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Do Health Behaviors Mediate the Relationships Between Loneliness and Health Outcomes in Caregivers of Cancer Patients?

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Approved by Major Professor(s): Catherine Mosher

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DO HEALTH BEHAVIORS MEDIATE THE RELATIONSHIPS BETWEEN LONELINESS AND HEALTH OUTCOMES IN FAMILY CAREGIVERS OF CANCER PATIENTS?

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TABLE OF CONTENTS

Page

APPENDICES

ABSTRACT

Adams, Rebecca Nichole M.S., Purdue University, May 2013. Do Health Behaviors Mediate the Relationships Between Loneliness and Health Outcomes in Family Caregivers of Cancer Patients? Major Professor: Catherine E. Mosher.

Greater levels of loneliness have shown consistent associations with poorer mental and physical health; however, the reason for these relationships is unknown. Engagement in poorer health behaviors among individuals with higher levels of loneliness is one potential explanation for this relationship. Self-regulation theory suggests that coping with feelings of loneliness may impair attempts to control health behaviors. Caregivers of cancer patients have been found to have poor health behaviors (e.g., inadequate exercise) and high levels of loneliness. Thus, the aim of the study is to examine whether health behaviors mediate the relationships between loneliness and mental and physical health outcomes among caregivers of cancer patients. Methods: A secondary data analysis was conducted using data from a longitudinal study of cancer patients and their family caregivers who were staying at the American Cancer Society's Hope Lodge. Participants completed self-report questionnaires measuring levels of loneliness, engagement in health behaviors (i.e., exercise and fruit and vegetable consumption), mental and physical health, and demographic and medical characteristics at three time points over a 4-month period. A bootstrapping macro was used to examine

the indirect effect of loneliness on mental and physical health via health behaviors. Results: Contrary to hypotheses, exercise and fruit and vegetable consumption did not mediate the relationships between loneliness and physical and mental health among cancer patients' caregivers. Additional research is needed to determine whether health behaviors partially account for the relationships between loneliness and health outcomes or whether alternate explanations for these relationships should be considered.

INTRODUCTION

Greater loneliness is related to poorer mental and physical health outcomes (Cacioppo, Hawkley, & Thisted, 2010; Hawkley & Cacioppo, 2003), but the reason for this relationship is unclear. Several mechanisms for this relationship have been proposed (Hawkley & Cacioppo, 2010), but the potential mechanism of health behaviors has received little research attention. According to self-regulation theory, the regulation of emotional distress, such as coping with feelings of loneliness, may undermine attempts to control health behaviors and other activities (Tice & Bratslavsky, 2000). Therefore, lonely individuals who are focused on regulating their mood may be less able to regulate their health behaviors. Cancer caregivers have greater levels of loneliness as well as poorer mental and physical health than non-caregivers (Bishop et al., 2007; Corà, Partinico, Munafò, & Palomba, 2012; Given et al., 2004; Ji, Zöller, Sundquist, & Sundquist, 2012; Sahin & Tan, 2012). This study examines whether health behaviors mediate the relationships between loneliness and mental and physical health in caregivers of cancer patients. First, I will define loneliness and discuss its relationship to poorer physical and mental health outcomes. Next, I will discuss health behaviors as a potential mediator of this relationship and provide potential explanations for the link between loneliness and health behaviors. Then, I will discuss the well-established link between engagement in health behaviors and mental and physical health outcomes. Finally, I will

describe the roles and health outcomes of family caregivers of cancer patients and discuss why they are an important population in which to examine this question. Following this review, I will present my hypotheses, study methods, results, study limitations, and directions for future research.

Loneliness

Feeling socially connected is a critical aspect of well-being; in the absence of social connection, we experience loneliness. Relationship quality has been found to be more predictive of loneliness than relationship quantity (Pinquart & Sörensen, 2001). Additionally, there is some evidence to suggest that lonely people spend the same amount of time alone or engaging in activities with others as non-lonely people (Cacioppo et al., 2000). Although some lonely people may have limited social interactions, loneliness is defined by the *perception* of social isolation and is characterized by dissatisfaction with the *quality* of relationships (Peplau & Perlman, 1982).

Although the current prevalence of loneliness in the United States is unknown, Hawthorne (2008) reported that 9% of Australian adults reported some social isolation, and 7% reported more frequent isolation. Recent studies have found that loneliness is most prevalent in older adults and young adults or adolescents (Pinquart & Sörensen, 2001; Victor & Yang, 2012). Hence, much of the literature on loneliness focuses on these age groups. Consistent predictors of loneliness include marital status, income, and health status, such than individuals who are unmarried, have a lower income, and are disabled or have poorer functional ability are more lonely (Cohen-Mansfield, Shmotkin, & Goldberg, 2009; Hawkley et al., 2008; Hawthorne, 2008; Pinquart & Sörensen, 2001;

Rokach, Lechcier-Kimel, & Safarov, 2006; Savikko, Routasalo, Tilvis, Strandberg, & Pitkälä, 2005; Theeke, 2009). Greater loneliness has also been linked to greater negative mood (e.g., anxiety, anger), greater fear of negative evaluation, and lower positive mood, optimism, social support, and self-esteem, even when controlling for the personality characteristics of extraversion, neuroticism, conscientiousness, agreeableness, shyness, and sociability (Cacioppo et al., 2006).

Evolutionary theories of loneliness posit that human interaction is a core human motivation (Baumeister & Leary, 1995). It has been suggested that feelings of loneliness might have evolved as a signal to human beings that they need to become more socially connected (Cacioppo et al., 2006). According to this theory, social connection is evolutionarily adaptive, with the genetic contribution to loneliness estimated to be 50% (Boomsma, Willemsen, Dolan, Hawkley, & Cacioppo, 2005; McGuire & Clifford, 2000). The disconnection of social relationships leads to social pain, which shares many neural mechanisms with the brain's response to physical pain (Eisenberger & Lieberman, 2004; Eisenberger & Lieberman, 2005). Thus, although loneliness has negative implications for long-term health (Cacioppo, Hawkley, & Thisted, 2010; Hawkley & Cacioppo, 2003), in the short term it may serve as an adaptive reminder to increase social connection.

Although loneliness has been described as multi-dimensional (i.e., chronic and situational loneliness have been distinguished; de Jong-Gierveld & Raadschelders, 1982), little research has examined the differential impact of chronic versus situational loneliness. Shiovitz-Evra and Ayalon (2010) found that, although both situational and chronic loneliness predicted increased risk for mortality, individuals who were chronically lonely had greater mortality risk.

Loneliness and Mental Health

Although loneliness may serve as an adaptive reminder to increase social connection, it has been linked consistently with poorer mental health (Heinrich & Gullone, 2006). Loneliness has been found to be related to greater general psychological distress (Paul, Ayis, & Ebrahim, 2006), poorer quality of life (Steptoe & Marmot, 2003), lower self-esteem and well-being (Cacioppo et al., 2006; Riggio, Watring, & Throckmorton, 1993), and greater anxiety, including social anxiety (Anderson & Harvey, 1988; Cacioppo et al., 2006). The relationship between loneliness and depression is the most well-documented; a higher level of loneliness has been linked to greater depressive symptoms in adolescents (Mahon, Yarcheski, Yarcheski, Cannella, & Hanks, 2006), college students (Swami et al., 2007; Wei, Russell, & Zakalik, 2005) and older adults (Adams, Sander, & Auth, 2004; Alpass & Neville, 2003; Golden et al., 2009; Luanaigh & Lawlor, 2008). Five and ten-year longitudinal studies have shown that loneliness predicts change in depressive symptoms in older adults (Cacioppo, Hawkley, & Thisted, 2010; Heikkinen & Kauppinen, 2004). Additionally, greater loneliness appears to be related to thoughts of suicide (Stravynski & Boyer, 2001). Therefore, interventions to reduce loneliness may result in meaningful reductions in depressive symptomatology (VanderWeele, Hawkley, Thisted, & Cacioppo, 2011).

Loneliness and Physical Health

Greater loneliness has also been associated with poorer physical health (Hawkley & Cacioppo, 2003). In particular, having a higher level of loneliness is a risk factor for cardiovascular problems (Caspi, Harrington, Moffitt, Milne, & Poulton, 2006). For

example, in a 20-year follow-up study of women, being lonely during the day predicted myocardial infarction or coronary death (Eaker, Pinsky, & Castelli, 1992). Another study reported that, at 14-year follow-up, greater loneliness predicted cardiovascular mortality in men (Olsen, Olsen, Gunner-Svensson, & Waldstrom, 2001). Thurston and Kubsanzky (2009), on the other hand, found that greater loneliness predicted coronary heart disease incidence in women, but not men. Increased loneliness also predicted higher total peripheral resistance, which may contribute to hypertension, in young adults (Hawkley, Burleson, Bernston, & Cacioppo, 2003). Furthermore, Caspi et al. (2006) found that socially isolated children had a greater number of risk factors for poor health (e.g., overweight, high blood pressure, high cholesterol) at 20-year follow-up than children who had not been socially isolated at baseline.

Greater loneliness has also been linked to poorer cognitive functioning (Cacioppo & Hawkley, 2009). Over 5- and 10-year periods, loneliness was related to greater decline in cognitive ability and performance and poorer executive functioning (Cacioppo & Hawkley, 2009; Tilvis et al., 2004; Wilson et al., 2007). Additionally, the risk of developing late-life Alzheimer's disease in older adults is more than double for lonely individuals (Wilson et al., 2007).

Why is Loneliness Related to Health Outcomes?

Although it is clear that greater loneliness is related to poorer health outcomes, the explanation for this relationship remains unknown. Hawkley and Cacioppo (2010) have proposed several potential mechanisms to explain this relationship including:

neuroendocrine effects, genetic effects, immune functioning, sleep disturbance, and engagement in health behaviors.

Neuroendocrine and Genetic Effects and Immune Functioning

Higher loneliness is related to increased blood pressure (Hawkley, Thisted, Masi, & Cacioppo, 2010) and higher levels of epinephrine (Hawkley, Masi, Berry, & Cacioppo, 2006) which, when elevated, have detrimental effects on health. Levels of the stress hormone cortisol are also heightened in lonely individuals (Cacioppo et al., 2000; Doane & Adam, 2010; Kiecolt-Glaser et al., 1984; Pressman et al., 2005; Steptoe, Owen, Kunz-Ebrecht, & Brydon, 2004), leading to greater activation of the hypothalamic-pituitary-adrenocortical (HPA) axis. In a review of stress system disorders, Chrousos and Gold (1992) discussed the many medical conditions associated with increased HPA axis activity, including hypertension and other chronic diseases. Increased levels of cortisol in lonely people may desensitize the glucocorticoid receptor pathway, making cells insensitive to anti-inflammatory effects. Therefore, differences in the transcription of glucocorticoid response genes and increased activity of pro-inflammatory transcription control pathways between lonely and non-lonely individuals may help explain the impact of loneliness on health (Cole et al., 2007). There is also evidence that greater loneliness and other social variables, such as lower levels of social support, are related to poorer immune functioning (e.g., lower active killer cell activity, poorer T-lymphocyte response, decreased antibody response) (Dixon et al., 2001; Glaser, Kiecolt-Glaser, Speicher, & Holliday, 1985; Kiecolt-Glaser et al., 1984).

Sleep Disturbance

The potential mediating role of sleep disturbance in the relationship between loneliness and health has also garnered some attention. Lonely college students and older adults report poorer sleep, experience poorer sleep efficiency, and spend more time awake than their non-lonely peers (Cacioppo et al., 2002a; Cacioppo et al., 2002b). Loneliness was also related to sleep disturbance in early and middle adolescents (Mahon, 1994). In a large study of seven European countries, Ohayon (2005) found that those less satisfied with their social network experienced more nonrestorative sleep than those more satisfied with their social network. Decreased quality and quantity of sleep could make lonely individuals less resistant to health threats.

Health Behaviors

The mediating role of health behaviors, such as smoking, diet, exercise, and alcohol and drug use, in the relationship between loneliness and health has been less clear. Cacioppo and colleagues (2002b) found no difference in alcohol consumption, drug use, number of cigarettes smoked, or exercise duration between groups of lonely and non-lonely undergraduate students (n = 89) and adults (n = 25) (Cacioppo et al., 2002b). However, other studies have suggested that lonely individuals engage in less health-promoting behaviors. For example, Theeke (2010) found that chronically lonely older adults used more tobacco and exercised less than those who were not chronically lonely. Other studies found that lonely people were more likely to smoke, be overweight, and have higher body mass indexes (BMIs) than non-lonely people (DeWall & Pond, 2011; Lauder, Mummery, Jones, & Caperchione, 2006; Shankar, McMunn, Banks, &

Steptoe, 2011). Additionally, loneliness predicted reduced odds of engagement in physical activity (Hawkley, Thisted, & Cacioppo, 2009; Reed, Crespo, Harvey, & Andersen, 2011; Shankar et al., 2011). Greater loneliness has been linked to the full spectrum of eating disorders (Levine, 2012), and lonely student dieters ate more than non-lonely student dieters when offered free food (Rotenberg & Flood, 1999). Although the reasons for these mixed findings are unclear, the small sample sizes and non-representative sampling methods may help explain the lack of differences in health behaviors between lonely and non-lonely groups in Cacioppo and colleagues' (2002) studies. Additionally, Cacioppo and colleagues created cutpoints to dichotomize loneliness into two categories (lonely and non-lonely), a method that reduces statistical power relative to examining the full continuum of loneliness scores (Babyak, 2004).

To my knowledge, only two formal tests of mediation have been conducted to examine whether engagement in health behaviors accounts for the relationship between loneliness and health outcomes. Caspi and colleagues (2006) found that the relationship between teacher-reported childhood isolation and adult physical health outcomes was not explained by adults' self-reported engagement in exercise, heavy smoking, or alcohol dependence. On the other hand, in a cross-sectional study of adults aged 19 to 85, Segrin and Passalacqua (2010) found that exercise, sleep, and medical adherence, but not diet or smoking, mediated the relationship between loneliness and health-related quality of life. Some health behaviors may require an extended period of time to show effects on an individual's health. A longitudinal approach should be taken to examine the extent to which health behaviors account for the relationships between loneliness and mental and physical health.

Self-regulation (Carver & Scheier, 1998) and self-control (Baumeister, Heatherton, & Tice, 1994) theories provide a useful framework for studying these relationships. According to these theories, exerting self-control over goal-related behaviors involves the use of depletable psychological resources. Consequently, efforts to achieve short-term goals (e.g., improve current mood) may impair efforts to achieve long-term goals (e.g., improve future health). Tice and Bratslavky (2000) suggest that the regulation of emotional distress (such as coping with feelings of loneliness) can undermine attempts at self-control. Consistent with their theory, lonely people have been found to have less control over the focus of their attention (Cacioppo et al., 2000). Thus, I reasoned that, given limitations in their psychological resources, lonely individuals who are focused on regulating their mood may be less able to regulate their health behaviors. In addition, substances such as tobacco and alcohol or unhealthy foods may be used to improve mood. Tice, Bratslavsky, and Baumeister (2001) tested the assumption that the regulation of emotional distress takes precedence over controlling health behaviors. It was found that emotional distress led participants to consume more snack foods; however, this effect was not found when participants were told that eating would not improve their mood. Additionally, depression, a form of emotional distress predicted by loneliness, is linked to poorer health behaviors (Allgöwer, Wardle, & Steptoe, 2001). This converging evidence suggests that loneliness may be related to less engagement in health promoting behaviors.

Health Behaviors and Health Outcomes

Engagement in health promoting behaviors, including healthy dietary behaviors and regular physical activity, has been consistently associated with better mental and physical health outcomes (CDC, 1999; Núñez-Córdoba & Martínez-González, 2011). With regard to diet, in particular, fruit and vegetable (F&V) consumption appears to have preventative effects against cardiovascular disease and cancer (Nöthlings et al., 2008; Núñez-Córdoba & Martínez-González, 2011). Higher intake of raw F&Vs is associated with reduced stroke risk (Oude Griep, Verschuren, Kromhout, Ocke, & Geleijnse, 2011), whereas lower intake of F&Vs is related to arterial stiffness and low density lipoprotein cholesterol (Aatola et al., 2010; Mirmiran, Noori, Zavareh, & Azizi, 2009), both of which are related to stroke and cardiovascular problems. Additionally, some studies have suggested that eating healthily has benefits for mental health, although findings are mixed (Akbaraly et al., 2009; Chai et al., 2010; Kiviniemi, Orom, & Giovino, 2011; Rohrer & Stroebel, 2009; Steptoe, Perkins-Porras, Hilton, Rink, & Cappuccio, 2004). Those eating more servings of F&Vs per day have been found to experience less emotional distress (Kiviniemi et al., 2011; Rohrer & Stroebel, 2009), and eating more whole foods (e.g., fruit, vegetables, fish) as opposed to processed foods is related to less depression (Akbaraly et al., 2009).

Physical activity may be one of the most significant predictors of physical and mental health. Exercise is related to cardiopulmonary fitness (Rojas, Schlicht, & Hautzinger, 2003), reduces the risk of developing chronic conditions, and helps build and maintain healthy bones and joints (CDC, 1999). Exercise also increases functionality and muscle strength and reduces pain and fatigue in older adults (CDC, 1999) and people

with chronic medical conditions (Adamsen et al., 2006; Sañudo, Galiano, Carrasco, de Hoyo, & McVeigh, 2011). In addition, exercise is related to better psychological well-being, quality of life, and overall mental health (Penedo and Dahn, 2005; Rojas, Schlicht, & Hautzinger, 2003; Sañudo et al., 2011). Research suggests that exercise may reduce anxiety and depressive symptoms, protect against the development of major depressive disorder and anxiety disorders, and delay the cognitive decline associated with aging (CDC, 1999). In summary, lifestyle factors, including F&V consumption and exercise, have predicted both mental and physical health. Thus, changes in these factors could have meaningful effects on health outcomes.

Family Caregiving

One population at risk for poorer health outcomes (Given et al., 2004; Ji, Zöller, Sundquist, & Sundquist, 2012) and increased levels of loneliness (Bishop et al., 2007; Sahin & Tan, 2012) is family caregivers. A family caregiver is a relative or friend who provides unpaid, informal care to patients or older adults with chronic medical conditions. The prevalence of family caregiving is increasing and is expected to continue to increase as the number of older adults in the U.S. rapidly grows. The population of older adults (65 years of age or older) is increasing much faster than the population as a whole (U.S. Bureau of the Census, 2012), and 80% of older adults have at least one chronic medical condition (CDC, 2009). Emanuel et al. (1999) found that 86.8% of terminally ill patients reported needing assistance with transportation, homemaking services, nursing care, and personal care and that 96% of the time this assistance was provided by family caregivers. According to a meta-analysis, the typical caregiver of an

older adult is a woman (72%) and a spouse (58.5%) who lives with the patient (71%), with about half of caregivers being employed full or part-time (47%). The meta-analysis also indicated that the average caregiver is 63 years old and spends an average of 43 hours per week providing care (Pinquart & Sörensen, 2003).

In recent years, family caregivers of cancer patients have received increased research attention (Kim & Given, 2008; Northouse, Williams, Given, & McCorkle, 2012). A large and growing population, spousal caregivers of cancer patients have been found to be more distressed and receive less social support than the patients themselves (Bishop et al., 2007; Northouse, Mood, Templin, Mellon, & George, 2011). The most common tasks performed by caregivers of cancer patients include assistance with transportation, emotional support provision, and household chores (Oberst, Thomas, Gass, & Ward, 1989). Caregivers of cancer patients often have unmet practical, psychosocial, and informational needs (Glajchen, 2004). Having unmet needs predicts worse quality of life and mental health (Carey, Oberst, McCubbin, & Hughes, 1991; Given et al., 2004; Kim, Kashy, Spillers, & Evans, 2010). Caregivers also may experience reduced work productivity, especially when the patient has a more advanced cancer stage and there is a high level of caregiving demands (Mazanec, Daly, Douglas, & Lipson, 2011). The estimated costs associated with caring for a family member over a 2-year period following a cancer diagnosis range from about $30,000 to $80,000 (Yabroff & Kim, 2008). Given the high levels of burden and stress experienced by cancer patients' caregivers, it is important to understand how providing care is related to health outcomes.

Caregiving and Mental Health

Compared to the general population, cancer caregivers have shown a high prevalence of distress, including depression and anxiety (Bishop et al., 2007; Friðriksdóttir, 2011; Grov, Dahl, Moum, & Fosså, 2005). Corà and colleagues (2012) found that caregivers of terminal cancer patients had higher depressive and anxiety symptoms than age and gender-matched control participants. In another study of caregivers of patients with advanced cancer, 25% accessed mental health services after the patient's diagnosis and 13% met DSM criteria for a psychiatric disorder (Vanderwerker, Laff, Kadin-Lottick, McColl, & Prigerson, 2005). Increased emotional distress, depression, and anxiety among cancer caregivers are associated with caregiving that impacts daily schedules and the ability to participate in valued activities (Cameron, Franche, Cheung, & Stewart, 2002; Kurtz, Kurtz, Given, & Given, 2004). A year after the cancer diagnosis, a substantial majority of distressed caregivers remain distressed, and many become more distressed over time (Ell, Nishimoto, Mantell, & Hamovitch, 1988).

Demographic and medical predictors of distress among cancer caregivers have been identified. Female caregivers tend to be more distressed than male caregivers; in fact, among couples coping with cancer, women are typically more distressed regardless of role (i.e., patient or caregiver) (Hagedoorn, Sanderman, Bolks, Tuinstra, & Coyne, 2008). In addition, caregivers with a lower education level (Cameron et al., 2002; Kim & Spillers, 2010; Papastavrou, Charalambous, & Tsangari, 2009) and lower income (Papastavrou, Charalambous, & Tsangari, 2009) tend to experience greater depression and burden than caregivers with a higher education level and higher income.

Furthermore, caring for a cancer patient with more severe symptoms or poorer health also predicts greater depression in caregivers (Kurtz et al., 2004; Papastavrou, Charalambous, & Tsangari, 2009).

Several social factors also predict cancer caregivers' mental health outcomes (Kurtz et al., 2004; Nijboer, Tempelaar, Triemstra, van den Bos, & Sanderman, 2001). Caregivers with poorer social functioning and less social support are more depressed and report poorer quality of life than caregivers with better social functioning and more social support (Kurtz et al., 2004; Mellon, Northouse, & Weiss, 2006). Furthermore, caregivers who are caring for a patient with depression (Kurtz et al., 2004), holding negative views of caregiving, or experiencing a low level of daily emotional support are more depressed (Nijboer et al., 2001).

In summary, providing care to cancer patients is linked to poorer mental health outcomes, especially depression. Research on caregivers of patients with a broad range of medical conditions also suggests that providing care can take a toll on mental health (Pinquart & Sörensen, 2003; Savage & Bailey, 2004). The results of a review on caregivers of patients with medical conditions and cognitive impairment suggest that they experience greater depressive symptoms and stress and have lower self-efficacy and well-being than non-caregivers (Pinquart & Sörensen, 2003).

Caregiving and Physical Health

Cancer caregivers may also be at risk for a number of physical health problems, although less research has been conducted on cancer caregivers' physical health than other types of caregivers (Kim & Schulz, 2008; Northouse et al., 2012). Caregivers of

terminal cancer patients have been found to have more sleep dysfunction and higher blood pressure than gender- and age-matched controls (Corà et al., 2012). In addition, spousal caregivers of cancer patients have been found to be at increased risk for coronary heart disease and stroke relative to non-caregivers (Ji, Zöller, Sundquist, & Sundquist, 2012). While providing care, cancer caregivers have also shown changes in inflammatory processes that could negatively impact health outcomes (Rohleder, Marin, Ma, & Miller, 2009).

Caregivers' subjective experiences providing care appear to be more predictive of health outcomes than patients' symptoms or health status. Consistent with this notion, cancer-specific stress symptoms among caregivers have been associated with increased physical symptoms and altered T-cell blastogenesis, which is related to immune functioning; patient disease recurrence status, however, was not predictive of caregivers' physical health (Gregorio et al., 2012). In addition, personal perceptions of the caregiving experience have been related to caregivers' perceptions of their physical health (Kurtz et al., 2004).

A large literature on the relationship between caregiving and physical health of caregivers of patients with a variety of chronic conditions provides additional evidence that providing care can have a negative impact on physical health outcomes (Buyck et al., 2011; Vitaliano, Zhang, & Scalan, 2003; Pinquart & Sörensen, 2003). Caregivers appear to have impaired physiological responses to stress and illness, such as having a poorer response to vaccines, accelerated cellular aging, and slower healing of wounds (Gouin, Hantsoo, & Kiecolt-Glaser, 2008; Kiecolt-Glaser, Marucha, Malarkey, Mercado, & Glaser, 1995). Caregiving has also been associated with a higher risk of coronary heart

disease in women (Lee, Colditz, Berkman, & Kawachi, 2003) and a greater risk of death when caregivers experience psychological strain (Schulz & Beach, 1999). Furthermore, results of a meta-analysis indicated that caregivers of dementia patients have worse global physical health, more stress hormones, and fewer antibodies than non-caregivers (Vitaliano, Zhang, & Scalan, 2003). Taken together, evidence suggests that cancer caregivers are at increased risk for poor physical health outcomes.

Caregiving and Loneliness

In addition to having negative consequences for mental and physical health, there is some evidence that providing care to cancer patients is related to greater levels of loneliness (Bishop et al., 2007; Sahin & Tan, 2012). In two qualitative studies (Grimm, Zawacki, Mock, Krumm, & Frink, 2000; Kalaygian, 1989), cancer caregivers have expressed feelings of loneliness, and, in a recent quantitative study, 63% of Turkish cancer caregivers showed high levels of loneliness (Sahin & Tan, 2012). In a study of spousal caregivers of cancer patients who underwent hematopoietic stem cell transplantation, caregivers were lonelier than the patients themselves and married, non-caregiving controls (Bishop et al., 2007). Loneliness was also higher among dying cancer patients and their caregivers than non-cancer controls (Rokach, Matalon, Safarov, & Bercovich, 2007). One possible explanation for greater loneliness among cancer caregivers than non-caregiving controls is caregivers' difficulty discussing their caregiving experience and feelings with others. Social constraints (i.e., perceived inadequacy of social support resulting in reluctance to disclose thoughts and feelings about a stressor) have been related to poorer quality of life in cancer caregivers (Bishop

et al., 2007). Another potential contributor to loneliness among cancer caregivers is reduced participation in social activities due to time-consuming caregiving responsibilities. Given the high rates of loneliness in caregivers of cancer patients (Bishop et al., 2007; Sahin & Tan, 2012), it is important to study loneliness and its relationship to health outcomes in this population.

Present Study

The present study aims to examine engagement in health behaviors as a possible mechanism underlying the relationships between loneliness and mental and physical health outcomes in family caregivers of cancer patients. This study focuses on caregivers of cancer patients because they are a large and growing group (Boyle, 2008), and there are different trajectories and types of stressors for cancer caregivers than other types of caregivers who are more widely studied (e.g., dementia caregivers; Kim & Schulz, 2008). Additionally, caregivers of cancer patients have reported engaging in poorer health behaviors (i.e., less exercise, poorer diet, more smoking) since becoming caregivers (Beesley, Price, & Webb, 2011), with poorer health behaviors being associated with greater caregiving strain (Beach, Schulz, Yee, & Jackson, 2000). Based on self-regulation theory (Tice & Bratslavsky, 2000) and prior research (Bishop et al., 2007; Sahin & Tan, 2012), I reasoned that higher rates of loneliness in caregivers might put them at increased risk for the depletion of resources for self-regulation that influence engagement in health behaviors. Therefore, cancer caregivers are an important population to study when examining whether health behaviors mediate the relationships between loneliness and health outcomes. It is hypothesized that: (1) loneliness will be

related to engagement in health behaviors (i.e., F&V consumption and exercise), such that individuals who are more lonely will have lower F&V consumption and exercise less; (2) health behaviors will be related to mental and physical health, such that lower F&V consumption and less exercise will be related to poorer physical and mental health; and (3) each of these health behaviors will partially mediate the relationships between loneliness and mental and physical health outcomes. Diagrams of the hypothesized mediation models are found in Appendix A.

METHOD

Participants

A sample of 154 cancer patients and 106 of their caregivers were recruited from the American Cancer Society (ACS) Hope Lodge in Rochester, Minnesota. ACS's Hope Lodge houses patients and their family caregivers for free if the patient is undergoing active outpatient cancer treatment at least three times weekly. To be eligible for the study, caregivers had to be unpaid and providing care to a patient undergoing active cancer treatment. Both patients and their caregivers had to be 18 years of age or older and able to speak and read English. Individuals who were commuting from out-of-town (not planning to stay at the Hope Lodge) or who had 2 days or less until moving into the Hope Lodge were excluded from study participation.

Measures

Demographics and Patient Medical Characteristics

Self-report questionnaires were used to collect demographic information from caregivers and medical characteristics from patients. Caregivers reported their age, gender, ethnicity, education level, income, marital status, employment status, and

relationship to the patient. Information about insurance status, date of diagnosis, cancer treatment, cancer type, and cancer stage was collected from patients.

Loneliness

Loneliness was assessed using four items from the UCLA Loneliness Scale – Version 3 (Russell, 1996), which is the most widely used measure of loneliness. The UCLA Loneliness Scale has shown high internal consistency (α = .89-.94) and test-retest reliability (r = .73 for a 1-year period) and has demonstrated convergent and construct validity. Items 12, 13, 16 and 20 were chosen to assess loneliness based on the item-total statistics for the items, with the constraint that two of the selected items were negatively worded and two of the items were positively worded (Russell, 1996).

Fruit and Vegetable Consumption

Respondents reported the number of days per week that they consumed five or more servings of fruits and vegetables in a typical week for the past couple of weeks.

Exercise

Exercise behavior was assessed using two items from the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). The Centers for Disease Control and Prevention (CDC) recommends moderate and vigorous intensity exercise and exercising for a minimum of 10 minutes at a time for health benefits (CDC, 2011); thus, items assessing the numbers of days spent engaging in a minimum of 10 minutes of moderate and vigorous exercise were used to assess exercise behavior. The number of days of

moderate or vigorous physical activity, rather than the number of minutes of this activity, was used because the IPAQ greatly overestimates exercise minutes (Lee, Macfarlane, Lam, & Stewart, 2011).

Physical and Mental Health

The Physical Component Summary (PCS) and Mental Component Summary (MCS) scores from the 12-item Medical Outcomes Study Short-Form Health Survey (SF-12; Ware, Kosinki, & Keller, 1996) were used to measure physical and mental health within the past 4 weeks, respectively. Test-retest reliability was high over a 2-week period for the SF-12 (PCS r = .89, MCS r = .76) for the general population. Construct validity has also been demonstrated with general population samples (Ware, Kosinki, & Keller, 1996).

Procedure

A secondary data analysis was conducted using data from a study of cancer patients and their family caregivers. The study was designed to examine the effects of social support and loneliness on quality of life among recently diagnosed cancer patients and their family members. In this study, patients and their caregivers were contacted if they were on the waiting list for the ACS Hope Lodge in Rochester, Minnesota and met eligibility criteria. A total of 143 caregivers were approached; 141 were eligible and 106 participated in the study (a 74% response rate). Common reasons that caregivers provided for refusal included feeling too overwhelmed with responsibilities and the time commitment. In five cases, two caregivers provided information about caring for the

same patient. The number of care tasks provided to the patient by the caregiver was assessed using the Dimensions of Care Tasks measure (Kim & Carver, 2007). In order to avoid violating the assumption of non-independence, data from the caregiver that reported completing fewer care tasks at baseline were excluded from analyses. In one case, two caregivers reported the same number of care tasks at baseline; thus, data from the caregiver reporting fewer care tasks at 12 months post-baseline were excluded from analyses, as this was the first time point at which scores for both caregivers were available and differed. Informed consent was obtained face-to-face at locations convenient for prospective participants (e.g., clinic appointments, hotel rooms) before their stay at the Hope Lodge.

Questionnaires were completed at four time points: the time 1 survey occurred at the time of enrollment (typically within a week before arriving at the Hope Lodge); the time 2 survey occurred approximately two weeks after study consent (or upon leaving the Hope Lodge, whichever came first); the time 3 survey occurred four months from time 1; and the time 4 survey occurred at 12 months from time 1. Questionnaires for times 1 and 2 were completed in-person, and questionnaires for times 3 and 4 were sent to participants by mail. Phone calls were made to participants to remind them to complete the questionnaires. Most participants completed the questionnaires independently, but the study coordinator was available to answer questions and administer the questionnaire when required. Information about participants' mental and physical health and health behaviors (i.e., exercise, F&V consumption) were collected at time points 1, 2, 3, and 4. Loneliness was assessed at time points 1, 2, and 4. Participants received no

compensation at time point 1, $35 in compensation at time point 2, $15 in compensation at time point 3, and $15 in compensation at time point 4.

Appendix B presents the sample size and retention rate by time point for caregivers included in the analyses for the present study. Caregiver retention rate at time 4 was 63.4%. At time 4, 17.9% (19/106) of all enrolled caregivers were lost to follow-up and 12.3% (13/106) were no longer eligible due to patient death. Another common reason for study withdrawal across time points was caregivers' time constraints.

Statistical Analyses

Data were analyzed with SPSS statistical software (version 19.0; SPSS, Chicago, IL, USA). First, the exercise variable was computed by adding the number of days each week caregivers reported engaging in a minimum of 10 minutes of vigorous exercise with the number of days each week they reported engaging in moderate exercise. Next, descriptive statistics were computed to characterize caregiver demographics and patient medical variables. Skewness and kurtosis of all study variables were examined in SPSS to investigate the assumption of normality. The data were also examined for outliers. Next, descriptive statistics were computed to characterize caregivers' loneliness, health behaviors, and mental and physical health.

In the analyses, the time 1 measure of loneliness, time 2 (~ two weeks) measure of health behaviors, and time 3 (four months) measures of mental and physical health were used. Time 4 data were not used in the analyses in order to maximize sample size and statistical power. Data from caregivers who completed time points 1, 2, or 3 were included in the analyses. Multiple imputation was used to fill in the missing data.

Imputation was used because it results in less sampling bias by allowing for greater variability in the data included in the analyses than deletion methods (Roth, Switzer III, & Switzer, 1999). Multiple imputation was used to generate five complete datasets in SPSS. SPSS uses a multiple imputation process called fully conditional specification, which has been shown to be a powerful and acceptable method (van Buuren, 2007; van Buuren, Brands, Roothuis-Oudshoorn, & Rubin, 2006). The multiple imputation process creates a range of simulated values for each missing value, accounting for the uncertainty that is characteristic of most imputation methods (Enders, 2006; Newgard & Haukoos, 2007; Schafer & Graham, 2002). Analyses to examine the hypotheses were completed five times, once on each of the five datasets generated. Equations (see Appendix C) derived from Rubin's (1987) mathematical rules were used to calculate the averages of the parameter estimates, standard errors, t-statistics, and degrees of freedom across analyses using each of the five datasets and to construct 95% confidence intervals (Newgard & Haukoos, 2007). Comparisons were made using correlation on all relevant demographic and medical characteristics and study variables between individuals who completed each time point and those whose responses were imputed. A macro ("INDIRECT") developed by Preacher and Hayes (2008) was used to test study hypotheses. In the macro, multiple regression was first used to examine the relationships between loneliness and mental and physical health, loneliness and each of the health behaviors, each of the health behaviors and mental and physical health, and the control variables and mental and physical health. The t-statistics for each of the hypothesized pathways were compared to a critical t-value to determine whether the relationships were significant. The critical t-value was 1.98, indicating a .05 level of significance for a two-

tailed test with 120 degrees of freedom. The value of 120 chosen for degrees of freedom was selected conservatively, as the exact degrees of freedom for each of the pathways fell between 120 and infinity. The relationships were considered significant if the t-statistic was greater than the critical t-value. In the macro, a non-parametric resampling method, bootstrapping, was used to examine the indirect effect of loneliness on physical and mental health via health behaviors (Shrout & Bolger, 2002). The method entails estimating the indirect effect one thousand times by repeatedly resampling from the dataset. A sampling distribution for the effect is approximated and used to construct a bias-corrected 95% confidence interval. The indirect effect is considered statistically significant when the confidence interval does not contain zero (Preacher & Hayes, 2004; Preacher & Hayes, 2008). The bootstrap method was used because it does not require a normal distribution (Preacher and Hayes, 2008), and problems associated with alternative methods of examining mediation (e.g., low statistical power) are of lesser concern (MacKinnon, Lockwood, & Williams, 2004). Using Rubin's (1987) equations to combine results across the datasets required confidence intervals to be calculated by hand using the parameter estimates and standard errors; thus, bias-corrected confidence intervals could not be obtained for the indirect effects and non-bias-corrected confidence intervals were used instead to determine significance.

Age, gender, and income were included as control variables in analyses examining mental health outcomes because they have been found to be related to mental health outcomes in caregivers of patients with medical conditions (Akosile, Okoye, Nwankwo, Akosile, & Mbada, 2011; Kim & Spillers, 2010; Markowitz, Gutterman, Sadik, & Papadopoulos, 2003). Age, education, and income were control variables when

examining physical health based on prior research with caregivers of patients with medical conditions (Akosile et al., 2011; Kim & Spillers, 2010; Markowitz et al., 2003).

RESULTS

Preliminary Analyses

Descriptive statistics were computed to characterize caregiver demographics (see Appendix D, Table D1) and patient medical variables (see Appendix D, Table D2). Most (77.2%) of the caregivers were female, Caucasian (94.1%), and spouses of the patient (82.0%). The average time since diagnosis at baseline was less than a month (.81 months, *SD* = 4.87). Cancer treatments received by patients included radiation (95.7%), chemotherapy (58.6%), surgery (45.0%), and hormonal therapy (9.3%).

Data were screened to ensure that the normality assumption was met and that outliers were not present. The skew and kurtosis of the variables were examined to investigate the assumption of normality. According to Kline's (2011) guidelines, the skew and kurtosis values for each of the study variables were appropriate (see Appendix E). Next, data were examined for outliers. Outliers were defined as values greater than 3 standard deviations from the mean. Four outliers were identified and were determined to represent true variability in caregivers' loneliness (one outlier) and exercise (three outliers). Some researchers contend that retaining legitimate outliers results in data that are more representative of the true population (Orr, Sackett, & DuBois, 1991). Because the outliers appeared to represent true variability and did not result in problematic skew and kurtosis values, the outliers were not removed from the dataset.

Descriptive statistics were then used to characterize caregivers' loneliness, health behaviors, and mental and physical health (see Appendix D, Table D3). On average, caregivers rarely reported feeling lonely, although observed scores nearly spanned the full scale. Also, on average, caregivers reported engaging in moderate to vigorous exercise for a minimum of 10 minutes approximately three days a week. Caregivers reportedly consumed five or more F&V per day less than three days per week, on average, whereas national guidelines recommend daily consumption of five or more F&V (Thompson & Veneman, 2005). Caregivers' mental functioning scores were below average, indicating that they have poorer mental health than the general population (Ware, Kosinki, & Keller, 1998). The caregivers' average physical functioning score was indicative of average physical health relative to the general population (Ware, Kosinki, & Keller, 1998). Comparisons were made on all relevant demographic and medical characteristics and study variables between caregivers who completed each time point and those whose responses were imputed. Study completers and noncompleters did not differ with regard to demographic and medical characteristics and study variables with one exception; spousal caregivers were more likely to complete each time point that non-spousal caregivers (e.g., siblings, adult children, and friends).

The relationships between demographic covariates and outcome variables were assessed with regression as part of the INDIRECT macro. Income significantly predicted physical health, such that higher levels of income were related to better physical health. Age and education did not predict physical health, and gender, education, and income did not predict mental health. Zero-order correlations between main study variables and covariates were also computed (see Appendix D, Table D4).

Study Hypothesis 1

Regression analyses were conducted as part of the INDIRECT macro to examine whether hypothesis 1 was supported. The first study hypothesis was that greater levels of loneliness would be related to lower F&V consumption and less exercise. The pathways associated with hypothesis 1, labeled with "*H1*," are shown in the hypothesized models (see diagrams in Appendix A). Contrary to hypotheses, when controlling for demographic covariates, loneliness was not significantly related to F&V consumption or exercise in either the model predicting physical health or the model predicting mental health (see Appendix F, Table F1).

Study Hypothesis 2

Regression analyses were also conducted as part of the INDIRECT macro to examine whether hypothesis 2 was supported. The second study hypothesis was that lower F&V consumption and less exercise would be related to poorer mental and physical health outcomes. The pathways associated with hypothesis 2, labeled with "*H2*," are shown in the hypothesized models (see Appendix A). Caregivers' F&V consumption was not significantly related to their mental or physical health over and above the effects of the control variables on these outcomes. Additionally, caregivers' exercise was not significantly related to their mental or physical health over and above the effects of the control variables on these outcomes (see Appendix F, Table F2).

Study Hypothesis 3

Hypothesis 3 was also tested using the INDIRECT macro. The third study hypothesis was that F&V consumption and exercise would partially mediate the relationships between loneliness and mental and physical health outcomes. The pathways associated with hypothesis 3, labeled with "*H3*," are shown in the hypothesized models (see Appendix A). The indirect effects of loneliness on mental and physical health outcomes through F&V consumption and exercise were calculated using the bootstrapping method in the macro. Neither F&V consumption nor exercise partially mediated the relationships between loneliness and mental and physical health outcomes (see Appendix F, Table F3).

DISCUSSION

The goal of the present study was to investigate whether health behaviors (i.e., F&V consumption and days of moderate and vigorous exercise) mediated relationships between loneliness and physical and mental health in caregivers of cancer patients. Support for study hypotheses was not found. Relationships between loneliness and health behaviors (hypothesis 1) and health behaviors and physical and mental health (hypothesis 2) did not emerge. Thus, health behaviors did not mediate relationships between loneliness and physical and mental health (hypothesis 3). Self-regulation theory predicts that mood dysregulation detracts from the ability to manage short-term goals, such as engaging in health promoting behaviors (Baumeister et al., 1994). The current findings are inconsistent with predictions based on self-regulation theory. However, to date, mixed evidence has been found for the hypothesized mediating role of health behaviors in the relationship between loneliness and health outcomes (Caspi et al., 2006; Segrin & Passalacqua, 2010).

Loneliness did not predict F&V consumption or exercise in this sample of cancer caregivers. Self-regulation theory (Baumeister et al., 1994) suggests that individuals who are focused on regulating their mood (e.g., feelings of loneliness) may have less attentional resources to dedicate towards the regulation of their dietary and exercise behaviors. Consistent with this theory, studies have found relationships between

loneliness and a range of health behaviors among adolescents, college students, and representative samples of middle-aged and older adults (DeWall & Pond, 2011; Hawkley et al., 2009; Lauder et al., 2006; Levine, 2012; Rotenberg & Flood, 1999; Reed et al., 2011; Shankar et al., 2011; Theeke, 2010). However, Cacioppo and colleagues (2002b) found no difference between lonely and non-lonely college students and older adults on several health behaviors (e.g., alcohol consumption, exercise). Differences in measurement, sample characteristics, sample size, and health behaviors are some potential reasons for mixed findings across studies. One potential explanation for the lack of relationship between loneliness and F&V consumption in the present study is that, rather than decreasing consumption of healthy food, lonely people might be increasing consumption of unhealthy food to improve mood. For example, socially excluded and emotionally distressed students ate more snack foods than non-distressed students in experimental studies (Baumeister, DeWall, Ciarocco, & Twenge, 2005; Tice et al., 2001). Additionally, studies have shown that exercise enhances mood (e.g., Sibold & Berg, 2010). Whereas some lonely individuals might exercise less, others may use exercise as a method for mood improvement, providing another potential explanation for the lack of relationship between loneliness and exercise in this study. Finally, another possible explanation for the current null findings is that the short time period between the assessment of loneliness and health behaviors (i.e., approximately 2 weeks) may have been an insufficient period for loneliness to exert effects on health behaviors.

Significant relationships between health behaviors and health outcomes also were not found in the current sample. Health promoting behaviors have been consistently related to positive health outcomes in general population samples (CDC, 1999; Núñez-

Córdoba & Martínez-González, 2011), but have remained largely unexamined among caregivers of cancer patients. The measurement of health behaviors and outcome variables may provide an explanation for the null results. The mental and physical component scores of the SF-12 are excellent measures of global health, but may be too general to detect differences in health status due to F&V consumption. Although F&V consumption has been linked specifically to cardiovascular disease, stroke, and distress (Núñez-Córdoba & Martínez-González, 2011; Oude Griep et al., 2011; Rohrer & Stroebel, 2009), relationships between F&V consumption and SF-12 Mental and Physical Component Summary scores have been mixed (Chai et al., 2010; Steptoe et al., 2004). Additionally, measurement of exercise by the number of days spent engaging in exercise may not have captured adequate detail about exercise behaviors to make health outcome predictions. Another possible explanation for the current null findings is that four months was an insufficient period for F&V consumption and exercise to exert effects on health. Thus, both study design and measurement issues may help explain the lack of relationship between health behaviors and health outcomes in this study.

Given null relationships between loneliness and health behaviors as well as health behaviors and outcomes, my meditational hypothesis was not supported. Specifically, F&V consumption and exercise did not mediate relationships between loneliness and physical and mental health. Previous studies examining health behaviors as mediators of the relationships between loneliness and health outcomes have resulted in mixed findings (Caspi et al., 2006; Segrin & Passalacqua, 2010). For example, exercise, heavy smoking, and alcohol dependence did not mediate the relationship between teacher-reported childhood isolation and objective adult physical health outcomes in one study (Caspi et

al., 2006). In a second study among adults in the general population, exercise, sleep, and medical adherence, but not diet or smoking, mediated the relationship between self-reported loneliness and health-related quality of life (Segrin & Passalacqua, 2010). Mixed findings could be attributed to differences in assessment methods (teacher-reported vs. self-reported loneliness; self-reported vs. objective measurement of health) and study design (longitudinal vs. cross-sectional). In general, when discussing null findings, authors have proposed alternate explanations for the relationship between loneliness and health (Cacioppo et al., 2003; Caspi et al., 2006; Segrin & Passalacqua, 2010). Caspi and colleagues (2006) suggested that social isolation may impact health through other mechanisms (e.g., chronic stress affects the HPA system and pathophysiological responses, disrupts sleep, and affects coping). More consistent evidence has been found for alternative explanations for the loneliness-health relationship, such as reduced sleep quality and increased stress (Cacioppo, Hawkley, & Bernston, 2003; Hawkley & Cacioppo, 2010).

Another notable finding was that, contrary to prior studies of cancer caregivers (Bishop et al. 2007; Sahin & Tan, 2012), caregivers reported low levels of loneliness on average. One potential explanation for this finding is that study personnel contact and anticipation of involvement with the Hope Lodge could have affected caregivers' level of loneliness. The Hope Lodge offers many educational and supportive services for caregivers (e.g., support groups for caregivers, yoga classes, informational sessions). Caregivers could reasonably expect to receive increased social support from staff and peers while staying at the Hope Lodge. Expectations have been found to play a large role in mental health outcomes among individuals seeking supportive services (DeFife &

Hilsenroth, 2011); patients have experienced improvement in mood before treatment begins (e.g., Hesser, Weise, Rief, & Andersson, 2011; Posternak & Miller, 2001). Thus, in this study, caregivers' expectations for support may have impacted their perceptions of social isolation. In addition, on average, caregivers' loved ones were only .8 months post-diagnosis of cancer. Although research has not examined caregivers' levels of social support shortly after the patient's cancer diagnosis, another potential explanation for the current finding is that caregivers may have received increased support from family and friends right after diagnosis. In the present analyses, I did not examine whether caregivers' levels of loneliness remained stable throughout the study period.

Limitations, Strengths, and Future Directions

Limitations of this secondary data analysis include the use of a homogenous (primarily Caucasian, middle-class, female) sample. Future studies should include caregivers with greater socioeconomic, gender, and ethnic diversity. Another limitation of this study is that only two health behaviors were examined as potential mediators of the relationship between loneliness and health. Future research should assess whether other health behaviors, such as the consumption of alcohol and other drugs, mediate the relationships between loneliness and mental and physical health. A third limitation is the attrition (22.3 %) over the 4-month study period. Caregivers who completed all time points may have differed from caregivers who did not complete all of the time points (e.g., they were more busy or distressed). However, use of multiple imputation allowed data from all caregivers to be included in analyses (minimizing bias resulting from

excluding cases), while accounting for error that is ignored in other data imputation methods (Schafer & Graham, 2002).

Limitations related to measurement also should be noted. First, loneliness was measured using only four items from the 20-item UCLA Loneliness Scale; thus, future studies should investigate whether using the 20-item UCLA Loneliness Scale would affect results. Second, caregivers' report on exercise was restricted to the number of days they spent engaging in vigorous or moderate exercise for 10 or more minutes at a time during the previous week. A more detailed measure of exercise (e.g., one including the number of minutes spent exercising on each day) would likely provide more information about the relationships between physical activity and loneliness and health outcomes. Although data were imputed, attrition is another study limitation. Furthermore, spousal caregivers were more likely to complete each time point than non-spousal caregivers. The spousal caregivers in this sample were older on average than non-spousal caregivers, putting them at increased risk for poorer physical health. Finally, the use of self-report measures to assess caregivers' health behaviors and health outcomes and patients' medical characteristics is another limitation of this study. More objective measures of health may provide more valid information and also reduce missing data. For example, 39.6% of data regarding patients' disease stage were missing.

This study also had a number of strengths, including the longitudinal study design and focus on cancer caregivers. Although one previous study (Caspi et al., 2006) examined the health behavior mediation hypothesis longitudinally, the researchers examined whether health behaviors mediated the relationship between teacher-reported isolation and adult health; this is the first study to examine whether health behaviors

mediated the relationships between *self-reported* loneliness and health outcomes longitudinally. Because loneliness is a subjective feeling characterized by the perception of social isolation, assessing the participant's personal experiences of loneliness is key to understanding these relationships. Furthermore, the use of the SF-12 is a strength of this study, as it is a well-validated and widely used measure of health that allows one to compare the sample's health to population norms (Ware, Kosinki, & Keller, 1998). Additionally, the focus on caregivers of cancer patients is a strength, as cancer caregivers are understudied and at risk for high levels of distress, including loneliness, and poor health behaviors (Beesley et al., 2011; Bishop et al., 2007; Cooley et al., 2012).

Additional research is needed to determine whether health behaviors mediate the relationships between loneliness and health outcomes or whether alternate explanations for these relationships should be considered (e.g., reduced sleep quality or stress). Before a definitive conclusion can be drawn, future studies should examine additional health behaviors as potential mediators of the relationship between loneliness and health and use more objective measures of health behaviors and physical health outcomes. Furthermore, longer time periods between assessments would allow researchers to better elucidate the relationships between loneliness and health behaviors and health behaviors and health outcomes. In future studies with cancer caregivers, loneliness should also be assessed in a context where caregivers do not anticipate support through the Hope Lodge or other programs.

If we found that health behaviors mediated the relationships between loneliness and health outcomes in cancer caregivers, these findings would suggest that health behaviors are one pathway to poorer health outcomes in lonely individuals. Results

would be consistent with the predictions of self-regulation theory (Baumeister et al., 1994) and would suggest that it is appropriate to apply self-regulation theory to better understand the relationship between loneliness and health behaviors. Additionally, these results would have implications for interventions targeting lonely caregivers of cancer patients. When an individual or their relative receives a cancer diagnosis, there is said to be a "teachable moment" (Demark-Wahnefried, Aziz, Rowland, & Pinto, 2005). Diagnosis of a chronic medical condition that is related to health behaviors provides an opportunity to educate patients and their family members about healthy behaviors (e.g., quitting smoking, eating healthily, exercising, and appropriate alcohol consumption). In couples, spouses tend to engage in similar health behaviors and have similar health outcomes (Hodges, Humphris, & Macfarlane, 2005; Wilson, 2002). Additionally, engagement in some health behaviors by one spouse, such as smoking, may have implications for the quality of life of the other spouse (Weaver, Rowland, Augustson, & Atienza, 2011). Patient-caregiver dyads coping with cancer who experience loneliness could receive psychoeducation on loneliness and be taught skills to manage loneliness and their health behaviors. For example, if self-regulation theory is supported, it may be beneficial to teach emotion regulation strategies to lonely patients and caregivers in order to change their health behaviors. Interventions to reduce loneliness and improve health behaviors among cancer patients and their family caregivers may reduce their risk of negative physical and mental health outcomes.

REFERENCES

REFERENCES

Aatola, H., Koivistoinen, T., Hutri-Kähönen, N., Juonala, M., Mikkilä, V., Lehtimäki, T., ... Kähönen, M. (2010). Lifetime fruit and vegetable consumption and arterial pulse wave velocity in adulthood: The Cardiovascular Risk in Young Finns Study. *Circulation*, *122*, 2521-2528. doi:10.1161/CIRCULATIONAHA.110.969279

Adams, K., Sanders, S., & Auth, E. (2004). Loneliness and depression in independent living retirement communities: Risk and resilience factors. *Aging and Mental Health*, *8*, 475-485. doi:10.1080/13607860410001725054

Adamsen, L., Quist, M., Midtgaard, J., Andersen, C., Møller, T., Knutsen, L., ... Rorth, M. (2006). The effect of a multidimensional exercise intervention on physical capacity, well-being and quality of life in cancer patients undergoing chemotherapy. *Supportive Care in Cancer*, *14*, 116-127. doi:10.1007/s00520-005-0864-x

Akbaraly, T., Brunner, E., Ferrie, J., Marmot, M., Kivimaki, M., & Singh-Manoux, A. (2009). Dietary pattern and depressive symptoms in middle age. *The British Journal of Psychiatry: The Journal of Mental Science, 195*, 408-413. doi:10.1192/bjp.bp.108.058925

Akosile, C., Okoye, E., Nwankwo, M., Akosile, C., & Mbada, C. (2011). Quality of life and its correlates in caregivers of stroke survivors from a Nigerian population. *Quality of Life Research*, *20*, 1379-1384. doi:10.1007/s11136-011-9876-9

Allgöwer, A., Wardle, J., & Steptoe, A. (2001). Depressive symptoms, social support, and personal health behaviors in young men and women. *Health Psychology*, *20*, 223-227. doi:10.1037/0278-6133.20.3.223

Alpass, F. M., & Neville, S. S. (2003). Loneliness, health and depression in older males. *Aging and Mental Health*, *7*, 212-216. doi:10.1080/1360786031000101193

Anderson, C. A., & Harvey, R. J. (1988). Discriminating between problems in living: An examination of measures of depression, loneliness, shyness, and social anxiety. *Journal of Social and Clinical Psychology*, *6*, 482-491. doi:10.1521/jscp.1988.6.3-4.482

Atalay, O. T., & Cavlak, U. (2011). The impact of unsupervised regular walking on health: A sample of Turkish middle-aged and older adults. *European Review of Aging and Physical Activity*, *9*, 1-9.

Babyak, M. A. (2004). What you see may not be what you get: a brief, nontechnical introduction to overfitting in regression-type models. *Psychosomatic Medicine, 66*, 411-421. doi:10.1097/01.psy.0000127692.23278.a9

Baumeister, R. F., DeWall, C. N., Ciarocco, N. J., & Twenge, J. M. (2005). Social exclusion impairs self-regulation. *Journal of Personality and Social Psychology*, *88*, 589.

Baumeister, R. F., Heatherton, T. F., & Tice, D. M. (1994). *Losing control: How and why people fail at self-regulation*. San Diego, CA US: Academic Press.

Baumeister, R., & Leary, M. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin, 117*, 497-529. doi:10.1037//0033-2909.117.3.497

Beach, S., Schulz, R., Yee, J., & Jackson, S. (2000). Negative and positive health effects of caring for a disabled spouse: Longitudinal findings from the caregiver health effects study. *Psychology and Aging, 15*, 259-271. doi:10.1037/0882-7974.15.2.259

Beesley, V., Price, M., & Webb, P. (2011). Loss of lifestyle: Health behaviour and weight changes after becoming a caregiver of a family member diagnosed with ovarian cancer. *Supportive Care in Cancer, 19*, 1949-1956.

Bishop, M., Beaumont, J., Hahn, E., Cella, D., Andrykowski, M., Brady, M., ... Wingard, J. (2007). Late effects of cancer and hematopoietic stem-cell transplantation on spouses or partners compared with survivors and survivor-matched controls. *Journal of Clinical Oncology, 25*, 1403-1411. doi:10.1200/JCO.2006.07.5705

Boomsma, D., Willemsen, G., Dolan, C., Hawkley, L., & Cacioppo, J. (2005). Genetic and environmental contributions to loneliness in adults: The Netherlands twin register study. *Behavior Genetics, 35*, 745-752. doi:10.1007/s10519-005-6040-8

Boyle, P. L. (2008). *World Cancer Report 2008.* Albany, NY: International Agency for Research on Cancer

Buyck, J., Bonnaud, S., Boumendil, A., Andrieu, S., Bonenfant, S., Goldberg, M., ... Ankri, J. (2011). Informal caregiving and self-reported mental and physical health: Results from the Gazel Cohort Study. *American Journal of Public Health, 101*, 1971-1979. doi:10.2105/AJPH.2010.300044

Cacioppo, J. T., Hawkley, L. C., & Berntson, G. G. (2003). The anatomy of loneliness. *Current Directions in Psychological Science, 12*, 71-74.

Cacioppo, J. T., Hawkley, L. C., Bernston, G. C., Ernst, J. M., Gibbs, A. C., Stickgold, R., & Hobson, J. (2002a). Do lonely days invade the nights? Potential social modulation of sleep efficiency. *Psychological Science, 13*, 384-387. doi:10.1111/j.0956-7976.2002.00469.x

Cacioppo, J., Ernst, J., Burleson, M., McClintock, M., Malarkey, W., Hawkley, L., ... Berntson, G. (2000). Lonely traits and concomitant physiological processes: the MacArthur social neuroscience studies. *International Journal of Psychophysiology, 35,* 143-154. doi:10.1016/S0167-8760(99)00049-5

Cacioppo, J., Hawkley, L., & Thisted, R. (2010). Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the Chicago Health, Aging, and Social Relations Study. *Psychology and Aging, 25*, 453-463. doi:10.1037/a0017216

Cacioppo, J. T., & Hawkley, L. C. (2009). Perceived social isolation and cognition. *Trends in Cognitive Sciences, 13,* 447-454. doi:10.1016/j.tics.2009.06.005

Cacioppo, J. T., Hawkley, L. C., Crawford, L.E., Ernst, J.M., Burleson, M.H., Kowalewski, R.B…Bernston, G.G. (2002b). Loneliness and health: Potential mechanisms. *Psychosomatic Medicine, 64*, 407-417.

Cacioppo, J. T., Hawkley, L. C., Ernst, J. M., Burleson, M., Berntson, G. G., Nouriani, B., & Spiegel, D. (2006). Loneliness within a nomological net: An evolutionary perspective. *Journal of Research in Personality, 40*, 1054-1085. doi:10.1016/j.jrp.2005.11.007

Cameron, J., Franche, R., Cheung, A., & Stewart, D. (2002). Lifestyle interference and emotional distress in family caregivers of advanced cancer patients. *Cancer, 94*, 521-527. doi:10.1002/cncr.10212

Carey, P., Oberst, M., McCubbin, M., & Hughes, S. (1991). Appraisal and caregiving burden in family members caring for patients receiving chemotherapy. *Oncology Nursing Forum, 18*, 1341-1348.

Carver, C. S., & Scheier, M. F. (1998). *On the Self-regulation of Behaviour*. Cambridge University Press: New York.

Caspi, A., Harrington, H., Moffitt, T., Milne, B., & Poulton, R. (2006). Socially isolated children 20 years later: Risk of cardiovascular disease. *Archives of Pediatrics & Adolescent Medicine, 160*, 805-811. doi:10.1001/archpedi.160.8.805

CDC. (1999). *The Link Between Physical Activity and Morbidity and Mortality* [Fact sheet]. Retrieved from http://www.cdc.gov/nccdphp/sgr/mm.htm

CDC. (2009). *Health Aging: Improving and Extending Quality of Life Among Older Americans* [Fact sheet]. Retrived from http://www.cdc.gov/nccdphp/publications/aag/pdf/healthy_aging.pdf

CDC. (2011). *Physical Activity for Everyone*. Retrieved from http://www.cdc.gov/physicalactivity/everyone/guidelines/adults.html#

Chai, W., Nigg, C. R., Pagano, I. S., Motl, R. W., Horwath, C., & Dishman, R. K. (2010). Associations of quality of life with physical activity, fruit and vegetable consumption, and physical inactivity in a free living, multiethnic population in Hawaii: A longitudinal study. *International Journal of Behavioral Nutrition and Physical Activity*, *7*, 83. doi:10.1186/1479-5868-7-83

Chrousos, G., & Gold, P. (1992). The concepts of stress and stress system disorders. *JAMA*, *267*, 1244-1252. doi:10.1001/jama.1992.03480090092034

Cohen-Mansfield, J., Shmotkin, D., & Goldberg, S. (2009). Loneliness in old age: Longitudinal changes and their determinants in an Israeli sample. *International Psychogeriatrics*, *21*, 1160-1170. Doi:10.1017/S1041610209990974

Cole, S., Hawkley, L., Arevalo, J., Sung, C., Rose, R., & Cacioppo, J. (2007). Social regulation of gene expression in human leukocytes. *Genome Biology, 8*, R189. Doi:10.1186/gb-2007-8-9-r189

Cooley, M. E., Finn, K. T., Wang, Q., Roper, K., Morones, S., Shi, L., ... Hayman, L. L. (2012). Health behaviors, readiness to change, and interest in health promotion programs among smokers with lung cancer and their family members: A pilot study. *Cancer Nursing*. doi: 10.1097/NCC.0b013e31825e4359

Corà, A., Partinico, M., Munafò, M., & Palomba, D. (2012). Health risk factors in caregivers of terminal cancer patients: A pilot study. *Cancer Nursing*, *35*, 38-47.

Craig, C., Marshall, A., Sjöström, M., Bauman, A., Booth, M., Ainsworth, B., ... Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine and Science in Sports and Exercise*, *35*, 1381-1395.

De Jong-Gierveld, J., & Raadschelders, J. (1982). Types of loneliness. *Loneliness: A sourcebook of current theory, research and therapy*, 105-119.

DeFife, J. A., & Hilsenroth, M. J. (2011). Starting off on the right foot: Common factor elements in early psychotherapy process. *Journal of Psychotherapy Integration*, *21*, 172. doi:10.1037/a0023889

Demark-Wahnefried, W., Aziz, N., Rowland, J., & Pinto, B. (2005). Riding the crest of the teachable moment: promoting long-term health after the diagnosis of cancer. *Journal of Clinical Oncology, 23*, 5814-5830.

DeWall, C., & Pond, R. R. (2011). Loneliness and smoking: The costs of the desire to reconnect. *Self and Identity, 10*, 375-385. doi:10.1080/15298868.2010.524404

Dixon, D., Cruess, S., Kilbourn, K., Klimas, N., Fletcher, M., Ironson, G., ... Antoni, M. H. (2001). Social support mediates loneliness and human herpesvirus type 6 (HHV-6) antibody titers. *Journal of Applied Social Psychology, 31*, 1111-1132. doi:10.1111/j.1559-1816.2001.tb02665.x

Doane, L., & Adam, E. (2010). Loneliness and cortisol: Momentary, day-to-day, and trait associations. *Psychoneuroendocrinology, 35*, 430-441. doi:10.1016/j.psyneuen.2009.08.005

Eaker, E., Pinsky, J., & Castelli, W. (1992). Myocardial infarction and coronary death among women: psychosocial predictors from a 20-year follow-up of women in the Framingham Study. *American Journal of Epidemiology, 135*, 854-864.

Eisenberger, N. I., & Lieberman, M. D. (2005). Why it hurts to be left out: The neurocognitive overlap between physical and social pain. In K. D. Williams, J. P. Forgas, W. von Hippel, K. D. Williams, J. P. Forgas, W. von Hippel (Eds.), *The social outcast: Ostracism, social exclusion, rejection, and bullying* (pp. 109-127). New York, NY US: Psychology Press.

Eisenberger, N. I., & Lieberman, M. D. (2004). Why rejection hurts: A common neural alarm system for physical and social pain. *TRENDS in Cognitive Sciences, 8*, 294-300. doi:10.1016/j.tics.2004.05.010

Ell, K., Nishimoto, R., Mantell, J., & Hamovitch, M. (1988). Longitudinal analysis of psychological adaptation among family members of patients with cancer. *Journal of Psychosomatic Research*, *32*, 429-438. doi:10.1016/0022-3999(88)90026-8

Emanuel, E., Fairclough, D., Slutsman, J., Alpert, H., Baldwin, D., & Emanuel, L. (1999). Assistance from family members, friends, paid care givers, and volunteers in the care of terminally ill patients. *The New England Journal of Medicine, 341*, 956-963. doi:10.1056/NEJM199909233411306

Enders, C. (2006). A primer on the use of modern missing-data methods in psychosomatic medicine research. *Psychosomatic Medicine, 68*, 427-436. doi:10.1097/01.psy.0000221275.75056.d8

Friðriksdóttir, N., Saevarsdóttir, T., Halfdánardóttir, S., Jónsdóttir, A., Magnúsdóttir, H., Olafsdóttir, K., ... Gunnarsdóttir, S. (2011). Family members of cancer patients: Needs, quality of life and symptoms of anxiety and depression. *Acta Oncologica (Stockholm, Sweden), 50*, 252-258. doi:10.3109/0284186X.2010.529821

Given, B., Wyatt, G., Given, C., Sherwood, P., Gift, A., DeVoss, D., & Rahbar, M. (2004). Burden and depression among caregivers of patients with cancer at the end of life. *Oncology Nursing Forum, 31*, 1105-1117. doi:10.1188/04.ONF.1105-1117

Glajchen, M. (2004). The emerging role and needs of family caregivers in cancer care. *The Journal of Supportive Oncology*, *2*, 145-155.

Glaser, R., Kiecolt-Glaser, J., Speicher, C., & Holliday, J. (1985). Stress, loneliness, and changes in herpesvirus latency. *Journal of Behavioral Medicine*, *8*, 249-260. doi:10.1007/BF00870312

Golden, J., Conroy, R. M., Bruce, I., Denihan, A., Greene, E., Kirby, M., & Lawlor, B. A. (2009). Loneliness, social support networks, mood and wellbeing in community-dwelling elderly. *International Journal of Geriatric Psychiatry*, *24*, 694-700. doi:10.1002/gps.2181

Gouin, J., Hantsoo, L., & Kiecolt-Glaser, J. (2008). Immune dysregulation and chronic stress among older adults: A review. *Neuroimmunomodulation*, *15*, 251-259. doi:10.1159/000156468

Gregorio, S., Carpenter, K. M., Dorfman, C. S., Yang, H., Simonelli, L. E., & Carson, W. (2012). Impact of breast cancer recurrence and cancer-specific stress on spouse health and immune function. *Brain, Behavior, and Immunity*, *26*, 228-233. doi:10.1016/j.bbi.2011.07.237

Grimm, P., Zawacki, K., Mock, V., Krumm, S., & Frink, B. (2000). Caregiver responses and needs. *Cancer Practice*, *8*, 120-128. doi:10.1046/j.1523-5394.2000.83005.x

Grov, E., Dahl, A., Moum, T., & Fosså, S. (2005). Anxiety, depression, and quality of life in caregivers of patients with cancer in late palliative phase. *Annals of Oncology*, *16*, 1185-1191. doi:10.1093/annonc/mdi210

Hagedoorn, M., Sanderman, R., Bolks, H., Tuinstra, J., & Coyne, J. (2008). Distress in couples coping with cancer: A meta-analysis and critical review of role and gender effects. *Psychological Bulletin*, *134*, 1-30. doi:10.1037/0033-2909.134.1.1

Hawkley, L. C., Masi, C. M., Berry, J. D., & Cacioppo, J. T. (2006). Loneliness is a unique predictor of age-related differences in systolic blood pressure. *Psychology and Aging*, *21*, 152-164. doi:10.1037/0882-7974.21.1.152

Hawkley, L., & Cacioppo, J. (2003). Loneliness and pathways to disease. *Brain, Behavior, And Immunity, 17,* 98-105. doi:10.1016/S0889-1591(02)00073-9

Hawkley, L., Burleson, M., Berntson, G., & Cacioppo, J. (2003). Loneliness in everyday life: cardiovascular activity, psychosocial context, and health behaviors. *Journal of Personality and Social Psychology, 85,* 105-120. doi:10.1037/0022-3514.85.1.105

Hawkley, L., Hughes, M., Waite, L., Masi, C., Thisted, R., & Cacioppo, J. (2008). From social structural factors to perceptions of relationship quality and loneliness: the Chicago health, aging, and social relations study. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 63,* S375-S384. doi:10.1093/geronb/63.6.S375

Hawkley, L., Thisted, R., & Cacioppo, J. (2009). Loneliness predicts reduced physical activity: Cross-sectional & longitudinal analyses. *Health Psychology, 28,* 354-363. doi:10.1037/a0014400

Hawkley, L. C, & Cacioppo, J. T. (2010). Loneliness matters: A theoretical and empirical review of consequences and mechanisms. *Annals of Behavioral Medicine, 40,* 218-227. doi: 10.1007/s12160-010-9210-8

Hawkley, L. C., Thisted, R. A., Masi, C. M., & Cacioppo, J. T. (2010). Loneliness predicts increased blood pressure: Five-year cross-lagged analysis in middle-aged and older adults. *Psychology and Aging, 25,* 132-141. doi:10.1037/a0017805

Hawthorne, G. (2008). Perceived social isolation in a community sample: Its prevalence and correlates with aspects of peoples' lives. *Social Psychiatry and Psychiatric Epidemiology, 43,* 140-150. doi:10.1007/s00127-007-0279-8

Heesch, K. C., van Uffelen, J. G. Z., van Gellecum, Y. R., & Brown, W. J. (2012). Dose–response relationships between physical activity, walking and health-related quality of life in mid-age and older women. *Journal of Epidemiology and Community Health*. doi:10.1136/jech-2011-200850

Hesser, H., Weise, C., Rief, W., & Andersson, G. (2011). The effect of waiting: A meta-analysis of wait-list control groups in trials for tinnitus distress. *Journal of psychosomatic research, 70*, 378-384. doi:10.1016/j.jpsychores.2010.12.006

Heikkinen, R., & Kauppinen, M. (2004). Depressive symptoms in late life: A 10-year follow-up. *Archives of Gerontology and Geriatrics, 38*, 239-250. doi:10.1016/j.archger.2003.10.004

Heinrich, L., & Gullone, E. (2006). The clinical significance of loneliness: A literature review. *Clinical Psychology Review, 26*, 695-718. doi:10.1016/j.cpr.2006.04.002

Hinds, C. (1985). The needs of families who care for patients with cancer at home: Are we meeting them? *Journal of Advanced Nursing, 10*, 575-581. doi:10.1111/j.1365-2648.1985.tb00550.x

Hodges, L. J., Humphris, G. M., & Macfarlane, G. G. (2005). A meta-analytic investigation of the relationship between the psychological distress of cancer patients and their carers. *Social Science & Medicine, 60*, 1-12. doi:10.1016/j.socscimed.2004.04.018

Ji, J., Zöller, B., Sundquist, K., & Sundquist, J. (2012). Increased risks of coronary heart disease and stroke among spousal caregivers of cancer patients. *Circulation, 125*, 1742-1747. doi:10.1161/CIRCULATIONAHA.111.057018

Kalayjian, A. (1989). Coping with cancer: The spouse's perspective. *Archives of Psychiatric Nursing*, *3*, 166-172.

Kellner, R., & Sheffield, B. F. (1971). The relief of distress following attendance at a clinic. *The British Journal of Psychiatry*, *118*, 195-198. doi:10.1192/bjp.118.543.195

Kiecolt-Glaser, J., Marucha, P., Malarkey, W., Mercado, A., & Glaser, R. (1995). Slowing of wound healing by psychological stress. *Lancet, 346,* 1194-1196. doi:10.1016/S0140-6736(95)92899-5

Kiecolt-Glaser, J., Ricker, D., George, J., Messick, G., Speicher, C., Garner, W., & Glaser, R. (1984). Urinary cortisol levels, cellular immunocompetency, and loneliness in psychiatric inpatients. *Psychosomatic Medicine*, *46*, 15-23.

Kim, Y., & Carver, C. (2007). Frequency and difficulty in caregiving among spouses of individuals with cancer: Effects of adult attachment and gender. *Psycho-Oncology, 16*, 714-723. doi:10.1002/pon.1110

Kim, Y., & Given, B. (2008). Quality of life of family caregivers of cancer survivors: Across the trajectory of the illness. *Cancer, 112*, 2556-2568.

Kim, Y., & Schulz, R. (2008). Family caregivers' strains: Comparative analysis of cancer caregiving with dementia, diabetes, and frail elderly caregiving. *Journal of Aging and Health*, *20*, 483-503. doi:10.1177/0898264308317533

Kim, Y., & Spillers, R. (2010). Quality of life of family caregivers at 2 years after a relative's cancer diagnosis. *Psycho-Oncology, 19,* 431-440. doi:10.1002/pon.1576

Kim, Y., Kashy, D., Spillers, R., & Evans, T. (2010). Needs assessment of family caregivers of cancer survivors: Three cohorts comparison. *Psycho-Oncology, 19*, 573-582. doi:10.1002/pon.1597

Kiviniemi, M., Orom, H., & Giovino, G. (2011). Race/ethnicity, psychological distress, and fruit/vegetable consumption. *Appetite*, *56*, 737-740. doi:10.1016/j.appet.2011.02.012

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (third ed.). New York: The Guilford Press.

Kurtz, M., Kurtz, J., Given, C., & Given, B. (2004). Depression and physical health among family caregivers of geriatric patients with cancer—a longitudinal view. *Medical Science Monitor, 10*, CR447-CR456.

Lauder, W., Mummery, K., Jones, M., & Caperchione, C. (2006). A comparison of health behaviours in lonely and non-lonely populations. *Psychology, Health & Medicine*, *11*, 233-245. doi:10.1080/13548500500266607

Lee, S., Colditz, G., Berkman, L., & Kawachi, I. (2003). Caregiving and risk of coronary heart disease in U.S. women: A prospective study. *American Journal of Preventive Medicine, 24*, 113-119.

Lee, P. H., Macfarlane, D. J., Lam, T. H., & Stewart, S. M. (2011). Validity of the international physical activity questionnaire short form (IPAQ-SF): A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 8*, 115. doi:10.1186/1479-5868-8-115

Levine, M. (2012). Loneliness and eating disorders. *The Journal of Psychology*, *146*, 243-257. doi:10.1080/00223980.2011.606435

Luanaigh, C., & Lawlor, B. A. (2008). Loneliness and the health of older people. *International Journal of Geriatric Psychiatry, 23,* 1213-1221. doi:10.1002/gps.2054

MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research, 39,* 99-128. doi:10.1207/s15327906mbr3901_4

Mahon, N. (1994). Loneliness and sleep during adolescence. *Perceptual and Motor Skills, 78,* 227-231. doi:10.2466/pms.1994.78.1.227

Mahon, N., Yarcheski, A., Yarcheski, T., Cannella, B., & Hanks, M. (2006). A meta-analytic study of predictors for loneliness during adolescence. *Nursing Research, 55,* 308-315. doi:10.1097/00006199-200609000-00003

Markowitz, J., Gutterman, E., Sadik, K., & Papadopoulos, G. (2003). Health-related quality of life for caregivers of patients with Alzheimer disease. *Alzheimer Disease and Associated Disorders, 17,* 209-214. doi:10.1097/00002093-200310000-00003

Mazanec, S., Daly, B., Douglas, S., & Lipson, A. (2011). Work productivity and health of informal caregivers of persons with advanced cancer. *Research in Nursing & Health, 34,* 483-495. doi:10.1002/nur.20461

McGuire, S., & Clifford, J. (2000). Genetic and environmental contributions to loneliness in children. *Psychological Science, 11,* 487-491. doi:10.1111/1467-9280.00293

Mellon, S., Northouse, L., & Weiss, L. (2006). A population-based study of the quality of life of cancer survivors and their family caregivers. *Cancer Nursing, 29,* 120-131. doi:10.1097/00002820-200603000-00007

Mirmiran, P., Noori, N., Zavareh, M., & Azizi, F. (2009). Fruit and vegetable consumption and risk factors for cardiovascular disease. *Metabolism: Clinical and Experimental, 58,* 460-468. doi:10.1016/j.metabol.2008.11.002

Newgard, C., & Haukoos, J. (2007). Advanced statistics: Missing data in clinical research—part 2: Multiple imputation. *Academic Emergency Medicine, 14,* 669-678. doi:10.1111/j.1553-2712.2007.tb01856.x

Nijboer, C., Tempelaar, R., Triemstra, M., van den Bos, G., & Sanderman, R. (2001). The role of social and psychologic resources in caregiving of cancer patients. *Cancer, 91,* 1029-1039. doi:10.1002/1097-0142(20010301)91:5<1029::AID-CNCR1094>3.0.CO;2-1

Northouse, L., Mood, D., Templin, T., Mellon, S., & George, T. (2000). Couples' patterns of adjustment to colon cancer. *Social Science & Medicine (1982), 50,* 271-284. doi:10.1016/S0277-9536(99)00281-6

Northouse, L., Williams, A., Given, B., & McCorkle, R. (2012). Psychosocial care for family caregivers of patients with cancer. *Journal of Clinical Oncology, 30,* 1227-1234. doi:10.1200/JCO.2011.39.5798

Nöthlings, U., Schulze, M., Weikert, C., Boeing, H., van der Schouw, Y., Bamia, C., ... Trichopoulo, A. (2008). Intake of vegetables, legumes, and fruit, and risk for all-cause, cardiovascular, and cancer mortality in a European diabetic population. *The Journal of Nutrition, 138,* 775-781.

Núñez-Córdoba, J., & Martínez-González, M. (2011). Antioxidant vitamins and cardiovascular disease. *Current Topics in Medicinal Chemistry, 11,* 1861-1869.

Oberst, M., Thomas, S., Gass, K., & Ward, S. (1989). Caregiving demands and appraisal of stress among family caregivers. *Cancer Nursing, 12,* 209-215. doi:10.1097/00002820-198908000-00003

Ohayon, M. (2005). Prevalence and correlates of nonrestorative sleep complaints. *Archives of Internal Medicine*, *165*, 35-41. doi:10.1001/archinte.165.1.35

Olsen, R. B., Olsen, J., Gunner-Svensson, F., & Waldstrom, B. (1991). Social networks and longevity. A 14 year follow-up study among elderly in Denmark. *Social Science and Medicine, 33*, 1189-1195. doi:10.1016/0277-9536(91)90235-5

Orr, J. M., & Sackett, P. R. (1991). Outlier detection and treatment in I/O psychology: A survey of researcher beliefs and an empirical illustration. *Personnel Psychology, 44*, 473-486. doi:10.1111/j.1744-6570.1991.tb02401.x

Oude Griep, L., Verschuren, W., Kromhout, D., Ocké, M., & Geleijnse, J. (2011). Raw and processed fruit and vegetable consumption and 10-year stroke incidence in a population-based cohort study in the Netherlands. *European Journal of Clinical Nutrition*, *65,* 791-799. doi:10.1038/ejcn.2011.36

Papastavrou, E., Charalambous, A., & Tsangari, H. (2009). Exploring the other side of cancer care: The informal caregiver. *European Journal of Oncology Nursing, 13,* 128-136. doi:10.1016/j.ejon.2009.02.003

Paul, C., Ayis, S., & Ebrahim, S. (2006). Psychological distress, loneliness and disability in old age. *Psychology, Health & Medicine*, *11*, 221-232. doi:10.1080/13548500500262945

Penedo, F., & Dahn, J. (2005). Exercise and well-being: A review of mental and physical health benefits associated with physical activity. *Current Opinion in Psychiatry, 18*, 189-193.

Peplau, L. A., & Perlman, D. (1982). Perspectives on loneliness. *Loneliness: A sourcebook of current theory, research and therapy*, 1-18.

Pinquart, M., & Sörensen, S. (2001). Influences on loneliness in older adults: A meta-analysis. *Basic and Applied Social Psychology, 23*, 245-266. doi:10.1207/153248301753225702

Pinquart, M., & Sörensen, S. (2003). Differences between caregivers and noncaregivers in psychological health and physical health: A meta-analysis. *Psychology and Aging, 18*, 250-267. doi:10.1037/0882-7974.18.2.250

Pinquart, M., & Sörensen, S. (2007). Correlates of physical health of informal caregivers: A meta-analysis. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences, 62*, P126-P137. doi:10.1093/geronb/62.2.P126

Posternak, M. A., & Miller, I. (2001). Untreated short-term course of major depression: A meta-analysis of outcomes from studies using wait-list control groups. *Journal of Affective Disorders, 66*, 139-146. doi:10.1016/S0165-0327(00)00304-9

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers, 36*, 717-731. doi:10.3758/BF03206553

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods, 40*, 879-891. doi:10.3758/BRM.40.3.879

Pressman, S., Cohen, S., Miller, G., Barkin, A., Rabin, B., & Treanor, J. (2005). Loneliness, social network size, and immune response to influenza vaccination in college freshmen. *Health Psychology, 24*, 297-306. doi:10.1037/0278-6133.24.3.297

Reed, S. B., Crespo, C. J., Harvey, W., & Andersen, R. E. (2011). Social isolation and physical inactivity in older US adults: Results from the third national health and nutrition examination survey. *European Journal of Sport Science, 11*, 347-353. doi:10.1080/17461391.2010.521585

Riggio, R. E., Watring, K. P., & Throckmorton, B. (1993). Social skills, social support, and psychosocial adjustment. *Personality and Individual Differences, 15*, 275-280. doi:10.1016/0191-8869(93)90217-Q

Rohleder, N., Marin, T., Ma, R., & Miller, G. (2009). Biologic cost of caring for a cancer patient: Dysregulation of pro- and anti-inflammatory signaling pathways. *Journal of Clinical Oncology, 27*, 2909-2915. doi:10.1200/JCO.2008.18.7435

Rohrer, J., & Stroebel, R. (2009). Does moderate fruit and vegetable intake protect against frequent mental distress in adult primary care patients? *Journal of Alternative and Complementary Medicine (New York, N.Y.), 15*, 953-955. doi:10.1089/acm.2009.0105

Rojas, R. Schlicht, W., & Hautzinger, M. (2003). Effects of exercise training on quality of life, psychological well-being, immune status, and cardiopulmonary fitness in an HIV-l positive population. *Journal of Sport and Exercise Psychology, 25*, 440-455.

Rokach, A., Lechcier-Kimel, R., & Safarov, A. (2006). Loneliness of people with physical disabilities. *Social Behavior and Personality, 34*, 681-700. doi:10.2224/sbp.2006.34.6.681

Rokach, A., Matalon, R., Safarov, A., & Bercovitch, M. (2007). The loneliness experience of the dying and of those who care for them. *Palliative & Supportive Care*, *5*, 153-159. doi:10.1017/S1478951507070228

Rotenberg, K. J., & Flood, D. (1999). Loneliness, dysphoria, dietary restraint, and eating behavior. *International Journal of Eating Disorders*, *25*, 55-64. doi:10.1002/(SICI)1098-108X(199901)25:1<55::AID-EAT7>3.0.CO;2-#

Roth, P. L., Switzer III, F. S., & Switzer, D. M. (1999). Missing data in multiple item scales: A monte carlo analysis of missing data techniques. *Organizational Research Methods, 2*, 211-232. doi:10.1177/109442819923001

Rubin, D. B. (1976). Inference and missing data. *Biometrika*, *63*, 581-592. doi:10.1093/biomet/63.3.581

Russell, D. (1996). UCLA Loneliness Scale (Version 3): Reliability, validity, and factor structure. *Journal of Personality Assessment*, *66*, 20-40. doi:10.1207/s15327752jpa6601_2

Russell, D., Peplau, L. A., & Cutrona, C. E. (1980). The revised UCLA Loneliness Scale: Concurrent and discriminant validity evidence. *Journal of Personality and Social Psychology*, *39*, 472-480. doi:10.1037/0022-3514.39.3.472

Sahin, Z., & Tan, M. (2012). Loneliness, depression, and social support of patients with cancer and their caregivers. *Clinical Journal of Oncology Nursing*, *16*, 145-149. doi:10.1188/12.CJON.145-149

Sañudo, B., Galiano, D., Carrasco, L., de Hoyo, M., & McVeigh, J. (2011). Effects of a prolonged exercise program on key health outcomes in women with fibromyalgia: A randomized controlled trial. *Journal of Rehabilitation Medicine, 43,* 521-526. doi:10.2340/16501977-0814

Savage, S., & Bailey, S. (2004). The impact of caring on caregivers' mental health: a review of the literature. *Australian Health Review, 27,* 111-117. doi:10.1071/AH042710111

Savikko, N. N., Routasalo, P. P., Tilvis, R. S., Strandberg, T. E., & Pitkälä, K. H. (2005). Predictors and subjective causes of loneliness in an aged population. *Archives of Gerontology and Geriatrics, 41,* 223-233. doi:10.1016/j.archger.2005.03.002

Schafer, J., & Graham, J. (2002). Missing data: Our view of the state of the art. *Psychological Methods*, *7*, 147-177. doi:10.1037/1082-989X.7.2.147

Schulz, R., & Beach, S. (1999). Caregiving as a risk factor for mortality: The Caregiver Health Effects Study. *JAMA, 282*, 2215-2219. doi:10.1001/jama.282.23.2215

Segrin, C., & Passalacqua, S. A. (2010). Functions of loneliness, social support, health behaviors, and stress in association with poor health. *Health Communication, 25*, 312-322. doi:10.1080/10410231003773334

Shankar, A., McMunn, A., Banks, J., & Steptoe, A. (2011). Loneliness, social isolation, and behavioral and biological health indicators in older adults. *Health Psychology*, *30*, 377-385. doi:10.1037/a0022826

Shiovitz-Ezra, S., & Ayalon, L. (2010). Situational versus chronic loneliness as risk factors for all-cause mortality. *International Psychogeriatrics, 22*, 455-62. doi:10.1017/S1041610209991426

Shrout, P., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: new procedures and recommendations. *Psychological Methods, 7,* 422-445. doi:10.1037/1082-989X.7.4.422

Sibold, J. S., & Berg, K. M. (2010). Mood enhancement persists for up to 12 hours following aerobic exercise: A pilot study. *Perceptual and Motor Skills*, *111,* 333-342.

Steptoe, A., & Marmot, M. (2003). Burden of psychosocial adversity and vulnerability in middle age: Associations with biobehavioral risk factors and quality of life. *Psychosomatic Medicine*, *65,* 1029-1037. doi:10.1097/01.PSY.0000097347.57237.2D

Steptoe, A., Owen, N., Kunz-Ebrecht, S., & Brydon, L. (2004). Loneliness and neuroendocrine, cardiovascular, and inflammatory stress responses in middle-aged men and women. *Psychoneuroendocrinology*, *29,* 593-611. doi:10.1016/S0306-4530(03)00086-6

Steptoe, A., Perkins-Porras, L., Hilton, S., Rink, E., & Cappuccio, F. P. (2004). Quality of life and self-rated health in relation to changes in fruit and vegetable intake and in plasma vitamins C and E in a randomised trial of behavioural and nutritional education counselling. *British Journal of Nutrition*, *92,* 177-184. doi:10.1079/BJN20041177

Stravynski, A., & Boyer, R. (2001). Loneliness in relation to suicide ideation and parasuicide: A population-wide study. *Suicide & Life-Threatening Behavior, 31,* 32-40. doi:10.1521/suli.31.1.32.21312

Swami, V., Chamorro-Premuzic, T., Sinniah, D., Maniam, T., Kannan, K., Stanistreet, D., & Furnham, A. (2007). General health mediates the relationship between loneliness, life satisfaction and depression. *Social Psychiatry and Psychiatric Epidemiology, 42,* 161-166. doi:10.1007/s00127-006-0140-5

Theeke, L. (2009). Predictors of loneliness in U.S. adults over age sixty-five. *Archives of Psychiatric Nursing, 23,* 387-396. doi:10.1016/j.apnu.2008.11.002

Theeke, L. (2010). Sociodemographic and health-related risks for loneliness and outcome differences by loneliness status in a sample of U.S. older adults. *Research in Gerontological Nursing, 3,* 113-125. doi:10.3928/19404921-20091103-99

Thompson, T. G., & Veneman, A. M. (2005). Dietary guidelines for Americans 2005. *United States Department of Health and Human Services and United States Department of Agriculture.*

Thurston, R.C., & Kubzansky, L.D. (2009). Women, loneliness, and incident of coronary heart disease. *Psychosomatic Medicine, 71,* 836-842. doi:10.1097/PSY.0b013e3181b40efc

Tice, D. M., Bratslavsky, E., & Baumeister, R. F. (2001). Emotional distress regulation takes precedence over impulse control: If you feel bad, do it! *Journal of Personality and Social Psychology, 80,* 53-67. doi:10.1037/0022-3514.80.1.53

Tice, D.M., & Bratslavsky, E. (2000). Giving in to feeling good: The place of emotion regulation in the context of general self-control. *Psychological Inquiry, 11,* 149-159. doi:10.1207/S15327965PLI1103_03

Tilvis, R., Kähönen-Väre, M., Jolkkonen, J., Valvanne, J., Pitkala, K., & Strandberg, T. (2004). Predictors of cognitive decline and mortality of aged people over a 10-year period. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences*, *59*, 268-274. doi:10.1093/gerona/59.3.M268

U.S. Bureau of the Census. (2012). Table 2. Annual estimates of the resident population for selected age groups by sex for the United States: April 1, 2010 to July 1, 2011 (NC-EST2011-02)

van Buuren, S. (2007). Multiple imputation of discrete and continuous data by fully conditional specification. *Statistical Methods in Medical Research*, *16*, 219-242. doi:10.1177/0962280206074463

van Buuren, S., Brand, J. P. L., Groothuis-Oudshoorn, C., & Rubin, D. B. (2006). Fully conditional specification in multivariate imputation. *Journal of Statistical Computation and Simulation*, *76*, 1049-1064. doi:10.1080/10629360600810434

VanderWeele, T. J., Hawkley, L. C., Thisted, R. A., & Cacioppo, J. T. (2011). A marginal structural model analysis for loneliness: Implications for intervention trials and clinical practice. *Journal of Consulting and Clinical Psychology*, *79*, 225-235. doi:10.1037/a0022610

Vanderwerker, L., Laff, R., Kadan-Lottick, N., McColl, S., & Prigerson, H. (2005). Psychiatric disorders and mental health service use among caregivers of advanced cancer patients. *Journal of Clinical Oncology*, *23*, 6899-6907. doi:10.1200/JCO.2005.01.370

Victor, C. R., & Yang, K. (2012). The prevalence of loneliness among adults: A case study of the United Kingdom. *The Journal of Psychology, 146*, 85-104. doi:10.1080/00223980.2011.613875

Vitaliano, P. P., Zhang, J., & Scanlan, J. M. (2003). Is caregiving hazardous to one's physical health? A meta-analysis. *Psychological Bulletin, 129*, 946-972. doi:10.1037/0033-2909.129.6.946

Ware, J. E., Kosinski, M., & Keller, S. D. (1996). A 12-item short-form health survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care, 34*, 220-233.

Ware, J. E., Kosinski, M., & Keller, S. D. (1998). *SF-12: How to score the SF-12 physical and mental health summary scales*. Health Institute, New England Medical Center.

Weaver, K., Rowland, J., Augustson, E., & Atienza, A. (2011). Smoking concordance in lung and colorectal cancer patient-caregiver dyads and quality of life. *Cancer Epidemiology, Biomarkers & Prevention*, *20*, 239-248. doi:10.1158/1055-9965.EPI-10-0666

Wei, M., Russell, D. W., & Zakalik, R. A. (2005). Adult attachment, social self-efficacy, self-disclosure, loneliness, and subsequent depression for freshman college students: A longitudinal study. *Journal of Counseling Psychology*, *52*, 602-614. doi:10.1037/0022-0167.52.4.602

Wilson, R. S., Krueger, K. R., Arnold, S. E., Schneider, J. A., Kelly, J. F., Barnes, L. L., ... Bennett, D. A. (2007). Loneliness and risk of Alzheimer disease. *Archives of General Psychiatry*, *64*, 234-240. doi:10.1001/archpsyc.64.2.234

Wilson, S. (2002). The health capital of families: An investigation of the inter-spousal correlation in health status. *Social Science & Medicine (1982), 55*, 1157-1172. doi:10.1016/S0277-9536(01)00253-2

Wright, K., & Dyck, S. (1984). Expressed concerns of adult cancer patients' family members. *Cancer Nursing, 7*, 371-374. doi:10.1097/00002820-198410000-00002

Yabroff, K., & Kim, Y. (2009). Time costs associated with informal caregiving for cancer survivors. *Cancer, 115*, 4362-4373. doi:10.1002/cncr.24588

Young, J. E. (1982). Loneliness, depression, and cognitive therapy: Theory and application. In L. A. Peplau and D. Perlman (eds.), *Loneliness: A Sourcebook of Current Theory, Research and Therapy* (pp. 379-406). New York: Wiley-Interscience.

APPENDICES

Appendix A: Mediation Models

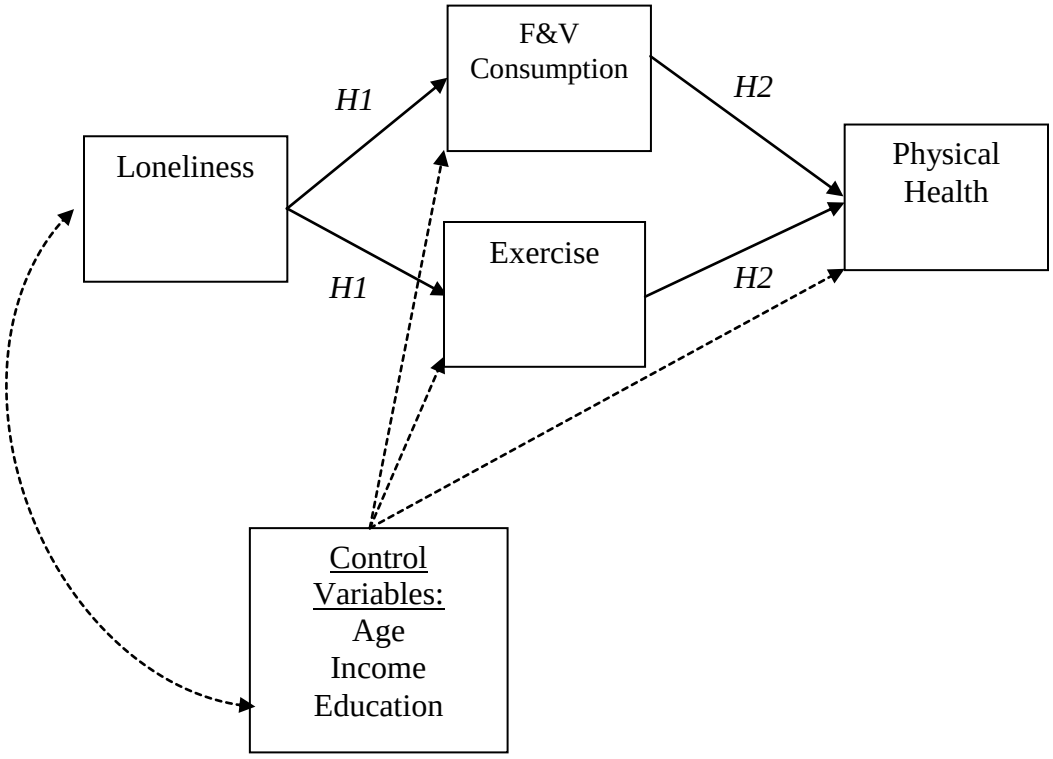
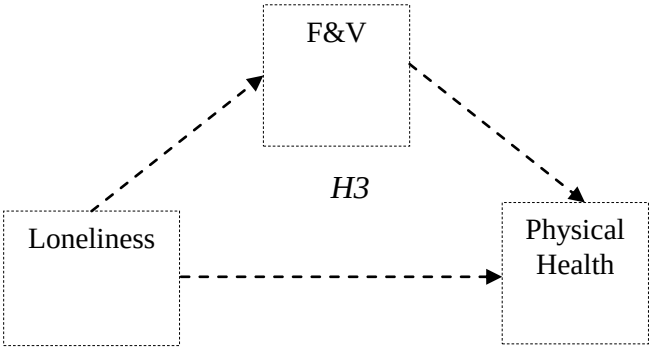
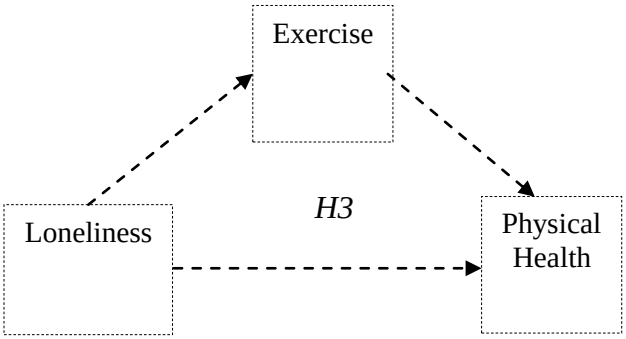


Figure A1





Note. F&V = fruit and vegetable.

Figure A1 Continued

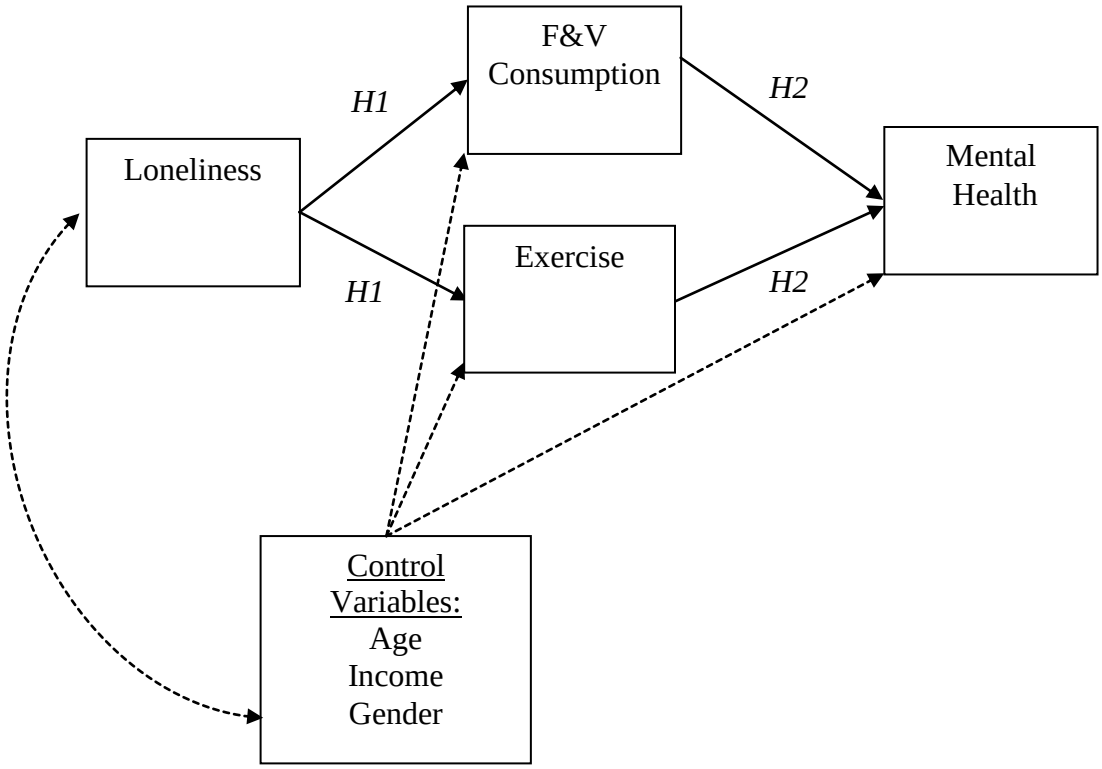
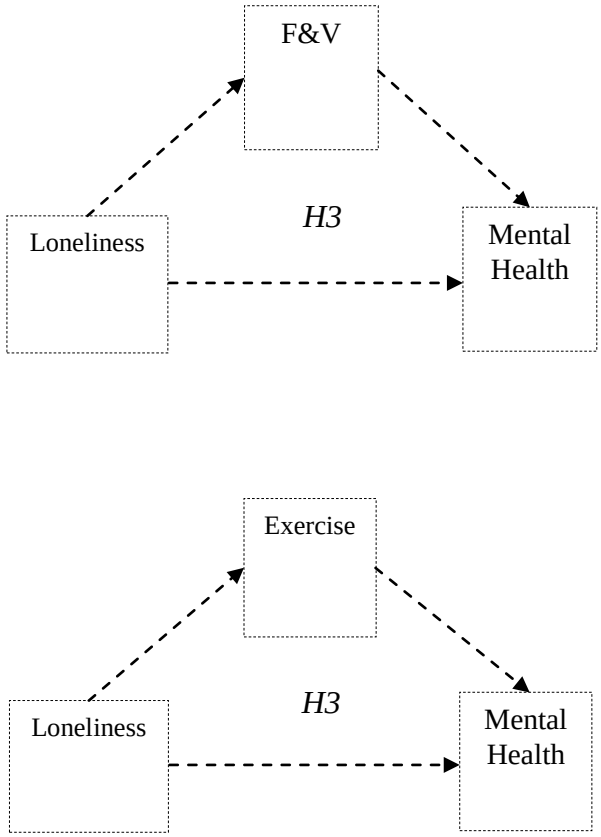

F&V
Consumption
H1
H2
Loneliness
Mental
Health
Exercise
H1
H2
Control
Variables:
Age
Income
Gender

Figure A2



Note. F&V = fruit and vegetable.

Figure A2 Continued

Appendix B: Sample Size

Sample Size by Time Point

	T1	T2	T3	T4	Retention Rate at T4
Caregivers	101	91	80	64	63.4%

Note. The five caregivers that were excluded from the analyses to avoid violating the assumption of non-independence are not included in this table. T1 = baseline. T2 = approximately two weeks post-baseline. T3 = four months post-baseline. T4= 12 months post-baseline.

Appendix C: Equations to Average Results

Equation to calculate the average for each parameter estimate, where Q_i represents the parameter estimate and Q_m equals the average value for the parameter estimate:

$$Q_m = 1/5 \sum Q_i$$

Equation to calculate within-imputation variation, where U_i represents the standard error associated with a Q_i, and U_m represents the average within-variance of the five datasets:

$$U_m = 1/5 \sum U_i$$

Equation to calculate the between-imputation variation (B_m):

$$B_m = 1/4 \sum (Q_i - Q_m)^2$$

Equation to calculate total variance (T_m):

$$T_m = U_m + (6/5)\, B_m$$

Equation to calculate standard error (SE):

$$SE = T_m^{1/2}$$

Equation to calculate a 95% confidence interval:

$$Q_m \pm 1.96\, T_m^{1/2}$$

Equation to calculate the t-statistic:

$$t = Q_m/SE$$

Equation to calculate the degrees of freedom (df):

$$df = 4\,(1+ 5\, U_m /6\, B_m)^2$$

Appendix D: Participant Demographics at Time Point 1

Table D1

Participant Demographics at Time Point 1

Demographic	Patients (*n* = 154)	Caregivers (*n* = 101)
Average Age	58.3 yrs (range: 22-83, *SD*: 13.1)	58.0 yrs (range: 21-80, *SD*: 13.8)
Female	45.0%	77.2%
Caucasian	95.0%	94.1%
Current Smoker	__	8.0%
Education (< college)	59.0%	60.4%
Income		
< $40,000 year	25.2%	23.0%
$40,000- $74,999 year	43.7%	41.0%
> $75,000 year	17.0%	22.0%
Prefer not to answer	14.1%	14.0%
Married/marriage equivalent	79.1%	95.0%
Employed	58.3%	45.5%
Relationship to the patient:	Spouse	82.0%
	Parent, Sibling, Child, Friend	17.0%

Table D2

Patient Medical Characteristics at Time Point 1

	Patients (n = 154)
Has Health Insurance	98.5%
Average Time Since Diagnosis	.81 months (range: 0- 52, SD = 4.87)
Cancer Treatment	
Surgery	45.0%
Chemotherapy	58.6%
Radiation	95.7%
Hormonal therapy	9.3%
Cancer Type	
Digestive system	21.4%
Genital system	15.6%
Breast	11.7%
Brain and other nervous system	9.1%
Respiratory system	7.1%
Lymphoma	6.5%
Skin	3.2%
Oral cavity and pharynx	2.6%
Soft tissue	2.6%
Urinary system	2.6%
Myeloma	1.9%
Endocrine system	1.3%
Leukemia	0.6%
Other and unspecified	5.2%
Missing	9.7%
Cancer Stage:	
0	3.1%
I	10.7%
II	10.1%
III	22.6%
IV	7.5%
Unstaged	6.3%
Missing/Unknown	39.6%

Table D3

Descriptive Statistics for Study Variables

Study variable	Mean	Standard Deviation	Range
Loneliness	7.01	2.60	4-15
F&V Consumption[a]	2.85	2.08	0-7
Exercise[b]	3.13	3.57	0-14
Mental Health Component Score	46.28	9.01	21-60
Physical Health Component Score	50.04	9.32	20-63

Note. F&V = fruit and vegetable.

[a]The number of days per week that the caregiver reported eating five or more fruits and vegetables.

[b]The sum of the number of days per week that the caregiver reported vigorous exercise and the number of days per week that the caregiver reported moderate exercise.

Table D4

Correlations among Study Variables

	Age	Gender[a]	Education[b]	Income	Loneliness	F&V	Exercise	MCS	PCS
Age	—								
Gender[a]	-.146	—							
Education[b]	-.132	.257**	—						
Income	-.231*	.154	.492**	—					
Loneliness	-.075	-.144	-.137	-.300**	—				
F&V	.032	.124	.096	-.292*	-.061	—			
Exercise	-.167	-.088	.158	-.138	.128	.063	—		
MCS	.116	-.059	.280*	.274*	-.322**	.191	.022	—	
PCS	-.082	.069	.164	.411**	-.301**	-.278*	-.153	.051	—

Note. ns = 66-101 due to missingness. Higher scores on MCS and PCS indicate better mental and physical health, respectively. F&V = fruit and vegetable consumption; MCS = Mental Health Component Score; PCS = Physical Health Component Score.

[a]Coded (male = 1 and female = 2).

[b]Coded (eighth grade or less = 1, some high school = 2, high school diploma/GED = 3, vocational school or some college = 4, college degree = 5, professional or graduate school = 6).

*p < .05. **p < .01.

Appendix E: Skewness and Kurtosis for Study Variables

Normality Data for Study Variables

	Normality estimate	
Variable	Skewness	Kurtosis
Loneliness	.514	-.555
F&V Consumption	.100	-.940
Exercise	1.180	1.200
Physical Health	-1.167	1.228
Mental Health	-.593	-.380
Income	.200	-.596
Education	.046	-.523
Age	-.711	-.002

Note. F&V = fruit and vegetable.

Appendix F: Main Results

Table F1

Hypothesis 1: Relationships between Loneliness and Health Behaviors

Model	Outcome	Predictors	*b*	*SE*	df	*t*	95% CI
Physical Health							
	F&V Consumption						
		Loneliness	-.132	.283	604448	-.466	[-.687, .423]
	Exercise						
		Loneliness	.101	.380	67707	.266	[-.644, .847]
Mental Health							
	F&V Consumption						
		Loneliness	-.114	.288	1754584	-.396	[-.679, .451]
	Exercise						
		Loneliness	.088	.385	92947	.228	[-.734, .774]

Note. Values are averaged using Rubin's (1987) recommendations across five datasets generated with the multiple imputation procedure in SPSS. In the Physical Health model, age, income, and education were included as control variables. In the Mental Health model, age, income, and gender were included as control variables. The parameter estimates for the control variables were not available. CI = confidence interval; F&V = fruit and vegetable.

Table F2

Hypothesis 2: Relationships between Health Behaviors and Health Outcomes

Outcome	Predictors	*b*	*SE*	df	*t*	95% CI
Physical Health						
	F&V Consumption	-.081	.214	2170896	-.466	[-.500, .339]
	Exercise	-.035	.164	124228	-.213	[-.426, .309]
	Age	-.003	.083	23165362	-.038	[-.017, .010]
	Income	.390	.393	43965	2.546*	[-.380, 1.160]
	Education	-.004	.332	4215	-.011	[-.654, .646]
Mental Health						
	F&V Consumption	.115	.288	87626	-.396	[-.493, .328]
	Exercise	.020	.155	20923805	.767	[-.453, .289]
	Age	.008	.081	36300000	.104	[-.093, .165]
	Income	.357	.394	1725	.908	[-.415, 1.129]
	Gender[a]	-.208	.505	93510	-.412	[-1.199, .783]

Note. Values are averaged using Rubin's (1987) recommendations across five datasets generated with the multiple imputation procedure in SPSS. CI = confidence interval; F&V = fruit and vegetable.

[a]Coded (male = 1 and female = 2).

*$p < .05$.

Table F3

Hypothesis 3: Indirect Effects of Loneliness on Health Outcomes via Health Behaviors

Independent Variable	Mediator	Outcome	Indirect effect	*SE*	95% CI
Loneliness					
	F&V Consumption				
		Physical Health	.012	.098	[-.180, .202]
		Mental Health	-.014	.133	[-.274, .247]
	Exercise				
		Physical Health	-.022	.098	[-.215, .170]
		Mental Health	.001	.079	[-.153, .155]

Note. Values are averaged using Rubin's (1987) recommendations across five datasets generated with the multiple imputation procedure in SPSS. The indirect effect was examined using bootstrapping, a non-parametric resampling method. The indirect effect is considered statistically significant when the confidence interval does not contain 0. CI = confidence interval; F&V = fruit and vegetable.