elevated risk for cardiovascular issues post-cancer only half of these overweight and obese breast cancer survivors had ever spoken to a health care provider about weight management. Thirty-six percent of the survivors initiated the weight-related conversations themselves; and, among those who raised weight related concerns these concerns were frequently dismissed by their providers (Christian et al., 2017). A recent study found that patient activation levels are high among breast cancer survivors (O'Malley et al., 2017). Despite this, there may be barriers to productive conversations between patients and providers to support breast survivors taking action toward reaching weight loss goals.

Policy Implications

The Affordable Care Act implementation in 2010 resulted in a rapid increase of insured younger Americans shortly after implementation (Cantor, Monheit, DeLia, & Lloyd, 2012); and, it is estimated that an additional 20 million Americans have gained health insurance as a result of this policy (Blumenthal & Collins, 2014). Prior to ACA implementation an estimated 14.7% of survivors were uninsured and 18% of this population reported having a financial hardship; it was anticipated that 30% of the uninsured cancer survivor population would become eligible for health insurance upon implementation (Davidoff, Hill, Bernard, & Yabroff, 2015). This is important for prevention of complex sequelae, as uninsured cancer survivors are less likely to receive preventive care, including cancer screenings (Yabroff et al., 2013) and are more likely to be diagnosed with later stage cancers which have poorer prognosis (Ward, Fedewa, Cokkinides, & Virgo, 2010).

The findings of this dissertation suggest that given the low rates of protective behaviors among survivors generally, and diabetic cancer survivors in particular barriers from engagement

in protective behaviors must be addressed. Previous research suggests that cancer survivors engage in chronic disease management sub optimally (Earle & Neville, 2004). Additionally, this study demonstrated that diabetic cancer survivors were more likely to be among the cluster of patients with complex multi-morbidity. Nationally, complex multi-morbid patients are expensive; strategies to identify and mitigate risks and encourage prevention strategies are needed (Anderson, 2012). A recent study found that African American/black and Caucasian/white cancer survivors had similar rates of cancer specific mortality when they were uninsured; however, Caucasians/whites had better mortality outcomes among the privately and publically insured (Pan et al., 2017). Therefore, there may be a greater benefit to being insured among Caucasian/white Americans (Pan et al., 2017). Given the racial and educational disparities among racial groups found in the presentation with diabetes during cancer survivorship.

There is uncertainty about how stable this enhanced insurance status among survivors will remain over the next four years, as efforts to repeal and replace the Affordable Care Act continue. An recent evaluation of the impact of repealing the ACA, using National Health Interview Survey data, which identified three groups whose future health insurance status is uncertain: (1) adults with incomes below 400% federal poverty levels, (2) those who are covered through Medicaid due to disability but not Social Security eligible; and Medicaid enrolled adults or adults in families who did not receive disability income (Karaca-Mandic et al., 2017). These three groups consists of adults who are more likely to be less educated, minorities, poor, unemployed and had significantly higher rates of self-assessed 'poor' health (Karaca-Mandic et al., 2017). Therefore, anticipated policy changes would add to the barriers to receive care among an already highly vulnerable population.

Financial toxicity (i.e., having high out of pocket expenses that lead to financial concerns, in turn leading to poor quality of life) is another concern where policy solutions could mitigate the physical and psychosocial consequences. Effective policy models have contained the costs for both the patients and healthcare systems in other countries; however, these practices are

unregulated in the United States (Kantarjian, Fojo, Mathisen, & Zwelling, 2013b). It is standard practice in several other countries to negotiate with pharmaceutical companies to contain the costs of standard cancer therapies (Zafar, 2016d).

In 2012, the American Society of Clinical Oncology issued a policy statement regarding the opportunities set forth within the Patient Protection and Affordable Care Act (PPACA) to reduce cancer-related health disparities (Moy et al., 2011). The policy statement comments on the PPACA for, lacking a commitment to improving survivorship care, citing the need for more comprehensive coordination and the need for survivorship care plans reimbursement that adequately covers the time needed for the coordinated activities (Moy et al., 2011). This endorsement followed the publication of the results of an efficacy trial, which suggested that care plans had no effect on patient care (Grunfeld et al., 2011). Further, while the ASCO's policy statement supported the strengthening of community health centers through the PPACA; it failed to make the connection to comorbidity burdens and the potential and unrealized role of community health centers. However, the policy did note that these same systems infrastructures were strengthened considerably through the PPACA in this statement (Moy et al., 2011). The only mention of comorbidity among underserved cancer survivors raised in the policy statement was levied to challenge the PPACA for penalties the providers and hospital would experience for the penalization around hospital readmissions (Moy et al., 2011).

In countries with stronger primary care systems (e.g., Canada and England) cancer survivorship programs in primary care settings have been shown to be effective (Cheung et al., 2013; Del Giudice, Grunfeld, Harvey, Piliotis, & Verma, 2009; Grunfeld et al., 2006; Grunfeld et al., 1996; Walter, Usher-Smith, Yadlapalli, & Watson, 2015). Yet, early innovators of primary care based model in the U.S. face substantial implementation challenges, including reimbursement issues, knowledge deficits among providers and poor information transfer between oncology and primary care systems (Nekhlyudov, Aziz, Lerro, & Virgo, 2014; Nekhlyudov et al., 2017; O'Malley et al., 2017). Recently, professional groups have begun to

emphasize the need for inter-disciplinary collaboration that more proactively engages primary care. In 2016, the American Academy of Family Physicians, the American College of Surgeons and ASCO have created a forum focused specifically on advancing the science related to primary care capacity in cancer survivorship care. Additionally, the American Cancer Society has issued cancer survivorship guidelines for breast, prostate, colon and head and neck cancers (Cohen et al., 2016; El-Shami et al., 2015; Runowicz, Leach, Henry, Henry, Mackey, Cowens-Alvarado, et al., 2016; Skolarus et al., 2014). These guidelines do not address how cancer survivorship should be integrated into multi-morbidity care models or which aspect of survivorship care needs to be emphasized for different subsets of patients (Nekhlyudov et al., 2017).

Future Research Directions

The National Cancer Institute's Centers for Population Health and Health Disparities emphasizes the need for multi-level approaches and research to understand the distinctions between health inequities and disparate health outcomes based on biological differences (Warnecke et al., 2008). Further research is needed to distinguish the components of the diabetic cancer survivorship phenomenon that are issues of inequity versus issues of disparate outcomes in specific subpopulations of cancer survivors (Harper & Lynch, 2006). To explore the health inequities and access issues, research using a 'fundamental causes' lens to explore how the contexts of cancer survivorship care model innovation are shaping who has access to this type of care and to assess whether these efforts are sufficiently reaching minorities and other at-risk subpopulations. Detailing these differences can inform strategies about which aspects of the multiple systems involved (ranging from policy to institutional to individual person levels) need to be intervened upon and how (Warnecke et al., 2008).

The Minority Health and Health Disparities Research framework conceptualizes the factors considered relevant to promoting minority health and eliminating health disparities identifies the following levels of influence: individual; interpersonal; community and societal (National Institute of Minority Health and Health Disparities, 2017). The domains of influence

where interventions can be leveraged to address disparate outcomes are: biological, behavioral, physical environment, sociocultural environment and the healthcare system. Based on the findings from this study, demonstrating racial and educational disparities exist for likelihood to have co-morbid diabetes during cancer survivorship and that diabetic survivors in particular adopt sub-optimal rates of protective health behaviors additional research is needed to identifying mediating factors could drive intervention development. The ‘risk of risks’ assessment suggests that cancer survivors with diabetes are less likely to maintain a healthy weight or engage in physical activity at recommended levels compared to non-diabetic survivors. Further, diabetic cancer survivors were significantly more likely to have complex multi-morbidity in the study sample. To add to these findings, future studies would benefit from a more robust conceptualization of Link and Phelan’s ‘flexible resources’ variables that extends beyond race, education, income and includes additional factors (e.g., prestige, occupation, social networks). Futures studies would also benefit from utilizing a data set that includes longitudinal measures that have additional clinical information, for example, stage of diagnosis and cancer treatment.

The relationships between social factors that contribute to the disparities in diabetic cancer survivors must be explored further. A next step for this research should more fully explore the relationship of obesity and patient activation as mediating variables between social factors and the likelihood of developing comorbid diabetes among cancer survivors and the development of complex multi-morbidity. First, an examination of the role of BMI on health outcomes is needed based on the findings of this dissertation and the current directions of the field, further explorations are needed to elucidated distinctions in health equity and population disparities that focus on the intersection of race, obesity and cancer survivorship. Among breast cancer survivors, previous research has shown that obesity and body fat distribution impacts cancer survival and these differ by race/ethnicity groups (Kwan et al., 2014). As described in Schmitz et al. (2014) cardiovascular disease race/ethnic disparities were found to be attributed to unmeasured environmental, social, and generic factors that contributed to excess risk among

African American and Native Hawaiians and lowered risk among Japanese Americans and Latinos compared to Non-Hispanic whites (Henderson et al., 2007).

Previous research has demonstrated that patient activation is lower among patients who have multiple chronic conditions (Hibbard & Cunningham, 2008) and among low socioeconomic groups (Greene & Hibbard, 2012; Hibbard & Cunningham, 2008). Exploring the mediation of patient activation on the relationship between socioeconomic status and health outcomes and socioeconomic status and BMI could provide valuable insights about where to best leverage interventions to mitigate the risks of diabetic cancer survivorship. Further, previous studies have shown that survivors with lower levels of activations are responsive to interventions to increase activation (Hibbard & Greene, 2013) and activation is amenable to change around several health behaviors for several conditions (Hibbard, Greene, & Tusler, 2009). Based on the present study's findings, future research using large multi-ethnic cohorts could provide more in-depth understandings about the relationships and mediating variables between race/ethnicity and obesity on cancer survivorship health outcomes (Schmitz et al., 2014). This would provide needed information to direct prevention efforts to address the issues faced by diabetic cancer survivors further up the causal chain to eliminate disparities in the burden of these diseases.

Discussion Figures

Figure 1

Summary of Dissertation Findings

Summary of Aim 1 Findings	Summary of Aim 2 Findings	Summary of Aim 3 Findings
Who is more likely to be a Diabetic Cancer Survivor (DCS)? <ul style="list-style-type: none"> High School Education 63% greater odds of DCS vs. Bachelor degree + Less than high school 215% greater odds of DCS vs. Bachelors degree + African American race 105% greater odds of DCS vs. Caucasians/White 	Factors Associated with Reporting Poor/Fair Health (PFH) <ul style="list-style-type: none"> DCS 170% greater odds of reporting PFH vs. NDCS Hispanic/Latino survivors 155% greater odds of reporting vs. Caucasians/Whites Bachelors+ education 50% lower odds of PFH vs. non high school degree Survivors with 5 or more comorbid conditions associated with 585% greater odds PFH vs. survivors with 1-3 conditions 	Psychosocial factors associated with physical functioning <p>Increases in PHS associated:</p> <ul style="list-style-type: none"> with lower Non-specific Distress (NSD) decreases in depression Increased MHS
'Risk of risks' –Diabetic Status Risk Profile <ul style="list-style-type: none"> DCS 48% lower odds of meeting physical activity recommendations vs. NDSC DCS 73% lower odds of being at a healthy weight compared NDSC DCS 186% greater odds of having 5 or more comorbid conditions vs. NDSC 	Factors Associated with Physical Health Status (PHS) and Mental Health Status (MHS) <ul style="list-style-type: none"> DCS associated with 4.20 decrease of PHS vs. NDSC High income positively associated with 3.44 increase in PHS vs. low income Survivors with 5+ comorbidities associated with 10.78 lower score on PHS] MHS not significantly associated with DCS As reports a physical health are less favorable MHS declines Survivors reporting PFH associated with associated with 12.24 reduction on mental health status (MHS) 	Psychosocial factors associated with income <ul style="list-style-type: none"> High and middle income associated with lower NSD vs. low income Middle income associated with lower depression vs. low income
		Psychosocial factors associated with financial sacrifice <p>Having had to make a financial sacrifice during cancer treatment is associated with:</p> <ul style="list-style-type: none"> increased NSD increased depression more frequent fears of disease recurrence decreased MHS
		Race/ethnicity factors associated with perception of 'chance of recurrence' <ul style="list-style-type: none"> African American/Black cancer survivors reported lower chance of recurrence vs. Caucasian/Whites Hispanic/Latina cancer survivors reported lower change of recurrence vs. Caucasian/Whites

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