THE E-DIARY-CS: AN INTERNET BASED DAILY DIARY STUDY OF STRESS, PHYSICAL ACTIVITY AND HEALTH IN CANCER SURVIVORS

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A thesis submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Arts in the Department of Psychology (Clinical Psychology).

Chapel Hill
2006

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ABSTRACT

EDWARD FORREST MORRILL: The E-Diary-CS: An Internet Based Daily Diary Study of Stress, Physical Activity and Health in Cancer Survivors
(Under the direction of Karen M. Gil, Ph.D.)

The current study had two goals; first, the study examined the relations among stress, physical activity, and health symptoms in cancer survivors, and second this study attempted to psychometrically validate an electronic daily diary measure of stress, physical activity and health symptoms in cancer survivors (E-Diary-CS). Participants were 20 cancer survivors who provided daily self-report data on their current level of stress, health symptoms, and physical activity, for 3 weeks using the E-diary-CS. Results of linear regression indicated that higher levels of stress explained a significant amount of variance in health symptoms (R^2 = .215, $p < .05$). Neither physical activity nor the interaction with stress predicted health symptoms. The association between well-validated, commonly used baseline measures and daily diary scores were moderate to strong and in the expected directions suggesting the E-diary-CS is a valid and reliable tool to assess stress, physical activity and health symptoms in cancer survivors.

ACKNOWLEDGEMENTS

To many of my colleagues the masters thesis is but another step along the long road we trudge toward a Doctor of Philosophy in clinical psychology. However, I firmly believe that the masters thesis is much more than a mere step along the way. Successfully, proposing, writing, and defending a masters thesis is a monumental milestone in both professional and academic development. It is a milestone that, is not ever reached by the vast majority of the population and I am immensely grateful for the opportunity to be one of the few who has been fortunate enough to complete such an enriching task. In that light I would like to thank those who have helped me along the way for without them, I would not have been able to achieve this accomplishment. First, I would like to express my gratitude to family, especially my mother and my father who instilled in me the work ethic and character necessary for such an undertaking. I would like to acknowledge the support of my friends without whom I would have been lost. Finally, I would like to thank the members of my thesis committee Deborah Jones and Abigail Panter for their valuable input and thoughtful comments on the design and execution of the study reported herein. Lastly, but certainly not least, I wish to thank my thesis committee chair, advisor, and friend, Karen Gil for without her support, assistance, and tireless patience throughout this process, I am certain that this study and subsequent thesis would not have been completed.

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ACS	American Cancer Society
AIDS	Acquired Immune Deficiency Syndrome
CHIPS	Cohen-Hoberman Inventory of Physical Symptoms
DRC	DNA Repair Capacity
E-Diary-CS	Electronic Diary for Cancer Survivors
E-VAS	Electronic visual analogue scale
HIV	Human Immunodeficiency Virus
HLM	Hierarchical Linear Modeling
HRSD	Hamilton Rating Scale for Depression
IBS	Irritable Bowel Syndrome
MDD	Major Depressive Disorder
MOS SF-36	Medical Outcomes Study 36-item Short Form
NCI	National Cancer Institute
NHIS	National Health Interview Survey
PANAS	Positive and Negative Affect Schedule
PSS	Perceived Stress Scale
RSCL-M	Modified Rotterdam Symptom Checklist

INTRODUCTION

The overall goal of this research was to examine the extent to which stress predicts daily health symptoms in adults who have survived cancer. In order to provide the relevant background for the proposal, this introduction will briefly summarize the research on stress, physical health, and physical activity, especially as they relate to cancer survivorship. In addition, given that the study incorporates a newly designed electronic daily diary method of data collection, the introduction will include a brief review of daily diary and electronic data collection methodologies as they relate to health psychology research.

Cancer Survivorship

Cancer is a term that refers to a conglomerate of separate but related diseases all of which have an underlying similarity, namely, uncontrolled cell growth (National Cancer Institute., 2004c). This uncontrolled cell growth can be detrimental to the body in a number of different ways such as damaging tissue and hindering normal body processes such as digestion, cardiovascular function, and neurological function (American Cancer Society., 2003).

According to the (National Cancer Institute., 2004d) there are an estimated 1.3 million new cancer cases diagnosed each year. Furthermore, 63% of children and adults diagnosed with cancer in recent years will survive for five years or more (American Cancer Society., 2003). Among the most common cancers in adults are prostate, breast, and skin, although there are more than 200 types of cancer (National Cancer Institute., 2004b).The most common forms of treatment for cancer are surgery, irradiation, and chemotherapy. Depending on the type of

cancer and treatment protocol, cancer patients often experience unpleasant side effects of treatment including nausea, hair loss, fatigue and cognitive deficits (Kangas *et al.*, 2002). Following the active treatment phase, most cancer patients with life threatening disease attend regular follow-up appointments, and many begin adjuvant medical therapies.

The physical and psychological challenges associated with the diagnosis and treatment of cancer are well documented (Bleiker *et al.*, 2000; Pettingale *et al.*, 1988; Sherliker & Steptoe, 2000; Smith *et al.*, 1999; Trask *et al.*, 2003). Given the challenges facing cancer patients during the active phase of treatment, it is very common for patients to experience anxiety, depression, fear of death and other psychosocial consequences. Indeed, regular visits to the treatment setting can act as an ongoing reminder of diagnosis/treatment and may extend the cancer experience for many months and potentially years (Gil *et al.*, 2004b; Smith et al., 1999).

In recognition of the significance of cancer survivorship, in 1996 the Office of Cancer Survivorship of the National Cancer Institute (NCI) was established for the purpose of enhancing the length and quality of life of the estimated 8.9 million cancer survivors in the United States and addressing their unique and poorly understood needs (National Cancer Institute., 2004a). The NCI Office of Cancer Survivorship supports research in the areas of physical effects of disease and treatment, psychosocial factors, health disparities, intervention, family issues, financial burden, communication, and instrument development. The recent focus on understanding the needs of cancer survivors has led to psychosocial research in the areas of quality of life, perceived stress, depression, and anxiety (Brown *et al.*, 2003; Carlson *et al.*, 2003; Drageset & Lindstrom, 2003; Giovagnoli, 1999; Trask et al., 2003). Cancer survivorship research has also focused on cognitive function, fatigue, physical

activity, spiritual/religious activity, and physical health (Bardwell *et al.*, 2004; Cordova *et al.*, 2001; Iconomou *et al.*, 2004; Mock *et al.*, 2001).

Health psychology research in cancer survivorship has paralleled the research in other chronic diseases in that investigators have not only tried to document the specific physical and psychosocial consequences of the cancer experience, but more importantly, to identify the significant predictors of physical and psychosocial adjustment. As in research with other chronic diseases, stress has emerged as a potentially salient predictor of overall adjustment for cancer survivors (L. Cohen *et al.*, 2000; Forlenza *et al.*, 2000; Porter *et al.*, 2003). Additionally, physical activity has been found to be an important component of quality of life in cancer survivors (Bardwell et al., 2004), and may be especially important in understanding the relations between stress and cancer survivorship (Kolden et al., 2002).

As Dr. George L. Engel pointed out nearly 30 years ago in his challenge to biomedicine, physical health outcomes ranging from serious chronic illness to the common cold occur in the context of a complex interaction of physiological, psychological and socio-cultural variables. This viewpoint, commonly referred to as the bio-psycho-social model (Engel, 1977), is the underlying basis of much of the current health psychology research (Jones *et al.*, 2004; Panter & Reeve, 2002), including the current study and many studies recently conducted by our laboratory (Gil *et al.*, 2001; Gil *et al.*, 2003; Gil *et al.*, 2004a; Schanberg *et al.*, 2003; Yacono Freeman & Gil, 2004).

Stress

Stress has been described as a "give-and-take" interaction between a person and their environment (Folkman *et al.*, 1986). In recent research, stress has emerged as a potentially salient factor in the area of physical health with regard to the development of illness,

exacerbation of symptoms and general physical health (S. Cohen *et al.*, 1993; DeLongis *et al.*, 1988; Reibel *et al.*, 2001). Lazarus and Cohen (1977) proposed a model incorporating two general levels of stressors: (1) major life events, such as natural disaster, injury, or diagnosis with a serious illness, and (2) minor daily hassles, which include day-to–day stressors such as problems with co-workers, professors, family members, significant others and friends as well as minor traffic accidents. Kanner et al., (1981) emphasized the importance of daily hassles and further conceptualized and integrated a model that incorporated measurement of minor stressors as they accumulate over time into stress research. Subsequent research has demonstrated that stress from daily hassles is an important predictor of poorer physical health outcomes even after controlling for the effect of major life events (DeLongis, 1982). The impact of stress on health has been documented in studies using both subjective (self-report) experiences as well as physiological reactions as the relevant outcome measure.

Specifically, daily stress has emerged as an important predictor of physiological health outcomes such as immune function (Glaser et al., 1992), DNA repair (L. Cohen et al., 2000; Glaser *et al.*, 1985), and health complaints (Torsheim & Wold, 2001). In a sample of 48-second year medical students, Glaser, and colleagues (1992) found that having less stress was related to a more functional immune system, as measured by immune response to inoculation for hepatitis B. Cohen and colleagues (2000) studied the effect of exam stress in 16 first and second year medical students. They report that exam stress caused elevations in DNA Repair Capacity (DRC), a potential measure of DNA damage, and perceived stress. Forlenza, Latimer, and Baum (2000), reported that among professional students (i.e.,

medical, dental, pharmacy, and law), both DRC and perceived stress were higher during the stressful exam period when compared with a non-stressful end of vacation assessment.

Within the context of cancer, research has demonstrated that cancer survivors have altered physiological responses that may be due to prolonged stress from their illness. In one study, Porter found that breast cancer survivors had a higher baseline cortisol level and experienced a reduction in cortisol levels from baseline to the mammography period whereas healthy controls had an increase in cortisol levels for the same stressful period of time (Gurevich et al., 2004; Porter et al., 2003). These findings suggest that chronic stress resulting from the cancer experience may lead to heightened baseline levels of physiological arousal and may suppress typical patterns of physiological reactions in acute stressful situations.

Taken together these results indicate that daily stress could prove particularly important to researchers interested in the physiological consequences of cancer diagnosis, treatment, and survivorship. If the cumulative stress caused by low intensity stressors and frustrations in daily life is layered upon and interacts with an underlying major life event, such as the cancer experience, it is possible that the resulting exacerbation of an already dysfunctional stress response could be particularly deleterious with regard to health.

Stress and Physical Health Symptoms

Stress has been associated with physical health symptoms in a multitude of health problems including HIV/AIDS, cancer, cardiovascular disease, gastrointestinal disorders, musculoskeletal disorders, ulcers, allergies, asthma, migraine headaches, backaches, herpes, influenza, and the common cold (Antoni, 2003; Carson, 1999; S. Cohen & Hoberman, 1983; S. Cohen et al., 1993; DeLongis et al., 1988; Leserman, 2003; Pereira *et al.*, 2003;

Takkouche *et al.*, 2001). For example, Pereira and colleges (2003) reported that stress was a significant predictor of genital herpes recurrence among 34 HIV+ African American women. DeLongis and colleagues (2004) reported an association between stress and health problems among 75 married couples who participated in their repeated measure design study. Specifically, they reported that daily stress was associated with same and subsequent day backaches, headaches, sore throat, and influenza.

Takkouche and colleagues (2001) found that among 1,149 faculty and staff at a Spanish university, perceived stress, positive and negative affect, and stressful life events were all associated with occurrence of the common cold. They report that lower levels of positive affect and higher levels of negative affect, perceived stress, and more stressful life events were all associated with an increased risk of occurrence of a common cold. Likewise, Cohen, Tyrrell, and Smith (1993) explored the relations between stress and the common cold among 394 healthy participants all of whom were intentionally exposed to a common cold virus. They reported that higher stress was associated with a greater risk of developing a common cold.

Physical health is an important component of quality of life in cancer patients and survivors (Cella & Tulsky, 1993). Cancer survivors often have increased difficulty with many health issues such as fatigue, pain, swelling, and acute illnesses and these difficulties are sometimes prolonged for years following active treatment (National Cancer Institute., 2004c). Research indicates that daily stress combined with other psychological and physiological sequelae of cancer diagnosis, treatment and survivorship have an effect on the physical and psychological wellbeing of those with a history of cancer (Abercrombie *et al.*, 2004; Golden Kreutz *et al.*, 2004).

Stress reduction interventions such as mindfulness-based meditation, yoga, self-hypnosis, progressive muscle relaxation, and guided imagery have been shown to improve physiological and psychological health (Carlson et al., 2003; Carson, 1999; Craske, 1999). Carlson and colleagues (2003) sought to explore the effect of a mindfulness-based stress reduction intervention on various aspects of physiological and psychological health among 49 women and 10 men undergoing active treatment for breast or testicular cancer respectively. They report that participation in a mindfulness based stress reduction intervention lowered stress related symptoms and improved quality of life, sleep quality and immune function. Carson (2002) sought to explore the efficacy of an 8-week mindfulness-based meditation intervention for irritable bowel syndrome (IBS). He reports that, among 13 Caucasian women, all of whom suffered from IBS, higher stress and anxiety predicted greater symptom severity, more meditation predicted less same-day stress and reduced symptom severity.

Collectively, the results of these studies indicate that stress is linked to a number of physical health problems and has been shown to exacerbate symptoms in a number of diseases including in cancer survivors. Stress may be particularly important to health in populations already under an extreme physical health burden such as treatment for cancer. Additionally, stress reduction interventions appear to be efficacious for the remediation of stress and for improving physiological health and psychological outcomes.

Stress and Physical Activity and Physical Health

In healthy individuals, physical activity, has been shown to buffer the relation between stress and physical illness (Blanchard *et al.*, 2003a; Carmack *et al.*, 1999; Kolden et al., 2002; Mock et al., 2001). For example, Carmack and colleagues (1999) found a

significant relationship between stress, physical activity, and physical illness among 135 undergraduate participants. They report that physical activity had a buffering effect on the relation between stress and physical symptoms. Researchers have identified a number of potential physiological mechanisms linking physical activity with health outcomes such as direct benefit to cardiovascular performance, increased overall fitness, and decreased obesity (Cooper & Brill, 1988; Hansen *et al.*, 2005). Physical activity may also have an effect on the stress response, and therefore the immune response, through several mechanisms including a relative decrease in the activation of the adrenal cortex and subsequent reduction of exogenous glucocorticoid in the circulatory system, thus buffering the deleterious effect of cortisol on immune system functioning (Carmack et al., 1999; Glaser et al., 1992; Segerstrom & Miller, 2004; Takkouche et al., 2001).

In a sample of 52 breast cancer survivors, Mock and colleagues (2001) reported that those who walked at least 3 days per week for at least 90 minutes experienced physical and psychological health benefits when compared to matched controls. Specifically, they found that participants who walked reported less fatigue and psychological distress and better functional ability and quality of life when compared to participants in the usual care control group. Likewise, Kolden and colleagues (2002) explored the benefits of participation in a group exercise program among 51 women with primary breast cancer. They reported that participation in the 16-week group exercise training intervention reduced distress and increased strength, vigor, flexibility, positive affect, wellbeing and overall functioning.

Blanchard and colleagues (2003) explored the pattern of physical activity among 335 breast cancer survivors and 6,880 non-cancer controls. They reported that breast cancer survivors engaged in as much moderate and vigorous physical activity as non-cancer

controls. However, the types of exercise that cancer survivors engaged in were characterized by more yard work and stretching.

Another way in which physical activity might benefit health is through the psychological benefits of activity and exercise. Research has shown that physical activity leads to psychological improvements in individuals with stress-related anxiety disorders such as panic disorder, and mood disorders such as major depressive disorder (Annesi, 2005; Dunn *et al.*, 2005; Stathopoulou *et al.*, 2006). For example, Dunn and colleagues (2005) report that among 80 otherwise physically healthy participants with Major Depressive Disorder (MDD), a prescribed exercise regime lowered depressive symptoms over a 12-week intervention. Results of this randomized, control group study utilizing the Hamilton Rating Scale for Depression (HRSD) were both statistically and clinically significant.

Researchers posit several mechanisms that may explain the beneficial effects of physical activity with regard to psychological health. As Stathopoulo and colleagues (2006) summarized, both psychological and physiological mechanisms have been hypothesized. Changes in coping self-efficacy and interruption of negative thoughts are among the psychological mechanisms that have been the focus of recent research. With regard to physiological mechanisms, changes in metabolism, sleep regulation, and availability of neurotransmitters such as serotonin and endogenous opioids have been studied (Stathopoulou et al., 2006). However, there is a paucity of research on the topic and thus further investigation is needed.

In summary, stress can impact health in cancer survivors, and physical activity has the potential to moderate the relation between stress and illness. Given the association between physical activity and emotional outcomes such as anxiety and depressive symptoms,

there could be indirect effects of physical activity on health through improvement in mood. Thus, any examination of physical activity in cancer survivors should take into consideration negative mood.

Daily Diary Methodology

The daily diary methodology lends itself particularly well to the collection of self-report data which are often used in health psychology, especially in research on stress and physical health (Stone et al., 1998). Until recently, retrospective interviews and surveys were the most common methods used to collect data in a naturalistic setting (Shiffman & Stone, 1998). Some of the problems with cross-sectional retrospective interviews and surveys are recall bias, the inability to accurately measure transient processes, and a lack of temporal sequence necessary for causal inference (Stone et al., 1998).

Daily diaries have a number of advantages over retrospective data collection. First diaries generally measure variables in closer temporal proximity to the events being examined, thereby reducing the potential for recall bias and increasing potential for internal validity (Stone et al., 1998). Second, diary measures permit researchers to more accurately measure the ebb and flow or varying patterns of transient factors such as stress and physical health (Affleck *et al.*, 1996; Gil et al., 2004a; Gil *et al.*, 2000; Gil *et al.*, 1993; Stone *et al.*, 1987). Third, because diaries measure daily or sometimes even hourly experiences they are useful in exploring temporal relations between variables (Gil et al., 2004a; Stone et al., 1987). For example, in a sample of 41 African American adults with sickle cell disease, Gil and colleagues (2004) reported an association between daily mood and subsequent day pain such that negative mood was associated with greater pain. Likewise, Stone and collaborators

(1987) reported a relation between the illness and undesirable events such that onset of illness was associated with an increase in undesirable events three to four days prior.

Recently, our laboratory used daily diaries to explore the relations between stress, mood, school or work activity, health care use, pain and other physical symptoms primarily in those suffering from sickle cell disease (Carson, 1999; Gil et al., 2001; Gil et al., 2003; Gil et al., 2004a; Gil et al., 2000; Gil *et al.*, 1991; Porter et al., 2003). For example, Gil and colleagues (2001) conducted a study using a paper and pencil daily diary to explore the benefits of coping practice on outcome in a sample of 46 African American children with sickle cell disease. The results demonstrated that daily coping skill use was associated with fewer healthcare contacts, less absence from school, and less interference with daily activities.

Daily diaries have also been used in research with cancer patients and survivors to explore relations between stress, sleep disturbance, coping, adjustment, physical symptoms, pain, depression, and anxiety (Ahles *et al.*, 1983; Shapiro *et al.*, 2003; Sherliker & Steptoe, 2000). Sherliker and Steptoe (2000) conducted a study using a daily paper and pencil diary to explore the relation between coping, adjustment, and symptoms. They reported that among 10 cancer patients enrolled in a phase 1 clinical trial of novel chemotherapeutic agents, coping styles of *ignoring their condition* and *fighting spirit* were related to positive mood. In a daily diary-based experimental design study, of stress, sleep disturbance, and self-efficacy, Shapiro and colleagues (2003) found that mindfulness-based stress reduction and education about stress reduction techniques and resources improved sleep quality practice in a sample of patients all of whom were diagnosed with Stage II breast cancer.

Collectively, these studies indicate that the daily diary methodology offers several distinct advantages over other common retrospective methods. Specifically, daily diaries offer increased validity, the ability to more accurately record transient factors and the ability to analyze temporal relations between variables. In general, daily diaries are an effective way to collect data in naturalistic settings for health related psychological research including in cancer patients and survivors. However, the utility of daily diaries has not been fully explored in cancer survivors.

Electronic Internet-Based Data Collection

Use of the internet-based data collection has become more common over the past several years (Bauer *et al.*, 2004; Bliven *et al.*, 2001; Fergusson *et al.*, 2003; Park *et al.*, 2004; Whybrow *et al.*, 2003). Bliven and colleagues (2001) sought to explore the reliability and validity of a cross sectional internet based health-related quality of life measure. They reported that in a sample of 55 cardiology outpatients, greater than 80% preferred the internet based collection over the paper and pencil versions, nearly 90% were comfortable using the application without additional technical support, and that data collected using electronic and paper and pencil versions were consistent (Bliven et al., 2001). In a study of stress, self-appraisal, coping and mood, Park and colleagues (2004) utilized an internet-based electronic daily diary with 190 undergraduate participants who were asked to complete diaries for 28 days. Studies such as these clearly highlight the benefits of electronic data collection strategies.

An additional benefit of internet-based data collection is the inherent efficiency of electronic data collection, as well as the data entry and management process (Bliven et al., 2001). Specifically, multiple time point data collection, data entry and coding can be

accomplished with a substantial reduction in labor, expense, missing data and data entry errors compared with traditional paper and pencil daily diary methodology (Bauer et al., 2004). Therefore, electronic internet based daily diary collection methods hold much promise, but have not been widely applied to the study of stress and physical health symptoms in cancer populations.

In summary, physical and psychological health of cancer survivorship is of great national health concern. Stress can produce particularly deleterious health effects in cancer patients and survivors, and physical activity has the potential to moderate the relation between stress and illness. Moreover, internet-based daily diary measures are effective, accurate, reliable, and valid methods that offer unique advantages in understanding the cancer survivorship experience. These measures allow cancer survivors to track events under natural conditions and, thereby, allow investigators to gain a greater understanding of the multidirectional interactive relations among stress, physical activity, and physical symptoms in cancer survivors.

Specific Aims and Hypothesis

The current study had two overall goals. First, the current study examined the relation between perceived stress, physical activity, and physical health symptoms in cancer survivors. Specifically, it was hypothesized (Hypothesis 1) that perceived stress would predict physical symptoms such that higher levels of perceived stress would predict higher levels of physical health symptoms. Moreover, it was hypothesized (Hypothesis 2) that physical activity would moderate the relation between stress and physical symptoms such that decreasing levels of perceived stress and increasing levels of physical activity would be associated with the fewer health symptoms whereas increasing levels of stress and decreasing

levels of physical activity will be associated with more symptoms (see Figure 1). The second aim was to empirically validate an electronic daily diary measure (E-Diary-CS) of perceived stress, physical symptoms, and physical activity in cancer survivors. I hypothesized that there will be moderate to high correlations between baseline measures of perceived stress, physical activity, physical symptoms, and the E-Diary-CS measures of each of these constructs, indicating that an electronic diary is a reliable and valid strategy for assessment of these variables in cancer survivors.

METHOD

Participants

Participants in the current study were 20 cancer survivors who were 18 years of age or older and at least 3 years post-treatment or 5 years post diagnosis and were not currently undergoing active treatment. The sample consisted of individuals who survived a variety of cancers (40% of breast cancer, 15 % lymphoma, 10% colon/rectal, 10% prostrate , with carcinoma, melanoma, kidney cancer, head and neck cancer, and leukemia accounting for 5% of participants each). Additionally, all participants were English speaking, and had daily internet access and an active email account. In order to be included in the study, participants must have completed at least of 50% of the daily diary entries for at least 21 days. Participants were on average 49.7 years of age (range 26-75 years old). They were affluent with the majority reporting yearly family income of $50,000-$75,000, and well educated with the majority reporting holding a minimum of a 4-year degree. Participants were largely Female (85%), Caucasian (85%), non-Hispanic (95%), and married or engaged (55%).

Procedures

A bulk email was sent out to approximately 10,000 faculty/staff and 25,000 students of the University of North Carolina – Chapel Hill. Of the 64 voluntary responses to the informational email, 28 met enrollment criteria and were willing to participate. Of the 28 participants, 20 completed at least 50% of the daily entries for 21 days. Thus, data for 20 participants were included in the analyses of this study. Following recruitment and

verification of eligibility, participants were introduced to and familiarized with all aspects of the study, and researchers obtained informed consent.

Data were collected at baseline and then subsequently on each day for the next 3 weeks. The baseline portion of the study used retrospective summary measures to assess perceived stress, physical activity, physical health symptoms, mood, and medical and demographic information. The daily diary was used to assess ongoing, daily perceived stress, physical activity, and health symptoms. Additional items were included on both the baseline and the daily diary, but not used in this study.

Researchers contacted participants via telephone as needed to answer any questions and help maintain participation in completing the diary entries. Additionally, researchers reminded participants, during each telephone or online contact, that they should report any significant change in health symptoms to their personal physician. The raw data for the E-Diary-CS entries were electronically appended to an MS-Access database, exported to MS-Excel for subsequent data management and processing, and finally exported to SPSS for analysis.

Daily Diary Measures

Stress. The first section contained an assessment of daily stress based upon the approach used by Stone and colleagues (Stone & Neale, 1982, 1984; Stone, Broderick, Porter, and Kaell, 1997). The paper and pencil measure used by Porter and colleagues (2000) was converted into an electronic form incorporating a "pop-up" list of daily stressors, to be used as a guide to the range of potential stressors. Each day, participants were asked to rate the perceived level of overall stress of the day using an electronic visual analogue scale (E-VAS) stress measure. The E-VAS was anchored at "not at all stressful" and "as stressful as I

can imagine." Participants were asked to describe, "What situations were you dealing with today," to identify the most stressful situation, and to select one of five categories that best described this situation: work, marital/romantic relationships, other relationships such as family or friends, cancer related, or other. In previous research with sickle cell disease patients, the mean daily stress level from the stress measure was significantly correlated with the Daily Hassle Scale, (r = .39, p < .05) (Gil et al., 2003). Although the time frame and the population studied by Gil and colleagues were different, these results indicated that the E-VAS stress measure had the potential to be a reliable and valid measure of stress.

Physical activity. The second section asked participants to report on daily physical activity, by asking participants to self-report, the amount of time, in 15-minute intervals, they engaged in both moderate-intensity and vigorous-intensity physical activity during the previous day, as defined by the U.S. Department of Health and Human Services, (2004). The U.S Department of Health and Human Services (2004) definitions of the two levels of intensity of exercise were incorporated in the E-Diary-CS via use of a "pop-up". The amounts of vigorous and moderate activity were combined by adding the weighted amount of both types of exercise according to the Centers for Disease Control guidelines (Centers for Disease Control., 2006) . The electronic physical activity assessment was created for this study, however there has been research conducted using similar methods of assessing physical activity (Blanchard *et al.*, 2003b; Mock et al., 2001).

Health symptoms. The third section contained the modified Rotterdam Symptom Checklist (Stein et al., 2003). The RSCL-M is a 28-item assessment of physical health symptoms, specifically designed and validated for use with cancer patients and survivors (Stein et al., 2003). The RSCL-M demonstrates adequate coefficient alpha reliability (0.83 –

0.90). With regard to convergent validity the RSCL-M was moderately correlated with the Physical Functioning (PF) and General Health (GH) scales of the Medical Outcomes Study 36-item Short Form (MOS SF-36) with Pearson's r = -0.59 and -0.61, respectively (Stein et al., 2003).

Baseline Measures

Baseline perceived stress. The Perceived Stress Scale (S. Cohen *et al.*, 1983) was used to measure baseline perceived stress. As reported by Cohen and colleagues, the PSS is a 10-item measure. In the literature, scores on the PSS have been correlated with health outcomes such as failure to quit smoking, failure among diabetics to control blood sugar levels, and more colds. With regard to concurrent and predictive validity, the PSS's correlation with measures of depressive and physical symptomology range from .65 - .76 and .52 - .70, respectively (S. Cohen et al., 1983). Additionally, the PSS demonstrates adequate coefficient alpha reliability (0.78) with test-retest reliability for the two reported intervals of 2 days and 6 weeks of .85 - .55, respectively. The lower correlation with regard to the longer interval is to be expected as perceived stress is subject to fluctuation due to the transient nature of daily hassles, and available coping resources (S. Cohen & Williamson, 1988). The PSS has been used in research with cancer patients and survivors (Abercrombie et al., 2004; Golden Kreutz et al., 2004).

Baseline physical activity. Participants were asked to report frequency and duration, for the past two weeks of nine specific types of exercise: walking, gardening or yard work, stretching, weight lifting or other exercises to increase muscle strength, jog or run, aerobics or aerobic dancing, riding a bicycle or exercise bike, stair climbing, swimming for exercise. Additionally, participants were asked to report frequency and duration of two different

intensity levels of physical activity: vigorous and light/moderate exercise. This method of measuring physical activity, based on the 1998 National Health Interview Survey (NHIS) has been used with cancer populations previously and has been described at length by (Blanchard et al., 2003b).

Baseline distress from physical health symptoms. The Cohen-Hoberman Inventory of Physical Symptoms (CHIPS) (S. Cohen & Hoberman, 1983), was used to assess baseline physical health symptoms. As Cohen and Hoberman report, the CHIPS is a 39 item self-report measure in which respondents are asked to rate how much a particular physical symptom (e.g., cold, cough, heart pounding, nausea, sleep problems) distressed them on a five point scale anchored at "not at all" and "extremely." The CHIPS has been shown to be related with health care use and has demonstrated adequate internal reliability with Cronbach's alpha = .88.

Baseline mood. The Positive and Negative Affect Schedule (PANAS) (Watson *et al.*, 1988; Watson *et al.*, 1999) was used to assess baseline mood. The 20-item PANAS has subscales for positive and negative affect. In prior research, internal consistency was demonstrated to be adequate with coefficient alphas ranging from .84 to .90, and the positive and negative affect scales were shown to be uncorrelated (-.12 to -.23). The PANAS is a widely used measure of mood state (Ennis & McConville, 2004; Manne & Schnoll, 2001).

Demographic and medical information. Information on demographics (gender, age, income, or education) and medical status (time since diagnosis, time since treatment, or having had chemotherapy, radiation, or hormone therapy) were collected using an electronic questionnaire.

Data Analysis and Management

Data were entered directly by participants using a Macromedia Flash ™ based user interface and a Microsoft Active Server Pages (ASP) ™ secure server interface into an MS Access Database stored on a secure (128-bit encrypted) web-server. Participants were permitted to complete daily diary entries for up to 6 weeks. However, data from only 21 days were used for the analyses. The current study used data for participants whom completed a minimum of 50% of the daily entries. Data for each eligible participant were exported from the raw database and aggregated.

Response rate and descriptive statistics were calculated for all variables. Demographic data were computed and normality was verified for all for all predictor and outcome variables. Transformations were calculated and used for analysis when appropriate. Standardized scores (z-scores) were generated for all predictor variables and used in all subsequent analysis.

In order to assess the reliability and validity of the diary measures, Pearson-product moment correlations were calculated to evaluate the strength, direction, and significance of the relations between the daily diary (VAS-stress, daily exercise, RSCL-M) and baseline (PSS, two week NIHS physical activity scale, and CHIPS) measures.

Hierarchical regression analyses were used to test Hypothesis 1 (that stress predicts health symptoms) and Hypothesis 2 (that physical activity moderates the relationship between stress and health symptoms). Using SPSS to test the first hypothesis, physical health symptom scores were regressed on VAS-stress scores in a linear regression analysis. Using SPSS to test the second hypothesis, the interaction term for VAS-Stress and physical activity scores was calculated using the standardized values (z-scores), to reduce

multicollinearity, as recommended by Aiken and West (1991). Multiple regression analysis was conducted in which physical health symptom scores were regressed on the interaction of stress and physical activity scores while controlling for stress and physical activity. In this hierarchical linear regression model, perceived stress was entered in Step 1, physical activity scores were entered in Step 2 followed by the interaction term in Step 3.

RESULTS

The result section is organized as follows. First, I summarize the diary completion data and simple descriptive statistics. Second, I present the results of the reliability and validity tests of each component of the daily diary measure. Third, I detail the results of the testing of the specific hypotheses that stress is associated with physical health symptoms; and that physical activity moderates the relation between stress and physical health symptoms.

Diary Completion and Descriptive Statistics

The 28 participants initially enrolled in the study completed between 1 and 41 daily entries (mean = 16.7 SD = 10.7). Overall, participants completed 704 daily entries over the course of 42 days (59.86%). The actual participants (n = 20) included in analysis completed on average 81% of entries (range 51%-98%). With regard to completion time, it took participants in the current study an average of 6.6 minutes to complete the daily diary each day. Baseline measures completed on the first day took an average of 33.1 minutes to complete. In order to determine whether any of the demographic or medical variables were related to diary completion, bivariate associations, and t-tests were conducted. Results of these analyses did not indicate any significant relationship between demographic (age, income, or education), or medical variables (time since diagnosis, time since treatment, or having had chemotherapy, radiation or hormone therapy) and diary completion.

Descriptive statistics were calculated for all predictor, outcome, reliability, and validity variables. Table 1 depicts the mean, standard deviation, skewness, and kurtosis of the predictor variables (daily stress, physical activity), outcome variables (health symptoms

on the RSCL-M), and variables used to establish the validity of the daily diary (daily positive and negative affect, PSS, baseline physical activity and PANAS). As can be seen in the table, average levels of stress (when aggregated and averaged over the 3 week period), were 32.52 (SD = 16.05) on a 0 (not at all stressful) to 100 (as stressful as I can imagine) VAS scale. Regarding physical activity, average levels of physical activity, when aggregated and averaged, were 21 minutes per day. When aggregated and averaged over the 3 week period, the participants in this study reported low levels of physical health symptoms with average sores on the RSCL-M of 33.73 (SD = 4.23) on a 0 to 112 point scale. In general, participants in this study exhibited low levels of stress and physical health symptoms, and engaged in relatively high levels of physical activity.

Reliability and Validity of the E-diary-CS

Pearson-product moment correlations were calculated to evaluate the strength, direction and significance of the relations between the daily diary measures (VAS-stress, mood, daily exercise, RSCL-M,) and the well-validated, commonly used summary measures included in the baseline assessment (PSS, PANAS, two week NHIS physical activity scale, and CHIPS) measures. As shown in Table 2 daily and baseline physical activity measures showed a strong association (r = .873, $p < .01$), as did the daily and baseline physical symptoms variables (r = .669, $p<.01$). Correlations between the daily stress and baseline positive and negative affect were significant (r = -0.567, $p < .009$) and (r = 0.611, $p <.004$) respectively. The relation between the daily and baseline measures of stress showed a moderate correlation (r = .381, $p<.09$), but failed to reach significance. In light of the variable nature of stress and the difference in time frame between baseline and daily self-report measures of stress (i.e., “in the past month” and “today”) these results suggest

adequate associations between the baseline and daily diary measures, all of which were in the expected direction.

Stress, Physical Activity, and Physical Symptoms

With regard to the normality assumption of linear regression, preliminary analyses indicated the need for transformation of the physical activity and health symptoms variables. However, there was no significant difference in results using the transformed variables versus non-transformed variables, and thus the results of analyses using the non-transformed variables are reported.

In order to determine whether any of the demographic or medical variables were associated with physical health symptoms, bivariate associations, and t-tests were calculated. There were no significant ($p < .10$) associations between age, education, income, time since diagnosis, or time since treatment, and physical health symptoms. There were not enough participants who were male (n = 3), who did not have surgery (n =3), who had hormone therapy (n=3) or gene therapy (n = 0), to include those variables in these analyses. Thus, none of the demographic or medical variables were entered in the regression models.

Given the potential relationship between physical activity and depressed mood that is reported in the literature, Pearson-product moment correlations were calculated to evaluate the strength, direction, and significance of the relation between the baseline measure of negative mood and daily physical activity. The association between negative mood and physical activity was ($r = -.06$) and was non-significant at the $p = .10$ level. Thus, negative mood was not included as a variable in regression analyses.

For Hypothesis 1, the results of the hierarchical linear regression indicate that daily stress scores were significantly associated with physical health symptom scores. Stress

accounted for 21.5% of the variance in physical health symptoms (R^2 = .215). Higher stress levels were associated with higher levels of physical symptoms (see Table 3).

Regarding Hypothesis 2 that physical activity would moderate the relation between stress and physical health symptoms, neither physical activity nor the interaction between physical activity and stress were significantly associated with physical health symptoms. Physical activity accounted for 5.4% of the variance in physical health symptoms and the interaction term accounted for 1% of the variance in physical health symptoms (R^2 = 0.54 and 0.010 respectively).

Explication of non-Significant Interaction

Even though it was not significant, I elected to explicate the interaction between stress and physical activity to visually clarify the interrelationship among the proposed predictor, moderator, and outcome variables. (see Figure 2). The interaction was explicated by hand by the method of substituting +/- one SD of both stress and physical activity and calculating the resulting regression equation for each of the four points high stress/high physical activity, low stress/low physical activity, low stress/high physical activity and low stress/high physical activity. As you can see in Figure 2, although decreasing levels of perceived stress and increasing levels of physical activity are associated with the fewer health symptoms these differences are not large or statistically significant.

DISCUSSION

The results of this study suggest that the E-diary-CS is a reliable and useful tool to assess stress and health symptoms in cancer survivors, thus extending the growing body of literature indicating that internet-based data collection is a reliable and valid method for the collection of health-related data from medical populations (Bliven et al., 2001). Moreover, as predicated, the results of the current study demonstrate a significant association between stress and physical health symptoms. However, results failed to support the hypothesis that physical activity buffers the deleterious relationship between stress and physical health symptoms.

E-Diary-CS

Recently, researchers have become increasingly interested in the use of daily diaries as a measure to capture daily fluctuations in stress and health symptoms in a variety of medical illnesses (Carson, 1999; Gil et al., 2001; Gil et al., 2003; Gil et al., 2004a; Gil et al., 2000; Gil et al., 1991; Porter et al., 2003). However, these methods have not been widely applied to cancer survivors. Moreover, paper and pencil diaries have been the most frequently used format to date (Carson, 1999; Gil et al., 2001; Gil et al., 2003; Gil et al., 2004a; Gil et al., 2000; Gil et al., 1991; Porter et al., 2003). For the current study, I designed an easy to use electronic daily diary -- the E-Diary-CS – in order for cancer survivors to track stress, physical activity, and health symptoms. The measure took 5 to 7 minutes to complete.

In terms of reliability and validity of the electronic measures, participants in the current study had similar baseline scores on the perceived stress scales, the measure of

common health symptoms, and they reported that they engaged in similar amounts of physical activity when compared with normative samples reported by Blanchard and colleagues (2003b), Cohen and Williamson (1988) and Cohen and Hoberman (1983), respectively. It should be noted that there were lower scores on the RSCL-M (the measure of physical health symptoms) when compared with the participants in the original study conducted by Stein and colleagues (2003). However, this was expected due to between sample differences in disease state (i.e. long-term survivors not currently undergoing treatment versus patients undergoing various forms of treatment respectively). These results suggest that the electronic format for completion of measure resulted in values in expected ranges. Additionally, Pearson product moment correlations between well-validated, commonly used baseline measures and daily diary scores were mostly significant suggesting adequate reliability and validity. Taken together, the findings suggest that the E-Diary-CS is a valid and reliable method for the assessment of stress, physical activity, and health symptoms.

Use of the internet-based data collection has become more common over the past several years (Bauer et al., 2004; Bliven et al., 2001; Fergusson et al., 2003; Park et al., 2004; Whybrow et al., 2003). Consistent with the previous research, results of this study indicate that participants were comfortable using the application without additional technical support (Bliven et al., 2001). Additionally, the internet-based data collection used in this study increased the efficiency of data collection, as well as the data entry and management process. Specifically, data collection, data entry, and coding were accomplished with a substantial reduction in labor, expense, missing data and data entry errors. There were however, issues with completion rate in this study. Specifically participants in this study had a completion

rate of approximately 60% whereas previous research with paper and pencil diaries report much higher completion rates (Gil et al., 2004a; Gil et al., 2000; Gil et al., 1993). With electronic data collection, it is possible to append the actual time and date of completion to the record when the entry is completed. Thus making it impossible for a participant to complete several entries at one time and submit them as though they were completed on a daily basis, thereby reducing the likelihood of participants relying on recollection and decreasing the potential of recall bias. It is possible that the lower completion rates and therefore higher attrition rate could be an artifact of more accurate assessment of completion. It is also possible that the lower completion rates associated with this study are due in part to the methodology differences (i.e. electronic versus paper and pencil), compensation, (not compensated versus compensated), or the nature of the medical sample (i.e. long term cancer survivors not currently involved in treatment versus patients actively involved in medical treatment). Future research using electronic daily diaries would likely benefit from higher completion rates and thus should use strategies designed to address these issues. Additionally, there are issues specific to internet based data collection, specifically, not everyone has reliable internet access, and therefore samples are limited to those that do, this reduces potential inclusion and therefore generalizability. However, as internet access continues to increase, electronic internet daily diary collection methods hold much promise.

Stress, Physical Activity, and Health Symptoms

As predicted by the first hypothesis the results indicated that daily stress accounted for a substantial amount of variance in physical symptoms. Higher stress levels were associated with higher levels of physical symptoms. This finding is consistent with previous research on the relationship between stress and health symptoms in a variety of health

problems (Antoni, 2003; Carson, 1999; S. Cohen & Hoberman, 1983; S. Cohen et al., 1993; DeLongis et al., 1988; Leserman, 2003; Pereira et al., 2003; Takkouche et al., 2001). Both stress and physical health have been shown to be important components of quality of life in cancer survivors (Bardwell et al., 2004; Cella et al., 1993; Kolden et al., 2002). Thus, these results are especially important in light of the rapidly growing population of long term cancer survivors (American Cancer Society., 2003; National Cancer Institute., 2004d).

Due to the correlational nature of this study, it is also possible that the results indicate that physical symptoms are stressful. Considering the potentially transactional nature of these two constructs, it is difficult to explore their relation in terms of causal inference, especially in a correlation study. The data for this study was, however, collected on a daily basis and therefore, with more sophisticated data analysis strategies such as hierarchical linear modeling (HLM) it would be possible to add the dimension of temporal ordering of events, perhaps establishing that stress is more likely to precede physical health symptoms than the other way around.

Neither physical activity nor the interaction of physical activity and stress predicted physical symptoms among our sample of 20 cancer survivors. This lack of significance in results was contrary to both Hypothesis 2 and previous research regarding the attenuating effect of physical activity on the deleterious relationship between stress and health symptoms (Carmack et al., 1999; Kolden et al., 2002). There are a number of potential explanations for the inability of the current study to support the hypothesis that physical activity buffers the relation between stress and physical health symptoms. First, it is quite likely that there were not enough participants in the current study to generate enough power to demonstrate a significant interaction. Second, I used a non-standardized measure of physical activity and

simply asked participants how many minutes of vigorous or moderate physical activity they engaged in. Specifically this measure, although highly correlated with the well validated baseline measure, may not demonstrate adequate construct validity when compared with other measures of physical activity such as those used by Carmack and colleagues (1999). Third there were limitations in the data analysis, namely the data set would have perhaps been more accurately analyzed using hierarchical linear modeling (HLM). The aforementioned potential explanations for the lack of significant findings are discussed in further detail in the limitations section of this discussion.

Limitations

As previously mentioned there were a number of shortcomings of this study. They fall into four broad categories first sample-related difficulties; second shortcomings with measures and data collection; third, difficulties related to data analysis; and fourth potential confounds or other variables or measures that are missing. I will address each individually in the following section.

Sample related shortcomings. Of the approximately 10,000 faculty/staff and 25,000 students of the University of North Carolina – Chapel Hill, 64 voluntarily replied to our email call for participants 28 of who were eligible to participate in the current study. Due to the inclusion criteria of an at least 50% completion rate, data from 8 participants were not used for analysis. The attrition rate for this study was approximately 30% which is quite high when compared to similar studies conducted with paper and pencil daily diaries (Gil et al., 2004a; Gil et al., 2000; Gil et al., 1993). Consequently, the sample size for this convenience sample study was relatively small, with only 20 participants. Others exploring

relations among the same constructs have used samples of 135 participants and report significant interaction effects (Carmack et al., 1999).

The sample used in this study was extremely homogeneous with regard to gender, race education, and income, while simultaneously being heterogeneous with regard to type of cancer and time since diagnosis or treatment. This pattern of variation, and lack thereof, presented us with a bit of a double bind. On one hand, the homogeneous nature of the sample with regard to demographic variables provides little in the way of generalizability while the heterogeneous nature of the sample with regard to medical variables most likely increased the variation in both the independent and dependent variables. Future studies need to attempt to achieve greater heterogeneity with regard to demographic variables, and perhaps limit participants to one particular type or several types of cancer. A much larger sample, which is possible with electronic data collection, could accomplish both of these goals simultaneously.

Measures-related shortcomings. The current study relied entirely on self-report measures and as such, the associations reported herein may be inflated and therefore suspect due to common method variance. With the exception of relation between stress and physical health symptoms which has been well addressed in the literature, there were no significant results generated by this study and thus it does not appear that inflation of correlations were problematic (Antoni, 2003; Carson, 1999; S. Cohen & Hoberman, 1983; S. Cohen et al., 1993; DeLongis et al., 1988; Leserman, 2003; Pereira et al., 2003; Takkouche et al., 2001). There were some technical difficulties with the E-VAS measure. Specifically the measure always presents with the movable stimulus centered at 50 on the scale from 1-100, thus in the current form it is impossible to tell from review of the data if a participant intended to leave

the measure at 50 or unintentionally skipped the measure. This is problematic as it could inflate the number of responses of 50 and thereby decrease the variability of the measure. In reviewing the raw data and descriptive statistics this does not appear to have negatively influenced the results of the current study. However, future research conducted using the E-VAS measure should address this issue.

Data analysis. The daily data was aggregated into a summary score for each participant on each measure, and subsequent analyses were conducted using the aggregate data. One shortcoming of the data analysis strategy is the fact that causation cannot be inferred in a correlational study. Specifically, it is possible that physical health symptoms lead to stress. In order to parse out whether or not it is stress that causes health symptoms, or vis-à-vis, temporal order must be established. The current study collected participant data on a daily basis, and therefore temporal order could have been established between variables. However, the aggregation of the data effectively rendered it cross sectional and thus a correlation based data analysis strategy was used. A more effective representation of the data would have, perhaps, been made using hierarchical linear modeling (HLM). An additional shortcoming of the data analysis strategy in the current study is the loss of power due to the aggregation of many data points into one aggregate score for each participant. It is entirely possible that the explanation for null results with regard to the interaction effect is that the analysis lacked the power to elucidate the effect. Multi-level models serve to increase power through the increase of degrees of freedom while simultaneously correcting for error due to intra-individual or intra-group covariance. An additional benefit to the increase in power made available by HLM, is found in utilizing the daily and therefore temporally ordered data thus making it possible to accurately model causal relationships. In light of the highly

transactional nature of stress, physical activity, and health symptoms and the relatively small sample size, the current data analysis strategy was ill suited to fully utilize the data that was collected. Future studies would likely benefit from the use of HLM, which would have been better suited to the dataset collected.

Potential confounds and other variables or measures that are missing. Depression is an additional potential confound, researchers have reported that it is associated with physical activity (Stathopoulou et al., 2006). The fact that I did not assess depression per se is a limitation of this study as it could be a potential mediator or moderator of the relation between physical activity and stress and/or physical health. I did however, assess negative affect, a major component of depression and results indicate that in this sample negative affect was not significantly associated with health symptoms. Additionally, researchers have reported that rates of depression are not higher in long-term cancer survivors when compared to healthy controls (Gotay *et al.*, 2004; Schwartz & Drotar, 2006). In fact the participants in this study had similar scores on both the positive and negative affect when compared with the healthy control samples used to establish validity, reliability and normative data for the scales of the PANAS (Watson et al., 1988). Nonetheless, future research in the area of stress, physical activity, and physical health symptoms would benefit from the inclusion of a measure to assess depression.

Implications for Future Research and Clinical Practice

This study is the first to demonstrate this magnitude of relationship between stress and physical health symptoms using an electronic online daily diary collection method among long-term cancer survivors. This research has implications for future research with regard to the mechanisms of the link between stress and health symptoms. Specifically, this

study demonstrated that the E-Diary-CS is a reliable and valid measure of stress, and physical health symptoms. If used in conjunction with physiological measures it could be integral in elucidating the transactional nature of the relationship between these three variables. Researchers might also include other potential moderating variables such as positive or negative mood.

Another implication of the findings is that the use of the electronic daily diary methodology may allow researchers to collect data from increasing numbers of participants, in naturalistic settings with very little impact on participants. In this study I collected, entered and coded 65,000 data points with no data entry errors, similarly to Bauer and colleagues (2004), I found that multiple time point data collection, data entry and coding could be accomplished with a substantial reduction in labor, expense, missing data and data entry errors if compared with traditional paper and pencil daily diary methodology. The data was collected from only 20 participants; however, it could have been 200 or 2000 participants with very little additional effort with regard to data entry and management. Collecting data on a daily basis and the temporal ordering of events, in conjunction with hierarchical linear modeling can bring us one-step closer to being able to make statements pertaining to causation with regard to stress and physical health.

There are also important implications of this research for research in the area of stress management interventions. Given the link between stress and physical health symptoms, stress management interventions may have important clinical benefits for cancer survivors, some which have been identified already in prior research (Carlson et al., 2003; Carson, 1999; Craske, 1999). Moreover, the E-Diary is a useful tool that may be used in data

collection before, after, and during the course of psychosocial interventions for stress management.

The findings presented herein not only serve to bolster but extend the results of previous research in the area of stress and physical health from both an experimental and methodological perspective. Both stress and physical health have been shown to be important components of quality of life in cancer survivors (Bardwell et al., 2004; Cella et al., 1993; Kolden et al., 2002). This is especially important in light of the rapidly growing population of long term cancer survivors (American Cancer Society., 2003; National Cancer Institute., 2004d).

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Table 1.

Mean, Standard Deviation, Range, and Normality of all Predictor, Outcome, Reliability, and Validity Variables.

	Mean	S.D	Skewness	S.E	Kurtosis	S.E
Predictors						
VAS Stress - Daily	32.53	16.05	.013	.512	-.704	.992
Physical Activity – Daily *	146.92	133.07	1.632	.512	2.438	.992
Outcome Variable						
RSCL-M - Daily	33.73	4.23	.889	.512	.302	.992
Reliability and Validity						
PSS – Baseline	15.71	6.87	-1.186	.512	.596	.992
Physical Activity – Baseline *	129.35	153.28	1.745	.512	2.250	.992
Positive Affect – Baseline	35.81	8.43	-.165	.512	-.609	.992
Negative Affect – Baseline	17.32	5.95	.875	.512	.138	.992
CHIPS -Baseline	17.07	14.32	.977	.512	-.296	.992

RSCL-M = the Modified Rotterdam Symptom Checklist; PSS = the Perceived Stress Scale; CHIPS = the Cohen-Hoberman Inventory of Physical Symptoms

* The physical activity measures are equivalent to minutes of vigorous physical activity per week and represent a weighted combination of both vigorous and moderate levels of exercise.

Table 2.

Baseline and Daily Measure Correlations to Analyze Reliability and Validity of the E-Diary-CS.

	Baseline				
Daily	PSS	Positive Affect	Negative Affect	Physical Activity	CHIPS
Stress	0.38	-.57**	.61**	-0.13	.51*
Physical Activity	0.16	0.21	-0.09	.87**	0.04
RSCL-M	0.28	-.56*	0.22	-0.26	.67**

*p < 0.05; ** p < 0.01; PSS = The Perceived Stress Scale; CHIPS = The Cohen-Hoberman Inventory of Physical Symptoms; RSCL-M = the modified Rotterdam Symptom Checklist.

Table 3.

Hierarchical Linear Regression with modified Rotterdam Symptom Checklist scores as the Outcome Variable.

Variable	Beta	T-score	p-value
Stress	.469	2.210	<0.05
Physical Activity	-.176	-.718	*n.s.*
Stress * Physical activity	.114	.464	*n.s*

Table depicts variables in the equation at Step 3.

Figure Caption

Figure 1. Proposed model of the interaction between stress and physical activity on health symptoms.

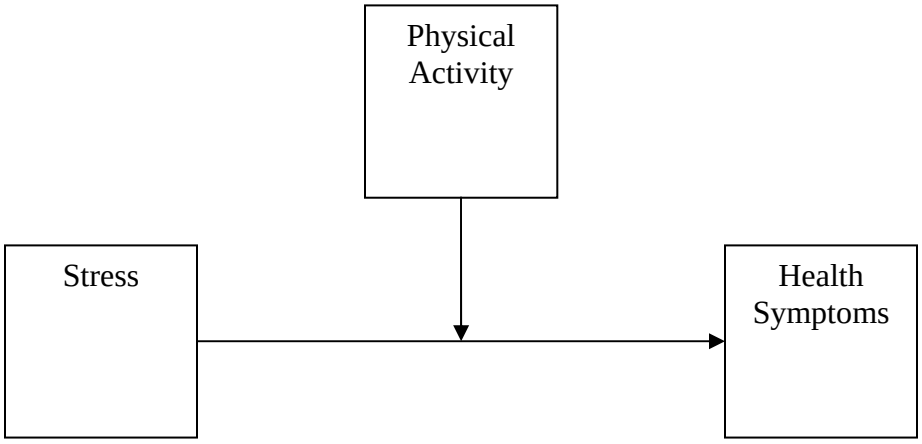
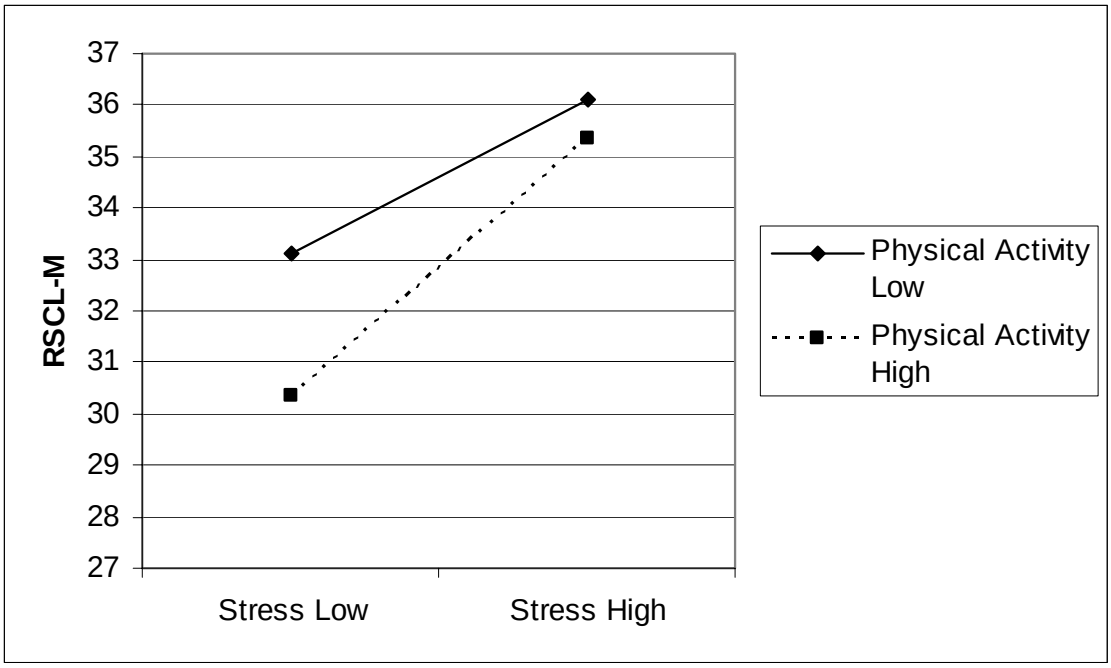

Physical Activity
Stress
Health Symptoms

Figure Caption

Figure 2. Explication of the interaction between daily stress and physical activity on health symptoms.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RSCL-M
Stress Low
Stress High
Physical Activity Low
Physical Activity High