EXAMINING THE USE OF ONLINE SOCIAL NETWORKING TO IMPROVE PHYSICAL ACTIVITY BEHAVIORS AMONG YOUNG ADULT CANCER SURVIVORS

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ABSTRACT

CARMINA G. VALLE: Examining the Use of Online Social Networking to Improve
Physical Activity Behaviors among Young Adult Cancer Survivors
(Under the direction of Dr. Deborah F. Tate and Dr. Marci K. Campbell)

eHealth interventions have the potential to reach young adult cancer survivors, who are increasingly turning to the Internet and social networking sites (SNS) for health information and support. The overall goal of this research project was to assess whether an existing SNS is an effective channel to deliver a physical activity (PA) intervention to young adult cancer survivors. Aim 1 examined distinct subgroups of young adults (n=1619, 18-39y) that vary in their likelihood of not meeting PA recommendations using signal detection analysis of data from the Health Information National Trends Survey 2007. Predictors of not meeting PA guidelines were general health, body mass index, perceived cancer risk, health-related Internet use, and trust in information sources. The purpose of Aim 2 was to evaluate the feasibility and efficacy of a 12-week, Internet-delivered intervention aimed at increasing moderate-intensity PA compared to a self-help comparison condition among young adult cancer survivors. Both interventions utilized Facebook as a means to promote social interaction. From baseline to 12 weeks, participants (n=86) in both groups increased self-reported weekly minutes of moderate-to-vigorous PA (intervention: 67.0 min/week, $p=0.009$ vs. comparison: 46.3 min/week, $p=0.045$), with no significant differences between groups. Intervention group participants had a significantly greater increase in mild PA (intervention: 163.6 min/week vs.

comparison: 28.5 min/week; *p=0.032* between groups) and reported significant weight loss over time (-2.1 kg, *p=0.004*), which was marginally significant between groups (*p=0.083*). Aim 3 examined the effects of the intervention on psychosocial factors (self-efficacy, social support, self-monitoring) and determined whether these factors mediated the relationship between the intervention and PA. The intervention group reported lower self-efficacy for sticking to exercise (mean change=-0.38; *p=0.025* between groups) and social support from friends on SNS (mean change=-0.47; *p=0.039* between groups) relative to the comparison group over time. Among all participants, social support from friends and self-monitoring were positively associated with changes in moderate-to-vigorous PA. The proposed psychosocial mediators did not explain the positive effect of the intervention on mild PA. Results of this dissertation project suggest that SNS intervention approaches may be an effective way to promote mild PA in young adult cancer survivors.

I dedicate this work to Marci Kramish Campbell, for her extraordinary

mentorship, nurturing and support, and for her grace and caring while living with cancer.

Her selflessness and legacy will always be remembered.

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LIST OF ABBREVIATIONS

AYA – adolescent and young adult

BMI – body mass index

CA – cancer

FACT-G – Functional Assessment of Cancer Therapy-General

FITNET – Fostering Improvement through Networking and Exercising Together (intervention)

i[2]y – I'm Too Young For This cancer foundation

MVPA – moderate- to-vigorous physical activity

NCI PRG – National Cancer Institute and Lance Armstrong Foundation-organized Progress Review Group on Adolescent and Young Adult Oncology

PA – physical activity

QOL – quality of life

SC – self-help comparison

SDA – signal detection analysis

SNS – social networking sites

YAA – LIVE**STRONG** Young Adult Alliance

CHAPTER I

INTRODUCTION

I.A. Overview

Currently there are over 565,000 young adult cancer survivors in the United States. Young adult cancer survivors, defined here as those diagnosed between the ages of 18 and 39, are at increased risk for second cancers, recurrence, psychological distress, morbidity, and mortality as a result of their cancer and treatment. Behavior change interventions that promote regular physical activity can potentially ameliorate some of these risks among survivors and enhance their quality and length of survival. While young adult cancer survivors have expressed interest in lifestyle interventions, few empirical studies have assessed the suitability and effectiveness of behavioral interventions among young adult cancer survivors.

An eHealth intervention represents an opportunity to reach young adult cancer survivors, who are increasingly turning to the Internet and other related technologies, such as social networking websites, for health information and support. Online social networks have the potential to facilitate social support, an important factor that may enhance health outcomes and encourage increased physical activity among young adult cancer survivors. With the continued growth in use and attention paid to social networking sites by young adults, it has become increasingly important to empirically investigate the potential to deliver health communication interventions through this existing technology platform. Therefore, the purpose of this research project was to develop and test the efficacy and acceptability of a

behavioral intervention, delivered through an existing online social networking site, that was aimed at improving physical activity behaviors among young adult cancer survivors.

I.B. Specific Aims

This was a two-phase project with the following specific aims:

Phase I: Signal detection analyses of data from the 2007 Health Information National Trends Survey to identify subgroups of physically inactive young adults and related health communication behaviors.

Aim 1: Determine mutually exclusive subgroups of young adults that vary in their likelihood of meeting physical activity recommendations using signal detection analysis.

> **1a:** Examine the validity of the identified subgroups by comparing levels of physical inactivity with an independent confirmatory sample stratified by the parameters that characterized the identified subgroups.

> **1b:** Determine the sociodemographic, health- and communication-related characteristics that are uniquely associated with the identified subgroups in the entire sample.

Phase II: Randomized controlled trial to determine the feasibility and efficacy of a behavioral intervention delivered through an existing social networking site on physical activity among young adult cancer survivors.

Aim 2: Develop and determine the effects of a behavioral intervention, delivered through an existing social networking site, on physical activity (moderate-intensity minutes per week) among young adult cancer survivors compared to a self-help education condition.

Aim 3: Determine psychosocial factors that mediate the relationship between the online

social networking intervention and physical activity behaviors among young adult cancer

survivors, including self-efficacy, social support, and self-monitoring.

CHAPTER II

LITERATURE REVIEW

II.A. Cancer Survivors

Currently there are an estimated 13.7 million cancer survivors in the United States.[1] With improvements in early detection and treatment, the number of cancer survivors will continue to grow. Cancer, however, exacts a tremendous burden, as survivors have increased medical and psychological needs, experience worse health outcomes and are at higher risk for death from noncancer causes relative to individuals without cancer.[2, 3] Cancer survivors are at increased risk for second cancers and may be at increased risk for cardiovascular disease, osteoporosis, diabetes and other chronic illnesses.[4-6] These increased risks and comorbidities may be due in part to cancer treatment, genetic predisposition, and lifestyle behaviors; as such, cancer survivors are a vulnerable population with unique needs.[3, 6-8] Given that modification of health behaviors, such as diet and physical activity (PA), has the potential to ameliorate some of these risks, cancer survivors are an important population in need of health promotion interventions.[3, 6, 8, 9]

II.B. Physical Activity among Cancer Survivors

There is a growing body of evidence that regular PA may help prevent recurrence and improve post-treatment quality of life in cancer survivors.[4, 10-17] Several evidence reviews on PA in cancer survivors have shown that exercise is related to enhanced quality of life.[3 ,6, 9, 16-21] Furthermore, an Agency for Healthcare Research and Quality review, as well as a meta-

analysis of controlled PA trials in survivors, have shown the positive effects of PA on cardiorespiratory fitness, symptoms and physiologic effects, vitality, vigor, quality of life, depression, anxiety, and fatigue.[16, 17] More recently, observational studies have shown that higher self-reported PA levels were protective against cancer recurrence and overall survival among breast and colorectal cancer survivors.[13-15]

The body of evidence to date indicates that cancer survivors can safely engage in PA with no adverse side effects, and they experience improvements in cancer-related symptoms and quality of life as a result of exercise.[22, 23] Despite this evidence, survivors have been shown to underestimate the association between behaviors like physical inactivity and obesity with increased cancer risk.[24] While research on how PA may impact cancer survivors' long-term outcomes is still up-and-coming,[9,10] health messages regarding weight and exercise can and should be conveyed responsibly to cancer survivors.[3] The importance of PA for cancer survivors is also supported by the existence of current PA guidelines for cancer survivors established by expert panels (Table 2.1).[10, 12, 22] However, PA declines among most cancer survivors after diagnosis, and many are not engaging in recommended levels of regular PA.[23, 25] Recent analyses of Behavioral Risk Factor Surveillance System data indicate that an estimated 31.5% of cancer survivors had not engaged in any leisure-time PA in the past 30 days.[26] Thus, interventions to promote increased PA among cancer survivors are important opportunities to potentially alleviate cancer-related morbidities, reduce recurrence, and enhance survival.

Table 2.1. Current physical activity guidelines for cancer survivors

	American Cancer Society (2012)[12]	American College of Sports Medicine (2011) / Physical Activity Guidelines for Americans[22]	American Institute for Cancer Research/ World Cancer Research Fund (2007)[10]
Physical Activity	• Adopt a physically active lifestyle. • Adults: engage 7in at least 30 minutes of moderate-to-vigorous PA, above usual activities, on 5 or more days of the week. Forty-five to 60 minutes of intentional PA are preferable.	• Avoid inactivity. Some physical activity is better than none. • Adults should do at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous intensity aerobic activity. • Adults should also do muscle-strengthening activities that are moderate or high intensity and involve all major muscle groups on 2 or more days a week.	• Be physically active for at least 30 minutes every day.
Weight	• Maintain a healthy weight throughout life. • Balance caloric intake with PA. • Avoid excessive weight gain throughout the lifecycle. • Achieve and maintain a healthy weight if currently overweight or obese.		• Be as lean as possible without becoming underweight.

II.C. Young Adult Cancer Survivors—An Understudied Population

Cancer is the most common cause of disease-related death among adolescents and young adults (AYAs), defined here as individuals between the ages of 15-39.[27] There are an estimated 565,450 cancer survivors currently between the ages of 20 and 39 in the United States.[1] The most prevalent cancers among younger AYAs include lymphomas, leukemias, and central nervous system tumors, while breast, cervical and colorectal cancer are more common among young adults ages 20-39.[28] Approximately 70,000 AYAs are diagnosed with cancer in United States each year, which represents about 8 times the number of cancer cases in children under age 15.[27, 28] Yet, in comparison to survivors of childhood cancer, there is a dearth of scientific literature on the psychosocial factors and health behaviors that influence outcomes among AYAs. Only recently has research using the Behavioral Risk Factor Surveillance System shown that AYAs with a history of cancer were more likely to be obese, be current smokers, be disabled, have various chronic conditions, and have poor mental and physical health than those without a history of cancer.[29]

Physical activity rates among young adult cancer survivors

There are relatively few studies that examine the needs of young adult cancer survivors, diagnosed between the ages of 18-39, as a distinct population separate from survivors of childhood cancer or older adults.[27, 30-33] While research shows that childhood cancer survivors often have poor dietary habits,[34-36] and sedentary behaviors,[35, 37-39] much less is known about the health behaviors of young adult cancer survivors, specifically those diagnosed between the ages of 18-39. Earlier published studies investigating PA behaviors in young adult cancer survivors were limited to survivors of childhood cancer.[35, 39-41] In a descriptive study of 117 young adult survivors of childhood cancers, 60% reported that they

were physically active for more than six months and 21% indicated being active for six months or less.[40] While over 80% reported being physically active, an estimate higher than previous studies of cancer survivors, it was unclear whether survivors were meeting recommended levels of PA since the PA measure consisted of a single-item self-reported PA stage of change.[40]

Studies investigating PA behaviors in cancer survivors diagnosed as young adults have emerged only recently.[42-47] A survey of 60 young adult cancer survivors, ages 18-40, found that 63% were not engaging in the recommended levels of either moderate- or vigorous-intensity PA,[44] which is greater than the proportion of U.S. young adults, ages 18-24, that are physically inactive (43%).[48] Another survey of Canadian young adult cancer survivors, 20-44 years old, estimated that 23% were sedentary and 48% were not meeting PA guidelines.[46]

Data from the 2000 National Health Interview Survey show that among cancer survivors between the ages of 18-40, 59.3% are inactive or do not meet PA guidelines and 52.1% are overweight.[49] Other studies of national cross-sectional surveys have demonstrated that PA behaviors of adult cancer survivors do not differ from age- and race-matched healthy controls without a history of cancer,[25, 50-52] and only 30-47% of survivors of six different cancer sites (breast, prostate, colorectal, bladder, uterine, skin melanoma) are achieving the recommended levels of exercise.[52] Overall, studies to date suggest that the PA behaviors of young adult cancer survivors may parallel those of populations without cancer, despite their increased risks for comorbidity and the benefits of PA after cancer. This supports the need for further research on PA interventions focused on this population.

In sum, interventions to promote healthy PA behaviors among young adult cancer survivors represent important opportunities to potentially reduce some of their risks for comorbid conditions and improve quality of life. A primary recommendation of the National Cancer Institute and Lance Armstrong Foundation-organized Progress Review Group (NCI PRG) on Adolescent and Young Adult Oncology was to "provide education, training, and communication to improve awareness, prevention, access, and quality cancer care for AYAs" (p. ii).[27] Furthermore, the NCI PRG stressed the need to evaluate existing resources and develop new interventions that are acceptable for this population.[27, 53] This dissertation research was responsive to these recommendations and contributes to the small but growing body of research focused specifically on young adult cancer survivors.

II.D. Need for Physical Activity Resources among Young Adult Cancer Survivors

The few studies that have explored the age-specific supportive care needs of young adult cancer survivors indicate that they are interested in PA resources.[30, 31, 33, 47, 54] For example, Rabin and Politi[44] surveyed young adult cancer survivors, ages 18 to 40, and found that 67% and 63% of participants expressed interest in moderate- and vigorous-intensity exercise programs respectively. This desire for PA interventions is borne out in studies of other age groups of cancer survivors.[7, 35, 55, 56] Several studies by Courneya and colleagues have demonstrated that adult cancer survivors of a variety of cancers (i.e., prostate, breast, colorectal, lung, brain, bladder, endometrial, non-Hodgkin lymphoma) are interested in participating in exercise programs and desire information on PA and cancer survivorship.[23, 57-61] Other surveys, including a needs assessment of cancer patients and survivors served by the UNC Lineberger Comprehensive Cancer Center[62] and findings from the LIVE**STRONG** Survivorship Center of Excellence Network,[63] suggest that young adults are interested in

receiving information about fitness and exercise. Most recently, Zebrack et al.[33]

demonstrated in a sample of 215 young adults within 4 months of a cancer diagnosis that

52.1% of those ages 20-29 and 43.1% of those 30-39 reported an unmet need for information

and counseling on exercise, highlighting the service gap in this population.

Existing physical activity resources for young adult cancer survivors

In searching for existing PA resources directed specifically at young adult cancer

survivors, a review of the LIVE**STRONG** Young Adult Alliance (YAA) online resource

page in 2010, which was "intended to be a central source of AYA-related cancer information

and services available on the Internet," revealed only five links to online resources dedicated

to the topic of PA and exercise.[64] These sites included: a video of testimonials from young

adult cancer survivors about the importance of healthy behaviors; two informational sites

from cancer advocacy organizations; and two links that led to error messages for sites that no

longer exist. Other links to community resources on the YAA page offered resources for

connecting with other young adult cancer survivors and information on activities such as

retreats, camping trips, kayaking programs, online games, and informational workshops.

A directed search in 2010 of the I'm Too Young For This (i[2]y) cancer foundation

website, a community-based organization that has "launched the Web's premiere AYA

community resource website"[65] located links to 66 different community organizations

offering exclusive support for young adults, ranging from one-on-one peer support and social

networking resources to financial assistance and professional counseling with a social

worker. In comparison, a 2006 Internet search to identify AYA cancer websites found 27

English-language websites run by cancer organizations.[66] While online cancer-specific

resources for young adults have proliferated, only some of these sites had general

information on the benefits of PA after cancer, and none of them appeared to provide specific

strategies and programs to support behavioral changes in PA after cancer. In 2010, the i[2]y

website linked to a number of social networking site resources (N=14), which provided some

evidence for the high use of computer-mediated communication and demand for peer-to-peer

support among young adult cancer survivors.

Given the high interest in exercise programming among young adults and the limited

number of existing AYA- and cancer-specific resources for PA, more research is necessary to

develop and test PA interventions that are appropriate for this group. Indeed, young adults

are an understudied group of cancer survivors with respect to research on the effects of PA,

and future research should include developing PA behavior changes interventions among

cancer survivors.[67] Therefore, in aim 2 we developed and tested the efficacy of a behavioral

intervention designed to increase PA among young adult cancer survivors.

Few behavioral interventions focus on young adult cancer survivors

While health promotion interventions among cancer survivors are emerging, most

interventions have narrowly focused on breast cancer survivors.[7] Only a few studies have

assessed the effectiveness of health promotion interventions in AYA cancer survivors. Of

these, all were focused exclusively on those diagnosed during childhood (0-14 years),[36, 37, 68-73]

and only three specifically targeted diet and/or PA behaviors.[36, 37, 71, 74] Furthermore, the

definitions of young adult used in eligibility criteria have varied across these studies.[30, 31]

Most of these trials utilized health behavior theories to guide intervention development and

focused on enhancing outcomes such as knowledge, motivating readiness to change, health

behavior intentions, and self-efficacy as mediators of behavior change.[68] Commonly used

intervention strategies included cognitive behavioral counseling, telephone follow-up, role

playing and goal setting.[36, 37] While these findings and pediatric psychosocial oncology research may have relevance to young adult cancer survivors,[27] there are currently no published studies evaluating PA interventions focused specifically on young adults diagnosed between the ages of 18-39. A review of methodologic issues in exercise interventions for adult cancer survivors found that most study participants were between the ages of 39 to 60 years.[75] The results of one currently funded study of a web-based PA intervention among young adult cancer survivors have yet to be published. Therefore, based on the existing literature and results from aim 1, we developed and tested the efficacy of an intervention designed to promote PA among young adult cancer survivors.

II.E. Physical Activity Determinants among Young Adult Cancer Survivors

Evidence related to PA behaviors among populations of adolescents, young adults or cancer survivors might potentially extend to young adult cancer survivors. It has been suggested that studies of predictors and determinants of PA among healthy populations can possibly guide the development of behavioral interventions among cancer survivors, since the prevalence of PA among cancer survivors is similar to the general population.[23] A comprehensive review of 108 studies of PA in children and adolescents showed that PA in adolescents (ages 13-18) was consistently related to the following variables: intentions, perceived competence in PA, previous PA, sensation seeking, parent support, support from others, community sports, and opportunities to exercise.[76] In a prospective study of young adult university students, self-efficacy, social support and self-regulation were significant predictors of PA.[77]

Behavioral determinants of physical activity in cancer survivors

Studies among other cancer survivor populations may be more salient to young adult cancer survivors given the common experience of cancer. While few studies have examined the correlates of PA in young adult cancer survivors, it has been noted that among cancer survivors, the most important correlates of PA adherence are psychosocial or social cognitive variables, rather than demographic or medical variables.[57]

Survivors of childhood cancer

Among adolescent and young adult survivors of childhood cancer, behavioral determinants that have been found to influence health behaviors include knowledge and perceptions of health vulnerability.[69] While young adult cancer survivors may lack consistent motivation to engage in health behaviors,[69] there is a dearth of literature on determinants specific to PA among those diagnosed with cancer during young adulthood. One cross-sectional study of young adult survivors of childhood cancer identified that autonomous motivation and perception of fewer PA cons were positively associated with being physically active (i.e., in action and maintenance stages).[40] Additionally, the relationship between PA cons and PA was moderated by worry about the present and future, such that survivors with less worry and perceived PA cons (barriers) were more likely to be physically active than those with greater worry and more perceived cons.[40] Another study of participants in the Childhood Cancer Survivor study found that motivation, fear and affect were important modifiable factors that either directly or indirectly influenced PA behaviors among childhood cancer survivors.[78]

Adult cancer survivors

Evidence on PA behaviors among adult cancer survivors might potentially extend to young adult cancer survivors. A review of the research on exercise in cancer survivors outlined several barriers to exercise, including fear of side effects, embarrassment about exercising around others, physical limitations, time constraints and discomfort.[79] In a review chapter on exercise motivation and behavior change in cancer survivors, Courneya et al. summarized theoretical exercise determinants in cancer survivors.[80] Of the 17 studies reviewed, 14 employed the Theory of Planned Behavior as a theoretical framework, and only 3 were randomized controlled trials. Results from the studies suggested that intention and perceived behavioral control account for 14% to 37% of the variability in PA behavior, while attitude, subjective norms and perceived behavioral control account for 23% to 68% of the variability in PA intentions.[80] Three other studies used Social Cognitive Theory, attribution theory, and the Five Factor Model of Personality as theoretical models for examining correlates of PA in cancer survivors.[80] Additional studies of randomized exercise behavior change trials in cancer survivors that utilized theoretical frameworks are reviewed below.

A recent issue of *Psycho-Oncology* dedicated to PA in cancer survivors published a handful of articles that represent some of the latest research on PA determinants among cancer survivors.[81-85] A study of exercise adherence in a home-based exercise intervention for breast cancer survivors determined that baseline exercise self-efficacy was the strongest predictor of adherence to the intervention.[81] In a five-year longitudinal study of PA determinants among breast cancer survivors, higher family support was related to a slower decrease in PA levels over time; depressive symptoms, poor physical health, and lower emotional health-related quality of life were associated with lower PA.[82] Another assessment

of correlates of PA change between 6 and 18 months post-diagnosis in breast cancer survivors found only two significant predictors—baseline PA and treatment-related complications, which were inversely associated with increasing PA levels.[83] Among lung cancer survivors, reported correlates of moderate/strenuous activity and leisurely walking included outcome expectations, self-efficacy, and social support from friends.[85] Older age, less education, greater surgical complications and poor preoperative pulmonary function predicted a lower likelihood of PA among these 175 survivors of early-stage lung cancer survivors.[85] Overall, self-efficacy has been recognized as an important predictor of PA in cancer survivors. Perkins et al.[84] assessed correlates of PA self-efficacy among breast and prostate cancer survivors and found that subjective measures of well-being (i.e., vitality, body pain) emerged as significant correlates of self-efficacy for PA, while treatment factors and comorbidities did not. The researchers concluded that interventions to promote PA in cancer survivors should take into account subjective measures of functioning and quality of life.[84]

Young adult cancer survivors

To date, only one published study has reported on theory-based correlates of PA in young adult cancer survivors.[45] Using path analysis of cross-sectional data from 588 Canadian cancer survivors diagnosed between the ages of 20-44, the study determined that intention, planning, affective attitude, education, and general health were independently associated with PA and explained 38% of the variance in PA.[45] Perceived behavioral control, instrumental attitude, and affective attitude were significantly and independently associated with intention to exercise.[45]

Environmental determinants of physical activity in cancer survivors

Environmental factors related to PA among young adult cancer survivors have received little research attention, but various studies and interventions among general populations provide evidence of environmental influences on PA behaviors. A comprehensive expert review of evidence on the effectiveness of environmental and policy level interventions to promote PA concluded that community- and street-scale urban design, land use policies, point-of-decision prompts, and increased access to places for PA combined with informational outreach activities are effective.[86] Among cancer survivors and healthy populations, a physician's recommendation to exercise has been shown to be an important predictor of PA adoption and maintenance.[23] One randomized control trial that targeted breast cancer survivors showed that a brief oncologist's recommendation to exercise was effective at increasing levels of PA among survivors compared to those who did not receive an exercise recommendation.[87, 88] Behavioral counseling in primary care settings has also been recommended as a strategy to increase PA based on a rigorous review of scientific evidence by the U.S. Preventative Services Task Force.[89]

Social support

To date, social support has emerged as a significant predictor of PA participation among both healthy populations and cancer survivors. In a variety of studies among adults, including systematic reviews, social support has been shown to be a consistent predictor of PA.[77, 86, 90-93] Social support was found to be significantly associated with PA behaviors among college students,[77] and a systematic review of observational studies suggested there is convincing evidence that social support is associated with a variety of PA types (e.g., walking, leisure-time PA).[94] Moreover, a church-based health promotion intervention among

999 adults showed that social support was a mediator of PA.[93] Systematic reviews of PA interventions have found strong evidence in favor of social support interventions in community settings[86, 95] and for social support as a mediator of intervention effects on PA behaviors.[92]

There is relatively little evidence on exercise interventions targeting social support among cancer survivors. Only recently has a systematic review shown that four out of seven PA intervention studies targeting social support in adult cancer survivors demonstrated improved outcomes in social support and PA behaviors.[96] Studies that have examined the relationship between social support and PA behaviors among cancer survivors have focused primarily on breast cancer.[97, 98] For example, Pinto et al. found that higher social support, in addition to younger age, having a spouse/partner, longer time since diagnosis, and higher depression predicted exercise participation in breast cancer survivors.[97] In determining the correlates of PA self-efficacy among 192 breast cancer survivors, Rogers reported that prediagnosis PA, social support, and barriers self-efficacy were significantly and directly associated with current leisure PA.[98]

Overall, there is a lack of evidence regarding patterns and determinants of PA behaviors, and behavior change interventions specific to young adult cancer survivors. Identifying predictors of physical inactivity in subgroups of young adults can help inform the future development of targeted interventions. Given the similarities in PA prevalence among cancer survivors and the general population, studies of predictors, barriers, and facilitators to PA among healthy populations can potentially guide the development of behavioral interventions among cancer survivors.[23] Furthermore, an important public health challenge is determining communication channels, sources and messages that are appropriate for

delivering targeted interventions to subgroups.[99] An understanding of health communication characteristics and preferences of physically inactive young adults is necessary for developing more effective and targeted PA interventions. Signal detection methodology is a useful approach for exploring factors related to PA behaviors in young adults, which may have some applicability to cancer survivors. Therefore, aim 1 determined predictors of PA among young adults, using signal detection methodology, to identify and characterize physically inactive subgroups that might benefit from future intervention. Results of this exploratory study advanced our understanding of health communication characteristics among physically inactive young adults and informed the development of future interventions among the identified subgroups.

Theories guiding previous physical activity interventions among cancer survivors

Behavioral theories may help to explain and predict health behaviors and are often used to guide the development of health behavior interventions.[100, 101] While the most important correlates of exercise adherence in cancer survivors have been shown to be social cognitive factors (e.g., attitudes, self-efficacy) rather than demographic or medical variables,[57] most exercise interventions among cancer survivors have not used theoretical bases to guide their development.[75] To date, there are over a dozen published studies on the effectiveness of theory-guided behavioral interventions with the primary goal of increasing PA in cancer survivors (see Table 3.2). Yet, no intervention studies have focused specifically on young adult cancer survivors as a distinct population separate from survivors of childhood cancer or older adults. Studies that have evaluated health promotion interventions among AYA cancer survivors of childhood cancer have targeted a variety of determinants, including knowledge, motivation, intention, self-efficacy or resilience.[68] Previous interventions among

a variety of cancer survivor populations have employed theoretical foundations that might be applicable to an intervention focused on improving PA among young adult cancer survivors. Table 3.2 provides a summary of theory-guided intervention trials aimed at PA behavior change among adult cancer survivors, and additional descriptions of the guiding theories are provided below.

Social Cognitive Theory (SCT)

Several interventions among cancer survivors have applied the SCT alone or in combination with the Transtheoretical Model (TTM) to guide intervention development. Self-efficacy has been the most commonly applied SCT construct in interventions, and outcome expectations and behavioral capabilities have also been targeted. A review of health promotion interventions among cancer survivors found that interventions applying SCT constructs have been effective, but additional analyses of whether the SCT constructs mediated the intervention effects are necessary.[102] A recent diet and exercise tailored mailed print intervention among breast and prostate cancer survivors was based on SCT and TTM constructs and significantly improved exercise behaviors.[103] Another intervention that applied SCT and TTM constructs found improved fitness and motivational readiness for PA among 60 breast cancer survivors.[104] Finally, breast cancer survivors who received a telephone delivered counseling intervention, based on TTM and SCT constructs, successfully increased their levels of PA and were more likely to achieve recommended levels of PA.[105] It has been noted that despite being recognized as a useful framework for guiding PA interventions, the SCT has not been studied enough among cancer survivors.[106]

Transtheoretical Model or Stages of Change (TTM)

In an evidence review of PA interventions in the general population and cancer survivors, the TTM was the most commonly used theory, guiding 29% of the interventions reviewed.[17] Cognitive and behavioral processes of change, as well as decisional balance, have been targeted in previous PA interventions specific to cancer survivors.[102] While interventions among cancer survivors guided by the TTM have generally been effective at enhancing PA (see Table 3.2), only a few trials investigated any potential changes in underlying TTM constructs as a result of intervention.[102] One randomized trial among prostate cancer survivors found significant improvements in cognitive and behavioral processes, as well as decisional balance, though no increase in PA after a lifestyle PA intervention.[107] While another PA trial among breast cancer survivors showed improvement in behavioral processes and increased PA after intervention, the intervention did not have an effect on underlying TTM constructs.[105, 108]

Theory of Planned Behavior (TPB)

The TPB has been applied extensively by Courneya and colleagues to elucidate correlates of PA behavior among survivors of various cancer types.[88,109-113] Overall, the studies support the use of intentions, attitudes, perceived behavioral control and norms for understanding exercise behaviors among cancer survivors.[80] For exercise interventions among the general population, a review has shown that the TPB explained from 27% to 36% of variance in PA behavior.[114] In studies involving cancer survivors, intention and perceived behavioral control have explained an estimated 23% to 68% of the variance in exercise behaviors.[80] However, few interventions have clearly used TPB constructs to guide

interventions targeting PA in cancer survivors,[102] making it challenging to understand how to

practically target these constructs in an exercise intervention study.

Table 3.2. Summary of theory-guided intervention trials aimed at physical activity behavior change among cancer survivors

Study	Sample	PA Outcome Measures	Intervention	Results
Vallance et al. (2007)[115]	N= 377 post-treatment breast cancer survivors, 30-90 y, mean 58 y, mean 39 months post-dx	1°: Self-reported moderate/vigorous PA minutes per week (Godin LSI) 2°: Self-reported brisk walking, 7-day step test (Digi-Walker pedometer), QOL (FACT-B), fatigue (FACT-B)	Intervention: PM (N=94): breast cancer-specific print guidebook; PED (N=94): step pedometer, 12-week step calendar, daily log of step count; COM (N=93): combination of PM + PED Control: (N=96) SR: Standard recommendation for PA; TPB	After 12 weeks, significant increases in self-reported PA and/or brisk walking in all three intervention groups compared to SR group. No differences in objective step counts across groups. COM group had significantly greater improvements in QOL and fatigue than SR group.
Pinto et al. (2005)[105]	N = 86 post-treatment breast cancer survivors, mean 53.14 y, mean <2 y post-dx	1°: Self-reported moderate-intensity PA minutes per week (7-day PAR) Accelerometer – 3 days of activity	Intervention (N= 43): 12 weeks of telephone counseling, weekly exercise tip sheets, pedometer, home logs to monitor PA Control (N=43): contact control; TTM	After 12 weeks, significant increases in total minutes of PA, minutes of moderate-intensity PA, energy expenditure per week compared to controls. Changes in PA not reflected in objective activity monitoring.
Matthews et al. (2007)[116]	N = 36 post-treatment breast cancer survivors, mean 54.1y, 0.6-1 y post-dx	1°: Self-reported leisure time PA (MET-h/week) (CHAMPS) 2°: Average activity counts (ct/min/day) and moderate walking duration (min/day) (Actigraph	Intervention (N=23): One in-person counseling visit, up to 5 telephone counseling calls, pedometers, weekly self-report logs of daily activity/walking, pedometer steps	After 12 weeks, significantly greater walking for exercise MET-h/wk compared to usual care. Increased activity counts/min/day as measured by accelerometer.

Study	Sample	PA Outcome Measures	Intervention	Results
		accelerometer)	Control (N=13): usual care, asked to maintain current PA levels, delayed intervention SCT	
Bennett et al. (2007)[117]	N = 56 post-treatment adult cancer survivors, 37-85 y, 1-23 years post-dx	1°: Self-reported leisure time PA (kcal/wk) (CHAMPS) 2°: Aerobic fitness (distance [ft] walked in 6 mins), Health status (SF-36), Fatigue (Schwartz)	Intervention (N= 28): One in-person counseling session, 2 MI telephone calls over 6 months, pedometer Control (N= 28): Asked to maintain current PA levels; 2 telephone calls w/o MI content SCT, TTM	Significant group differences in regular PA (energy expenditure/week), controlling for time since completion of tx
Rogers et al. (2009)[118]	n = 41 breast cancer survivors, mean 53 y, on hormonal therapy	1°: Total 7-day PA counts (GT1M accelerometer) 2°: Self-reported leisure time PA (Godin LSI), aerobic fitness, muscle strength, BMI, WHR, QOL Social well-being	Intervention (N=): 6 discuss-ion group, 12 supervised exercise, 3 face-to-face counseling sessions over 12 weeks, weekly exercise log Control (N=): Usual care, written PA-related materials from ACS, no specific instructions re: PA SCT	Significant group differences favoring intervention group for PA counts, muscle strength, WHR, social well-being
Demark-Wahnefried et al. (2007)[103]	N = 515 breast and prostate cancer survivors, mean 57 y, w/in 9 mos	1°: % of patients achieving at least 2 out of 3 lifestyle behavior goals (PA, FV & fat intake)	Intervention (N= 271): sequentially tailored mailed print materials, personalized workbook, 7	After 10-months, intervention effective in increasing number of lifestyle behaviors practiced

Study	Sample	PA Outcome Measures	Intervention	Results
	of dx	Self-reported leisure time PA (7-DPARQ)	newsletters at 6-week intervals, brief interim mailed surveys Control (N=272): nontailored mailed materials, personalized workbook, 7 public available health education materials at 6-week intervals, brief interim mailed surveys SCT and TTM	at recommended levels, increasing PA mins/week, daily FV intake, decreasing fat intake. Intervention produced significant weight loss.
Demark-Wahnefried et al. (2006)[119]	N=182 older breast and prostate cancer survivors age 65+y, mean 71.7 y, mean, w/in 18 mos of dx	1º: physical functioning (SF-36), QOL (FACT-B/P) 2º: self-reported PA (CHAMPS), Diet quality index (3-day dietary recall)	Intervention: (N=89): 12 bimonthly 20- 30-min telephone counseling sessions for 6 months, tailored print workbook Control: (N=93): 12 bimonthly 20- 30-min telephone counseling sessions for 6-months on general health promotion, print workbook SCT and TTM	Diet quality significantly improved in intervention group from pre to post. Trend toward improved change scores in physical functioning and PA.
Carmack Taylor et al. (2006)[107]	N = 134 prostate cancer patients, mean 69.2 y, receiving continuous androgen-ablation therapy	1º: General health-related QOL, mood, pain (SF-36, CES-D, State Scale of the State/Trait Anxiety Inventory (STAI), Brief Pain Inventory-Short	Intervention (N=35): 6-month group based lifestyle PA program – orientation session, 16 weekly sessions, 4 biweekly sessions (all 90	No significant changes in QOL or PA as measured by 7-DPARQ at 6 and 12 months. No significant differences on measures of body

Study	Sample	PA Outcome Measures	Intervention	Results
		Form (BPI) 2°: 6-minute walk test, BMI, waist, hip, WHR, 7-DPARQ	mins) Controls (N=44) group-based educational support program, orientation session, 16 weekly sessions, 4 biweekly sessions (all 90 mins) ; (N= 34) standard care, one mailing of educational & informational materials SCT and TTM	composition or endurance at 6 or 12 months.
Jones et al. (2004)[87]	N = 450 recently diagnosed breast cancer survivors, mean 56 y,	1°: Self-reported total exercise (MET-h/week) (Godin LSI) 2°: Total exercise frequency/wk (MET times/wk), moderate intensity exercise minutes and frequency/wk, % meeting 150+min moderate intensity PA/week guideline	Intervention : at 1st adjuvant tx consultation oncology exercise recommendation only (N=119) OR oncologist exercise recommendation + referral to exercise specialist (N=113) Control (N=97): usual care at 1st adjuvant tx consultation TPB	At 5 weeks, recommendation only group had significantly greater total exercise (MET-h/wk) compared to usual care.
Morey et al., (2009)[120]	N = 641 older long-term survivors of colorectal, breast and prostate cancer survivors, mean 73y, mean 8.6 y since dx	1°: Change in self-reported physical function (SF-36) 2°: Self-reported PA (CHAMPS), BMI, HRQOL, lower extremity function	Intervention (N=319): 12-month home-based program – tailored workbook, quarterly newsletters, 15 telephone counseling sessions, 8 automated prompts,	Intervention significantly reduced rate of self-reported functional decline. Significant increase in duration of strength training exercise, duration of endurance exercise minutes,

Study	Sample	PA Outcome Measures	Intervention	Results
			pedometer, exercise bands, exercise poster, table guide to food portioning, personalized daily exercise and diet log Control (N=322): delayed intervention, wait-listed for 12 months SCT and TTM	overall QOL in intervention group.
Basen-Engquist et al. (2006)[104]	N=60 post-treatment breast cancer survivors, mean 55y, mean 38.2 mos since dx	1°: Physical performance (6-min walk test, 50-ft walk test, timed sit- to-stand test, timed reach-up test, forward-reach test), QOL (SF-36) 2°: PA (7-DPARQ), body composition, lymphedema	Intervention (N=35): 21 90-min group meetings - 16 weekly sessions, 4 biweekly sessions, booklet matched to stage of readiness to change, written materials re: survivorship, pedometer Control (N= 25): standard care, two written mailings on survivorship topics unrelated to PA SCT and TTM	At 6 months, intervention group performed better on 6-minute walk test and had positive effects on bodily pain and general health. No significant group differences in number of minutes of moderate or more intense PA or number of days on which they did 30 min+ of of moderate or more intense PA

Study	Sample	PA Outcome Measures	Intervention	Results
Blaauwbroek et al. (2009)[121]	N = 46 adult survivors of childhood cancer, median 29y, mean N=33 aged matched sibling/friend controls	1°: Fatigue (Checklist individual strength [CIS]) 2°: Daily steps (Yamax pedometer, step diary)	Intervention: (N=46) survivors, 1 counselor home visit, 3 MI-based counseling calls, 3 written summaries of calls, pedometer, 7-day step diary (4 different weeks) Comparison: (N=33) not randomized, no pedometer, control for CIS measurement TTM and MI	Significant improvements in fatigue from baseline to 10 and 36 weeks in intervention group. After 10 weeks, intervention group significantly increased daily PA (steps per day - 54% increase from baseline)
Wilson et al. (2006)[122]	N=24 cancer patients receiving chemotherapy, mean 54y	1°: HRQOL (SF-36)	Intervention (N=3): brief in-person introduction, videotape, audiotape, and brochure re: stress, exercise instruction booklet, exercise logs, up to 5 brief clinic-based meetings over 10-13 weeks No Control	Significant improvement over time in bodily pain and mental health scores. General health, vitality, and physical functioning changed nominally in negative direction over time, but declines were not significant.

CHAPTER III

INTERVENTION FRAMEWORK

III.A. Intervention Strategies for Young Adult Cancer Survivors

A review of 28 lifestyle interventions in cancer survivors suggested several attributes that must be considered in developing and delivering health promotion interventions, including the use of behavioral theory and appropriate delivery channels.[7] Furthermore, the NCI PRG emphasized that "targeted education and *online resources* for cancer information, insurance resources, *peer support*, and other information needs will help empower AYAs to understand and manage their own care" (p. iii).[27] Important factors to consider in delivering interventions among young adult cancer survivors are detailed below.

Applying behavioral theories to improve physical activity

Based on a review of the literature, as well as the relevance, changeability and applicability to PA behaviors among young adult cancer survivors, this intervention aimed to influence behavioral capability, self-efficacy, self-monitoring, and social support as potential mediators of PA among young adult cancer survivors.

Behavioral capability

Behavioral capability, or knowledge and skills, was targeted as a determinant of PA among young adult cancer survivors given its relevance, changeability and applicability to overall health behavior change. While it may not be an explicit construct in health behavior theories, a level of knowledge about PA is necessary for subsequent behavior change. Knowledge is widely accepted as a construct that should be targeted, as it is an essential

condition for most other behavioral determinants.[123] Skills are highly relevant to focus on in PA interventions. Several individually-adapted behavior change interventions have taught participants specific skills related to PA, and a systematic review found strong evidence that these interventions effectively promoted PA.[86] Knowledge and skills have been addressed in a number of randomized controlled PA trials among cancer survivors that were found to effectively increase participants' levels of exercise.[103, 104, 116, 119, 120, 124]

Self-efficacy

Self-efficacy has been targeted by several health promotion interventions, not only among cancer survivors, but the general population. There is evidence that exercise self-efficacy is a mediator of PA among adults and children,[92] and interventions that have addressed self-efficacy among survivors have shown some effectiveness.[102] A randomized diet and exercise intervention found significant increases in self-efficacy for exercise after 6 months of intervention.[124] Among childhood cancer survivors, Emmons et al. conducted a randomized trial to promote smoking cessation and found that long-term self-efficacy was a strong predictor of cessation.[72] Additionally, a randomized motivational interviewing intervention to promote PA in long-term cancer survivors showed that the intervention was more effective at increasing PA among participants with high self-efficacy for exercise at baseline than those with low self-efficacy.[117] Cross-sectional data also support the association between self-efficacy and PA behavior among breast cancer patients in treatment, breast cancer survivors, and lung cancer survivors.[85, 98, 106] Most recently, Pinto et al showed that exercise self-efficacy significantly predicted exercise adherence in a 12-week home-based exercise intervention for cancer survivors.[81] Furthermore, mediation analyses of a 12-week supervised PA intervention for breast cancer survivors demonstrated that barriers self-

efficacy partially mediated the intervention effect on objectively measured PA.[125] Other mediation analyses of a home-based diet and PA intervention for breast and prostate cancer survivors found that self-efficacy for exercise was positively associated with PA behaviors in the total sample at follow-up, but did not explain the intervention effects on PA.[126,127] Therefore, as a highly relevant and changeable construct, this intervention focused on exercise self-efficacy.

Self-monitoring

Several PA interventions among survivors have successfully employed components like exercise logs and pedometers as intervention strategies to promote self-monitoring in support of increased exercise.[105, 115-117, 120, 121] Pedometers have been shown to be helpful for setting specific goals and providing feedback for those who wear them to determine if they are meeting step recommendations.[128, 129] They are increasingly used in community-based interventions and clinical interventions on PA to objectively measure ambulatory PA.[130] Additionally, a systematic review of 26 studies on the use of pedometers to increase PA in adults determined that pedometer use is associated with significant increases in PA and significant decreases in body mass index and blood pressure.[131] For the current study, pedometers were used as an intervention strategy that allowed participants to self-monitor their daily step counts.

Social support

Social support was targeted as an external determinant of young adult cancer survivors' PA behavior. While there is limited evidence on the use of social support as a construct in PA interventions with survivors, systematic reviews have found that social support interventions in community settings were effective at increasing PA.[86,95] Most

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recently, a systematic review demonstrated that half of the 22 studies reviewed (four out of seven intervention studies) indicated a positive relationship between social support and PA engagement in adult cancer survivors.[96] Data from observational studies among cancer survivors provide evidence on the influence of social support on PA. A 5-year longitudinal study of PA and its determinants among breast cancer survivors found that higher family social support was associated with a slower decline in PA over time.[82] Additionally, a cross-sectional study of breast cancer survivors demonstrated that social support was directly related to leisure time PA among breast cancer survivors.[98] Therefore, the intervention also targeted social support as a determinant of PA among young adult cancer survivors.

III.B. Conceptual Model

The conceptual model for the intervention study draws primarily from SCT constructs to guide our understanding of how to improve PA in young adult cancer survivors (Figure 3.1). Based on a review of the literature on determinants of PA and previous exercise interventions among survivors, we hypothesized that the following model would explain the relationships between various psychosocial factors, including self-efficacy, social support, self-monitoring and physical activity behaviors in young adult cancer survivors.

Figure 3.1. Conceptual model guiding physical activity intervention for young adult cancer survivors
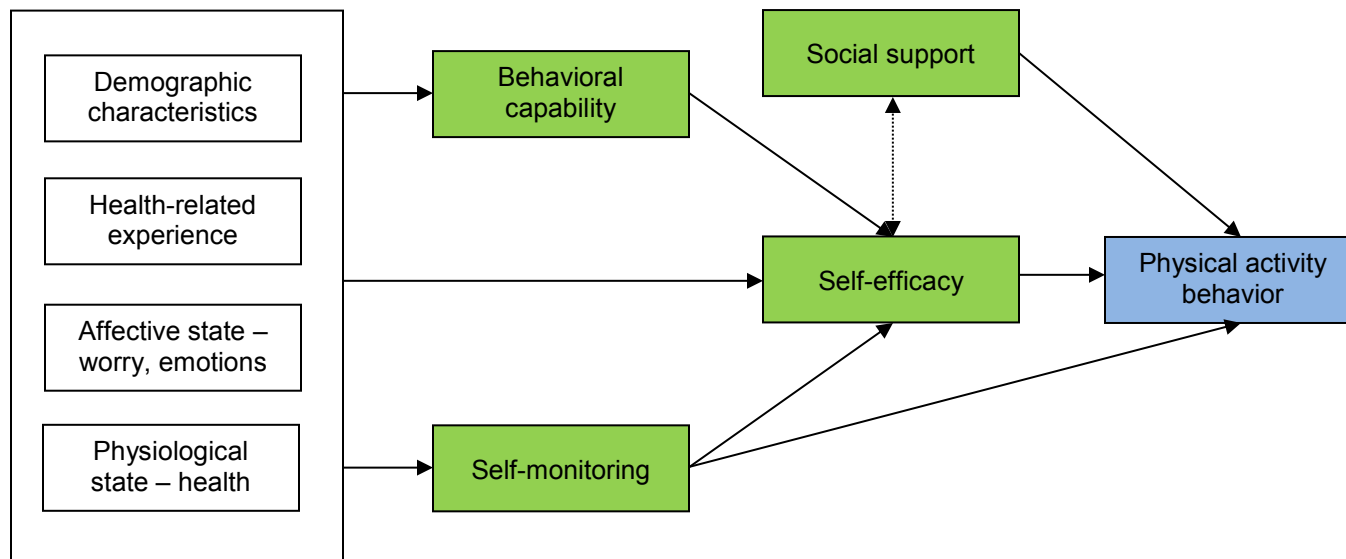
III.C. Importance of a Home- and Internet-based Intervention

Health promotion interventions among cancer survivors predominantly have been delivered in clinic settings, or in combination with telephone counseling.[3, 9, 132, 133] A review of recommendations for healthy lifestyle behaviors among cancer survivors commissioned by the Institute of Medicine noted the "enhanced need to develop interventions that, if not initially—then ultimately are disseminable to populations of cancer survivors at large" (p. 188).[3] Advantages of a home- and/or Internet-based intervention include: potential for wider dissemination; cost savings and fewer expenses than supervised programs; reduced transportation and scheduling challenges; minimal or no supervision requirements; and no requirements for participants to join a health club or attend classes.[105,134] Indeed, an intervention study on restorative yoga for breast cancer survivors found that a primary reason for nonparticipation in the study was distance from the intervention site.[135] Other potential advantages of Internet interventions include convenient access to intervention content, possible delivery of tailored messages, use of interactive content and elaborate graphics, and lower overall costs.[136]

One of the few published studies that assessed survivors' preferences for intervention delivery and may have relevance to young adult cancer survivors showed that more young adult survivors of childhood cancer reported "*extremely high*" to "*high*" levels of interest in mailed interventions (59%), compared to computer-based interventions (45-47%) and telephone counseling (10%).[35] However, these preferences may have changed over time. A more recent study by Tercyak[137] found that adolescents with multiple behavioral risk factors were willing to use the Internet for health promotion activities. Additionally, results of surveys of young adult cancer survivors by the LIVE**STRONG** Survivorship Center of

Excellence Network,[63] and survivors served by the UNC Lineberger Comprehensive Cancer Center[62] demonstrate high interest in Internet-based programs and services. A more recent study has indicated that young adult cancer survivors are interested in convenient and remotely-delivered lifestyle interventions.[138] Moreover, technology- and peer-based approaches are emerging as potentially effective strategies to reach and promote health among young adult cancer survivors.[139]

Recent estimates indicate that over 97% of 18-29 year olds and 91% of those ages 30-49 use the Internet,[140] and the most frequently used source of cancer information for U.S. adults is the Internet.[141] Furthermore, our preliminary analysis of data from the 2007 Health Information National Trends Survey showed that of the 84% of young adults between ages 18-39 who reported using the Internet, 44% reported using a website in the last 12 months to help them with their diet, weight or PA. While public health Internet interventions have shown efficacy across various clinical outcomes,[136] studies evaluating diet and/or exercise interventions delivered completely online to cancer survivors have yet to be reported.[3, 9] Among young adult cancer survivors, the Internet holds much promise as an appropriate technology platform for delivery and eventual dissemination of PA interventions. The online intervention in the present project has the possibility to be widely disseminated online and through smartphone technology that is rapidly being adopted, especially among young adults.

Utilizing an existing social networking site (SNS) for intervention delivery

Although use of the Internet in behavior change interventions has shown promise for promoting healthy eating and PA,[136, 142-147] the potential of online social networking sites (SNS) as an intervention delivery channel or the relative benefits of online social networking features have rarely been evaluated in randomized controlled trials [136,148]. To date, studies of

online social networking have focused on observational studies, predominantly cross-sectional surveys of users. Only recently has a study been published on a weight loss intervention using Facebook and text messaging—the 8-week intervention produced a significant 2-kg weight loss in college-aged young adults compared to Facebook only and wait-listed control groups.[148]

The significant increase in the use of online social networking by young adults suggests that delivering a PA intervention through an existing online SNS is warranted. Recent estimates indicate that 83% of young adults ages 18-29 and 65% of online adults use SNS, with 61% of young adults using them on a typical day.[149] Among adults, the most commonly used online social network is Facebook—92% of adults who use SNS use Facebook.[150] Furthermore, evidence from a 2012 consumer survey of 1,060 individuals indicated that among those ages 18-24, almost 90% had viewed health-related information or ever done health-related activities via social media and over 80% were likely to share health information through social media.[151]

Online SNS have many appealing characteristics as an intervention platform. They may offer a rich opportunity to recruit participants for medical research, especially among younger age groups with the highest usage.[152] Facebook, in particular, provides the potential for patients and health professionals to communicate and share experiences related to a specific disease and its management.[152] In a search of the Facebook website from December 2007 to January 2009, Farmer et al. determined that Facebook user groups related to malignant neoplasms had the largest number of individuals associated with them (i.e., 77,822 users), which is consistent with the high prevalence of cancer in the overall population.[152] In addition to serving as an accessible portal to recruit and communicate with young adult

cancer survivors, Facebook also provides tools and features that can facilitate social support between peers[153, 154] and have the potential to promote healthy behaviors,[155, 156] factors that may enhance health outcomes among young adult cancer survivors.

Facilitating peer support through social networking sites

Prevalent among existing online resources for young adult cancer survivors are SNS offered by community-based organizations; these allow young adult cancer survivors to connect with other survivors and provide peer-to-peer support (See Chapter II.D.). Data suggest that young adults are interested in connecting with other young adult cancer survivors, either in-person or online,[54] and peer support may help empower young adult cancer survivors to better manage their care.[27] Furthermore, young adult cancer survivors have shown specific preferences for interventions that offer social support and are delivered remotely.[138]

While an abundance of studies suggest that social support is an important predictor of PA in children and adults,[77, 86, 90-93] there have been no reported findings on the effectiveness of these peer-to-peer support programs accessed through the Internet. The first health promotion intervention delivered to young adult participants in the Childhood Cancer Survivor Study, the Partnership for Health study, utilized telephone-based peer counseling and print materials to effectively increase smoking cessation relative to a self-help intervention.[72, 157] In addition to enhancing knowledge, reducing barriers, providing feedback, and facilitating goal-setting, the intervention aimed to improve self-efficacy and social support by employing trained childhood cancer survivors as peer counselors.[72]

Although the potential for online SNS to facilitate support and motivation for behavior change has received little empirical focus, computer-mediated communication, such

as electronic support groups that address health concerns and offer peer-to-peer support, have received some attention.[158] While there is still inadequate research to make conclusions on the impact of online peer-to-peer communication on health and well-being,[159] a study on how cancer survivors provide support via Internet cancer-related mailing lists concluded that many survivors seek and offer informational and emotional support through the Internet.[158] Group-based support for young adult cancer survivors may facilitate opportunities for greater interaction with peers, enhanced social support, and observation of peer social norms, all potential theoretical constructs that have been identified previously as mediators of PA change. Given the potential for Internet communication to facilitate support for cancer survivors,[160] and the high prevalence of SNS use among young adults, we hypothesized that a behavior change intervention delivered over an existing SNS would be an acceptable and effective strategy for promoting PA among young adult cancer survivors. Since there are few published randomized trials on the efficacy of SNS interventions or the relative benefits of SNS features, aim 2 evaluated one of the earliest interventions delivered through Facebook and designed to increase PA among young adult cancer survivors. A limitation of the existing exercise intervention research among cancer survivors is the lack of attention to determining the mechanisms of change and potential mediators of intervention effects on PA behavior change.[75] Therefore, aim 3 contributes to the relatively small body of literature testing the mediating effects of psychosocial factors on PA change in cancer survivors.

III.D. Summary

In summary, there is a lack of research focused on supporting the unique needs and promoting healthy behaviors among young adult cancer survivors, a vulnerable population at increased risk for morbidity and mortality. Guided by Social Cognitive Theory, this

dissertation project determined whether an exercise intervention delivered through an existing online SNS positively increased PA behaviors among young adult cancer survivors. A theory-based intervention designed to promote PA that is delivered through the popular Facebook site has the potential for efficient recruitment, greater reach and dissemination among the growing population of young adult cancer survivors that deserves attention.

CHAPTER IV

PHYSICAL ACTIVITY IN YOUNG ADULTS: A SIGNAL DETECTION ANALYSIS OF HEALTH INFORMATION NATIONAL TRENDS SURVEY (HINTS) 2007 DATA

IV.A. Overview

Many young adults are insufficiently active to achieve the health benefits of regular physical activity (PA). We examined distinct subgroups of young adults (18-39y) that vary in their likelihood of not meeting PA recommendations using signal detection analysis of data from the Health Information National Trends Survey 2007. The sample was randomly split and signal detection analysis was conducted on the exploratory half to identify subgroups and interactions among sociodemographic and communication variables that predicted engaging in <150 weekly minutes of moderate-intensity PA (low PA). Rates of low PA among subgroups were compared with similarly defined subgroups in the validation sample. Overall, 62% were not meeting PA recommendations. Among eight subgroups identified, low PA rates ranged from 31%-90%. Predictors of low PA were general health, BMI, perceived cancer risk, health-related Internet use, and trust in information sources. The least active subgroup (90% low PA) included young adults in poor-good health with a BMI>30.8 (obese). The most active subgroup (31% low PA) comprised those in very good-excellent health who used a website to help with diet, weight or PA and had no/little trust in health information on television. Findings suggest potential intervention communication channels and can inform targeted interventions for young adults.

IV.B. Introduction

There is strong evidence that more physically active adults are at lower risk for all-cause mortality, heart disease, high blood pressure, stroke, type 2 diabetes and some cancers.[10, 161-164] Based on this evidence, several national guidelines on physical activity (PA) recommend that adults engage in at least 150 weekly minutes of moderate-intensity, or 75 weekly minutes of vigorous-intensity aerobic activity for improved health.[10, 161, 162, 164] However, according to self-reported data, about 40% of 20 to 39 year-olds in the US are not meeting these recommended levels[165] and may be insufficiently active to achieve the health benefits of regular PA.

Behavioral interventions that promote regular PA can potentially reduce risks for chronic disease and enhance quality of life. Considering that PA declines and weight gain often occur during young adulthood, leading to subsequent hypertension and cardiovascular conditions,[166-169] the adoption of healthy behaviors and health promotion interventions for young adults are particularly important for the prevention of health issues later in life. Identifying correlates of PA and elucidating appropriate communication channels and health information sources is important for guiding the development of targeted interventions to enhance PA behaviors in this population. Yet, there are relatively few studies that examine individual predictors of insufficient activity or communication preferences in young adults as a distinct population separate from older adults.[48, 170, 171] Therefore, we examined distinct subgroups of young adults that vary in their likelihood of not meeting the recommended levels of moderate-intensity PA using signal detection methodology with data from the 2007 Health Information National Trends Survey (HINTS).

With the dynamic growth and use of new technology, especially among young adults, it is increasingly important to investigate the potential to deliver health communications and interventions through emerging media. In addition to elucidating the sociodemographic and behavioral correlates of insufficient PA in young adults, describing their use and attention to various health communication channels may be helpful for developing more targeted interventions. The objectives of this study were to identify mutually exclusive subgroups of young adults that vary in their likelihood of not meeting PA recommendations, and to describe higher order interactions among sociodemographic, health and communication characteristics that may predict PA in young adults. In addition, we determined whether the subgroups identified in the initial signal detection analyses were stable in a separate set of HINTS data. Our analyses were exploratory in nature with an overall goal of generating future hypotheses related to PA behaviors in young adults.

IV.C. Methods

Data source

Data were drawn from the 2007 HINTS, a biennial cross-sectional survey conducted by the National Cancer Institute (NCI) to monitor the American public's use of cancer-related information and to assess national trends in health communication.[172] The survey collects nationally representative data from US civilian noninstitutionalized adults (ages 18+) on the health information environment. Public use datasets are available for each of the three HINTS iterations (2003, 2005, 2007), all of which were collected in English and Spanish (hints.cancer.gov).

Data collection and sample

The 2007 HINTS collected data between January and April 2008 and was the first

iteration to use two sampling modes with the goal of reducing bias and increasing response

rates: 1) computer-assisted telephone interviews using a list-assisted random digit dial

sample (n=4092); and 2) mailed paper and pencil questionnaires using a stratified cluster

sample from a list of US Postal Service addresses that oversampled for minorities (n=3582).

The 2007 HINTS yielded a total sample of 7674 adults; the overall weighted response rate

was 24.2% for the random digit dial sample and 31.0% for the address-based sample.[172]

Consistent with age limits defined by the Adolescent and Young Adult Oncology Progress

Review Group,[27] the study sample comprised young adult participants, ages 18 to 39, from

the 2007 HINTS (n=1619).

Measures

The HINTS instrument employs items from varying origins, including existing

national surveys (e.g., Behavioral Risk Factor Surveillance System), smaller health-related

surveys, and original items created by the HINTS program. Prior to launching each HINTS

survey, items were cognitively tested to confirm that they are psychometrically sound.[172]

Physical activity outcome

The binary outcome of not meeting PA recommendations (<150 minutes of moderate-

intensity PA per week) was derived from three separate HINTS items. One item, from the

2000 Behavioral Risk Factor Surveillance System, assessed any participation in physical

activities or exercise over the past month: "*During the past month, did you participate in any*

physical activities or exercises such as running, yoga, golf, gardening, or walking for

exercise?" Respondents who answered "No" were classified as not meeting PA

recommendations. Those who answered "Yes" were asked two follow-up questions about duration of moderate-intensity exercise that were originally from the 2005 HINTS: "*In a typical week, how many days do you do any PA or exercise of at least moderate intensity, such as brisk walking, bicycling at a regular pace, swimming at a regular pace, and heavy gardening?*" and "*On the days that you do any PA or exercise of at least moderate intensity, how long are you typically doing these activities?*" Using the product of these two measures, minutes of moderate-intensity PA per week were calculated. Participants were then classified as either meeting (≥150 minutes per week, subsequently described as high PA) or not meeting the weekly PA recommendation (<150 minutes per week, referred to as low PA).

Correlates of physical activity

Several independent variables that may be related to PA behaviors were included in the study as suggested by theory,[173, 174] empirical evidence on PA determinants,[86, 94, 175] and previous signal detection analyses related to PA.[176-178] Measures were selected from various domains as potential predictor variables, including sociodemographics, health, and psychosocial variables. In addition, several communication-related variables were included that could be useful for describing each subgroup and identifying communication channels that might be most appropriate for reaching different subgroups with exercise interventions.

Sociodemographic characteristics. Items assessed age (continuous), gender, annual household income (<$20,000, $20,000 to <$50,000, $50,000 to <$75,000, ≥$75,000), education (less than high school, high school graduate, some college, vocational or technical school training, college graduate), marital status (married or living as married, not married) and employment status (employed, not employed). Responses to race/ethnicity items were

classified into four categories (non-Hispanic white, non-Hispanic black, Hispanics, and non-Hispanic others).

Health status. Measures of self-reported health included general health (excellent to poor), having health insurance (yes/no), seeing a regular health provider (yes/no), ever diagnosed as having cancer (yes/no), and family members ever having cancer (yes/no). Using respondents' self-reported height and weight, body mass index (BMI) (kg/m^2) was calculated and considered normal weight (18.5-24.9), overweight (25.0-29.9), or obese ($\geq$30).[230]

Health beliefs and behaviors. Participants were asked if they believe exercise decreases the chances of getting some cancers (yes/no), about their knowledge of the recommended days and minutes of PA for the average adult (<150 minutes per week/ $\geq$150 minutes per week), how many daily servings of fruits and vegetables the average adult should eat (<5 or >9 servings/ 5 to 9 servings), their fruit and vegetable consumption (continuous), and their smoking history (smoked $\geq$100 cigarettes/ smoked <100 cigarettes). Questions regarding participants' health-related perceptions were about the likelihood of developing cancer in the future (very low to very high), worry about getting cancer (rarely/never to all the time), and confidence in their ability to take good care of their health (health-related self-efficacy: completely confident to not at all confident).

Health communication characteristics. To characterize participants' health communication behaviors and experiences, the following items were included: (1) ever looked for health-related information (yes/no); (2) where looked for health information first; (3) an information-seeking experiences scale, calculated from the mean of four items about their most recent information search[179] (*took a lot of effort to get information, felt frustrated during information search, concerned about information quality, information was hard to*

understand: strongly agree to strongly disagree); (4) confidence in getting health-related information/advice (completely confident to not confident at all); (5) and ever went online to access the Internet or email (yes/no). Participants that reported using the Internet were asked if during the past 12 months they had done nine separate actions while using the Internet (see Table 4.2). Additionally, respondents were asked how much they trust health or medical information (a lot to not at all) from nine different sources (see Table 4.2).

Data analyses

Stata IC/Version 11 (StataCorp, College Station, TX) was used to conduct descriptive analyses on the entire 2007 HINTS sample of young adults (N=1619) and determine means and proportions of the outcome variable, sociodemographic characteristics and other predictor variables. Using NCI guidelines on testing mode effects in HINTS analyses,[180] the random digit dial full-sample and mail full-sample weights were used to produce two different US population estimates for the outcome variable and its relationships with indicator variables. Given that differences in variables by survey mode were rarely statistically significant and this was an exploratory study, data from both survey modes were combined into one sample for analyses. Descriptive and bivariate analyses were conducted to examine differences in characteristics between participants that met and did not meet PA recommendations.

Next, the sample was randomly split in half to create an exploratory sample and a validation sample, an approach used in previous studies employing signal detection methodology.[176, 181, 182] From the original sample of n=1619, data on meeting PA recommendations were missing for 92 respondents, leaving randomly-split samples of n=757 and n=770. Using the publicly available Signal Detection Software for Receiver Operating

Characteristics (ROC4),[183] signal detection analyses (SDA) were conducted on the initial

exploratory sample (n=757) using low PA as the outcome measure and all of the indicator

variables. Since SDA cannot utilize survey sampling weights, these exploratory analyses

used unweighted data.[176] The ROC4 program partitioned data by employing a weight of

r=0.5 to optimize both specificity (avoiding false positives) and sensitivity (minimizing false

negatives) in detecting young adults with low PA. ROC4 calculated the first optimal cutpoint

for the best indicator variable that split the data into two homogenous subgroups that were

maximally differentiated in their likelihood of not meeting PA recommendations. Through

recursive partitioning, the most significant correlates of low PA were identified, which split

the sample into mutually exclusive subgroups. The resulting model combined different

independent variables with "and/or" decision rules that optimally predicted the binary

outcome of low PA[183] and identified subgroups of individuals who shared characteristics that

predicted their PA status. Subgroups were partitioned until no additional indicator variables

significantly predicted the outcome ($p<.01$) and/or partitioning would result in no fewer than

25 young adults in a subgroup.

Following split-sample validation procedures used in previous studies,[176, 182, 184] the

variables and cutpoints identified in the exploratory sample were used to create homogeneous

subgroups in the validation sample (n=770) using STATA IC/Version 11 (StataCorp, College

Station, TX) and incorporating sampling weights. The proportions of low PA were calculated

in these validation subgroups, and chi-square analyses (Cochran-Mantel-Haenszel test) were

used to compare them to the proportions of low PA in the exploratory subgroups. If the levels

of physical inactivity were not significantly different between the corresponding subgroups

in the exploratory and validation samples, this would support the stability of results from the SDA.[176, 182]

To further characterize the subgroups identified in the exploratory sample, descriptive analyses were performed using all the indicator variables entered into the original analyses and incorporating sampling weights. Differences in sociodemographic, health-related beliefs and behaviors, and communication characteristics were explored by conducting chi-square and analysis of variance tests with pairwise comparisons and Bonferroni adjustment to correct for multiple comparisons.

IV.D. Results

Demographics

Among the overall sample of young adults (n=1527), 62.2% were not engaging in recommended levels of moderate-intensity PA (i.e., performing <150 minutes per week). The sample is described in Table 4.1. Over half of participants were women, white, employed, and married or living as married. On average, young adults were 30.2 ± 6.2 years old, had completed some college education (30.3%), and were overweight (BMI, 26.8 ± 6.5). Compared to young adults with high PA, participants with low PA were more likely to be women, non-white, married or living as married, and less likely to have health insurance, were older, less educated, of lower income, higher BMI, and in poorer general health. Regarding health beliefs and behaviors, low activity young adults were less likely to believe that exercise lowers cancer risk, know PA recommendations, consume five or more daily servings of fruits and vegetables, and be less confident about taking care of their health. Those with low PA were less likely to have ever sought health-related information, had poorer experiences when searching for health information, and were less confident they

could get needed health-related information. Regarding Internet use, the groups differed such that low activity participants were less likely to use email or the Internet to communicate with a doctor or doctor's office, to use a website to help with diet, weight or PA, and to download to a portable device, compared to sufficiently active participants. Trust in health or medical information on television and from religious organizations and leaders was higher among participants with low PA compared to those with high PA.

Low physical activity predictors in signal detection analyses

Eight subgroups of young adults with varying rates of low PA were identified in the initial exploratory sample (n=757). Subgroup partitioning is displayed in Figure 4.1 with 62.8% of the sample not meeting PA recommendations. Predictors of low PA were general health, BMI, use of the Internet for health-related functions, trust in health information from communication channels, and perceived cancer risk.

Young adults in poor to good general health

In the exploratory sample, general health emerged as the strongest predictor of low PA and differentiated the sample into two homogeneous groups—young adults reporting poor to good health and young adults reporting very good to excellent health. Among those in poorer general health, BMI of 30.8 was the next predictor of low PA. Young adults who were obese (BMI$\geq$30.8) and reported poor to good health comprised the subgroup with the highest proportion of individuals not meeting PA recommendations (subgroup 8, 89.7%).

Further splitting of the group reporting poor to good health and BMI<30.8 identified a BMI of 27.9 as a cutpoint, resulting in a subgroup of overweight (BMI$\geq$27.9) young adults with over half reporting low PA (subgroup 5, 55.6%). Among the young adults with BMI<27.9, perceived likelihood of developing cancer in the future was the next significant

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predictor of low PA, which distinguished between subgroups 6 and 7. Young adults in subgroup 6 (60.0% low PA) perceived their cancer risk as somewhat high to very high, while those in subgroup 7 (79.5% low PA) reported a future cancer risk of very low to moderate.

Young adults in very good to excellent general health

Among young adults that were in very good to excellent general health, use of a website to help with diet, weight or PA was the next significant predictor of low PA. Users of websites for diet, weight or PA were further distinguished into subgroups by their trust in health or medical information on television. The subgroup with the highest rate of individuals meeting PA recommendations (subgroup 1, 31.3% low PA) had no to little trust in health information on television, while subgroup 3 (57.9% low PA) reported some to a lot of trust in health information on television.

For young adults in better health that had not used a website to help with their diet, weight or PA, trust in information about health or medical topics on the Internet was the subsequent predictor of low PA. Subgroup 2, with the second highest proportion of young adults meeting PA recommendations (38.9% low PA), included those with no to little trust in health information on the Internet. Young adults that had some to a lot of trust in health information from the Internet comprised the third-highest proportion of young adults with low PA (subgroup 4, 65.1%).

Comparison of exploratory and validation samples

The rates of low PA were comparable across exploratory and validation samples when stratifying by subgroups (Figure 4.2). When comparing the percentages of low PA between the exploratory and validation samples using weighted data by subgroup, significant differences were found for subgroup 4 (67.0 % vs. 49.5%, *p*=0.02) and subgroup 8 (90.8%

vs. 66.8%, *p*=0.001). However, when testing the association between sample and proportion of low PA while adjusting for the eight subgroups, there was no significant difference between the exploratory and validation samples (Cochran-Mantel-Haenszel χ^2=0.81, *p*=0.37), suggesting stability of the SDA results across the samples.

Subgroups with highest risk of low physical activity

The characteristics of the eight identified subgroups of low PA among the full sample are displayed in Table 4.2. When examining defining characteristics of subgroups beyond those that significantly distinguished them through SDA (Table 4.2 in bold), several differences emerged among the groups. Individuals in the subgroup with the highest proportion of young adults with low PA (subgroup 8) were older and had the lowest education level of all the subgroups. This subgroup was also characterized as having the second-highest scores of perceived cancer risk (3.1=moderate), more frequent worry about getting cancer, and lower confidence in taking good care of one's health. While participation in an online support group for people with similar health issues was low in the overall sample, more individuals in subgroup 8 had participated relative to other subgroups.

The subgroup with the next highest proportion of low PA (subgroup 7) comprised individuals that perceived the lowest chances of getting cancer. Individuals in this subgroup were younger, of lower income, and had the lowest BMI compared to all other subgroups. Almost half of individuals in Subgroup 7 were non-white, and less than a third had used a website to help with diet, weight or PA.

Subgroups with lowest risk of low physical activity

Those in the subgroup with the highest percentage of high PA young adults (subgroup 1) were more likely to be white, have the highest education level, know and consume the

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recommended daily intake of fruits and vegetables, and less likely to have smoked 100 cigarettes. Information seeking experiences were more positive, and confidence in taking good care of their health was higher in subgroup 1. These young adults reported the lowest trust in health information on the radio and television, and from charities and religious organizations.

Similarly, the subgroup with the second-highest proportion of high PA young adults (subgroup 2) had the lowest trust in health or medical information in newspapers/magazines, on the Internet, and from the government and charitable organizations. Subgroup 2 also consisted of individuals with higher income levels that had lower perceived risk of cancer and worry about getting cancer, and higher confidence in taking good care of their health.

IV.E. Discussion

Eight subgroups of young adults were more or less likely to not meet PA recommendations of at least 150 weekly minutes of moderate-intensity PA. Signal detection analyses (SDA) among young adults drawn from a nationally representative sample revealed higher-order interactions among various correlates of low PA. These included general health, BMI, perceived risk for cancer, using the web for help with diet, weight or PA, trust in health/medical information on television or the Internet. In addition to the distinguishing predictors determined through SDA, several characteristics were significantly different among the eight subgroups, which allowed for a more robust segmentation of young adults into groups to potentially focus on in future PA promotion interventions. The subgroup with the highest risk of low PA reported poor to good health, were obese, had the lowest education level, and were older (Mean=30.8 years) relative to the other subgroups. The second-highest low PA subgroup was composed of individuals in poor to good health with lower BMI, that

were younger (Mean=27.0 years), of lower income, and perceived a low likelihood of getting cancer in the future.

The identification of general health and BMI as the strongest correlates of low PA in young adults is consistent with results of a previous study of 2005 HINTS data that characterized subgroups of sedentary adults.[176] While previous studies have consistently shown PA behavior to be inversely associated with age in adults,[91, 165] significant variability in correlates of low PA was found across subgroups of young adults. Several of the discriminating variables identified with SDA have been related to PA in other studies. The inverse association between PA and BMI have been reported in numerous studies, and considering that over half of adults ages 20 to 39 are overweight or obese,[185, 186] PA promotion in the context of weight loss interventions that are targeted to the specific needs of young adults may be warranted.[187-190]

Contrary to a previous study that found no association between physical inactivity and perceived cancer risk,[191] two subgroups were distinguished by varied perceptions of the likelihood of getting cancer. As greater awareness and media surrounding cancer in young adults has recently emerged,[192] recognition of physical inactivity as a risk factor for some cancers may potentially influence risk behaviors among young adults.

The classification of subgroups by communication-related behaviors may have important implications for targeting young adults using various media. Several studies have shown the Internet as a key source of health information.[193-196] While Internet-based interventions to promote PA have frequently been tested in randomized trials, they have had varying degrees of success.[142, 143, 197-200] A systematic review of eHealth interventions for PA[199] found that only one of seven studies specifically aimed at college students

demonstrated the effectiveness of an eHealth approach for improving exercise behaviors.[201] Using the web for help with diet, weight or PA was a distinguishing characteristic among groups, suggesting that Internet-based interventions may be more appropriate for some groups of young adults as opposed to others that might prefer non Internet-based formats. Studies on weight control in young adults have emphasized that standard weight loss programs may not adequately meet the needs of young adults, and alternate delivery schedules and formats are warranted.[187-190] Research on understanding what contributes to the effectiveness of web-based and technology-based PA interventions among young adults deserves future attention.

Lower trust in health information on the Internet defined one subgroup, while lower trust in health information on television defined another, both of which consisted of the lowest proportions of young adults at risk for low PA. A recent study of PA behaviors in adults with type 2 diabetes showed physicians and television to be the main PA-related information sources.[202] While incorporation of health-related storylines in television have the potential to impact viewers' knowledge, attitudes and health behaviors,[203] exercise-related depictions are relatively uncommon compared to other health issues.[204] Entertainment education approaches that explore the potential for television and other emerging media (e.g., online videos) to influence PA-related behaviors in young adults might be worth pursuing.

The two subgroups at highest risk for low PA, with over three quarters of young adults reporting low PA (subgroups 7 and 8), may be most important to address through public health intervention. For instance, findings suggested that obese young adults may be especially in need of interventions to help them achieve weight loss and improve PA habits. Health messages that educate normal weight young adults about their risks of getting cancer

and encourage PA might be persuasive in encouraging those in earlier young adulthood. Subgroup 6 is distinctive in that it consisted of individuals most likely to have smoked 100 cigarettes in their lifetime, suggesting that smoking cessation interventions be considered in conjunction with promoting PA in young adults. Indeed, a recent systematic review concluded that more trials of exercise interventions for smoking cessation are necessary.[205]

Examining the subgroup with the greatest proportion of high PA young adults may shed light on positive characteristics that encourage an active lifestyle. This subgroup was distinguished from others by having the highest education level and lowest trust in health information on television and radio, and from charities and religious organizations. Perhaps enhancing health literacy and educating young adults about the reliability of various media and being more selective about health information sources might be beneficial for promoting better understanding of health messages and behaviors.

While these findings can inform the development of targeted PA interventions for young adults, the cross-sectional nature of the HINTS survey limited the examination of longitudinal and causal associations between PA and other variables included in analyses. However, the data were drawn from a nationally representative sample that oversampled minority participants, and this is one of the few studies of HINTS data that focuses specifically on young adults. All of the measures were self-reported, which may have led to over- or under-reporting and biased estimates as a result of social desirability, poor recall and other potential biases. Furthermore, the use of self-reported measures to derive the outcome of PA may have resulted in overestimating the percentage of young adults meeting PA recommendations.

The proportion of young adults meeting PA guidelines in the study sample (37.8%) was higher than the 7.0% to 10.8% of 20-39 year olds meeting guidelines according to accelerometry, but lower than the 55.8%-63.9% classified as meeting PA recommendations by self-report measures (NHANES 2005-2006).[165] The dramatic differences between self-reported and objective measures highlight the need for more objective studies of PA among young adults. Another study limitation was the lack of measures that have been shown to be correlates of PA behaviors, including environmental determinants (e.g., availability of PA facilities) and attention to media channels (e.g., hours watching television), as the 2007 HINTS did not include such measures. Since the SDA were conducted without taking sampling weights into consideration, the possibility of subgroup misclassification due to underestimated standard errors cannot be eliminated.

Despite these limitations, understanding the unique characteristics and high-order variable interactions of these low PA subgroups is useful for informing audience segmentation of young adults into groups requiring more immediate attention. SDA estimated the best grouping or interactions of multiple variables that influenced the probability of low PA in young adults.[177, 206] While logistic regression methods can be applied to distinguish groups of individuals that are at risk for low PA, SDA are potentially more informative for developing targeted interventions, because they identify groups of individuals that are homogenous in not only the binary outcome, but also in indicator variables.[207]

Young adults in the eight subgroups shared common characteristics that emerged as cutpoints for low PA. Had logistic regression techniques been used, participants would have been classified into subgroups that were homogenous by outcomes, but heterogeneous by

predictor variables.[207] Another study strength derived from the use of SDA was the non-parametric approach, which is not based on the assumptions of normal distributions and linear relationships between variables.[208] Furthermore, the signal detection methods used were less impacted by missing data and multicollinearity among independent variables, and were also appropriate for distinguishing higher order interactions among variables that might predict a binary outcome.[208] Split-sample validation and use of a nationally representative dataset that administered validated and cognitively tested items were additional study strengths that enhance generalizability of the exploratory findings.

With dynamic changes in the use of Internet and social media, these findings from data collected in 2008 may have limited application to the current health communication and media environment. Interestingly, there were no significant differences among the eight subgroups in reported use of social networking sites—overall, half of young adults had used them. The most recent estimates indicate that 87% of young adults ages 18-29 and 64% of adults online use social networking sites, with 64% of young adults 18-34 using them once to several times a day.[209] These trends and results suggest that testing of interventions delivered through social media, and understanding the characteristics of young adults that do better with specific communication channels may be warranted.

Results of this exploratory study can inform hypothesis generation, suggest potential intervention communication channels, and guide the future development of targeted interventions for young adults. Further research should examine PA intervention strategies that appeal to the distinguishing characteristics and unmet needs in the identified subgroups of PA in young adults.

Table 4.1. Descriptive statistics for young adult sample from HINTS 2007 (unweighted data)

Characteristics	n	Full sample (n = 1527) % or M (SD)	Meets PA recommendations No (n = 949) % or M (SD)	Yes (n = 578) % or M (SD)	Bivariate significance level
Does not meet PA recommendations	1527	62.2	—	—	—
Any exercise during past month (yes)	1527	73.0	56.5	100	*p*<0.0001
Sociodemographics					
Age (years)	1527	30.2 (6.2)	30.4 (6.1)	29.8 (6.4)	*p*<0.05
Gender (female)	1527	65.0	68.0	60.2	*p*<0.005
Race/ethnicity (white)	1475	64.2	60.9	69.6	*p*<0.005
Education[a]	1496	3.0 (1.0)	3.0 (1.0)	3.1 (1.0)	*p*<0.05
Annual income[b]	1387	3.3 (1.5)	3.3 (1.5)	3.5 (1.5)	*p*<0.005
Employed	1497	65.9	66.6	64.8	NS
Married or living as married	1495	53.6	55.7	50.2	*p*<0.05
Health					
Body mass index	1467	26.8 (6.5)	27.5 (7.1)	25.7 (5.3)	*p*<0.0001
General health[c]	1499	2.5 (0.9)	2.7 (0.9)	2.3(0.9)	*p*<0.0001
Health insurance (yes)	1508	79.4	77.4	82.8	*p*<0.05
Regular provider (yes)	1521	62.6	62.4	62.9	NS
Ever had cancer (yes)	1499	2.4	2.2	2.8	NS
Family member ever had cancer (yes)	1457	70.4	69.2	72.4	NS
Health beliefs and behaviors					
Believes exercise lowers cancer risk	1517	62.4	60.1	66.0	*p*<0.05
Knows PA recs ≥150 min/week	1439	58.6	56.1	62.7	*p*<0.05
Knows daily FV intake recs	1513	38.1	37.0	39.8	NS
Eats ≥5 FVs per day	1513	35.6	30.6	43.6	*p*<0.0001
Smoked ≥ 100 cigarettes in entire life	1511	36.9	35.4	39.3	NS
Perceived cancer risk[d]	1480	2.7 (1.1)	2.7 (1.1)	2.7 (1.1)	NS
Cancer-related worry[e]	1504	1.7 (0.8)	1.7 (0.8)	1.6 (0.8)	NS
Health-related self-efficacy[f]	1515	2.1(0.9)	2.2 (0.9)	2.0(0.8)	*p*<0.0001
Health communication					

| | | Full sample (n = 1527) | Meets PA recommendations | | Bivariate significance level |
| | | | No (n = 949) | Yes (n = 578) | |
Characteristics	n	% or M (SD)	% or M (SD)	% or M (SD)	
Ever looked for health information	1524	76.2	74.1	79.6	$p<0.05$
Seek health information from Internet 1st	1154	75.5	76.9	73.2	NS
Information seeking experiences scale[g]	1157	2.9 (0.8)	2.9 (0.8)	3.0 (0.7)	$p<0.05$
Information seeking self-efficacy[f]	1520	2.2(1.0)	2.3(1.0)	2.1(1.0)	$p<0.005$
Internet use (past 12 months)					
Ever accessed Internet	1527	84.9	83.8	86.9	NS
Bought medicine or vitamins on-line	1295	11.6	10.3	13.6	NS
Participated in online support group	1295	6.0	6.3	5.4	NS
Communicated with doctor or doctor's office	1295	16.1	14.5	18.8	$p<0.05$
Used website to help with diet, weight/PA	1294	44.4	41.1	49.6	$p<0.005$
Looked for healthcare provider	1294	45.8	47.7	42.9	NS
Downloaded to portable device	1295	43.1	40.3	47.5	$p<0.05$
Visited a "social networking" site	1295	50.2	51.0	49.1	NS
Wrote in an online diary or "blog"	1295	15.4	14.7	16.6	NS
Kept track of personal health information	1295	14.8	14.5	15.4	NS
Trust in information sources[h]					
Doctor/ health care professional	1520	1.3 (0.6)	1.3 (0.6)	1.3 (0.6)	NS
Family/ friends	1518	2.2 (0.8)	2.2 (0.8)	2.3 (0.7)	NS
Newspapers/ magazines	1511	2.5 (0.8)	2.5 (0.8)	2.5 (0.8)	NS
Radio	1497	2.8 (0.8)	2.8 (0.8)	2.9 (0.8)	NS
Internet	1497	2.1 (0.8)	2.1 (0.8)	2.1 (0.7)	NS
Television	1512	2.7 (0.8)	2.6 (0.8)	2.7 (0.8)	$p<0.01$
Government health agencies	1500	1.8 (0.8)	1.8 (0.8)	1.8 (0.8)	NS
Charitable organizations	1494	2.4 (0.8)	2.4 (0.8)	2.4 (0.8)	NS
Religious leaders and organizations	1504	2.8 (0.9)	2.8 (0.9)	2.9 (0.9)	$p<0.05$

Note. PA, physical activity; FV, fruit and vegetable; recs, recommendations.

[a]1 = less than high school, 2 = high school graduate, 3 = some college, 4 = college graduate.

[b]1 = <$20,000, 2 = $20,000 to <$50,000, 3 = $50,000 to <$75,000, 4 = ≥$75,000.
[c]1 = excellent, 2 = very good, 3 = good, 4 = fair, 5 = poor.
[d]1 = very low, 2 = somewhat low, 3 = moderate, 4 = somewhat h   5 = very high.
[e]1 = rarely or never, 2 = sometimes, 3 = often, 4 = all the time.
[f]1 = completely confident, 2 = very confident, 3 = somewhat confi   4 = a little confident, 5 = not confident at all.
[g]1 = strongly agree, 2 = somewhat agree, 3 = somewhat disagree, 4 – strongly disagree.
[h]1 = a lot, 2 = some, 3 = a little, 4 = not at all.

Figure 4.1. Signal detection analysis for young adults not meeting physical activity recommendations in exploratory sample
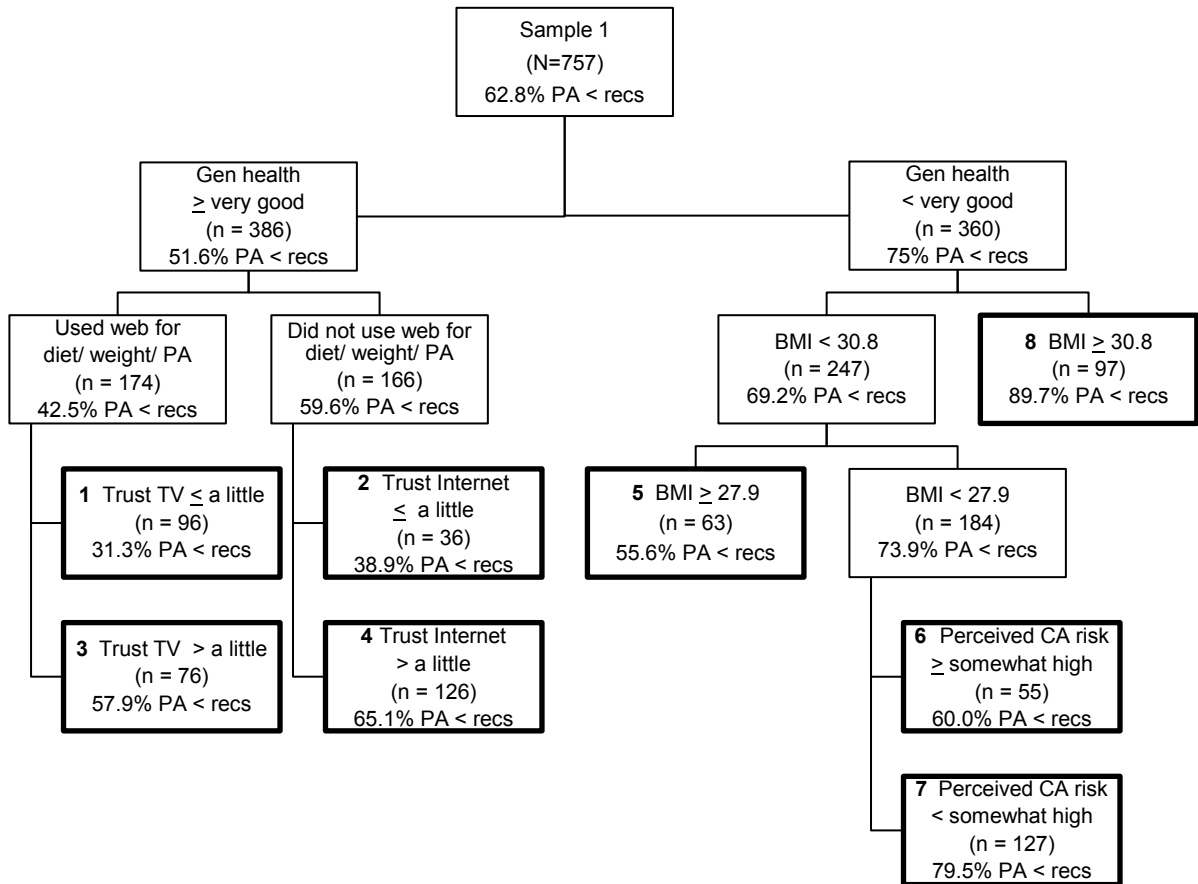
Note. PA = physical activity; PA < recs = not meeting physical activity recommendations; Gen = general; BMI = body mass index; CA = cancer.

Figure 4.2. Stability of % of young adults not meeting physical activity recommendations in exploratory sample (n=757) versus validation sample (n=770) (weighted data)
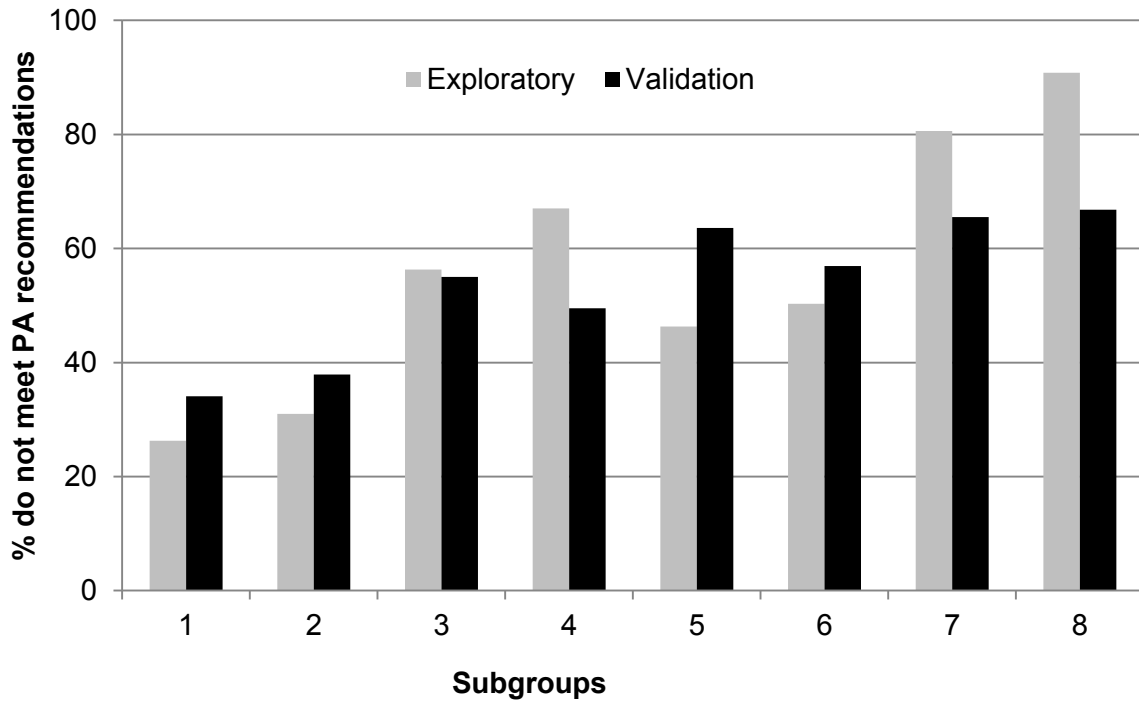
Note. Cochran-Mantel-Haenszel test=0.81, *p*=0.37.

Table 4.2. Characteristics of identified subgroups of young adults in full sample (weighted data)

Characteristics	Lowest risk				Highest risk			
	General health ≥ very good				General health < very good			
	1	2	3	4	5	6	7	8
	Use DWP web Low TV trust	No DWP web Low web trust	Use DWP web Trust TV	No DWP web Trust web	BMI≥27.9	BMI<27.9 High CA risk	BMI<27.9 Low CA risk	BMI≥30.8
n	173	80	143	271	120	101	259	213
	% or M	% or M	% or M	% or M	% or M	% or M	% or M	% or M
Does not meet PA recs	29.8	34.4	55.6	56.9	53.7	53.1	73.2	77.3
Sociodemographics								
Age (years)**	27.6	27.1	29.5	28.0	29.1	30.0	27.0	30.8
Gender (female)	45.7	50.1	60.1	47.9	33.3	60.2	49.5	57.2
Race/ethnicity (white)**	83.2	57.9	56.9	75.2	52.4	79.3	52.7	58.1
Education[a], **	3.3	2.7	3.0	3.0	2.5	2.7	2.6	2.4
Annual income[b], *	2.8	3.0	3.0	2.9	2.3	2.6	2.3	2.4
Employed (yes)	69.0	64.7	72.8	54.5	69.1	64.9	60.2	63.1
Married or living as married	45.9	37.3	54.1	45.1	41.2	44.6	44.4	52.8
Health								
Body mass index**	24.5	24.8	26.7	24.8	29.3	23.3	23.1	36.7
General health[c], **	1.8	1.8	1.7	1.8	3.3	3.3	3.2	3.4
Health insurance (yes)	90.1	72.3	88.2	84.8	67.8	69.4	69.6	72.8
Regular provider (yes)	59.0	59.4	69.5	61.7	50.5	60.3	48.1	63.2
Ever had cancer (yes)	0.3	0.6	0.7	0.5	1.4	4.2	0.4	2.5
Family member ever had cancer (yes)*	78.5	76.1	63.5	65.4	57.6	89.2	62.9	73.2
Health beliefs and behaviors								
Believes exercise lowers cancer risk	70.0	59.1	66.9	69.7	59.3	55.6	56.2	55.9
Knows PA recs ≥150 min/week	56.5	60.0	58.9	63.5	51.4	60.1	58.2	64.6

	Lowest risk						Highest risk	
	General health ≥ very good				General health < very good			
	1	2	3	4	5	6	7	8
Knows daily FV intake recs*	54.5	27.1	43.8	38.3	21.3	33.1	24.3	32.4
Eats ≥5 FVs per day*	52.1	30.8	45.6	37.8	27.8	18.2	29.7	28.2
Smoked ≥100 cigarettes in entire life**	30.0	39.8	32.4	32.3	58.0	71.7	41.0	43.5
Perceived cancer risk[d], *	2.5	2.4	2.5	2.6	2.8	4.2	2.4	3.1
Cancer-related worry[e], **	1.6	1.4	1.6	1.5	1.7	2.1	1.6	1.9
Health-related self-efficacy[f], **	1.8	1.8	1.8	1.9	2.7	2.6	2.4	2.6
Health communication								
Ever looked for health information*	87.9	49.7	92.8	72.1	56.6	77.7	71.2	72.7
Seek health information from Internet 1st	72.2	64.6	76.9	83.9	65.6	74.0	78.6	75.3
Information seeking experiences scale[g], **	3.0	2.7	3.2	3.0	2.5	2.8	2.7	2.7
Information seeking self-efficacy[f], **	2.0	2.3	1.8	2.0	3.1	2.3	2.3	2.4
Internet use (past 12 months)								
Ever accessed Internet**	100	100	100	100	73.8	86.7	78.9	81.3
Bought medicine or vitamins online	17.2	5.4	14.4	6.7	9.8	10.7	12.2	7.1
Participated in online support group**	4.5	1.1	2.0	5.3	7.8	6.1	6.7	9.2
Communicated with doctor or doctor's office	16.5	9.8	23.7	11.3	9.6	16.4	17.5	9.8

	Lowest risk						Highest risk	
	General health ≥ very good				General health < very good			
	1	2	3	4	5	6	7	8
Used website to help with DWP*	100	0	100	0	39.2	40.5	31.2	47.5
Looked for healthcare provider*	55.5	24.3	56.7	31.7	32.6	46.2	38.6	47.4
Downloaded to portable device	61.6	46.0	52.0	50.4	52.0	35.1	39.7	43.1
Visited a "social networking" site	65.3	48.6	64.1	45.3	50.7	50.0	58.9	59.9
Wrote in an online diary or "blog"	21.0	17.3	24.5	11.9	15.2	11.3	12.0	21.6
Kept track of personal health information	13.2	7.5	27.0	9.6	16.5	8.2	13.6	10.5
Trust in information sources[h]								
Doctor/ health care professional	1.3	1.4	1.2	1.2	1.5	1.3	1.3	1.4
Family/ friends	2.3	2.1	2.2	2.2	2.4	2.3	2.1	2.3
Newspapers/ magazines*	2.7	2.8	2.2	2.4	2.6	2.5	2.5	2.5
Radio*	3.2	3.1	2.6	2.7	2.8	2.8	2.9	2.8
Internet**	2.2	3.1	1.7	1.8	2.2	2.2	2.2	2.1
Television**	3.2	3.0	1.9	2.6	2.7	2.7	2.6	2.6
Government health agencies**	2.0	2.2	1.5	1.7	2.0	1.9	1.9	1.8
Charitable organizations**	2.7	2.7	2.1	2.3	2.4	2.5	2.3	2.5
Religious leaders and organizations**	3.2	3.0	2.5	2.8	2.8	3.0	2.7	2.9

Note. Bolded variables indicate characteristics that significantly differentiate all groups in signal detection analyses. DWP, diet, weight or physical activity; BMI, body mass index; CA, cancer; PA, physical activity; recs, recommendations; FV, fruit and vegetable.
[a] 1= less than high school, 2 = high school graduate, 3 = some college, 4 = college graduate.

[b] 1 = <$20,000, 2 = $20,000 to <$50,000, 3 = $50,000 to <$75,000, 4 = ≥$75,000.
[c] 1 = excellent, 2 = very good, 3 = good, 4 = fair, 5 = poor.
[d] 1 = very low, 2 = somewhat low, 3 = moderate, 4 = somewhat high 5 = very high.
[e] 1 = rarely or never, 2 = sometimes, 3 = often, 4 = all the time.
[f] 1 = completely confident, 2 = very confident, 3 = somewhat confident, 4 = a little confident, 5 = not confident at all.
[g] 1 = strongly agree, 2 = somewhat agree, 3 = somewhat disagree, 4 = strongly disagree.
[h] 1 = a lot, 2 = some, 3 = a little, 4 = not at all.
*Differences among all groups using chi-square or ANOVA tests of homogeneity are statistically significant at $p \leq 0.005$.
**Differences among all groups using chi-square or ANOVA tests of homogeneity are statistically significant at $p \leq 0.0001$.

CHAPTER V

FOSTERING IMPROVEMENT THROUGH NETWORKING AND EXERCISING TOGETHER (FITNET): RESULTS OF A RANDOMIZED FACEBOOK-BASED PHYSICAL ACTIVITY INTERVENTION FOR YOUNG ADULT CANCER SURVIVORS

V.A. Overview

Over half of young adult cancer survivors do not meet physical activity (PA) guidelines and are overweight. PA interventions can enhance health and quality of life among young adult cancer survivors. However, few exercise interventions have been designed and tested in this population. This study evaluated the feasibility and efficacy of a 12-week, Facebook-based intervention (FITNET) aimed at increasing moderate-intensity PA compared to a self-help comparison (SC) condition. Young adult cancer survivors (n=86) were randomly assigned to the FITNET or SC group. All participants were asked to complete self-administered online questionnaires at baseline and after 12 weeks. Seventy-seven percent of participants completed post-intervention assessments. From baseline to 12 weeks, self-reported moderate-to-vigorous PA significantly increased by 67 min/week in the FITNET group ($p=0.009$) vs. 46 min/week in the SC group ($p=0.045$), with no significant difference between groups ($p=0.549$). Increases in mild PA were 135 min/week greater in the FITNET group relative to the SC group ($p=0.032$). The FITNET group reported significant weight loss over time (-2.1 kg; $p=0.004$), which was marginally different from the SC group ($p=0.083$). Facebook-based intervention approaches improved PA behaviors and hold promise for promoting healthy behaviors in young adult cancer survivors.

V.B. Introduction

Cancer is the most common cause of disease-related death among adolescents and young adults between the ages of 15-39.[27] Cancer exacts a tremendous burden, as survivors have greater medical and psychological needs and may be at increased risk for mortality, second cancers, recurrence, cardiovascular disease, osteoporosis, diabetes and other chronic illnesses.[2,4-6] These increased risks and co-morbidities may be due in part to cancer treatment, genetic predisposition, and lifestyle behaviors; as such, cancer survivors are a vulnerable population with unique needs.[3,6-8] There is a growing body of evidence that regular physical activity (PA) may help prevent recurrence and improve post-treatment quality of life in cancer survivors.[4,10-17] Modifying health behaviors such as PA have the potential to ameliorate these risks and provide benefits for cancer survivors, an important population in need of health promotion interventions.[3,6-9]

Currently there are an estimated 565,450 young adult cancer survivors between the ages of 20 and 39 in the United States.[1] Yet, few studies examine the needs of young adult cancer survivors, defined here as those diagnosed between the ages of 18 and 39, as a distinct population separate from survivors of childhood cancer or older adults.[27, 30, 31] Only recently have studies investigating PA behaviors in young adult cancer survivors emerged.[42-47] Earlier published studies on PA behaviors in young adult cancer survivors are limited to survivors of childhood cancer.[35, 39-41] It has been shown previously that an estimated 59.3% of US cancer survivors between the ages of 18-40 do not meet PA guidelines, and 52.1% are overweight.[49] A more recent survey of 60 young adult cancer survivors in the US, ages 18-40, found that 63% were not engaging in the recommended levels of either moderate- or vigorous-intensity PA,[44] which is greater than the proportion of US young adults, ages 18-24, that are physically

inactive (43%).[48] Another survey of Canadian young adult cancer survivors, 20-44 years old, estimated that 23% were sedentary and 48% were not meeting PA guidelines.[46]

Overall, studies to date suggest that the PA behaviors of young adult cancer survivors may parallel those of populations without cancer, despite their increased risks for comorbidity and the benefits of PA after cancer. Young adult cancer survivors have expressed interest in lifestyle interventions and PA counseling.[43, 44, 47] However, few empirical studies have assessed the suitability and effectiveness of behavior change interventions among cancer survivors diagnosed in young adulthood, and outcomes of randomized trials have not been published to date. Therefore, behavioral interventions to promote healthy PA behaviors among young adult cancer survivors represent important opportunities to potentially reduce some of their risks for comorbid conditions and improve quality of life.

While web-based behavioral interventions have shown potential for promoting PA,[136, 142, 143, 145-147] few published randomized controlled trials have evaluated the potential of online social networking sites as an intervention delivery channel.[136, 148] Online social networks are increasingly being used for health communication[210] and have the potential to promote healthy behaviors [155, 156] and facilitate social support,[153, 154] factors that may enhance health outcomes and encourage increased PA among young adult cancer survivors. Facebook, in particular, provides the potential for patients and health professionals to communicate and share experiences related to a specific disease and its management.[152] One study demonstrated that Facebook user groups related to malignant neoplasms had the largest number of individuals associated with them (i.e., 77,822 users), which is consistent with the high prevalence of cancer in the overall population.[152] With over 950 million Facebook users

to date[211] and an estimated 92% of adults on social networking sites using Facebook,[150] it has become increasingly important to empirically investigate the potential to deliver health communication interventions through this existing technology platform. This is the first randomized controlled trial to evaluate the efficacy and feasibility of a behavioral intervention, delivered through Facebook, that was aimed at improving PA behaviors among young adult cancer survivors.

The primary hypothesis of this trial was that young adults cancer survivors assigned to the intervention (FITNET) group would achieve greater self-reported moderate-to-vigorous intensity PA (MVPA) minutes per week at 12-week follow-up relative to those in the self-help comparison (SC) group. Secondary and feasibility assessments included quality of life, body weight, and use of intervention components.

V.C. Methods

Participants

We recruited and enrolled young adult cancer survivors by working with community-based organizations and advocates dedicated to young adults with cancer. Interested organizations posted recruitment advertisements through various mass distribution channels such as Facebook, Twitter, listservs, flyers and email. Recruitment strategies also included disseminating study information through a mass distribution email to the University of North Carolina at Chapel Hill (UNC) community, flyers in UNC cancer clinics, message boards, and via the study administrator's personal Facebook and Twitter accounts. Participants met the following eligibility criteria: young adults between ages 21-39 diagnosed with cancer (excluding non-melanoma skin cancer) at age 18 or older; ≥1 year beyond date of diagnosis with no evidence of progressive disease or second primary cancers; completed cancer

treatment; English-speaking and writing; no pre-existing medical condition(s) or contraindications that preclude adherence to an unsupervised exercise program, including cardiovascular disease, heart failure, pulmonary conditions, renal disease, and severe orthopedic conditions; not adhering to the American Cancer Society's recommendation of at least 150 minutes of moderate-intensity exercise per week (<150 minutes/week)[12]; having access to Internet service and an active Facebook account.

Recruitment advertisements directed interested individuals to the study website with a link to a brief, online screening questionnaire. To confirm eligibility, the self-administered screener assessed: current age; cancer diagnosis when at least 18 years old; cancer diagnosis at least 1 year prior; completion of cancer treatment; regular access to the Internet; active Facebook account; 2 items assessing weekly minutes of moderate-intensity physical activity[212]; and the Physical Activity Readiness questionnaire (PAR-Q), a standard 7-item questionnaire that evaluates possible contra-indications to exercise.[213] Respondents that endorsed any of the PAR-Q items were excluded.

Study design

This study was a 2-arm randomized trial, delivered through Facebook and the Internet, that aimed to increase MVPA levels among young adult cancer survivors to at least 150 minutes per week with a focus on walking. Based on screening responses, the study administrator directly emailed eligible individuals a study invitation with a unique web link that directed them to an online informed consent. When the number of consenting survivors approached the target sample size, all participants were emailed a link to a self-administered online baseline questionnaire. Following baseline data collection and using a computer-generated random numbers list, participants were randomly assigned with equal allocation to

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one of two study groups: Facebook-based self-help comparison (SC; n=41) or Facebook-based intervention (FITNET; n=45). After completion of the 12-week study period, follow-up data collection occurred using another online self-administered questionnaire. If necessary, we sent emails and Facebook messages to non-respondents prompting them to complete the follow-up questionnaire. All participants gave online informed consent, and participants received a $30 gift card for completion of the baseline and post-intervention online questionnaires. The study was conducted from April to December 2011 and was approved by the Public Health-Nursing Institutional Review Board of UNC.

Procedures for self-help comparison (SC) group

Table 5.1 provides an overview of the differences between study groups procedures. All participants received a Digi-Walker SW-200 pedometer (Yamax, Tokyo, Japan) through the mail with instructions on how to use the step counter and record their total step count each day. The study administrator sent participants an introductory email stating the intervention goal and recommendation to increase their moderate intensity-PA levels to at least 150 minutes per week. The introductory email instructed participants on how to use the pedometer and notified them that they would receive a separate Facebook friend request and invitation to join one of the study Facebook groups.

Once enough participants accrued to meet the planned sample size, the study administrator sent Facebook friend requests and invited participants to become a member of either the SC or FITNET Facebook groups. This ensured that all group members gained access to the groups at the same time, experienced similar opportunities to participate in peer support activities, and helped maintain a consistent group size. The Facebook groups were created with "secret" access, an existing functionality of Facebook groups with the following

restrictions: 1) membership is by invitation only; 2) the group does not appear in search results or in member profiles; and 3) only members can see the group information and content.

After participants had initially joined the Facebook group, the study administrator posted to the group wall a welcome message and a reminder about respectful Facebook communications and maintaining confidentiality. To ensure that participants were sufficiently aware of Facebook privacy settings and could set up their individual preferences, three resources on Facebook privacy and intellectual property were posted to the group wall. Each week during the 12-week study period, participants received a message through the Facebook messages feature with basic information and tips related to PA and several links to publicly available websites. The websites included resources on PA specifically for cancer survivors and covered other topics such as PA benefits, overcoming exercise barriers, goal-setting, social support, strategies for problem solving, stress management, and making time for PA. Other web resources focused on cancer survivorship, including some on young adults in particular, and all were from credible sources (e.g., National Cancer Institute,[214] LIVE**STRONG**,[215, 216] American Cancer Society,[217] and the American Institute for Cancer Research.[218] While the participants in the SC group had access to all of the secret Facebook group features (e.g., ability to post comments, links, videos to the group wall), the study administrator did not post any discussion questions to encourage interaction with other members, so any posting or interaction was self-directed.

Procedures for FITNET group

FITNET participants received all of the above plus additional intervention components that were designed based primarily on Social Cognitive Theory[173, 174] and

focused on strategies to enhance self-efficacy, behavioral capability, self-monitoring and social support among participants. The Facebook message sent to FITNET participants during each of the 12 weeks was an expanded behavioral lesson with more specific guidance on PA and behavioral strategies, such as enlisting social support, incorporating PA into daily routines, problem solving, self-monitoring and maintaining PA. We modified lessons and tips used in previous intervention studies[219-221] to be suitable for self-directed learning and appropriate for young adult cancer survivors.

In addition, participants had password-protected access to a separate study website with a goal-setting tool and PA diary. The website offered tips on setting short-term, achievable PA goals, allowed survivors to specify a personal weekly goal, (i.e., number of 10-minute blocks of activity) and included a PA tracker to log self-monitoring information. Participants were encouraged to wear their pedometers every day over the 12-week intervention period and to record their exercise type, intensity and duration at the end of each day using the online PA tracker. In addition to exercise activities, the PA diary included a separate entry for walking steps. Based on data entered, the website provided personalized feedback charts comparing individuals' recorded minutes of PA with his/her weekly exercise goal and in comparison to the overall intervention goal of 150 minutes a week.

To foster group interaction and social support on the Facebook group page, the study administrator posted various prompts to the group wall, which consisted of: 1) discussion questions; 2) links to videos, exercise- or cancer-related news articles, or electronic PA resources; and 3) a weekly reminder to set an exercise goal, log daily PA, and check out the Facebook group. During the first four weeks, discussion questions were posted twice a week to support initial group interactions; one question related to PA and the other to cancer

survivorship. Throughout the last eight weeks of the study, discussion questions were posted once a week. The study administrator also posted one other resource and a reminder during each week of the program, answered any questions posted by participants, and included general words of encouragement and support when posting to the group wall.

Measures

Baseline and post-intervention survey items included measures of the primary behavioral outcome of PA, and secondary outcomes of quality of life, body weight, psychosocial factors, and process measures.

Demographics and health-related variables

We assessed age, race/ethnicity, education level, marital status, income, employment and living arrangements. We also asked participants about their cancer history, including cancer type, time since diagnosis, cancer stage, and treatment type.

Physical activity

Physical activity was assessed using the leisure score index of the Godin Leisure Time Exercise Questionnaire (GLTEQ), which includes four items regarding the frequency of strenuous, moderate and mild intensity exercise over the last week.[222, 223] This self-administered instrument is appropriate for assessing leisure time activity in a community setting and has been used in several studies of PA in cancer survivors.[87, 98, 106, 118, 224] Consistent with these studies among cancer survivors and to allow for comparability, we modified the GLTEQ by asking participants to report times per week of strenuous, moderate and mild exercise, along with average duration for each intensity. Minutes per week of PA were calculated by multiplying days and minutes of reported activity for each intensity; for baseline and post-intervention time points, MVPA was calculated from the sum of moderate

and strenuous exercise, and total PA from the sum of moderate, strenuous and mild exercise. Change in PA for each PA category was calculated by subtracting the baseline measure from the post-intervention measure. The GLTEQ has demonstrated test-retest reliability of 0.62-0.81 and concurrent validity of 0.32-0.56 when compared to several other self-report exercise measures and objective measures ($V0_2$ max, accelerometer) in different populations.[222, 225-227]

Body mass index

Participants self-reported their height and weight with survey items from the demographics section of the Behavioral Risk Factor Surveillance System[228] and adapted for use in the NCI's Health Information National Trends Survey.[229] The questions included: "*About how tall are you without shoes*?" (feet, inches) and "*About how much do you weigh without shoes?*" (pounds). Body mass index (BMI) was calculated using the standard equation [(mass (kg)/(height (m))^2].[230]

Quality of life (QOL)

Participants completed the Functional Assessment of Cancer Therapy-General (FACT-G) scale survey, which was originally developed by Cella to assess four primary domains: physical well-being, social/family well-being, emotional well-being, and functional well-being.[231] The FACT-G (version 4, 2007) consists of 27 Likert-type items rated on a 0-4 point scale of agreement from "*not at all*" to "*very much*." The range of possible scores was 0-108, with higher scores indicating a better quality of life. The FACT-G has been shown to be reliable and valid among cancer patient populations with internal consistency alphas on the subscales from 0.60 to 0.89.[231-233]

Process measures

We collected data on exposure to study components in the 12 week assessment. Measures were adapted from previous studies,[219, 220] and assessed intervention exposure, attention, and recall, as well as satisfaction with intervention components and whether participants would recommend the intervention to peers. Objective data on goal-setting frequency, number of PA entries, number of walking steps entries, and number of posts to the Facebook group wall were also collected. Tertiles of intervention adherence were constructed from objective data on numbers of PA entries, steps entries, weekly goals, and Facebook posts, and from a composite score that summed tertile scores of PA entries and weekly goals.

Statistical analyses

All data analyses were performed using SAS statistical software (Version 9.2, Cary, NC). As this study was aimed at determining feasibility and initial efficacy of a PA intervention delivered through Facebook, there were no data available on expected between-group differences for moderate-intensity minutes per week of PA or accrual rates. Therefore, we estimated study sample size based on assumptions of individual level randomization, within-group standard deviation, and least detectable difference in effect sizes from previous 12-week exercise intervention trials among cancer survivors.[105, 115] To observe a group difference of 92 minutes per week of MVPA, we aimed for a sample size of n=50 per group to test our primary hypotheses. Assuming a 30% attrition rate comparable to Internet-based studies, a loss of 15 participants from each group would result in 80% power (alpha = 0.05, two-tailed t-test) to detect a group difference of 111 minutes per week.

We assessed measures for normality, conducted outlier analyses, and used transformations when necessary. To maximize sample sizes for analyses, all self-reported

data were used, with any outliers (z-scores>3.29) adjusted to be one unit lower than the next highest reported measure.[115, 234] Outliers for the primary PA outcome data were identified and adjusted for five participants (FITNET: n=3; SC: n=2). Descriptive analyses compared groups on baseline demographics and health-related variables using chi-square or Fisher's exact tests for categorical variables and/or Student's t-tests for continuous variables. Similar analyses were used to assess differential attrition by comparing study completers with dropouts on demographic characteristics and baseline dependent variables. Intervention efficacy was evaluated by comparing differences between the FITNET and SC groups in changes in PA behaviors and secondary outcomes over time. Under the assumption that follow-up data were missing completely at random, we used maximum likelihood methods (PROC GENMOD) to conduct mixed model analyses with repeated measures. Models included a random intercept, time variable (0=baseline, 1=post-intervention), group variable (0=FITNET, 1=SC) and group x time variable, to estimate each outcome measure at baseline and follow-up, and to test for statistical differences between groups in changes over 12 weeks. For the outcome analyses reported, we used all available data at baseline (n=86) and at follow-up (n=66) and estimated mean changes in unadjusted models and with adjustment for covariates: months post cancer diagnosis, marital status, and Facebook use time. Data were also analyzed when baseline observations were carried forward (BOCF) for dropouts as in an intent-to-treat approach. Spearman correlations were calculated to assess relationships between data on intervention adherence or change in weight and change in PA outcomes. In addition, logistic regression procedures were used to compare the groups on the proportion achieving PA guidelines, and chi-square tests were performed to assess level of statistical significance.

To explore the relationship between intervention adherence and PA outcomes at 12 weeks, analysis of covariance models were conducted in a subsample of FITNET completers and SC completers. Analyses evaluated whether PA outcomes differed among tertiles of adherence while adjusting for baseline PA values. All reported *p*-values are for two-sided tests with no adjustment for multiple comparisons; *p*-values of 0.05 are considered statistically significant, while *p*-values of 0.10 are considered marginally significant.

V.D. Results

Of 167 potential participants who completed the screener between April and August 2011, 58% (97 of 167) were eligible and consented to participate, and 89% (86 of 97) completed the baseline questionnaire and were randomized (Figure 5.1). Reasons for exclusion were cancer diagnosis less than 1 year prior (n=22), endorsed 1 or more PAR-Q items (n=13), exercising ≥150 minutes per week (n=10), currently undergoing cancer treatment (n=6), age younger than 21 or older than 39 (n=5), never diagnosed with cancer (n=2), cancer diagnosis before age 18 (n=1), and no active Facebook account (n=1). Participants were a mean age of 31.7 (SD=5.1) years old, 91% female, and mostly of non-Hispanic white race (91%). The young adult cancer survivors reported diagnoses of 18 different cancer types (20% breast) and were on average 58.2 months (SD=44.0) post-diagnosis (Table 5.2). At baseline, participants reported an average of 68.4 minutes (SD=77.0) of moderate-intensity physical activity per week. There were no differences in baseline characteristics between groups, except intervention group participants reported higher daily Facebook use (2.6 ± 1.4 vs. 2.0 ± 1.0; *p*=0.049). Seventy-seven percent (n=66) of randomized participants completed the final online questionnaire. Retention rates did not differ between groups (χ^2= 1.68; *p*= 0.195), but non-completers were disproportionately less

likely to be married (χ^2= 4.17; p=0.041) and were fewer months post-diagnosis compared to completers (t=3.31; p=0.001).

Changes in physical activity

The FITNET group reported an increase of 237.0 weekly minutes of total PA (95% CI: 74.0, 501.7; p=0.001) compared to 75.7 minutes (95% CI: 12.6, 157.6; p=0.015) in the comparison group. The group x time interaction was not significant, but suggestive of a difference between groups in minutes over time (p=0.078) (Table 5.3, unadjusted model). Both groups significantly increased weekly minutes of MVPA from baseline to 12 weeks. The estimated increase over 12 weeks was 67.0 min (95% CI: 13.6, 143.4; p= 0.009) in the FITNET group and 46.3 min (95% CI: 0.8, 109.0; p= 0.045) in the SC group, but there was no significant group x time interaction between groups. There was a significant difference between groups in estimated change in mild PA minutes per week from baseline to 12 weeks (p=0.032), with FITNET participants increasing by about 135 min/week more than SC participants.

The adjusted models and BOCF analyses (data not shown), demonstrated consistent results with some attenuation of group differences, but significant increases over time in weekly minutes of MVPA, mild PA and total PA remained for the FITNET group and for total PA in the SC group. At 12 weeks, no difference was observed in the achievement of recommended PA levels (150+ min/week of moderate or 75+ min/week of vigorous PA), with 43.7% in the intervention group and 44.1% in the comparison group (χ^2= 0.001; p=0.976). In BOCF analyses, the proportions were smaller, and the group effect remained nonsignificant (42.2% vs. 39.0%; χ^2= 0.091; p=0.763).

Changes in body weight, body mass index and QOL

Comparisons between the groups in body weight, BMI and QOL are shown in Table 5.4. At 12 weeks, the intervention group had lost an estimated -2.1 kg (95% CI: -3.6, -0.7; p=0.004) compared to no significant weight loss in the comparison group (-0.1 kg, 95% CI: -1.9, 1.7; p=0.904); the weight changes over time were not different between groups, but approached significance (p=0.083). There was no difference between groups in reported changes in QOL over 12 weeks. In unadjusted and adjusted analyses with BOCF (data not shown), weight loss over time remained significant in the FITNET group (both p=0.041), and the group x time interaction was attenuated (both p=0.219). Among FITNET participants, change in vigorous PA was marginally associated with weight loss between baseline and 12 weeks (r_s=-0.27, p=0.056), while change in PA was not associated with weight loss for SC participants (all p>0.05).

Adherence and feasibility

All study completers recalled receiving Facebook messages, and there was no difference between groups in the proportion that reported receiving 10 or more messages (81.3% for FITNET vs. 82.4% for SC; χ^2= .01; p= 0.908). A total of 62.5% of intervention participants and 79.4% of comparison participants reported usually reading some to all/most of the Facebook messages (χ^2= 2.30; p= 0.129). Both groups reported using various Facebook group features 1 to 2 days a week (1 to 6 with 6=several times a day): visited the Facebook group (FITNET=2.6 $\pm$ 1.3; SC=2.9 $\pm$ 1.1; p=0.271); saw a FITNET group post in their News Feed (FITNET=2.8 $\pm$ 1.0; SC=2.6 $\pm$ 1.0; p=0.456); and read FITNET group discussions (FITNET=2.7 $\pm$ 1.1; SC=2.6 $\pm$ 1.0; p=0.886).

FITNET participants posted a total of 153 Facebook comments to the group wall over 12 weeks compared to 188 comments by SC participants in the unmoderated Facebook group. There was no difference in the mean number of posts over the 12-week program (FITNET=3.4 $\pm$ 4.6 vs. SC=4.6 $\pm$ 7.8; p=0.388), and over 50% percent of participants in both groups made 0 or 1 Facebook post over the course of the study period (FITNET: 51.1%, n=23; SC: 51.2%, n=21). Results of exploratory intervention adherence analyses are presented in Table 5.5. Among FITNET group completers, participants in the highest tertile of Facebook posting commented an average of 10 $\pm$ 5.6 times. Post-intervention minutes of PA did not differ among Facebook posting tertiles for MVPA ($F_{2, 28}$=1.29, p=0.291), mild ($F_{2, 28}$=0.81, p=0.456), or total PA ($F_{2, 28}$=1.78, p=0.186). Similarly, number of Facebook posts was not associated with PA outcomes in the unmoderated SC group, as PA minutes at 12 weeks were not different across tertiles (MVPA: $F_{2, 30}$=0.15, p=0.863; mild: $F_{2, 30}$=1.24, p=0.303); total: $F_{2, 30}$=0.17, p=0.842).

FITNET only

FITNET participants set an average of 4.2 $\pm$ 4.8 goals (range: 0-13) over the 12-week study, and 66.7% (n=30) used the goal-setting feature at least once. Participants in the highest tertile of goal setting set at least 83% or 10 weekly goals (Mean=11.6 $\pm$1.0), and vigorous PA minutes were marginally different across tertiles ($F_{2, 28}$=2.96, p=0.068). Individuals in the highest tertile reported higher vigorous PA at post-intervention compared to individuals in tertile 2 (82.7 min/week, SE=16.9 vs. 30.3 min/week, SE=17.7; p=0.043). Differences across goal setting tertiles in weekly minutes of MVPA approached marginal significance ($F_{2, 28}$=2.44, p=0.105), while other PA outcomes did not differ among goal-setting tertiles.

Participants submitted a mean of 21.9 $\pm$ 37.9 PA entries (range: 0-170) and 13.1 $\pm$ 24.2 steps entries (range: 0-78) over the 12-week program with 71.1% (n=32) tracking any exercise data at least once. Frequency of PA entries decreased over the study period from a mean of 2.1 $\pm$ 3.4 entries in week 1 to 1.5 $\pm$ 3.4 during week 12. Similarly, the number of steps entries declined from an average of 1.3 $\pm$ 2.2 to 0.7 $\pm$ 1.7 over 12 weeks. The proportion of participants logging either PA or steps declined from 57.8% (n=26) in week 1 to 24.4% (n=11) in week 12. In dose-response analyses, MVPA minutes were marginally different across tertiles of PA entries ($F_{2,28}$=2.82, p=0.077), with participants in the highest tertile reporting more MVPA minutes compared to tertile 2 (p=0.039). Participants that logged the most PA entries had greater vigorous PA minutes at 12 weeks relative to those in tertile 2 (p=0.034). For number of steps entries, tertiles of participants did not differ in PA outcomes. When ranking participants according to a composite score of adherence to logging PA entries and setting weekly goals, those in the tertile of highest participation reported greater MVPA minutes as compared to those in tertile 2 (p=0. 039), but was not different from those with the lowest participation (p=0.792).

Satisfaction and acceptability

Both groups agreed (1=strongly disagree to 7=strongly agree) that accessing study information was very easy (FITNET=5.1 $\pm$ 1.4; SC=5.7 $\pm$ 1.5; p=0.087), and that accessing study information was an effective way to get information about exercise (FITNET= 4.9 $\pm$ 1.4; SC=5.2 $\pm$ 1.9; p=0.348). On average, participants agreed with the statement "*I enjoyed participating in this study*" (FITNET=4.6 $\pm$ 1.7; SC=4.9 $\pm$ 1.9; p=0.480). At follow-up, 46.9% of FITNET participants and 61.8% of SC participants agreed or strongly agreed with

the statement, "*I would recommend the FITNET program to other young adult cancer survivors*" (χ^2= 1.47; *p*=0.225).

V.E. Discussion

The FITNET study is the first to report randomized trial outcomes of a Facebook-based intervention to promote PA in young adult cancer survivors and demonstrates that delivery of behavioral interventions through Facebook is feasible among young adult cancer survivors. The study had a retention rate that was comparable with other Internet-based studies, and most participants reported using intervention components as intended. Total weekly minutes of self-reported PA increased over time in both the group that received the more structured FITNET intervention, including expanded weekly Facebook messages, links to PA websites, self-monitoring and moderated group discussion, and the SC group that received basic weekly Facebook messages, links to PA websites, and unmoderated group discussion. The difference in total PA between groups was marginally significant (p=0.078). Participants in both groups also showed significant increases from baseline to 12 weeks in weekly minutes of MVPA, but there was no difference between groups. Rather than increasing moderate-intensity PA, which was the intervention focus, the FITNET intervention was effective in increasing mild PA minutes per week (activities such as easy walking and yoga) compared to the SC group. The weight loss over time in the FITNET group was an unexpected finding, as interventions focused solely on PA without a dietary component typically produce little weight loss[235] and since self-report measures of PA suggest the only difference between groups was in mild activity. Taken together these findings suggest support for the feasibility of Facebook-based approaches to delivering behavioral interventions to young adult cancer survivors.

The marginally significant difference in total PA changes between groups appears to be driven by the greater increases in mild PA among FITNET participants. Considering that the FITNET intervention focused on walking, and several studies indicate that walking is the preferred exercise type for an estimated 55%-81% of survivors of varying cancer types,[57-60] the observed increase in mild PA minutes per week relative to the SC group is not unexpected. At baseline, 8.9% of FITNET participants were completely sedentary and 22.2% reported no moderate-intensity PA. It is possible that some participants were slowly increasing exercise intensity over time, the importance of which was emphasized in study messages. Furthermore, participants were encouraged to wear their pedometers every day over the 12-week intervention period and may have spent more time doing mild, as opposed to brisk walking, which competed with time spent on moderate-to-vigorous intensity activities. While there were no reports of adverse events or injuries, participant scores on physical well-being were lower than those reported in previous PA trials and studies among cancer survivors.[236-239] This suggests that survivors may have been limited in their ability to engage in higher-intensity PA. However, since recent PA guidelines for cancer survivors assert that any activity is better than none,[12, 22, 164] the observed increases in mild PA are still encouraging.

It is unclear what accounts for the group differences in mild PA. Both FITNET and SC groups, on average, posted a similar number of Facebook comments to the respective group walls. Interestingly, the SC participants posted 188 comments without being prompted by the study administrator compared to 153 posts by FITNET participants, who received regular discussion prompts. Posts among both groups included a combination of participant introductions, comments related to PA, encouragement, support, accomplishments and PA

resources. Frequency of Facebook posts did not appear to be related to changes in PA in either group. However, since over half of participants in both groups never posted or posted only once, it is unclear if access to a Facebook group wall and interaction with peers influenced changes in PA over time. The objective measure of posts is unable to account for those who read others posts and resources posted by the moderator but did not interact with peers. Future studies should examine the potential for both moderated and self-directed group discussions on Facebook to enhance behavior change in young adult cancer survivors and other ways to integrate additional features that have been related to enhanced PA adoption such as tailored feedback.[240]

Findings from intervention dose analyses indicate that there were marginal differences in MVPA at 12 weeks across tertiles of the composite measure of PA entries and weekly goal setting. Participants who logged the most PA entries and set more weekly goals reported greater MVPA minutes compared to the middle tertile, suggesting that these self-monitoring behaviors may have led to MVPA increases over time in the most adherent FITNET participants. Previous home-based PA interventions among cancer survivors have produced increases in self-reported MVPA using exercise logs and pedometers as intervention strategies.[105, 115] Unexpectedly, MVPA in the lowest tertile of participation was not different from that of the highest tertile, with participants in the middle tertile reporting the lowest mean MVPA. Since participants with the lowest adherence never, or only once, logged PA entries and/or set a weekly goal, the observed decreases in objective self-monitoring behaviors over time are likely attributable to participants in the middle tertile. During the study, FITNET participants were asked to access a separate website to record activity, which may have grown burdensome over time, as the website was poorly utilized

with only 24% of participants using it at 12 weeks. Furthermore, though they occurred on only a few occasions, website outages due to weather and site maintenance may have discouraged participant use. It is conceivable that survivors in the lowest adherence tertile were using other tools to self-monitor their PA, but the current study is unable to explain why their levels of MVPA were comparable with survivors in the highest tertile of adherence. Future studies should examine strategies for self-monitoring PA that are more easily accessible and less time intensive (e.g., Facebook application, phone accelerometers).

The improvements in PA among the SC group suggest that young adult cancer survivors are interested in behavioral interventions as demonstrated by previous studies,[43, 44, 47] and their cancer experiences may serve as a teachable moment that motivates them to make lifestyle behavior changes. Though not significantly different from the FITNET group, in general, higher proportions of individuals in the SC group reported attending to study components (i.e., received and read Facebook messages, visited Facebook group) and would recommend FITNET to other young adult cancer survivors. Despite receiving more minimal message content, SC group participants reported that accessing study information was easy and an effective way to get information about exercise. Whereas the FITNET group received enhanced PA messages, were encouraged to set goals and self-monitor PA, and periodically asked questions to promote group discussion, the SC group received general PA information and access to the unmoderated Facebook group. Given the limitations on formatting the appearance of Facebook messages, it is possible that the shorter, simpler messages were more appealing. Furthermore, the SC participants posted their own discussion questions and posted a comparable number of Facebook comments as FITNET participants; support may have been just as encouraging and acceptable when offered by a peer, as opposed to a study

moderator. These findings suggest that a minimal intervention delivered through Facebook may promote behavior change in young adult cancer survivors. Though, this could not be confirmed in the current study given the lack of a true control group with which to compare the SC group.

Other studies, however, have also found that a minimal intervention offered to the control group, such as a pedometer and/or standardized print materials, produced increases in PA.[103, 105, 115] While the body of literature on behavior change interventions among post-treatment cancer survivors is growing with over 25 published PA interventions to date,[241] most have focused on breast cancer survivors,[7] and only a few studies have assessed the effectiveness of health promotion interventions in adolescent and young adult cancer survivors. Of these, all were focused exclusively on those diagnosed during childhood (0-14 years),[36, 37, 68-74] and only three specifically targeted diet and/or PA behaviors.[36, 37, 71, 74] Furthermore, the definitions of young adult used in eligibility criteria have varied across these studies.[30, 31] The FITNET study differs from previous ones with its focus on cancer survivors diagnosed as young adults and its recruitment and delivery through a social media channel.

However, the current study can be compared to other distance-based intervention studies that evaluated PA behavior change as the primary outcome and QOL and body weight as secondary outcomes among post-treatment survivors. After a 12 week study period, we found the FITNET intervention produced an average increase of 67 MVPA min/week; this was comparable to increases of 70-89 MVPA min/week among breast cancer survivors receiving a home-based intervention with step pedometers and print materials,[115] but we observed much greater within-group standard deviations in self-reported PA minutes

per week. Based on this variance and the postintervention sample size of 66, the study was potentially underpowered to detect a significant difference between groups in MVPA and total PA.

While Vallance et al.[115] also showed significant improvements in QOL among an intervention group that received both pedometers and print materials relative to the standard control group, this study did not demonstrate enhanced QOL as has been reported in other PA trials among survivors.[107, 236] A recent review of QOL outcomes in PA interventions for cancer survivors demonstrated that the more effective interventions focused on higher-intensity aerobic exercise and were longer in duration.[242] Given that PA gains were more demonstrable in lower-intensity PA, it is not surprising that increases in QOL were not realized. The fact that reported QOL among this sample of young adults was lower relative to QOL among cancer survivors participating in other PA studies that used the FACT-G survey[236, 238] is deserving of further research and suggests that QOL may be lower in young adult survivors than those previously studied. It may indicate a greater need for PA and psychosocial support interventions in this population.

Notably, this study showed a reported 2-kg weight loss from baseline to 12 weeks in the FITNET group with no significant weight loss over time in the SC group, which was an unexpected finding. It should be noted that, while this outcome is not measured weight, self-reported weight has been shown to be strongly correlated with clinically measured weight in cancer survivors.[103] While change in vigorous PA was marginally associated with weight loss over time in the FITNET group (r_s=-0.27, p=0.056), dietary intake was not measured. So while dietary change is the likely mechanism, given that the SC and FITNET groups were not different in vigorous PA, this study does not provide evidence as to why FITNET

participants' self-reported weight significantly decreased over time. Previous exercise interventions among survivors have not demonstrated significant changes in body weight.[105, 107, 243] A recent weight loss intervention using Facebook and text messaging produced a significant 2-kg weight loss in college-aged young adults after 8 weeks compared to Facebook only and wait-listed control groups.[148] Given that weight gain and declines in PA often occur during young adulthood, these results suggest that future studies should examine the long-term effects of social networking site approaches to behavioral change.

A major strength of this study was that it was one of very few randomized, controlled trials to evaluate a PA intervention among young adult cancer survivors. Furthermore, it used a popular and publicly available social networking site and was completely home-based. Both of these features facilitated the recruitment of young adult cancer survivors, a rare population of survivors relative to survivors of other age groups, from different parts of North America, and enhanced generalizability of our findings to those that are interested in social networking site-based PA interventions. The fact that the study was delivered through a popular social networking site improves the possibility for future dissemination. The SC group also received an active intervention, allowing for a more robust test of the effects of the goal-setting, self-monitoring and moderated group discussion components on PA outcomes.

Despite these strengths, the study was not without its limitations. The relatively small sample size may have resulted in inadequate power to detect a significant difference between groups in the primary outcome of weekly minutes of MVPA. Self-report measures may have resulted in over- or underreporting of activity minutes and other outcomes, resulting in biased estimates due to social desirability and recall errors; though, presumably these were equally

distributed between groups through randomization. The relatively short study duration may have not allowed sufficient time for participants to gradually increase their PA intensity, and the lack of long-term follow-up was also a limitation. Participants that enrolled earlier during the course of the four-month recruitment period may have been motivated to start exercising prior to the start of the 12-week study, which could have biased study findings. In addition, the study did not address the needs of young adult cancer survivors who are not on Facebook or lack Internet access, a population that may be most in need of health-related information.[244] Due to the lack of diversity in the study sample, findings may have limited generalizability to the broader population of young adult cancer survivors.

Behavioral interventions among young adult cancer survivors are important opportunities to improve health and enhance quality of life among cancer survivors. Given the limited availability of behavioral interventions for young adult cancer survivors and their interest in making lifestyle changes, Facebook-based approaches hold potential for promoting health in this population. Our findings have implications for health care professionals and organizations that serve young adult cancer survivors and suggest that communicating through an existing social networking site that is commonly used by cancer survivors may be beneficial. Future research that is adequately powered to compare Facebook-based intervention approaches and examines cancer survivors of various age groups, cancer types and in different stages of the cancer continuum may be warranted.

Figure 5.1. Study enrollment and retention
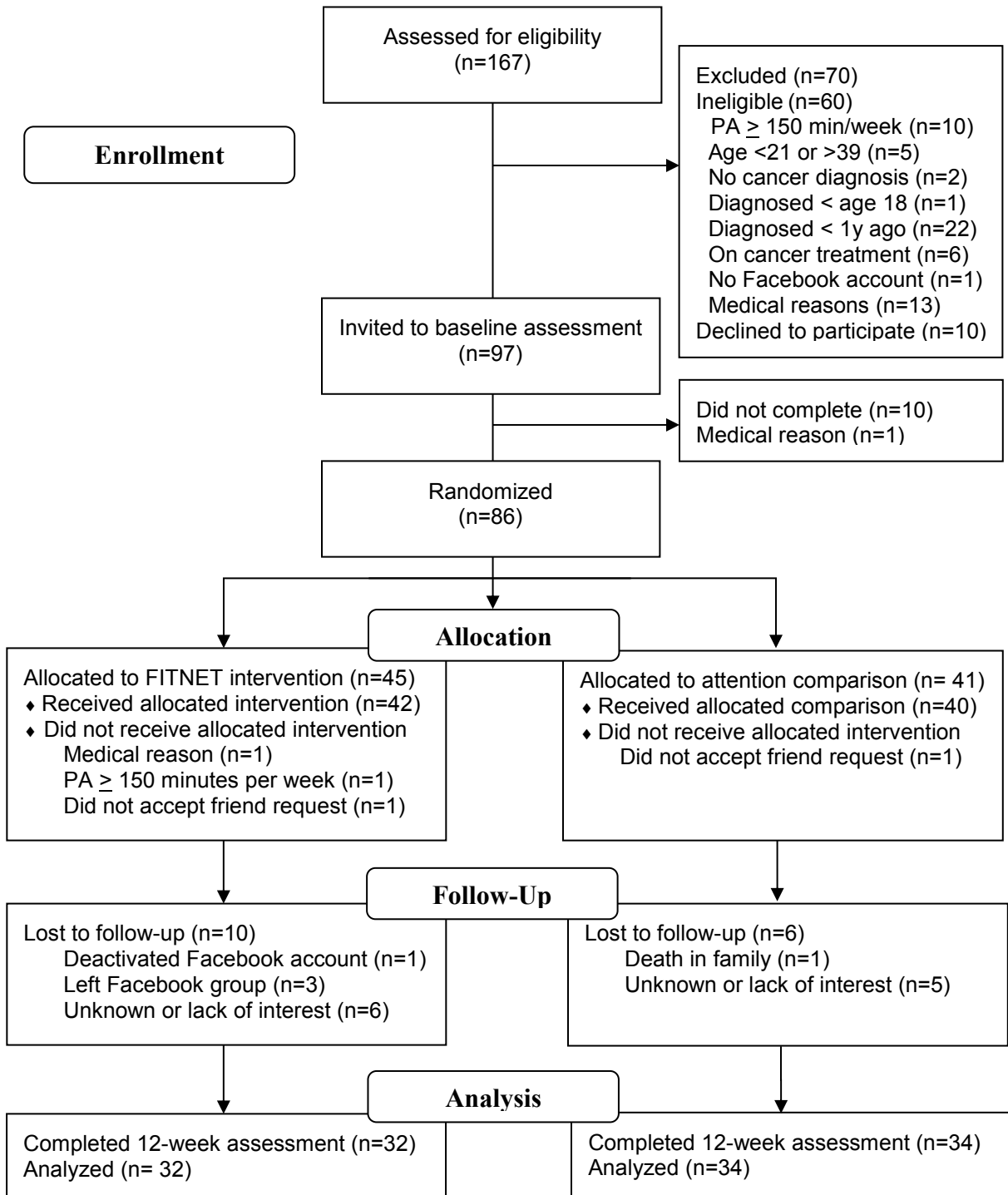
Table 5.1. Overview of differences between study groups

Concept Targeted	FITNET	Self-help Comparison
Overall goal	Meet PA recommendation for cancer survivors: 150 minutes of moderate-intensity physical activity per week.	Meet PA recommendation for cancer survivors: 150 minutes of moderate-intensity physical activity per week.
Behavioral Capability	Links to publicly available websites related to PA and/or cancer survivorship.	Links to publicly available websites related to PA and/or cancer survivorship.
	12 weekly Facebook messages with expanded behavioral lessons on PA topics and behavioral strategies.	12 weekly Facebook messages with basic information on PA.
Self-efficacy	Pedometer provides feedback on daily walking	Pedometer provides feedback on daily walking
	Website with weekly goal-setting and charts providing feedback on performance relative to weekly exercise goal, previous weeks, and overall intervention goal	
Self-monitoring	Pedometer to monitor steps	Pedometer to monitor steps
	Website with diary to record walking steps and PA type, duration and intensity	
Social support	Facebook group with moderated discussion prompts to encourage support, links and weekly reminders	Facebook group with unmoderated discussion

Table 5.2. Baseline characteristics of participants in the <u>F</u>ostering <u>I</u>mprovement <u>T</u>hrough <u>N</u>etworking and <u>E</u>xercising <u>T</u>ogether trial

Characteristics	FITNET ($n = 45$)	Comparison ($n = 41$)
Age (y), mean (SD)	30.8 (5.7)	32.7 (4.2)
Female sex, n (%)	41 (91.1)	37 (90.2)
Race/ethnicity, n (%)		
Non-Hispanic White	42 (93.3)	36 (87.8)
African-American	1 (2.2)	0 (0)
Hispanic	1 (2.2)	4 (9.8)
Asian	1 (2.2)	1 (2.4)
Marital status, n (%)		
Married or living as married	21 (46.7)	22 (53.7)
Divorced, separated	1 (2.2)	4 (9.8)
Single	23 (51.1)	15 (36.6)
Education Level, n (%)		
Some college, vocational/trade school	9 (20.0)	10 (24.4)
College graduate	26 (57.8)	19 (46.3)
Postgraduate	10 (22.2)	12 (29.3)
Annual Income $\geq$ \$50,000, n (%)	25 (55.6)	23 (56.1)
Employment Status,[a] n (%)		
Full-time	20 (44.4)	20 (48.8)
Part-time	7 (15.6)	6 (14.6)
Full-time student	10 (22.2)	7 (17.1)
Living arrangements, n (%)		
Live with others	38 (84.4)	34 (82.9)
Responsible for children <18y	17 (37.8)	16 (39.0)
Body mass index (kg/m^2), mean (SD)	28.4 (8.2)	29.1 (8.9)
Months postdiagnosis	63.2 (7.8)	53.7 (5.1)
Cancer type, n (%)		
Hematologic	14 (31.1)	13 (31.7)
Breast	8 (17.8)	9 (22.0)
Gynecologic	5 (11.1)	8 (19.5)
Head and neck	7 (15.6)	3 (7.3)
Gastrointestinal	4 (8.9)	5 (12.2)
Other (musculoskeletal, genitourinary, lung)	7 (15.6)	3 (7.3)
Stage of cancer, n (%)		
Not staged / Don't know	7 (15.6)	7 (17.1)
I-II	20 (44.4)	20 (48.8)
III-IV	18 (40.0)	14 (34.2)
Treatment, n (%)		
Chemotherapy	31 (68.9)	32 (78.1)
Surgery	33 (73.3)	30 (73.2)
Radiation	24 (53.3)	22 (53.7)
Bone marrow transplant	8 (17.8)	6 (14.6)
Other	10 (22.2)	8 (19.5)
$\geq$3 h daily Internet use, n (%)	25 (55.6)	27 (65.9)
Daily Facebook use,[b]* mean (SD)	2.6 (1.4)	2.0 (1.0)

Note. PA, physical activity.

a Check all that apply.
b 0 = less than 10 minutes, 1 = 10–30m, 2 = 31–60m, 3 = 1–2 hours, 4 = 2–3 hours, 5 = more than 3 hours.
*p<0.05

Table 5.3. Baseline means and estimated mean changes in physical activity

Outcome	Baseline Mean (SD)	12 weeks Mean (SD)	Unadjusted Mean Change Mean (95% CI)	Time P	Group x Time P	Adjusted[a] Mean Change Mean (95% CI)	Time P	Group x Time P
MVPA (min/week)					0.549			0.832
FITNET	109.3 (125.0)	165.1 (196.9)	67.0 (13.6, 143.4)	**0.009**		67.9 (17.4, 136.8)	**0.0050**	
Comparison	118.4 (126.3)	164.4 (171.1)	46.3 (0.8, 109.0)	**0.045**		55.0 (-1.2, 133.9)	0.0562	
Mild PA (min/week)					**0.032**			0.070
FITNET	78.3 (91.8)	232.6 (610.0)	163.6 (47.2, 387.9)	**0.001**		97.8 (18.4, 252.7)	**0.0071**	
Comparison	81.0 (78.5)	101.5 (107.1)	28.5 (-5.7, 78.3)	0.115		20.6 (-11.0, 66.0)	0.2324	
Total PA (min/week)					0.078			0.154
FITNET	187.6 (171.1)	397.7 (778.4)	237.0 (74.0, 501.7)	**0.001**		178.5 (45.4, 387.7)	**0.0037**	
Comparison	199.3 (151.5)	265.9 (228.1)	75.7 (12.6, 157.6)	**0.015**		77.7 (8.5, 167.1)	**0.0251**	

Note. Mean and SD at 12 weeks are based on available data. Mean change is estimated from maximum likelihood repeated measures mixed models. Number of participants for all models was: FITNET, Baseline=45, 12 weeks=32; Comparison, Baseline=41, 12 weeks=34. MVPA, moderate-to-vigorous physical activity; PA, physical activity.
[a]Adjusted models include marital status, months since diagnosis and baseline Facebook use as covariates.
Statistically significant P values are shown in bold.

Table 5.4. Baseline means and estimated mean changes in quality of life and body mass index

Outcome	Baseline Mean (SD)	12 weeks Mean (SD)	Unadjusted Mean Change Mean (95% CI)	Time *P*	Group x Time *P*	Adjusted[a] Mean Change Mean (95% CI)	Time *P*	Group x Time *P*
Body mass index (kg/m^2)					0.103			0.112
FITNET	28.4 (8.2)	26.6 (6.7)	-0.6 (-1.1, -0.1)	**0.014**		-0.6 (-1.0, -0.1)	**0.0172**	
Comparison	29.1 (8.9)	28.7 (8.2)	0.01 (-0.6, 0.6)	0.961		0.03 (-0.5, 0.6)	0.9243	
Body weight (kg)					0.083			0.083
FITNET	79.5 (24.5)	73.3 (18.6)	-2.1 (-3.6, -0.7)	**0.004**		-2.0 (-3.4, -0.7)	**0.0032**	
Comparison	80.3 (25.6)	78.8 (23.7)	-0.1 (-1.9, 1.7)	0.904		-0.1 (-1.8, 1.7)	0.9161	
FACT-G (0-108)					0.818			0.732
FITNET	73.9 (18.1)	76.7 (17.5)	2.9 (-0.7, 6.6)	0.113		2.7 (-0.6, 6.2)	0.1144	
Comparison	72.1 (19.6)	76.9 (18.3)	3.4 (0.2, 6.8)	**0.039**		3.3 (0.2, 6.6)	**0.0358**	
Physical well-being (0-28)					0.678			0.621
FITNET	20.9 (5.6)	20.9 (5.4)	0.5 (-0.3, 1.3)	0.195		0.5 (-0.3, 1.3)	0.2096	
Comparison	19.4 (6.4)	20.5 (5.9)	0.7 (-0.1, 1.5)	0.080		0.7 (-0.04, 1.5)	0.0651	
Social well-being (0-28)					0.663			0.711
FITNET	18.6 (6.9)	19.7 (6.2)	0.9 (-0.7, 2.5)	0.277		0.8 (-0.6, 2.4)	0.2736	
Comparison	18.9 (6.3)	19.8 (6.3)	0.4 (-1.0, 1.9)	0.596		0.4 (-1.0, 1.9)	0.5673	
Emotional well-being (0-24)					0.777			0.655
FITNET	15.8 (4.2)	16.6 (5.1)	0.9 (-0.4, 2.2)	0.171		0.7 (-0.4, 2.0)	0.2271	
Comparison	15.7 (5.0)	17.1 (4.4)	1.1 (-0.1, 2.5)	0.080		1.1 (-0.1, 2.5)	0.0744	
Functional well-being (0-28)					0.540			0.492
FITNET	18.6 (5.9)	19.4 (5.6)	0.8 (-0.6, 2.2)	0.271		0.7 (-0.6, 2.1)	0.3009	
Comparison	18.0 (5.5)	19.5 (5.5)	1.3 (0.1, 2.5)	**0.027**		1.2 (0.1, 2.4)	**0.0287**	

Note. Mean and SD at 12 weeks are based on available data. Mean change is estimated from maximum likelihood repeated measures mixed models. Number of participants for all models was: FITNET, Baseline=45, 12 weeks=32; Comparison, Baseline=41, 12 weeks=34. FACT-G, Functional Assessment of Cancer Therapy-General survey.

[a]Adjusted models include marital status, months since diagnosis and baseline Facebook use as covariates.

Statistically significant *P* values are shown in bold.

Table 5.5. FITNET intervention dose analysis of physical activity outcomes by tertiles of weekly goal setting, exercise entries and Facebook posts for study completers

Outcome	Tertiles of Intervention Use			$F (2, 28)$	P	Partial Eta^2
	1	2	3			
	Mean (SE)	Mean (SE)	Mean (SE)			
Weekly goal setting	**0 - 1**	**2 - 9**	**10 - 13**			
Mod-Vig PA (min/week)	189.9 (49.7)	72.7 (51.4)	224.2 (50.1)	2.44	0.105	0.15
Mild PA (min/week)	323.8 (122.0)	196.9 (124.8)	173.9 (128.2)	0.41	0.668	0.03
Vigorous PA (min/week)***	82.9 (16.9)	30.7 (17.7)	82.7 (16.9)	2.96	0.068	0.17
Total PA (min/week)	521.9 (158.5)	249.5 (161.7)	408.2 (163.8)	0.75	0.480	0.05
No. of PA entries	**0 - 1**	**3 - 23**	**26 – 170**			
Mod-Vig PA (min/week)*	203.4 (52.0)	72.4 (48.5)	222.9 (49.6)	2.82	0.077	0.17
Mild PA (min/week)	341.4 (127.7)	193.7 (118.6)	172.7 (127.8)	0.51	0.606	0.04
Vigorous PA (min/week)**	88.7 (17.4)	30.3 (16.6)	82.6 (16.6)	3.65	0.039	0.20
Total PA (min/week)	571.3 (165.1)	234.9 (151.8)	402.7 (161.7)	1.17	0.326	0.08
No. of steps entries	**0**	**1-15**	**16 – 78**			
Mod-Vig PA (min/week)	171.21 (46.7)	203.0 (66.9)	133.1 (52.5)	0.35	0.706	0.02
Mild PA (min/week)	198.3 (105.4)	267.4 (149.8)	254.2 (118.8)	0.10	0.908	0.007
Total PA (min/week)	348.3 (138.2)	532.7 (197.8)	374.6 (155.7)	0.30	0.741	0.02
No. of Facebook posts	**0 - 1**	**2 - 4**	**5 - 22**			
Mod-Vig PA (min/week)	123.7 (48.7)	235.6 (53.9)	144.2 (54.4)	1.29	0.291	0.08
Mild PA (min/week)	188.4 (112.5)	360.2 (121.8)	158.1 (125.3)	0.81	0.456	0.05
Total PA (min/week)	301.6 (143.0)	643.2 (156.4)	267.4 (160.7)	1.78	0.186	0.11
Composite rank of PA entries and goal setting	**0**	**1 – 2**	**4**			
Mod-Vig PA (min/week)*	203.4 (52.0)	72.4 (48.5)	222.9 (49.6)	2.82	0.077	0.17
Mild PA (min/week)	341.4 (127.7)	193.7 (118.6)	172.7 (127.8)	0.51	0.606	0.04
Vigorous PA (min/week)**	88.7 (17.4)	30.3 (16.6)	82.6 (16.6)	3.65	0.039	0.20
Total PA (min/week)	571.3 (165.1)	234.9 (151.8)	402.7 (161.7)	1.17	0.326	0.08

*Post-hoc tests indicated that tertile 3 was different from tertile 2 ($p=0.039$, $p=0.094$ for Tukey HSD).
**Post-hoc tests indicated that tertile 3 was different from tertile 2 ($p=0.034$, $p=0.083$ for Tukey HSD).
***Post-hoc tests indicated that tertile 3 was different from tertile 2 ($p=0.043$, $p=0.104$ for Tukey HSD).

CHAPTER VI

POTENTIAL MEDIATORS OF PHYSICAL ACTIVITY CHANGE IN YOUNG ADULT CANCER SURVIVORS: EVIDENCE FROM THE FOSTERING IMPROVEMENT THROUGH NETWORKING AND EXERCISING TOGETHER (FITNET) STUDY

VI.A. Overview

This study examined the effects of a physical activity intervention for young adult cancer survivors on changes in psychosocial factors (self-efficacy, social support, self-monitoring) and determined whether these factors mediated the relationship between the intervention and changes in physical activity. A twelve-week randomized trial compared a Facebook-based intervention (FITNET) aimed at increasing moderate-intensity physical activity (PA) to a self-help education comparison (SC) condition. Young adult cancer survivors (n=86) were randomly assigned to the FITNET or SC group. Measures of PA and psychosocial variables were collected using self-administered online questionnaires at baseline and after 12 weeks. The intervention group reported lower self-efficacy for sticking to exercise (mean change=-0.38; 95% CI: -0.62, -0.12; p=0.025 between groups) and social support from friends on social networking sites (mean change=-0.47; 95% CI: -1.45, 0.65; p=0.039 between groups) relative to the SC group over time. The intervention had a significant mediated effect on changes in moderate-to-vigorous PA through social support from friends on social networking sites, but in the unexpected direction. While the intervention was not significantly associated with social support from friends or self-monitoring, there was a positive association between changes in these psychosocial factors

and changes in moderate-to-vigorous PA in the total sample. The proposed psychosocial mediators did not explain the positive effects of the FITNET intervention on mild PA. The lack of significant improvements in psychosocial constructs among FITNET participants may partly explain the lack of significant increase in moderate-to-vigorous PA compared to the SC group. Future research should examine mediators of PA behavior change in young adult cancer survivors.

VI.B. Introduction

There is a growing body of evidence that physical activity (PA) has several benefits for cancer survivors, including positive effects on fatigue, depression, quality of life and physical functioning.[10-12, 16] PA is also known to lower the risk of several chronic diseases and conditions, such as diabetes and obesity,[164] for which cancer survivors are at higher risk as a result of cancer and its treatment.[4, 5] As a result, recent national guidelines recommend that cancer survivors engage in regular PA.[12, 22] Despite these PA recommendations, most young adult cancer survivors are not participating in sufficient levels of exercise to achieve these health benefits.[42, 44, 46] Therefore, PA interventions represent important opportunities to promote health and quality of life in young adult cancer survivors.[6, 7, 245]

In developing PA interventions, a theoretical framework is often used to guide the development of program components and strategies. Many researchers rely on health behavior theories, such as the Social Cognitive Theory (SCT)[173, 174] and existing literature on the psychosocial correlates and determinants of PA to design interventions. While several theory-based PA interventions have been tested and shown to effectively increase exercise among cancer survivors,[103, 105, 115, 241] few studies have determined the mechanisms of change and potential mediators of intervention effects on PA behavior change in cancer survivors.[246]

In previous intervention studies in non-cancer populations, self-efficacy is one of the most commonly identified mediators of PA behaviors.[92, 247] Among cancer survivors, interventions that have addressed self-efficacy have shown some effectiveness,[75] but a limited number of secondary analyses have examined self-efficacy as a potential mediator of intervention effects, and results have been mixed.[107, 125-127, 248, 249] Changes in self-efficacy were found to partially mediate the effects of a randomized diet and exercise intervention among older breast and prostate cancer survivors on dietary practices at 1-year and 2-year follow-up, but did not mediate PA behaviors at follow-up.[126,127] One study found that barriers self-efficacy mediated PA behaviors in breast cancer survivors.[125] Results of other studies in breast cancer survivors have not indicated that self-efficacy mediated PA outcomes.[107, 125, 248, 249]

While a systematic evidence review found that social support interventions in community settings were effective at increasing PA,[86] few studies have assessed the potential mediating effect of social support on PA outcomes in intervention trials. Cerin et al.[250] found that social support significantly mediated the effect of an intervention on initial changes in walking behaviors in inactive adults. Several studies suggest an association between social support and PA engagement in adult cancer survivors.[96] However, the limited evidence from PA intervention studies among adult cancer survivors has not shown social support to be a mediator of PA behavior.[107, 125]

Similarly, self-regulation has rarely been examined in previously mediation analyses of intervention effects on PA in cancer survivors. Several PA interventions have successfully employed components like exercise logs and pedometers as intervention strategies to promote self-monitoring in support of increased exercise in cancer survivors,[105, 115, 117] but

these have focused exclusively on breast cancer survivors. In a study of SCT determinants of PA in young adults, self-regulation mediated the effect of self-efficacy on PA and was significantly positively associated with PA.[77] Furthermore, self-regulation was the strongest predictor of PA in a structural equation analysis of adult participants in a church-based health promotion study.[93]

Overall, reviews of health promotion interventions among cancer survivors have found that interventions applying SCT constructs have been effective.[102, 246] But despite being recognized as a useful framework for guiding PA interventions, the SCT has not been studied enough among cancer survivors,[106] and additional analyses of whether the SCT constructs mediate intervention effects in cancer survivors are necessary.[102,246] This is especially important considering that exercise motivations and determinants of PA behavior may differ between non-cancer and cancer populations.[80, 109]

In a recent intervention study (see Chapter V), we used SCT as a theoretical foundation to develop a 12-week intervention to increase PA in young adult cancer survivors. The intervention components focused on targeting self-efficacy, social support, and self-monitoring as potential mediators of PA among young adult cancer survivors. We demonstrated that the intervention group (FITNET) significantly increased self-reported weekly minutes of mild PA by 135 minutes compared to the self-help comparison group (SC). The FITNET group increased moderate-to-vigorous PA (MVPA) by 67 minutes per week compared to 46 minutes per week in the SC group, with no significant difference between groups. Considering the scarcity of PA interventions and the limited evidence examining theoretical determinants of PA behaviors in young adult cancer survivors, research is needed to advance knowledge about mechanisms of PA behavior change and to

guide future intervention development in this population. By conducting mediation analyses, we sought to not only identify psychosocial factors that are most relevant for increasing PA in young adult cancer survivors, but to elucidate how the intervention may have worked to produce changes in psychosocial factors and PA behaviors. Therefore, the goals of this study were to evaluate the effects of the FITNET intervention on psychosocial factors, including self-efficacy, social support, and self-monitoring, and to determine if these psychosocial factors mediated the relationship between the intervention and PA behaviors among young adult cancer survivors. We hypothesized that changes in self-efficacy, social support, and self-monitoring would mediate the effects of the intervention on change in weekly minutes of PA over time.

VI.C. Methods

Participants

Details of recruitment methods and eligibility were described previously (see Chapter V).Young adult cancer survivors were recruited for the parent intervention trial, from April through August 2011, primarily through community-based organizations and advocates dedicated to young adults with cancer. The main recruitment strategy was via advertisements posted by community-based organizations on social media channels such as Facebook and Twitter. Eligibility criteria were: young adults between ages 21-39 diagnosed with cancer (excluding non-melanoma skin cancer) at age 18 or older; ≥ 1 year beyond date of diagnosis with no evidence of progressive disease or second primary cancers; completed cancer treatment; English-speaking and writing; no pre-existing medical condition(s) or contraindications that preclude adherence to an unsupervised exercise program, including cardiovascular disease, heart failure, pulmonary conditions, renal disease, and severe

orthopedic conditions; not adhering to the American Cancer Society's recommendation of at least 150 minutes of moderate-intensity exercise per week (<150 minutes/week)[251]; had access to Internet service and an active Facebook account. All participants were screened through an online eligibility questionnaire and gave online informed consent. Of 167 survivors screened through an online screener, 97 were eligible and consented through the online consent form. Out of the 97 invited to complete the baseline online questionnaire, a final sample of 86 completed the baseline assessment.

Procedures

The aim of the parent intervention trial was to increase MVPA levels among young adult cancer survivors to at least 150 minutes per week with a focus on walking. After completion of an online, self-administered, baseline questionnaire, participants were randomly assigned, using computer-generated random numbers list, to one of two study arms: 1) Facebook-based intervention (FITNET); 2) Facebook-based self-help comparison (SC). Prior to the 12-week intervention period, we mailed all participants a Digi-Walker SW-200 pedometer (Yamax, Tokyo, Japan), and participants were then invited to join one of the two study Facebook groups. Study methods and intervention components are described in detail elsewhere (Chapter V). Briefly, intervention participants received twelve different weekly lessons through the Facebook message feature to enhance their skills and knowledge related to physical activity. Messages offered skill building tips and information about setting goals, exercise benefits, overcoming barriers, problem solving, self-monitoring, and enlisting social support. Each Facebook message also included links to publicly available websites from credible national organizations focused on cancer. To promote self-efficacy and encourage self-monitoring, intervention participants had password-protected access to a

separate website, which allowed survivors to set weekly goals, log daily PA minutes and steps, and view feedback charts comparing individuals' exercise minutes with his/her weekly goal and the overall intervention goal of 150 minutes a week. In addition, the study administrator posted various discussion prompts (e.g., questions about cancer experience, exercise videos, cancer-related news) to the wall of the Facebook group to promote group discussion and encourage social support. The SC group also received 12 weekly Facebook messages with general exercise information that included the same links to publicly available websites that the intervention participants received. SC participants had access to the Facebook group wall, but were not actively encouraged to interact with other group members (i.e., unmoderated group discussion). After the 12-week intervention period, participants were asked to complete another online, self-administered questionnaire.

Measures

Demographics and health-related variables

Age (continuous), race/ethnicity, education level, marital status, and income were assessed at baseline. Participants were also asked about their smoking behavior and cancer type. Self-reported height (feet, inches) and weight (pounds) were collected at baseline and post-intervention.

Physical activity

Self-reported PA was the primary outcome for the main trial and was measured using the leisure score index of the Godin Leisure Time Exercise Questionnaire (GLTEQ).[222, 223] The GLTEQ asks four questions about the frequency of strenuous, moderate and mild intensity exercise over the last week; it has demonstrated test-retest reliabilities of 0.62-0.81 and concurrent validity of 0.32-0.56 in comparison to a variety of other self-report and

objective measures of PA (V0$_2$ max, accelerometer) among different populations.[222, 225-227] The GLTEQ has frequently been used in studies of PA in cancer survivors.[87, 98, 106, 118, 224] Similar to these studies and to allow for comparability, we used a modified version of the GLTEQ and asked participants to report times per week and average duration of strenuous, moderate and mild exercise. Days and minutes of reported activity for each intensity were multiplied to calculate PA minutes per week, and five different measures of PA were computed—moderate, vigorous, mild, MVPA, and total minutes per week. The sum of moderate and strenuous exercise was used for the outcome of MVPA minutes per week, and the sum of moderate, strenuous and mild exercise for total PA minutes per week.

Social Cognitive Theory constructs

Self-efficacy for specific behavior changes in PA was assessed using 11 items with a 5-point response scale based on the Self-Efficacy and Exercise Habits Survey by Sallis et al.[252] Questions asked participants to "rate how confident you are that you could really motivate yourself to do things like these consistently, for at least six months; item responses ranged from 1 (*I know I cannot*) to 5 (*I know I can*). Two factors, sticking to it (8 items) and making time (3 items), were scored by calculating the mean of items. Cronbach's alpha for the two scales demonstrated good to high reliability for the factors at baseline: sticking to it (α=0.90), making time (α=0.68) and post-intervention: sticking to it (α=0.90), making time (α=0.71)

Social support. We assessed social support for exercise behaviors using items developed by Sallis et al.[253] for the Friends Support for Exercise Habits Scale (5 items), which asks participants to rate the frequency with which friends said or did specific actions in the previous 3 months: 1) "exercised with me"; 2) "offered to exercise with me"; 3) "gave

me helpful reminders to exercise"; 4) "gave me encouragement to stick with my exercise program"; and 5) "changed their schedule so we could exercise together." We adapted the scale to include three subscales related to support in the past month from family (5 items), friends (not including friends on Facebook or other social networking sites) (5 items), and friends on social networking sites (SNS) (5 items). Items were assessed on a 5-point scale ranging from 1 (*none*) to 5 (*very often*). To account for the fact that various social support sources may influence different PA behaviors/types (e.g., total social support may be important for total PA,[254] we computed four measures of social support (total, family, friends, friends on SNS) by summing respective items. Internal consistencies were high for all four measures at baseline: total (α=0.91), family (α=0.90), friends (α=0.94), friends on SNS (α=0.94) and post-intervention: total (α=0.89), family (α=0.90), friends (α=0.92), friends on SNS (α=0.90). At post-intervention, we also asked participants to rate how often other FITNET group members had said or done the 5 specific actions during the past month.

Self-monitoring was measured using the 10-item Exercise Goal-Setting Scale (EGS) developed by Rovniak et al.[77] to assess PA in young adults and 2 items adapted from a scale developed by Petosa[255] to assesses self-regulation strategies related to exercise. Participants were asked to specify the extent to which statements about goal-setting or self-monitoring strategies described them, with responses ranging from 1 (*does not describe*) to 5 (*describes completely*). Item scores were averaged to yield a total self-monitoring score. The EGS demonstrated good internal consistency (α = .89) in a study of young adults.[77] In this study, Cronbach's alpha reached α=0.92 for the total 12-item measure at baseline and α=0.94 for the total measure at post-intervention.

Statistical analyses

All data analyses were performed using SAS statistical software (Version 9.2, Cary, NC) with baseline observations carried forward under intention-to-treat principles for participants missing post-intervention data. Any outliers (z-scores>3.29) for self-reported PA outcome data (FITNET: n=3; SC: n=2) were identified and adjusted to be one unit lower than the next highest reported measure.[115, 234] Descriptive statistics were computed using chi-square tests for categorical outcome variables and/or t-tests and ANOVA for continuous variables to compare the groups on demographic and health-related variables and to identify important covariates for inclusion in multivariable analyses. As previously reported, the study groups had similar baseline demographic and health-related characteristics, though were significantly different in daily Facebook use ($p<0.05$). We conducted subsequent analyses with and without adjustment for baseline daily Facebook use as potential confounder. Adjusted analyses did not alter study findings; thus, data are presented from unadjusted analyses.

To compare intervention groups on changes in SCT constructs over 12 weeks, we conducted mixed model analyses with repeated measures to estimate maximum likelihood models (PROC GENMOD). Models included a random intercept, time variable (0=baseline, 1=post-intervention), group variable (0=FITNET, 1=SC) and group x time variable, to estimate each outcome measure at baseline and follow-up, and to test for statistical differences between groups in changes over 12 weeks. Consistent with previous mediation analyses evaluating PA interventions, measures for changes in PA behavior were calculated using residualized change scores by regressing the post-intervention PA measure on the baseline PA measure. Used as the outcome measures in the current study, these residualized

PA change scores indicate the change in PA between baseline and post-intervention time points, independent of baseline PA levels.[256] We calculated residualized change scores for all of the potential mediator variables in a similar manner.

Mediation analyses examined if changes in self-efficacy (sticking to it, making time), social support (total, from family, from friends, from friends on SNS), and self-monitoring mediated the effect of the intervention on changes in self-reported PA (MVPA, mild, and total). As described by MacKinnon et al.[257] and suggested by Cerin and MacKinnon,[258] we used bootstrapping methods[259] and the product-of-coefficient test ($\alpha \times \beta$) to evaluate the significance of the mediated effect.[260] This approach is recommended for non-normally distributed data and small samples sizes, such as the present study.[250] Evidence of mediation using the product-of-coefficient test requires a series of tests to evaluate: 1) the relationship between the intervention and the mediator variable (α coefficient); 2) the relationship between the mediator variable and the outcome variable, while controlling for the intervention (β coefficient); and 4) the indirect effect of the intervention on the outcome variable through the mediator (mediated effect), or product of the coefficients ($\alpha \times \beta$) divided by its standard error.

Using a macro developed by Preacher and Hayes,[260] we computed a series of multiple regression models to estimate the relationships above by: 1) regressing the PA residualized change scores (MVPA, mild, total) on the intervention variable (total effect of intervention on PA); 2) regressing the residualized change scores of potential mediators (self-efficacy, social support, self-monitoring) on the intervention (α coefficient); and 3) regressing the PA residualized change scores on the intervention while controlling for potential mediators (direct effect of intervention on PA). Finally, using 5000 bootstrap samples, a point estimate,

standard error and 95% bias-corrected bootstrap confidence interval estimates of the indirect effect (product of α and β coefficients) were generated. The indirect effect of the intervention was considered significant at the α=0.05 level when the 95% bias-corrected confidence intervals did not include zero. For the linear regression models, a *p*-value of <0.05 was considered statistically significant and *p*-values between 0.05 and 0.10 were considered marginally significant.

While our hypothesis was that multiple psychosocial determinants would concurrently mediate the effects of the intervention on PA behavior change, multicollinearity in multiple mediation models may mask the effect of a single mediator.[261] Therefore, we conducted analyses first for single-mediator models, and then planned to conduct multiple-mediation analyses that assessed the independent effects of any variables that were statistically significant mediators in the single-mediator models.[254] If there was no intervention effect on changes in a potential mediator variables, we conducted linear regression analyses in the total sample (i.e., with groups combined) to examine whether residualized change in those variables was associated with changes in PA at follow-up. Finally, we conducted Spearman rank correlations to explore the relationship between reported self-monitoring at 12 weeks and objective measures of self-monitoring in intervention completers, including total number of goals set, PA entries, and steps entries over the 12-week study period.

VI.D. Results

Participant characteristics

Baseline demographic information on the sample has been described previously (see Chapter V, Table 5.2). Participants were 31.7 years old (±5.1), mostly White (90.7%), and

women (90.7%). The majority were college educated (77.9%) and reported an annual household income above $50,000 (55.8%). The young adults were survivors of 18 different cancer types (30% hematologic, 20% breast, 12% thyroid) and reported an average of 115.6 minutes per week ($\pm$132.7) of MVPA. There were no significant differences between groups on baseline demographics and weekly PA minutes, except intervention participants reported spending more time per day using Facebook (2.6 vs. 2.0; $p<0.05$). Due to this baseline significant difference in daily Facebook use, this variable was included as potential confounders in subsequent analyses, but yielded findings consistent with unadjusted analyses.

Intervention effects on potential mediating variables (changes in SCT constructs)

Table 6.1 presents the descriptive statistics and changes in potential mediating variables over 12 weeks. Participants in the intervention group reported lower self-efficacy for sticking to exercise over time (mean change=-0.38; 95% CI: -0.62, -0.12; $p=0.005$), which was significantly different from the SC group (group x time interaction, $p=0.025$). Social support from friends on SNS was significantly different between groups (group x time interaction, $p=0.039$), with the SC group increasing over time (mean change=1.46; 95% CI: -0.002, 3.20; $p=0.050$). Other potential mediating variables did not differ between groups over the 12-week study period.

Mediation of intervention effects on physical activity outcomes

Since intervention condition was associated only with changes in self-efficacy for sticking to PA and social support from friends on SNS, mediation analyses focused on these variables as potential mediators of the intervention effects on changes in MVPA, mild and total PA. For other psychosocial constructs (self-efficacy for making time, total social

support, social support from family and friends, self-monitoring), we examined the effects of changes in the SCT factors across groups on changes in weekly PA minutes at 12 weeks.

Self-efficacy as a potential mediator of physical activity outcomes

While the intervention condition was negatively associated with self-efficacy for sticking to PA (α=-0.34; SE=0.16; p=0.031), change in self-efficacy was not associated with changes in any of the PA outcomes (all p>0.05), so there was no evidence for a mediating effect (see Figure 6.1). When combining participants in both groups, we found no associations between changes in self-efficacy for making time and changes in weekly minutes of MVPA, mild or total PA (all p>0.05).

Social support as a potential mediator of physical activity outcomes

The intervention was significantly associated with changes in social support from friends on SNS (α=-1.67; SE=0.81; p=0.043), and changes in social support from friends on SNS was positively related to changes in MVPA (β=13.61; SE=3.80; p=0.0006), (see Figure 6.2). After adjusting for the effects of the mediating variable, the estimated indirect effect showed that changes in social support from friends on SNS partially mediated the effect of the intervention condition on changes in MVPA (mean indirect effect=-22.43, SE= 14.51, 95%CI=-62.00, -2.81). However, social support from friends on SNS demonstrated inconsistent mediation effects (i.e., the magnitude of the intervention effect on changes in MVPA increased from 11.89 min/week to 34.60 min/week when adjusted for changes in social support from friends on SNS).[257] SC participants reported higher social support from friends on SNS relative to intervention participants, which appeared to result in a decrease in the positive intervention effect on changes in MVPA. Social support from friends on SNS was not associated with changes in mild PA or total PA, indicating no mediating effects.

Change in social support from friends on SNS also partially mediated the effect of the intervention on change in self-efficacy for sticking to it. The intervention was significantly associated with changes in social support from friends on SNS (α=-1.67; SE=0.81; p=0.043), and changes in social support from friends on SNS was positively related to changes in self-efficacy for sticking to exercise (β=0.05; SE=0.02; p=0.029) (see Figure 6.3). After adjusting for the effects of social support from friends on SNS, the estimated indirect effect indicated that changes in social support from friends on SNS partially mediated the effect of the intervention condition on changes in self-efficacy (mean indirect effect=-0.08, SE= 0.05, 95%CI=-0.22, -0.01).

Since changes in other measures of social support (total, family and friends) did not differ by intervention condition, we examined the relationships between these variables and PA outcomes across both groups. Changes in MVPA minutes per week were significantly predicted by changes in total social support (β(SE) = 6.21 (1.65); t=3.77, p=0.0003) and social support from friends (β(SE) =10.35 (3.68); t=2.82, p=0.006). Both changes in mild PA (β(SE) =-27.69 (8.12); t=-3.41, p=0.001) and changes in total PA (β(SE) =-22.41 (11.07); t=-2.02, p=0.046) were negatively associated with changes in social support from family. At post-intervention, there was no reported difference in mean social support from other Facebook group participants (FITNET: 8.25 $\pm$ 4.23 vs. SC: 9.06 $\pm$ 4.18; p=0.437).

Self-monitoring as a potential mediator of physical activity outcomes

Since we found no association between intervention condition and changes in self-monitoring, we assessed the effect of changes in self-monitoring on changes in PA at 12 weeks in the total sample. Changes in self-monitoring was significantly positively related to changes in weekly minutes of MVPA (β(SE) =57.22 (19.47); t=2.94, p=0.004) in the

expected direction, but was not associated with changes in mild or total PA. In exploratory analyses of intervention completers, self-monitoring at 12 weeks was significantly correlated with objective measures of total number of PA entries (r_s=0.37; p=0.040), steps entries (r_s=0.38; p=0.034), and goal-setting (r_s=0.37; p=0.036) over the 12-week intervention period.

VI.E. Discussion

Given the dearth of PA interventions for young adult cancer survivors and the opportunity to identify potential mechanisms underlying intervention effects in this population, this study examined the relationships between a SNS-based PA intervention, changes in psychosocial factors and changes in self-reported PA. Results did not support our hypotheses that self-efficacy, social support and self-monitoring would mediate the relationship between intervention condition and changes in PA behavior. The positive effect of the FITNET intervention on mild PA was not explained through the proposed mediation mechanisms. Unexpectedly, social support from friends on SNS appeared to suppress the effects of the intervention on MVPA behavior change. Specifically, comparison group participants positively increased exercise-related social support from friends on SNS while intervention participants did not, and this social support was positively related to changes in MVPA behaviors. As a result, the indirect effect of the intervention through social support from friends on SNS seems to have negatively impacted the increases in MVPA that the intervention produced among intervention group participants. Neither self-efficacy for sticking to exercise, nor making time for exercise, demonstrated mediating effects on changes in PA as we had hypothesized. These findings are some of the first conducted among young adult cancer survivors and suggest that psychosocial mediators of PA require further attention in this population.

We anticipated that other types of exercise social support, from family and friends, would mediate intervention effects on changes in PA, but findings did not indicate this to be true in our sample of young adult cancer survivors. The intervention was not associated with significant improvements in total, family or friend social support relative to the comparison group. This was unexpected, as messages delivered to the FITNET participants focused on strategies to enlist social support for PA from friends and family. However, our findings are consistent with the few theoretically-based PA interventions among cancer survivors that have specifically targeted social support but found no intervention effects on social support for PA.[107, 125] While the FITNET intervention was not related to total social support or support from friends, changes in these factors were significantly related to change in weekly minutes of MVPA from baseline to post-intervention in the total sample. These findings extend results from previous studies that have demonstrated positive associations between social support and PA engagement in adult cancer survivors[96] and suggest that additional empirical evidence on social support as a determinant of PA among cancer survivors is needed.

The intervention strategies used did not appear to increase social support from friends on SNS as we had anticipated. On the contrary, intervention participants reported no change in this type of social support over 12 weeks; this was significantly different than the self-help comparison participants that reported a positive increase. Although it is not possible to isolate the effects of the specific FITNET intervention components that may have impacted perceptions of social support from friends on SNS, the intervention was designed to capitalize on the features of Facebook that might encourage social support between peers and potentially support positive health outcomes. Discussion prompts were posted on the

Facebook group wall to stimulate discussion about exercise and cancer survivorship among intervention group participants. Alternatively, SC group participants engaged in unprompted discussions on the Facebook group wall; any interaction was self-directed and initiated by SC participants. We previously reported no significant differences between the FITNET and SC groups in the mean number of Facebook posts, frequency of seeing FITNET group posts in the News Feeds, and frequency of reading FITNET group discussions over the 12-week intervention (Chapter V). These measures of adherence did not appear to be related to changes in PA in either group. In the present study, we were unable to determine the relative influences of posting comments or reading moderator or peer comments on PA outcomes; thus, the factors that contribute to perceptions of social support from friends on SNS remain unclear.

The finding that the mediated effect of the intervention through social support from friends on SNS resulted in decreases in MVPA should be interpreted with caution. The inconsistent mediation and large confidence interval for the mediated effect indicate possible issues that limit our interpretation of findings. As suggested by Cerin and MacKinnon,[258] potential problems might include: 1) an inadequate sample size; 2) measurement errors related to the mediating variable; 3) issues with our hypothesis that the intervention strategies would positively change social support from friends on SNS; 4) wide variability between individuals in the intervention effects on social support from friends on SNS (α path) and/or effects of social support from friends on SNS on MVPA (β path); and 5) unstable β coefficient estimate due to collinearity between the intervention and the social support variable. Regression diagnostic tests indicated that collinearity was not an issue in estimating the β path coefficient.

Given the small study sample size, our use of bootstrap methods was an appropriate approach for estimating the mediated effect.[250] However, the measure we used may not have validly captured exercise social support from friends on SNS. While items were adapted from a previously validated scale used for family and friends, some of the examples of support may not be applicable to friends on SNS. For instance, one item asked how often friends on SNS "exercised with me." Yet some Facebook users may not have actually met or been capable of meeting (due to geographic constraints) their friends on Facebook in person to exercise. In addition, the measure used may more adequately capture the types of social support derived through offline support (e.g., instrumental), as opposed to online SNS (e.g., emotional, companionship, informational). Furthermore, our measure inquired about all friends on SNS, which participants may have interpreted to include both friends outside of the study and within the same Facebook study group. The observed increase in this measure among the SC group could be reflective of perceived support derived from Facebook posts by other SC group participants. However, the post-intervention only measure that asked specifically about social support from other FITNET study group members showed no difference between groups. With this conflicting evidence, we are unable to disentangle the specific effects of other FITNET group members over time on perceptions of social support for exercise in the present study.

If there were problems with the theoretical principles guiding our intervention and our related hypothesis about the intervention increasing social support from friends on SNS, then it seems unlikely that we would have observed a significant increase in this mediating variable over time in the SC group. Rather, our findings suggest that group interaction prompted by peers who share a similar cancer experience, rather than the study administrator,

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may be a superior intervention strategy for positively influencing perceptions of social support among young adult cancer survivors. Alternatively, exposure to the intervention and baseline measures may have potentially affected reinterpretation of the items measuring social support from friends on SNS.[262] For instance, intervention participants may have developed a better understanding of the influence of social support on PA and had greater awareness about potential deficits in social support at follow-up. Taken together with the results on other forms of social support, it appears that intervention strategies to improve social support from friends, whether in-person or on SNS, may facilitate improvements in PA behavior change in young adult cancer survivors. Recent research has shown that young adult cancer survivors have specifically acknowledged a need for interventions that offer social support.[138] Therefore, additional research on social support for exercise, including improved measures and strategies for increasing support from friends and friends on SNS, are warranted among young adult cancer survivors.

It has been shown previously that social support influences self-efficacy, which in turn affects PA behaviors among young adults.[77] In the present study, self-efficacy did not mediate the effects of the intervention on changes in PA in young adult cancer survivors, possibly due to an insufficient increase in social support. The intervention appeared to have a negative effect on self-efficacy for sticking to exercise relative to the SC group. While self-efficacy has been recognized as an important predictor of PA in cancer survivors, no other mediation analyses of PA intervention studies in young adult cancer survivors are available for comparison. However, our findings are consistent with other 12-week home-based PA interventions among breast cancer survivors that have not found self-efficacy to be a mediator of PA behaviors.[248, 249] Mediation analyses of a home-based exercise intervention

that involved weekly telephone counseling and pedometers determined that self-efficacy did not mediate intervention effects on moderate-intensity PA, despite the intervention producing positive changes in psychosocial factors from baseline to post-intervention in the intervention group.[249] Another mediation analysis of a PA intervention using print materials based on Theory of Planned Behavior constructs showed that self-efficacy was not a mediator of the intervention effects on PA behavior change in breast cancer survivors.[248] Contrary to our findings, results from a more intensive 12-week exercise intervention for breast cancer survivors, which included weekly supervised exercise sessions, discussion groups and face-to-face counseling, found that barriers self-efficacy partially mediated the effect of the intervention on objectively measured PA change.[125] However, results from a mediation analysis of a PA intervention among adolescents found that the intervention had a negative effect on self-efficacy, which resulted in unexpected inconsistent mediation effects that suppressed the effect of the intervention on PA.[254]

A potential explanation for the lack of mediation effect by self-efficacy is the small study sample size, which limited statistical power. Furthermore, post-intervention self-efficacy was concurrently assessed with PA after 12 weeks. Assessment of potential mediators during the course of the intervention and prior to the final PA outcome assessment might have improved our ability to show mediation effects. It is also possible that other psychosocial factors, measured or unmeasured, mediated the effect of self-efficacy on changes in PA.[93] Finally, as the intervention appeared to have negatively affected changes in self-efficacy, participants' adherence to the intervention may have waned over the course of the intervention, as is common with web-based intervention studies, resulting in decreased confidence that they could stick with an exercise program. Another possibility is that

participants, having overcome cancer treatment and other potentially life-threatening circumstances, had higher health-related self-efficacy at baseline; exposure to intervention content may have given participants a more accurate perception of their self-efficacy related to PA. Alternatively, the decrease in self-efficacy among intervention participants may be indicative of problems with the theory-based intervention strategies that we used. It has also been suggested that achieving increases in self-efficacy that are adequate to predict behavior change may require supervised PA intervention components.[125] Future research should continue to explore the underlying psychosocial mechanisms of PA interventions in larger samples of young adult cancer survivors.

We found that the intervention did not positively impact self-monitoring in the intervention group relative to the SC group. Changes in self-monitoring, however, were significantly positively associated with increases in PA in the full sample of young adult cancer survivors. This is consistent with findings from Rovniak et al.,[77] that demonstrated in college-aged young adults, that self-regulation significantly predicted greater PA after 8 weeks. Using structural equation modeling, this study also found that self-regulation mediated the effect of self-efficacy on PA behaviors, while social support influenced self-efficacy, which in turn positively influenced self-regulation and PA behaviors.[77] Indeed, results of the present study indicated that social support from friends on SNS partially mediated the effect of the intervention on self-efficacy for sticking to exercise, and changes in social support from friends on SNS was positively associated with changes in self-efficacy for sticking to it. Considering the lack of increased social support in the intervention group, this may partially explain why no significant improvements in self-efficacy or self-regulation were found in the intervention group relative to the SC. In other words, the effects of the

intervention on social support were insufficiently positive enough to exert positive effects on self-efficacy and in turn self-monitoring.

Another possible explanation for the lack of self-monitoring improvements favoring the intervention group may be related to their receiving guidance and access to a goal-setting and exercise tracking tool. This may have helped intervention participants to more accurately report their self-monitoring behaviors compared to the SC group, which may have over-reported self-monitoring. In exploratory analyses of intervention participants that completed the 12-week study, we found that reported self-monitoring at 12 weeks was significantly associated with objective measures of goal-setting and total number of PA entries and steps entries over 12 weeks. Without an objective measure to corroborate reported self-monitoring in the SC group, we are unable to clarify the intervention effects on self-monitoring relative to the SC group. Considering that changes in self-monitoring were significantly positively associated with reported weekly MVPA across groups, further research on self-monitoring as a potential mediator of PA in young adult cancer survivors is warranted.

Since the intervention was relatively low-intensity, had a short timeframe, and was delivered entirely electronically without face-to-face interaction, the lack of positive changes on psychosocial factors is not surprising and suggests that more intensive intervention approaches be examined among young adult cancer survivors. Alternatively, with the extensive reach of online SNS, such as Facebook, it could be argued that achievement of small changes in psychosocial factors that encourage improved PA behaviors among larger populations might have greater public health implications. With the potential for Internet communication to facilitate support for cancer survivors,[160] and the high prevalence of SNS

use among young adults, future studies are necessary to elucidate components and mediators of SNS interventions that promote healthy behavior change in young adult cancer survivors.

This study presents some initial evidence on potential mediators of PA change in young adult cancer survivors that use SNS. Limitations of the study include the use of self-reported measures of PA and the relatively homogeneous sample, which limits generalizability of study results. Due to the relatively small sample size, the study may have been underpowered to detect mediational effects. However, we used more robust bootstrapping procedures that are appropriate for small samples.[250] As previously mentioned, data on psychosocial mediators were collected simultaneously with post-intervention data on PA outcomes, rather than prior to the final assessment. In addition, the multicomponent intervention design limited our ability to isolate the effects of individual intervention components on potential mediators of PA behavior change. Future studies are needed to elucidate the relative importance of various intervention components and the associated underlying mechanisms of PA behavior change in cancer survivors. Strengths of the study were that it was a longitudinal, randomized controlled trial delivered through a popular existing SNS. It is one of the first mediation analyses of PA behavior change among young adult cancer survivors, a relatively understudied population.

This study examined the potential underlying mechanisms of a SNS-based intervention that produced significant increases in self-reported mild PA relative to an SC group. Our findings suggest that the lack of intervention effects on MVPA may be related to insufficient changes in SCT constructs and partial suppression of effects by social support from friends on SNS. SCT constructs may provide a useful framework for designing intervention strategies to promote improved PA behaviors in young adult cancer survivors,

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but more research is necessary. Future research should examine the potential of SNS for promoting social support, self-efficacy and self-monitoring for behavior change and identify mediational pathways that influence the effectiveness of online SNS for PA change.

Table 6.1. Effects of FITNET intervention on Social Cognitive Theory constructs post-intervention (n = 86)

Variable and Possible Range	Baseline	12 weeks	Mean Change	Time	Group x Time Interaction
	M (SD)	M (SD)	M (95% CI)	*P*	*P*
Self-efficacy – sticking to it (1-5)					**0.025**
FITNET	3.71 (0.86)	3.33 (0.93)	-0.38 (-0.62, -0.12)	**0.005**	
SC	3.63 (0.77)	3.63 (0.83)	-0.01 (-0.20, 0.20)	0.944	
Self-efficacy – making time (1-5)					0.736
FITNET	3.57 (0.94)	3.34 (1.06)	-0.23 (-0.48, 0.03)	0.079	
SC	3.61 (0.95)	3.44 (1.02)	-0.17 (-0.41, 0.08)	0.178	
Social support – total (15-75)					0.597
FITNET	29.11 (13.12)	29.13 (10.11)	0.02 (-2.58, 2.88)	0.987	
SC	30.80 (10.70)	31.98 (12.20)	1.17 (-1.81, 4.46)	0.455	
Social support – family (5- 25)					0.551
FITNET	10.56 (5.30)	10.82 (5.11)	0.27 (-0.86, 1.53)	0.657	
SC	11.98 (4.92)	11.68 (5.70)	-0.29 (-1.62, 1.21)	0.688	
Social support – friends (5-25)					0.808
FITNET	10.18 (5.69)	10.40 (5.37)	0.22 (-0.90, 1.49)	0.712	
SC	11.00 (5.76)	11.00 (5.64)	0.00 (-1.35, 1.53)	1.000	
Social support – SNS friends (5-25)					**0.039**
FITNET	8.38 (5.36)	7.91 (3.98)	-0.47 (-1.45, 0.65)	0.397	
SC	7.83 (4.24)	9.29 (5.13)	1.46 (-0.002, 3.20)	**0.050**	
Self-monitoring (1-5)					0.479
FITNET	2.25 (0.81)	2.44 (0.87)	0.19 (-0.04, 0.43)	0.104	
SC	2.40 (0.93)	2.73 (1.06)	0.33 (0.09, 0.59)	**0.006**	

Note. Mean and SD at baseline and 12 weeks are based on raw data. Mean changes are estimated from mixed model analyses. Number of participants for all models was: FITNET group, n=45; Self-help Comparison group, n=41. FITNET, FITNET intervention group; SC, self-help comparison group.
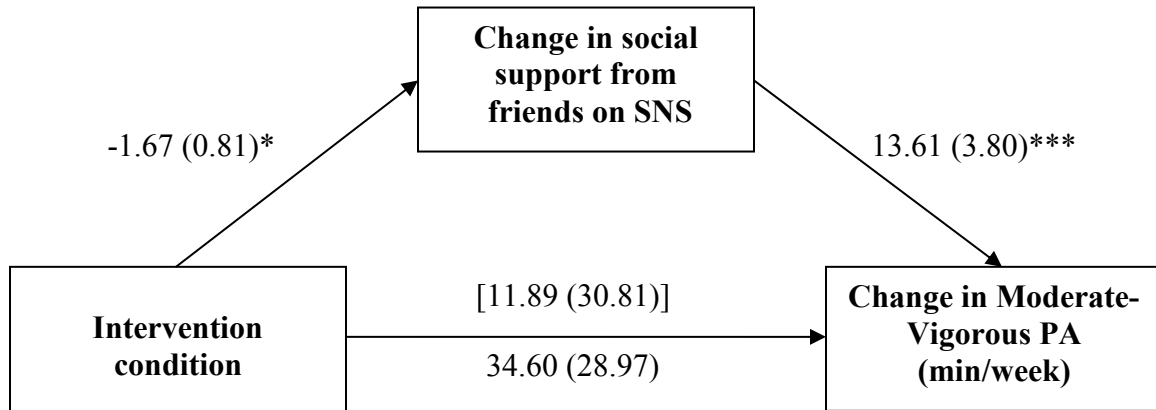
Figure 6.1. Diagram of model testing self-efficacy for sticking to it as mediator of intervention effects
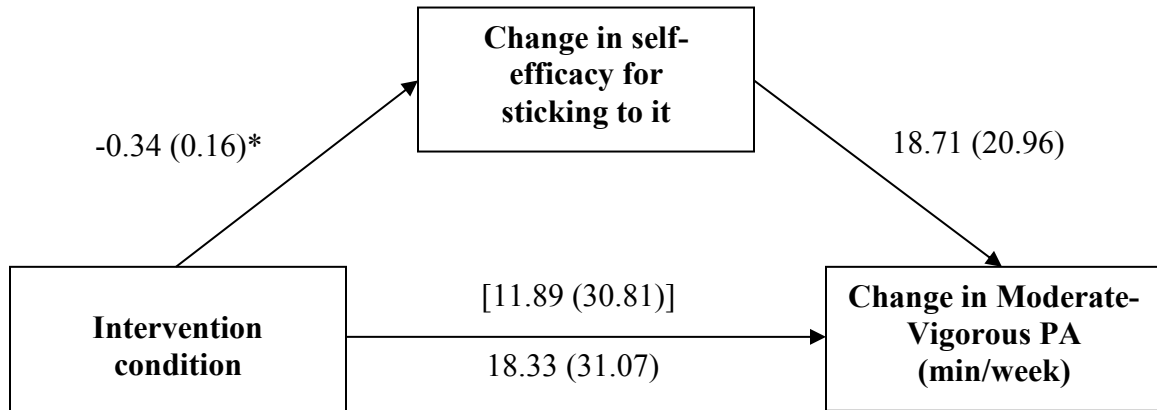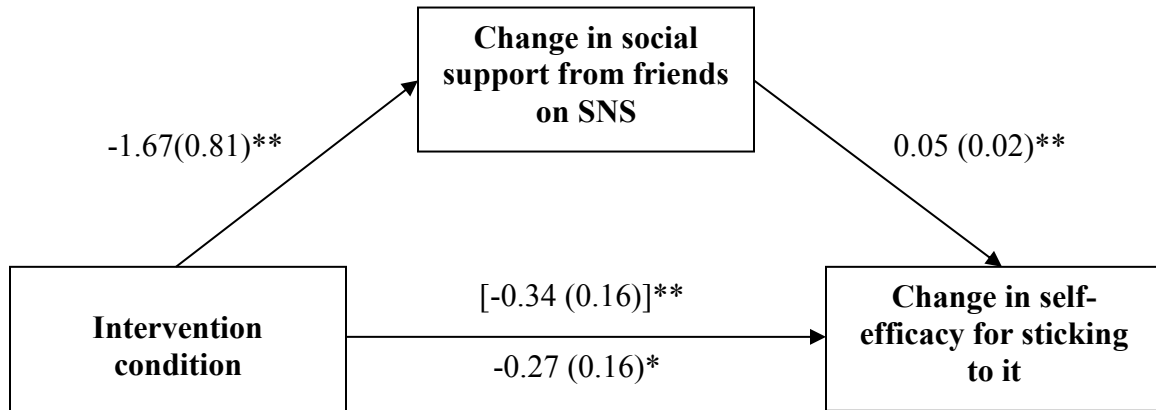

Note. Diagram of model testing residualized change in self-efficacy for sticking to it as a mediator of the effects of intervention condition on residualized change in self-reported moderate-to-vigorous intensity physical activity minutes per week. Unstandardized regression coefficients are shown with standard errors in parentheses. Coefficients in the brackets are from models not including the mediator (total effect). PA, physical activity. *$p \leq 0.05$, **$p \leq 0.01$.

Figure 6.2. Diagram of model testing social support from friends on social networking sites as mediator of intervention effects

Note. Diagram of model testing residualized change in social support from friends on social networking sites as a mediator of the effects of intervention condition on residualized change in self-reported moderate-to-vigorous intensity physical activity minutes per week. Unstandardized regression coefficients are shown with standard errors in parentheses. Coefficients in the brackets are from models not including the mediator (total effect). SNS, social networking sites; PA, physical activity.
*$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.001$.

Figure 6.3. Diagram of model testing social support as mediator of self-efficacy for sticking to physical activity

Note. Diagram of model testing residualized change in social support from friends on social networking sites as a mediator of the effects of intervention condition on residualized change in self-efficacy for sticking to it. Unstandardized regression coefficients are shown with standard errors in parentheses. Coefficients in the brackets are from models not including the mediator (total effect). SNS, social networking sites; PA, physical activity.
*$p \leq 0.10$, **$p \leq 0.05$.

CHAPTER VII

SUMMARY AND RECOMENDATIONS

VII.A. Summary of Findings

The goal of this research project was to assess whether an existing social networking site (SNS) is an effective channel to deliver a physical activity (PA) intervention to young adult cancer survivors. Major findings of this dissertation demonstrated that: 1) general health, body mass index (BMI), perceived cancer risk, health-related Internet use, and trust in information sources were predictors of not meeting PA guidelines in a national sample of young adults; 2) a SNS-based intervention was feasible and effective for producing significant increases in mild PA relative to a self-help comparison group, while both groups increased moderate-to-vigorous PA (MVPA) over time; 3) in mediation models, the proposed psychosocial mediators targeted through the intervention (self-efficacy, social support, self-monitoring) did not explain the positive effect of the intervention on mild PA; and 4) social support from friends and self-monitoring were positively associated with changes in MVPA among all study participants. The finding that participants in the unmoderated comparison group significantly increased perceptions of social support from friends on SNS over time, while the use of a study moderator did not enhance social support among intervention group participants, was an unexpected but noteworthy contribution of this dissertation project. Overall, the results of this dissertation suggest that Facebook- and SNS-based approaches may be effective ways to recruit, reach and deliver behavioral interventions to young adult cancer survivors who are interested in improving their PA behaviors.

Current efforts to promote healthy PA behaviors in cancer survivors do not adequately meet the needs of young adult cancer survivors. Compared to their young adult peers without a history of cancer, young adult cancer survivors are more likely to be obese and have chronic conditions,[29] and less than half are adhering to PA guidelines; clearly more behavioral interventions are necessary to help reduce risk for future morbidity and enhance quality of life in this population. Behavioral interventions for cancer survivors that are self-directed and home-based have potential for greater dissemination and at a lower cost than supervised, in-person interventions. It is unknown whether SNS approaches are as effective as other home-based approaches that have previously improved PA behaviors in cancer survivors (e.g., telephone counseling, tailored print materials with and without telephone counseling, pedometers and theory-based print materials). This dissertation project addressed this research gap and was responsive to previous research suggesting that a peer- and technology-based approach appears to be an effective way to reach young adult cancer survivors.[139] However, SNS-based strategies may not appeal to all young adults or reach those in greatest need who lack access to the Internet and other technologies. Thus, additional research on PA interventions among young adult cancer survivors is necessary.

The information in this dissertation contributes to the design and delivery of PA interventions for young adult cancer survivors in five main ways: 1) by increasing understanding of sociodemographic and communication factors associated with not meeting PA recommendations in young adults; 2) by evaluating the feasibility of recruiting and retaining young adult cancer survivors in a home-based PA intervention delivered through a popular and publicly available SNS; 3) by assessing the efficacy of an enhanced, theory- and Facebook-based intervention on PA behaviors in young adult cancer survivors compared to a

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more minimal Facebook-based self-help education approach; 4) by examining the effects of the intervention on changes in psychosocial factors and identifying psychosocial determinants of PA behaviors in young adult cancer survivors; and 5) by determining whether psychosocial factors mediated the relationship between the intervention and changes in PA in young adult cancer survivors.

In the first aim, presented in chapter IV, we conducted an exploratory signal detection analysis using data from the 2007 Health Information National Trends Survey (HINTS), to identify mutually exclusive subgroups of young adults that vary in their likelihood of not meeting PA recommendations. Among the eight subgroups identified, frequency of not meeting recommendations ranged from 31%-90%. Predictors of insufficient PA included general health, BMI, perceived risk for cancer, using the web for help with diet, weight or PA, and trust in health/medical information on television or the Internet. These findings helped to describe groups at highest risk of not meeting PA recommendations and to identify potential intervention communication channels for PA interventions in young adults. Results suggested that obese young adults may be in greatest need of interventions to help them achieve weight loss and increase PA. Furthermore, using the web for help with diet, weight or PA was a distinguishing characteristic among groups, suggesting that some young adults that are turning to the Internet for help may be interested in Internet-based PA and/or weight control interventions. There were no significant differences among the eight subgroups in reported use of SNS, which supported our rationale for examining intervention strategies to increase PA among young adult cancer survivors using an existing SNS.

In the second aim, found in chapter V, we designed and tested the efficacy of a theory-based PA intervention (FITNET) for young adult cancer survivors compared to a self-

help comparison (SC) condition, both of which were delivered through Facebook. Young adult cancer survivors (n=86) were successfully recruited primarily through social media advertisements posted by community-based organizations focused on young adults with cancer. From targeted emails to over 60 organizational members and stakeholders of the LIVE**STRONG** Young Adult Alliance, we observed 31 separate Facebook posts from 18 different organizations that advertised the study and 22 tweets from 12 organizations. An additional 21 Facebook posts were shared by the study administrator and 15 different individuals with whom the study administrator was friends on Facebook. Almost half of the young adult survivors screened and enrolled learned about the FITNET study through Facebook posts by cancer organizations. More specifically, of the 167 respondents to the online screener and the 86 randomized, young adult cancer survivors learned about the FITNET program most often through Facebook posts by cancer organizations (45% and 42% respectively), Facebook posts by friend/family (23% and 28%), and on a website (14% and 9%). Analytic data on the study website (www.fitnet-unc.org) during the recruitment period from mid-April to mid-August 2011 indicated that 983 unique visitors came from 20 countries/territories, while study participants hailed from the United States and Canada. Over the whole study period from mid-April through December 2011, the study website received 3,010 visits from 38 countries/territories. Although enrollment of participants from across North America precluded our ability to collect objective measures of PA, our study had the advantage of reaching participants from geographically diverse regions of the continent. These findings demonstrate the feasibility of recruiting young adult cancer survivors through community-based cancer organizations via Internet and SNS-based communications.

Consenting participants were randomly assigned to one of two Facebook groups and received either enhanced Facebook messages, access to a self-monitoring website and moderated group discussions (FITNET), or basic Facebook messages and unmoderated group discussion (SC) over the course of 12 weeks. We assessed several variables, including self-reported PA, quality of life, body weight, Social Cognitive Theory (SCT) variables, and process-related variables. Having designed the intervention with the goal of increasing moderate-intensity PA levels among young adult cancer survivors to at least 150 minutes per week with a focus on walking, we hypothesized that participants in the FITNET group would report more weekly minutes of MVPA at 12-week follow-up relative to those in the SC group. While both intervention and comparison group participants showed increases in MVPA over 12 weeks (FITNET: 67.0 min/week, $p=0.009$ vs. SC: 46.3 min/week, $p=0.045$), there was no significant difference between groups. However, participants in the FITNET group had a significant increase in self-reported weekly minutes of mild PA (FITNET: 163.6 min/week vs. SC: 28.5 min/week; $p=0.032$ between groups) and a marginal increase in weekly minutes of total PA (FITNET: 237.0 min/week vs. SC: 75.7 min/week; $p=0.078$ between groups) as compared to the SC group. An unexpected finding was that intervention participants reported significantly decreased weight over time (FITNET: -2.1 kg, $p=0.004$ vs. SC: -0.1 kg, $p=0.904$), which was marginally significant between groups ($p=0.083$). Participants in both groups agreed that accessing study information was easy and an effective way to get information about exercise. On average, both groups enjoyed participating in the study and would recommend the program to other young adult cancer survivors. These findings suggest that Facebook-based approaches may be an appropriate way to reach and deliver PA interventions to young adult cancer survivors and should be studied further.

In the third aim, presented in chapter VI, we assessed how the intervention affected SCT constructs and conducted a mediation analysis to determine if any of these psychosocial constructs mediated the effect of the intervention on changes in PA outcomes among young adult cancer survivors. We found that self-efficacy for sticking to PA and social support from friends on SNS was lower in the FITNET group as compared to the SC group, but found no other differences between groups. Among all study participants, changes in total social support, social support from friends, and changes in self-monitoring were significantly positively associated with changes in MVPA. Results of mediation analyses suggested that changes in social support from friends on SNS may have suppressed the effects of the intervention on changes in MVPA. The lack of an intervention effect on MVPA found in aim 2 may partly be a function of insufficient positive changes in psychosocial constructs among intervention participants over the 12 weeks.

VII.B. Recommendations

Aim 1

The results from aim 1 highlight the variability in sociodemographic and health communication characteristics across subgroups of young adults that are more or less likely to engage in recommended levels of PA. These distinctive groups might not have been identified through more traditional logistic regression methods. Specifically, signal detection analyses allowed for segmentation of young adults into eight subgroups and identification of two subgroups at highest risk for not meeting PA recommendations, both of which reported poor to good general health—one was further characterized by obesity and the other by overweight status and a low perception of risk for developing cancer in the future.

Results of these exploratory analyses achieved the overall study goal of generating future hypotheses related to PA behaviors in young adults. In particular, study findings might lead us to hypothesize that PA levels could be improved by capitalizing on motivation to lose weight and targeting weight loss interventions to the specific needs of young adults. We might also hypothesize that health communication campaigns or interventions that educate young adults about their cancer risk and emphasize PA as a way to prevent some cancers might increase the proportion of young adults that meet PA recommendations. Furthermore, exercise interventions that are aimed at smoking cessation may also be effective for enhancing PA behaviors among this population.

Our study is the first, of which we are aware, to classify subgroups of PA in young adults by communication-related behaviors and suggests some important implications for targeting young adults using various media. Use of websites for help with diet, weight or PA emerged as a significant predictor of not meeting PA recommendations. Of the two subgroups at lowest risk for not meeting PA recommendations, one subgroup included participants that had used these websites while the other included participants that had never used these websites. In another subgroup that reported not using diet, weight and/or PA websites, over half of young adults were not meeting PA guidelines. This suggests that both web-based and offline delivery of health information to young adults might be worth testing. In addition, trust in Internet and television as sources of health information were also distinguishing characteristics and highlight the potential role that health literacy may play in promoting better understanding of health messages and improving health behaviors among young adults. Finally, social media use continues to grow among this demographic, and our results on data from 2008 showed no significant differences in use across subgroups of

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inactivity. Further elucidation of young adult preferences for intervention format delivery and identification of the "active ingredients" for effective web-based and technology-based PA interventions among young adults deserves future attention. Furthermore, given the high rates of obesity and physical inactivity in young adults, interventions that focus on helping adolescents develop and maintain healthy behaviors before they transition into young adulthood appear warranted.

We have demonstrated the utility of signal detection analyses for identifying subgroups at higher or lower risk for a particular behavior in a nationally representative sample, which enhances generalizability of our findings. But the cross-sectional study design limits our ability to characterize the temporality of these relationships with PA behaviors. A potentially more useful application of signal detection methodology is to identify subgroups of study participants that perform better or worse (e.g., lose 10% body weight) in prospective randomized trials of behavioral interventions. Results of these analyses could enhance our understanding of the most effective intervention strategies for different subgroups of participants, identify constructs for future tailoring of intervention messages, and help to improve upon existing intervention strategies. Finally, we undertook this study with HINTS data to better understand predictors of PA in young adult cancer survivors, since previous studies suggest that their PA behaviors may be similar to their noncancer peers. The sample size of young adults with a history of cancer in HINTS 2007 data precluded our ability to identify PA predictors specific to young adult cancer survivors. Therefore, additional research using data specifically on young adult cancer survivors is necessary.

Aims 2 and 3

Research among young adult cancer survivors diagnosed specifically during young adulthood, as opposed to during childhood, has emerged only recently. Furthermore, no randomized trials of PA interventions for this population have been published to date. Thus, it is noteworthy that the FITNET study was one of the first to test a completely home-and Internet-based, self-directed intervention to promote PA among a relatively understudied population of young adult cancer survivors recruited from across North America. In addition, this was one of the initial studies to evaluate the efficacy of a Facebook-based approach to promoting PA in a randomized trial.

As anticipated, we demonstrated the feasibility of recruiting and retaining young adult cancer survivors to participate in a Facebook-based PA intervention. Over a four-month recruitment period, largely due to social media advertising by community-based organizations focused on young adults with cancer, we screened 167 individuals, consented 97 (58% of screened) and randomized a total of 86 (89% of consented) young adult cancer survivors. While participants were predominantly educated, White women, there was considerable variability in cancer types, months since diagnosis, and geographic areas represented. Over three-quarters of participants completed the post-intervention assessment, which is comparable to other Internet-based studies, though lower than other PA interventions among cancer survivors. Together, these findings indicate that Facebook may be a suitable recruitment and delivery channel for behavioral interventions among young adult cancer survivors. We recommend that researchers continue to examine ways to recruit and deliver behavioral interventions to young adult cancer survivors via SNS. Additionally, recruitment of more diverse and larger sample sizes of young adult cancer survivors to

behavioral interventions is necessary. With the large proportions of young adults and racial/ethnic minorities using SNS,[149] researchers should consider examining the use of SNS to promote healthy behaviors in these populations.

We found that the theory-based FITNET intervention delivered primarily through Facebook produced marginally significant increases in self-reported total PA among young adult cancer survivors. Although differences in mild PA were achieved, weekly minutes of MVPA were not different between the FITNET and SC groups (between-group difference in mean change=24 min/week). On the contrary, previous 12-week home-based interventions among breast cancer survivors produced significant increases in self-reported MVPA ranging from 57 to 98 min/week relative to a comparison group.[105, 115] However, it is difficult to make comparisons with these previous PA intervention trials, as ours is the first to be delivered primarily via Internet, to focus specifically on young adults diagnosed with cancer during young adulthood, and to include young adult survivors of various cancer types.

In the present study, the lack of an intervention effect on MVPA relative to the SC group could be due to insufficient power to detect a significant difference as a result of a small sample size and a larger within-group variance than we had anticipated. It is also possible that the lack of differences in MVPA were attributable to the particular intervention strategies used. Unfortunately, the comprehensive nature of the FITNET program, with multiple components targeting multiple psychosocial constructs, did not allow us to determine which specific strategies accounted for the group differences in mild PA.

However, synthesis of results from aims 2 and 3 allows for further speculation on potential explanations for our findings, which are summarized in Table 7.1 below. The intervention components delivered and studied in both aims 2 and 3 were designed using

theoretical constructs from SCT, including PA-related self-efficacy, social support, and self-monitoring. Our results from aim 2 suggest that group discussions through Facebook posting were not responsible for the improvements in mild PA, and the highest and lowest users of self-monitoring components in the intervention group engaged in higher levels of MVPA. The fact that the lowest users of goal-setting and PA tracking reported MVPA levels that were comparable with the most frequent users of these self-monitoring strategies is a puzzling pattern that is an atypical finding contrary to the dose-response relationship often found in intervention studies.

Results from aim 3 shed additional light on the potential relationships among the intervention components, the theoretical constructs they were meant to improve, and PA outcomes. We found no differences between the groups on most of the theoretical constructs, with the exception of self-efficacy for sticking to PA and social support from friends on SNS. In contrast to the lack of group differences in number of Facebook posts, perceptions of social support from friends on SNS were significantly lower in the FITNET group compared to the SC group, which reported increases in this psychosocial factor over time. Among the total sample of young adult cancer survivors, total social support, social support from friends and self-monitoring were significant predictors of weekly self-reported MVPA, while self-efficacy was not.

Overall, it appears that the FITNET intervention did not produce changes in the intended SCT constructs. The lack of changes in psychosocial factors in the expected direction may be indicative of an insufficient intervention dose or problems with the measurement of our mediation variables. Ultimately, the lack of significant improvements in SCT constructs were likely important reasons for lack of significant differences in MVPA.

However, our findings are consistent with previous PA interventions among cancer survivors that showed no significant effects on social support or self-efficacy, extending this to young adult cancer survivors.

While we found a positive association between social support from friends on SNS and changes in MVPA levels, the intervention had no effect on this mediating variable while the comparison group significantly increased on this measure, resulting in a suppression effect. In other words, the effect of the intervention on MVPA appeared to be attenuated, partly due to the significant increase over time in social support from friends on SNS among the SC group. Findings from these mediation analyses, however, should be interpreted with caution. The inconsistent mediation and large confidence interval for the mediated effect indicate that insufficient sample size and/or measurement errors related to the mediating variable may be possible issues.[258] That our proposed psychosocial mediators did not explain the positive intervention effects on mild PA is not surprising and is comparable to findings from previous mediation analyses of PA intervention studies among cancer survivors. Among the seven published mediation studies in the literature, most did not find that social support or self-efficacy mediated PA behaviors among cancer survivors.[107, 125-127, 248, 249] This highlights the need for more research on psychosocial determinants and mediators of PA in cancer survivors.

There are several possible explanations for the unexpected finding that perceived social support from friends on SNS significantly increased over time in the SC group. First, since any discussion within this group was unprompted by the study moderator and initiated by participants, it is possible that the posts and comments that naturally emerged among peers with shared cancer experiences more positively influenced perceptions of social

support. Second, the lack of changes in perceived social support from friends on SNS among intervention participants may reflect a negative effect of having a study moderator posting to the Facebook group. FITNET group participants may have grown tired of attending to the frequent posts and questions by the study moderator and/or the more visible presence of a study administrator may have prevented participants from freely engaging in discussion on their own topics of interest.

Third, the measure used may not have validly captured exercise social support from friends on SNS. While items were adapted from a previously validated scale used for family and friends, some items may not have been applicable to friends on SNS. For instance, one item asked how often friends on SNS "exercised with me." Yet, participants may not have actually met some of their friends on SNS in person. Alternatively, exposure to the intervention may have enhanced participants' awareness about not receiving adequate social support, thereby potentially improving their accuracy in reporting levels of social support. It has been shown that behavioral interventions may induce response bias by influencing self-reporting of behavior changes independent of true change,[263] and exposure to an intervention may influence interpretation of items related to a psychosocial construct.[258, 262] Taken together with the results on other forms of social support, it appears that increasing social support from friends, whether in-person or on SNS, may facilitate improvements in PA behavior change in young adult cancer survivors.

In the present study, functionalities accessible to participants through the SNS included posting comments, links or videos to the wall, liking and reading comments. Yet, we do not have a clear understanding of what specific functionalities used influenced perceptions of support and promoted user engagement among participants. In light of the

finding that SC group participants, without prompts from a moderator, increased perceptions of social support from friends on SNS while posting as frequently as FITNET participants, future research is necessary to examine alternative strategies to increase social support from friends on SNS. In particular, the potential for unprompted or minimally guided group discussions on SNS to enhance social support for healthy behaviors among cancer survivors should be examined further. Strategies to enhance social support within an existing SNS that could be tested include: 1) allowing relationships and conversations to naturally emerge on a SNS vs. directed discussions; 2) use of video narratives from peers vs. study personnel; or 3) disseminating health information within an existing Facebook group using a community-based organization page as the unit of randomization vs. building a new group with individuals as the unit of randomization.

Interestingly, though the intervention was designed to target self-efficacy, specifically through the use of verbal persuasion (e.g., lessons on overcoming barriers and goal-setting, and encouragement from peers), feedback on performance (e.g., weekly goal-setting and self-monitoring tool provided progress reports), and vicarious experience (e.g., role modeling and social support from peers), we found a decrease in self-efficacy for sticking to it among intervention participants. This finding that change in self-efficacy was not related to PA behaviors is partially supported by results of our signal detection analyses in aim 1, in which health-related self-efficacy was not a significant predictor of meeting PA recommendations among young adults.

It is possible that self-efficacy for PA may not be as salient for young adult cancer survivors as for other populations for whom self-efficacy has been shown to mediate PA behaviors. However, an alternative and perhaps more likely explanation is that enhancing

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self-efficacy for PA in young adults that have faced cancer and overcome a life-threatening illness is more complex than increasing self-efficacy for PA in healthy individuals.[107] Participants may have started with higher confidence overall in their ability to overcome obstacles and overestimated their self-efficacy for PA. After 12 weeks of behavioral lessons about PA, intervention participants may have become better at more accurately judging their self-confidence for exercise. It is also possible that SC group participants may have set goals and experienced adequate feedback from a pedometer to increase their self-confidence. Given the lack of evidence on mediators of PA in young adult cancer survivors, further research is necessary.

In addition, more research on self-monitoring tools and additional features that have been shown to be related to improved PA adherence (e.g., tailored feedback) and can be accessed from within the existing Facebook platform (e.g., Facebook applications) is warranted. Rather than accessing complementary intervention components or functionalities within a SNS, it is could be that other strategies might be better accessed through a different technology platform. For instance, perhaps a SNS group is most beneficial as a discussion forum for an intervention that is otherwise delivered via text messages. As the dynamic growth in technology has greatly influenced communication platforms and patterns over the years, younger populations may have grown accustomed to accessing multiple media channels and attending to smaller sound bites of information, such as text messages and 140 character tweets. Therefore, additional testing of whether more minimal, but more frequent and less time-intensive strategies, like the simpler messages offered to SC group participants, might be effective among young adult cancer survivors is warranted.

Because the intervention was a comprehensive program, with some strategies potentially influencing multiple psychosocial factors, it was not possible with the current study to isolate the specific effects of individual intervention components on SCT constructs. For example, the goal-setting tool may have influenced both self-monitoring and self-efficacy; yet intervention participants did not demonstrate favorable changes in either of these constructs relative to the comparison group. The randomized trial lacked a true control group, as the SC group received materials that could have feasibly influenced psychosocial factors. For instance, all participants received pedometers, which if used, provided feedback on walking performance and may have positively influenced self-efficacy and self-monitoring among SC participants. Together, these limitations hinder our ability to draw clear conclusions about the utility of specific intervention components used. In the future, intervention designs that allow for specific testing of an individual intervention component (e.g., true control group, factorial design) would be beneficial for determining the "active ingredients" in an intervention that produce changes in PA among young adult cancer survivors.

VII.C. Theoretical Implications

The intervention components delivered and studied in both aims 2 and 3 were designed using theoretical constructs from SCT, including PA-related self-efficacy, social support, and self-monitoring. As previously described, several intervention trials among cancer survivors have used SCT constructs to guide the development of health promotion interventions[103-105, 107, 116, 124]; however, ours is one of the first to test a theory-guided PA intervention specifically among young adult cancer survivors.

At the time we designed the intervention, due to insufficient information on PA determinants in young adult cancer survivors, we relied on evidence in other populations, such as childhood cancer survivors, and from previous theory-based interventions among cancer survivor populations. Only recently has one study been published about PA determinants in Canadian cancer survivors specifically diagnosed as young adults (ages 20-44) using the Theory of Planned Behavior as a framework.[45] While our intervention did not positively impact the hypothesized mediators of PA, among the total study sample, total social support, social support from friends, and self-monitoring were positively associated with changes in MVPA in the expected direction. These findings support previous evidence on social support and self-monitoring as determinants of PA, extends them to young adult cancer survivors, and suggests that targeting social support and self-monitoring in future interventions may facilitate improvements in PA behaviors among young adult cancer survivors.

Our finding that changes in social support from friends on SNS mediated the intervention effect on self-efficacy for sticking to PA suggests that the lack of improvement in social support may explain the insufficient increase in self-efficacy and in turn a lack of change in MVPA. Since previous intervention studies among cancer survivors have demonstrated that self-efficacy mediated dietary behaviors, additional research is needed among young adult cancer survivors to understand the role of self-efficacy in mediating PA and other healthy behaviors and how specifically to promote it.

Finally, few psychosocial measures have been psychometrically tested and validated among young adult cancer survivors. Improved measurement of perceived social support, from friends on SNS in particular, is important for advancing our understanding of how SNS

can be utilized to effectively facilitate changes in health behavior. Therefore, future research should create or adapt existing measures of SCT constructs, conduct psychometric testing, and determine their validity in young adult cancer survivors.

VII.D. Future Directions and Research Needs

Based on the findings of this dissertation project, recommendations for possible areas of future research are as follows:

1. There is still a dearth of information on predictors and mediators of PA in young adult cancer survivors that were specifically diagnosed during young adulthood, as opposed to childhood. Future research should be conducted to identify these determinants among diverse populations of young adult cancer survivors, as this would be helpful for guiding the development of future behavioral interventions. The upcoming iteration of HINTS in August 2012 presents a potential opportunity to replicate our analyses or combine datasets and focus specifically on young adult cancer survivors. Alternatively, identification of PA determinants among young adult cancer survivors may now be feasible using other recently released datasets (e.g., NCI's Adolescent and Young Adult Health Outcomes and Patient Experience survey, LIVE**STRONG** survey of cancer survivors). Moreover, analyses from longitudinal studies and in-depth qualitative research should be pursued to more adequately describe barriers and facilitators to PA in young adult cancer survivors and other factors that might influence their adherence to PA.

2. In order to guide the development of future SNS-based interventions among young adult cancer survivors, additional research is necessary to better understand how they use sites like Facebook and to characterize the different types of users that might benefit from

certain features of a behavioral intervention more than others. Using data from the current study, a content analysis of Facebook comments posted by participants in comparison with self-reported data on how they use SNS would contribute to the small body of knowledge about how cancer survivors use SNS. Additionally, qualitative and quantitative analyses are necessary to shed light on how young adult cancer survivors engage with peers, the types of health information they seek, and the support they derive through Facebook and SNS participation. This could include content analyses of Facebook pages for community-based organizations that specifically serve young adult cancer survivors (e.g., Ulman Cancer Fund for Young Adults, Stupid Cancer), as well as quantitative surveys of young adult cancer survivors to capture information from those that may not be active posters, but "lurkers" on SNS.

3. The self-reported measures used in the current study have not been previously validated specifically among young adult cancer survivors. In particular, the lack of change in SCT constructs may partly be a function of using measures that did not validly capture the underlying psychosocial variable among young adult cancer survivors. In the future, cognitive testing and factor analyses of survey items would be worthwhile to enhance measurement of psychosocial factors among young adult cancer survivors. It might be especially important to develop a better measure of social support derived through SNS and characterize the types of perceived support resulting from different types of friends (e.g., never met, know in person) and different Facebook activities (e.g., reading posts, posting comments, liking a comment).

4. Future intervention studies among young adult cancer survivors would benefit from message testing and further identification of potential tailoring constructs for intervention

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messages. Various message lengths, formats and delivery channels should be tested. While some participants were active posters to the Facebook group, this was a small minority of participants, and some never introduced themselves to the group. Some participants were open about their cancer experiences, while others were not. Though we anticipated that intervention messages with specific information related to cancer survivorship would be well received, this may not have been the case for those that wanted to put their cancer behind them and rarely think about it. Data from process measures that we collected post-intervention about message relevance, trust, elaboration and amount of cancer information could provide insights on how participants processed study information and may be helpful for designing future messages. For instance, research might identify characteristics of those participants who perceived that messages had too much content about cancer and develop a measure so future interventions could tailor messages according to this characteristic. Another approach for researchers to consider testing is whether existing messages that have effectively increased PA in young adults without cancer would improve PA behaviors in young adult cancer survivors when adapting them specifically to include cancer-specific information or with few changes to the original content.

5. With the exponential growth in use of SNS and their accessibility through computers, smartphones and tablets, it is clear that SNS-based interventions must continue to be studied. Given the ability for widespread reach and evidence suggesting high participation in minority and global populations, the potential for using SNS to eliminate health disparities should be further examined. Future research is needed to determine the most effective methods and functionalities to engage users of SNS in behavioral

interventions, including strategies that are available within existing SNS or used in conjunction with SNS. Defining and measuring success in user engagement on SNS are additional challenges that should be studied further.[264] In evaluating SNS interventions, researchers should develop valid metrics to assess how engagement or interaction contributed to achieving intervention goals[264] and consider designs to isolate specific technological functions that are better at promoting engagement and PA adherence.

6. Longer-term studies should be conducted among young adult cancer survivors to determine whether the Facebook-based strategies used might produce better PA outcomes over longer periods of time. In the present study, for participants that enrolled earlier on in the study, there was a lag time between enrollment and the start of the 12-week intervention period. As a result, their baseline levels may have been elevated from initiating exercise on their own and influenced study findings. Future studies may wish to recruit participants in waves to reduce the possibility of losing participants due to waning interest over time and to decrease the potential for bias from participants starting PA on their own. In addition, objective measures of PA should be used in future studies to more accurately assess PA outcomes in young adult cancer survivors.

7. The unexpected finding of significant weight loss in the intervention group suggests that weight control and weight loss interventions might be feasibly delivered to young adult cancer survivors in part through SNS like Facebook. Indeed, we did receive questions from one participant who was specifically interested in losing weight. Given that young adult cancer survivors may be at higher risk for obesity-related chronic disease and are living for many years after treatment, future research should be conducted to understand which young adult cancer survivors are at greatest risk of weight gain during and after

treatment (e.g., breast), and examine strategies and interventions for weight control in these populations. Additionally, it is unknown whether successful weight loss programs among noncancer populations can be applied, with or without adaption, to cancer survivor populations. Future testing of evidence-based weight control interventions may be warranted among young adult cancer survivors and other survivor populations.

8. While the FITNET intervention study included broad representation by survivors of 18 different cancer types, the small sample size precluded our ability to examine outcomes by cancer type. Future PA interventions among young adult cancer survivors should attempt to recruit larger, more sociodemographically diverse sample sizes, and may wish to focus on a few particular cancer types to allow for better targeting and determination of efficacy by cancer type. Furthermore, as criteria for inclusion, all FITNET study participants had completed their cancer treatment. Given that exercise is considered safe for cancer survivors during treatment, future research that employs SNS and targets participants earlier in their cancer trajectory, (e.g., a few months after diagnosis, when transitioning off of treatment) may be worthwhile. Since the need for social support from peers may be especially relevant soon after diagnosis or during treatment, it is possible that SNS would be more beneficial for enhancing support and encouraging behavior changes earlier in the cancer continuum or within clinical settings. Results from the SC group suggest that a minimal intervention delivered in a clinical setting (e.g., survivors communicating to each other about PA and symptoms during treatment) might be worth testing as a means to enhance social support. Finally, as the use of SNS among minority and older populations continues to grow, researchers might consider conducting SNS

interventions that aim to promote health among older cancer survivors, minority and underserved communities.

In summary, this research has provided insight into the use of SNS to improve PA behaviors among young adult cancer survivors. This research lays some groundwork for the continuation of work related to understanding how people use SNS and utilizing SNS-based approaches to improve healthy behaviors. While this research has shed light on how delivering health information through Facebook can be useful to young adult cancer survivors interested in improving PA behaviors, more research is necessary to further elucidate the potential of SNS for promoting health. Recruiting more diverse populations of cancer survivors, using objective measures of PA and more valid measures for potential mediators and participant engagement, extending the intervention and follow-up period, and testing additional intervention strategies within or in conjunction with SNS is necessary to more completely understand how young adult cancer survivors use SNS and to create effective, disseminable interventions that promote PA in young adult cancer survivors.

Table 7.1. Summary of results from the FITNET randomized controlled trial

	Social Cognitive Theory Construct Targeted			
	Self-efficacy (SE)			
	Social Support (SS)		Self-monitoring (SM)	
	Intervention Component			
FITNET intervention	Facebook messages with expanded behavioral lessons on PA and links to websites.	Facebook group with moderated discussion	Pedometer to monitor steps	Website included: 1) weekly goal-setting; 2) diary to record walking steps and PA type, duration and intensity; 3) charts with feedback on performance
Self-help comparison (SC)	Facebook messages with basic information on PA and links to websites.	Facebook group with unmoderated discussion	Pedometer to monitor steps	
Significant PA Findings	FITNET ↑ Mild PA Both FITNET and SC ↑ MVPA			
Aim 2 Findings		No difference in Facebook posts		FITNET: ↑MVPA in low and high self-monitors
Aim 3 Findings	FITNET: ↓self-efficacy	SC: ↑SNS social support	FITNET: ↓self-efficacy	FITNET: ↓self-efficacy
Predictors of MVPA in total sample	social support (total, friends)		self-monitoring	

Note. MVPA, moderate-to-vigorous physical activity.

APPENDIX A. HEALTH INFORMATION NATIONAL TRENDS SURVEY ITEMS FOR AIM 1

Outcome Variables

Physically inactive (yes/no)		
Physical Activity (BR04)	*During the past month, did you participate in any physical activities or exercises such as running, yoga, golf, gardening, or walking for exercise?*	Yes / No Source: 2000 Behavioral Risk Factor Surveillance System
Meet physical activity recommendations (yes/no)		
Days of PA (BR05) *People who did any PA during past month.*	*In a typical week, how many days do you do any physical activity or exercise of at least moderate intensity, such as brisk walking, bicycling at a regular pace, swimming at a regular pace, and heavy gardening?*	__ __ days Source: Original to HINTS 2005. L. Masse.
Minutes of PA (BR06t)	*On the days that you do any physical activity or exercise of at least moderate intensity, how long are you typically doing these activities?*	__ __ __ __ number minutes hours Source: Original to HINTS 2005.

Predictor Variables

Sociodemographic variables

CC-02. Age
What is your age? Are you
    1 Less than 18 years old
    2 18-34
    3 35-39
    4 40-44
    5 45 or older?

CC-03. Gender
Are you male or female?
    1 Male
    2 Female

HHInc. Household income
{Thinking about members of your family living in this household, what/What} is your {combined} annual income, meaning the total pre-tax income from all sources earned in the past year?
  1 <$20k
  2 $20k-<$35k
  3 $35k-<$50k
  4 $50k-<$75k
  5 $75k and over
  98 Refused
  99 Don't know

HD-05. Employment status
What is your current occupational status? Would you say…
  1 employed
  2 unemployed
  3 homemaker
  4 student
  5 retired, or
  6 disabled?
  7 Other
  98 Refused
  99 Don't know

HD06. Marital status
What is your marital status? Would you say…
  1 married
  2 living as married
  3 divorced
  4 widowed
  5 separated
  6 single, never been married?
  97 Not ascertained
  98 Refused
  99 Don't know

HD-07. Education
What is the highest grade or level of schooling you completed?
  1 Less than 8 years
  2 8 through 11 years
  3 12 years or completed high school
  4 Post-high school training other than college (vocational or technical)
  5 Some college
  6 College graduate
  7 Postgraduate
  98 Refused

99 Don't know

HD-08. Ethnicity
Are you Hispanic or Latino?
    1 Yes
    2 No
    98 Refused
    99 Don't know

HD-09. Race
Which one or more of the following would you say is your race? Are you American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or other Pacific Islander, or White?

[DM-05t] Race/Ethnicity Recode
    1   Hispanic
    2   Non-Hispanic White
    3   Non-Hispanic Black or African American
    4   Non-Hispanic American Indian or Alaska Native
    5   Non-Hispanic Asian
    6   Non-Hispanic native Hawaiian or other Pacific Islander
    7   Non-Hispanic multiple races mentioned
    98 Refused
    99 Don't know

Health and physiologic variables

BMI. Body Mass Index (BMI)
    1   Less than 18.5 (underweight)
    2   18.5 to less than 25 (normal)
    3   25 to less than 30 (overweight)
    4   30 and over (obese)
    98 Refused
    99 Don't know

HD-01. Health status
In general, would you say your health is…
    1   excellent
    2   very good
    3   good
    4   fair
    5   poor

BR28. Tobacco Use
Have you smoked at least 100 cigarettes in your entire life?
  1 Yes
  2 No
  98 Refused
  99 Don't know

BR29. Current smoking status
Do you now smoke cigarettes everyday, some days, or not at all?
  1 Every day
  2 Some days
  3 Not at all
  98 Refused

BR01. Fruit and vegetable consumption
How many servings of fruits do you usually eat or drink each day? Think of a serving as being about 1 medium piece, or 1/2 cup of fruit, or 3/4 cup of fruit juice.
  0 0
  1 1
  2 2
  3 3
  4 4
  5 5
  6 6
  7 7
  8 8
  9 9
  10 10
  11 11
  12 12
  22 22
  23 23
  98 Refused
  99 Don't know

HS01. Health care provider
Not including psychiatrists and other mental health professionals, is there a particular doctor, nurse, or other health professional that you see most often?
  1 Yes
  2 No
  98 Refused
  99 Don't know

HS04. Health insurance
Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare?
    1 Yes
    2 No
    98 Refused
    99 Don't know

CS17. Personal cancer history
Have you ever been diagnosed as having cancer?
    1 Yes
    2 No
    98 Refused
    99 Don't know

CS22. Family history of cancer
Have any of your family members ever had cancer?
    1 Yes
    2 No
    3 Has no family
    98 Refused
    99 Don't know

Health beliefs and behaviors		
Variable	**Item**	**Responses**
Beliefs re: exercise lowering cancer risk	*As far as you know, does physical activity or exercise increase the chances of getting some types of cancer, decrease the chances of getting some types of cancer, or does it not make much difference?*	Increases chances of cancer Decreases chances of cancer Makes no difference
Knowledge re: recommended physical activity levels	*How many days a week of physical activity or exercise of at least moderate intensity are recommended for the average adult to stay healthy?* *On those days, how long should the average adult be physically active to stay healthy?*	__ __ days __ __ __ __ number minutes hours
Knowledge re: daily fruit and vegetable consumption recommendation	*How many servings of fruits and vegetables do you think the average adult should eat each day for good health?*	__ __ servings

Perceived cancer risk	*How likely do you think it is that you will develop cancer in the future?*	Very low Somewhat low Moderate Somewhat high Very high
Cancer-related worry	*How often do you worry about getting cancer? Would you say rarely or never, sometimes, often, or all the time?*	Rarely or never Sometimes Often All the time
Health-related self-efficacy	*Overall, how confident are you about your ability to take good care of your health?*	Completely confident Very confident Somewhat confident A little confident Not confident at all
Health communication		
Information seeking	*Have you ever looked for information about health or medical topics from any source?*	Yes / No
Information source use	*The most recent time you looked for information about health or medical topics, where did you go first?*	
Information-seeking experiences scale Based on the results of your most recent search for information about health or medical topics, how much do you agree or disagree with the following statements?	• *It took a lot of effort to get the information you needed.* • *You felt frustrated during your search for the information* • *You were concerned about the quality of the information.* • *The information you found was hard to understand.*	strongly agree somewhat agree somewhat disagree strongly disagree
Information seeking self-efficacy	*Overall, how confident are you that you could get health-related advice or information if you needed it? Would you say...*	completely confident very confident somewhat confident a little confident not confident at all

Internet use	*Do you ever go on-line to access the Internet or World Wide Web, or to send and receive e-mail?*	Yes / No
Internet use functions (responses only from people who use internet) In the past 12 months, have you done the following things while using the Internet?	• *Bought medicine or vitamins on-line?* • *Participated in an on-line support group for people with a similar health or medical issue?* • *Used e-mail or the Internet to communicate with a doctor or a doctor's office?* • *Used a website to help you with your diet, weight, or physical activity?* • *Looked for a healthcare provider?* • *Downloaded to a portable device, such as an iPod, cell phone, or PDA?* • *Visited a "social networking" site, such as "My Space" or "Second Life"?* • *Wrote in an online diary or "blog" (i.e., Web log)?* • *Kept track of personal health information, such as care received, test results, or upcoming medical appointments?*	Yes / No
Trust in information sources In general, how much would you trust information about health or medical topics…	• *from a doctor or other health care professional?* • *from family or friends?* • *in newspapers or magazines?* • *on the radio?* • *on the Internet?* • *on television?* • *from government health agencies?* • *from charitable organizations?* • *religious organizations and leaders?*	a lot some a little not at all

APPENDIX B. EXAMPLES OF FITNET STUDY ADVERTISEMENTS

Facebook Advertisement

Twitter Advertisement

Online Cancer Forum Advertisement

Recruitment Flyer

APPENDIX C. ORGANIZATIONS THAT POSTED FITNET STUDY ADVERTISEMENTS

Break Cancer
Brenda Mehling Cancer Fund
Cam Mak-a-Dream
Cancer Legal Resource Center
Cancer to 5K
Children's Brain Tumor Association
Chordoma Foundation
Cornucopia Cancer Support Center
Corporal Assistance Network
Fertile Action
First Descents
Facing Our Risk of Cancer Empowered (FORCE)
I'm Too Young for This! National
I'm Too Young for This! North Carolina Chapter
Imerman Angels
Jen's Thank You Alliance
The LiveLovely Foundation
LIVE**STRONG**
Love Hope Strength
mAss Kickers Foundation
Michael G. Belz Foundation
MyLifeLine.org Cancer Foundation
National Collegiate Cancer Foundation
Oregon Health Sciences University Adolescent and Young Adult Oncology
Pink Ribbons Project
Rocky Mountain Cancer Assistance
Tamika and Friends, Inc.
The SAMFund for Young Adult Survivors of Cancer
Tigerlily Foundation
True North Treks
Ulman Cancer Fund for Young Adults
Yellow Umbrella
You Can Thrive! Foundation
Young Survival Coalition
UNC Carolina Well Survivorship Program
UNC NC Cancer Hospital

APPENDIX D. FITNET STUDY SCREENER QUESTIONNAIRE

Q1 Thank you for your interest in the FITNET Study.

Purpose of this study:
FITNET (Fostering Improvement Through Networking and Exercising Together) is a web-based research program designed to teach young adult cancer survivors strategies that can help them increase physical activity. The program is aimed at improving physical activity among young adult cancer survivors.

What will happen during the study?
You will have access to a Facebook group and websites with information and strategies to help cancer survivors become more physically active and improve their health. Information and tips are posted through Facebook each week for 12 weeks. Participants assigned to one Facebook group will be encouraged to participate in 16 Facebook group discussions and use an exercise website over the course of the 12-week study. We will ask all participants to complete two online questionnaires and to record the number of steps taken over two 7-day periods, once at the beginning of the study and once at the end, after 12 weeks. You will also receive a $30 gift card for completing all study-related questionnaires.

What are the benefits of participating in FITNET?
Research shows that regular physical activity after cancer treatment may be beneficial for cancer survivors and result in improvements in physical functioning, quality of life and fatigue. This program provides information and strategies to help you become more physically active.

What are the risks from participating in FITNET?
We do not anticipate any personal risks or discomforts involved from participating in this study. Experts have determined that exercise is safe after cancer treatment, and inactive people who gradually progress over time to relatively moderate-intensity activity have no known risk of sudden cardiac events, and very low risk of bone, muscle, or joint injuries. Some people may feel shy or uncomfortable about revealing personal information about their experience as a cancer survivor.

If you choose to participate in the study:
We will ask you to answer some questions so that we can verify that you are eligible to participate. We will ask you for an email address to be used for the study. Your responses will be securely transmitted to us via the Internet, and you will receive an email in 1-2 days indicating if we will be able to enroll you in the study. If we are unable to enroll you in the study, you will be notified at the end of this online screening questionnaire.

If you are eligible to participate in the study:
You will receive an email with a link to a website that will help you enroll in the study. We will ask you to complete an online consent form, which will explain the study in greater detail and ask for your consent to participate in the study. Following your completion of the

consent form, you will be asked to complete an interactive online questionnaire that will take between 30-40 minutes to complete.

What if you have questions about your rights as a research participant?
All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns about your rights as a research subject you may contact, anonymously if you wish, the Institutional Review Board at 919-966-3113 or by email to IRB_subjects@unc.edu.

If you have any questions about the study, please do not hesitate to send an email to fitnet@unc.edu.

In order to see if we will be able to include you in the study, please press the "Next" button to answer the following questions and submit your responses.

Q2 How old are you?
20 or younger (1)
21 (2)
22 (3)
23 (4)
24 (5)
25 (6)
26 (7)
27 (8)
28 (9)
29 (10)
30 (11)
31 (12)
32 (13)
33 (14)
34 (15)
35 (16)
36 (17)
37 (18)
38 (19)
39 (20)
40 or older (21)

Q3 Have you ever been diagnosed as having cancer (not including non-melanoma skin cancers)?
Yes (1)
No (2)

Q4 Were you at least 18 years old when you were diagnosed with cancer (not including non-melanoma skin cancers)?
Yes (1)
No (2)

Q5 How long ago were you diagnosed with cancer (not including non-melanoma skin cancers)?
1 or more years from today's date (1)
Less than 1 year from today's date (2)

Q6 Are you currently receiving treatment for cancer (not including tamoxifen or other similar maintenance therapies)?
Yes (1)
No (2)

Q7 Add up all the time you spend in physical activity each day.   Over the past 7 days, on how many days were you physically active for a total of at least 30 minutes per day?
0 days (1)
1 (2)
2 (3)
3 (4)
4 (5)
5 (6)
6 (7)
7 days (8)

Q8 Over a typical or usual week, on how many days are you physically active for a total of at least 30 minutes per day?
0 days (1)
1 (2)
2 (3)
3 (4)
4 (5)
5 (6)
6 (7)
7 days (8)

Q9 Do you have access to the Internet?
Yes (1)
No (2)

Q10 Do you have an active Facebook account?
Yes (1)
No (2)

Q11 Please read the questions carefully and answer each one honestly.

	YES (1)	NO (2)
Has your doctor ever said that you have a heart condition and that you should only do physical activity as recommended by a doctor? (1)		
Do you feel pain in your chest when you do physical activity? (2)		
In the past month, have you had chest pain when you were not doing physical activity? (3)		
Do you lose your balance because of dizziness or do you ever lose consciousness? (4)		
Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity? (5)		
Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition? (6)		
Do you know of any other reason why you should not do physical activity? (7)		

Q12 How did you learn about the FITNET program?   (Please check all that apply.)
Facebook post by friend, family, co-worker, etc. (1)
Facebook post by cancer organization (2)
Tweet by friend, family, co-worker, etc. (3)
Tweet by cancer organization (4)
Email from friend, family, co-worker, etc. (5)
Email from cancer organization (6)
On a website (7)
Word of mouth (friend, relative, co-worker, etc.) (8)
Saw a flyer (9)
Other (Please specify): (10) _____

Q13 Do you live in the United States?
Yes (1)
No (2)

Q14 Please provide the following contact information:
First Name (1)

Q15 Please provide us with an email address for use in the study:
email address: (1)

Q16 Please verify the email address you want us to use in the study:
email address: (1)

APPENDIX E. FITNET STUDY BASELINE QUESTIONNAIRE

Q1 Congratulations on joining the FITNET study and choosing to improve your health!   As a first step, please complete this questionnaire, which should take approximately 20-30 minutes. It is important that you read the questions carefully and complete the entire questionnaire. The information you provide us will be kept confidential. Thank you, and we look forward to having you as a participant.

Press the Next button to continue.

Q2 In general, would you say your health is…
Excellent (1)
Very good (2)
Good (3)
Fair (4)
Poor (5)

Q3 What is your age?
21 (1)
22 (2)
23 (3)
24 (4)
25 (5)
26 (6)
27 (7)
28 (8)
29 (9)
30 (10)
31 (11)
32 (12)
33 (13)
34 (14)
35 (15)
36 (16)
37 (17)
38 (18)
39 (19)

Q4 Are you male or female?
Male (1)
Female (2)

Q5 What is your current occupational status?   (Please select all that apply.)
Part-time student (1)
Full-time student (2)
Working part-time (3)
Working full-time (4)
Unemployed (5)
Full-time homemaker or family caregiver (6)
Other (Please specify): (7) _____

Q6 What is your current marital status?
Single, never been married (1)
Married, or living as married (2)
Divorced (3)
Separated (4)
Widowed (5)

Q7 What is the highest level of education you have completed?
Grade school - between 1 and 8 years (1)
Some high school (2)
Completed high school (graduate or GED) - 12 years (3)
Some college, vocational or training school (4)
College graduate - (e.g., B.A. or B.S. degree) (5)
Postgraduate education - (e.g., M.A., M.S., J.D., M.D., Ph.D.) (6)

Q8 Are you Hispanic or Latino?
Yes (1)
No (2)

Q9 Which one or more of the following would you say is your race? (Please select all that apply.)
American Indian/Alaskan Native (1)
Asian (2)
Black/African American (3)
Native Hawaiian/ other Pacific Islander (4)
White (5)
Other (Please describe): (6) _____

Q10 Do you currently live alone or with others?
Live alone (1)
Live with others (e.g., parent, roommate, spouse/partner, brother, sister, children) (2)

Q11 Are you now responsible for raising any children under the age of 18?
Yes (1)
No (2)

Q12 Which of the following best describes your total yearly household income (before taxes)?
less than $10,000 (1)
$10,000 - $19,999 (2)
$20,000 - $29,999 (3)
$30,000 - $49,999 (4)
$50,000 - $69,999 (5)
$70,000 - $99,000 (6)
$100,000 - $149,000 (7)
$150,000 or more (8)

Q13 When was the first time that a doctor or health care professional told you that you had cancer?
Month (mm) (1)
Year (yyyy) (2)

Q14 What type of cancer were you first diagnosed with? (Please select all that apply.)
Bone cancer (1)
Brain cancer (2)
Breast cancer (3)
Cervical cancer (cancer of the cervix) (4)
Colon cancer (5)
Endometrial cancer (cancer of the uterus) (6)
Head and neck cancer (7)
Hodgkin lymphoma (8)
Leukemia/ blood cancer (9)
Liver cancer (10)
Melanoma (11)
Non-Hodgkin lymphoma (12)
Oral cancer (13)
Ovarian cancer (14)
Rectal cancer (15)
Sarcoma (16)
Testicular cancer (17)
Thyroid cancer (18)
Other (Please specify): (19) _____

Q15 What stage was your cancer?
Stage I (1)
Stage II (2)
Stage III (3)
Stage IV (4)
Other (Please specify): (5) _____
I don't know. (6)

Q16 Have you ever received any of the following treatments for your cancer?

	No (1)	Yes (2)	I don't know. (3)
Chemotherapy (1)			
Surgery (2)			
Radiation (3)			
Bone marrow transplant or stem cell transplant (4)			
Other (Please describe): (5)			

Q17 Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicaid?
Yes (1)
No (2)

Q18 About how tall are you without shoes? Feet
3 (1)
4 (2)
5 (3)
6 (4)

Q19 Inches
1 (1)
2 (2)
3 (3)
4 (4)
5 (5)
6 (6)
7 (7)
8 (8)
9 (9)
10 (10)
11 (11)

Q20 About how much do you weigh without shoes?
Pounds (1)

Q21 How many hours a day do you spend online on a computer?
< 1 hour (1)
1-2 hours (2)
3-4 hours (3)
> 4 hours (4)

Q22 The next section is about your Facebook use and attitudes about Facebook.

Q23 About how many total Facebook friends do you have?
Less than 100 (1)
100-200 (2)
201-300 (3)
301-400 (4)
401-500 (5)
501-600 (6)
601-700 (7)
More than 700 (8)

Q24 In the past week, on average, approximately how many minutes per day have you spent on Facebook?
Less than 10 (1)
10-30 (2)
31-60 (3)
1-2 hours (4)
2-3 hours (5)
More than 3 hours (6)

Q25 Please indicate how much you agree with the following statements.

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree(3)	Agree (4)	Strongly Agree (5)
Facebook is a part of my everyday activity. (1)					
I am proud to tell people I'm on Facebook. (2)					
Facebook has become a part of my daily routine. (3)					
I feel out of touch when I haven't logged onto Facebook for a while. (4)					
I feel I am part of the Facebook community. (5)					

I would be sorry if Facebook shut down. (6)				

Q26 Below is a list of statements that other people with your illness have said are important. Please select one answer per line to indicate your response as it applies to the past 7 days. PHYSICAL WELL-BEING

	Not at all (1)	A little (2)	Some- what (3)	Quite a bit (4)	Very much (5)
I have a lack of energy. (1)					
I have nausea. (2)					
Because of my physical condition, I have trouble meeting the needs of my family. (3)					
I have pain. (4)					
I am bothered by side effects of treatment. (5)					
I feel ill. (6)					
I am forced to spend time in bed. (7)					

Q27 Please select one answer per line to indicate your response as it applies to the past 7 days. SOCIAL/FAMILY WELL-BEING

	Not at all (1)	A little (2)	Somewhat (3)	Quite a bit (4)	Very much (5)
I feel close to my friends. (1)					
I get emotional support from my family. (2)					
I get support from my friends. (3)					
My family has accepted my illness. (4)					
I am satisfied with family communication about my illness. (5)					
I feel close to my partner (or the person who is my main support). (6)					
Regardless of your current level of sexual activity, please answer the following question. If you prefer not to answer it, please go to the next section. I am satisfied with my sex life. (7)					

Q28 Please mark one answer per line to indicate your response as it applies to the past 7 days. EMOTIONAL WELL-BEING

	Not at all (1)	A little (2)	Some-what (3)	Quite a bit (4)	Very much (5)
I feel sad. (1)					
I am satisfied with how I am coping with my illness. (2)					
I am losing hope in the fight against my illness. (3)					
I feel nervous. (4)					
I worry about dying. (5)					
I worry that my condition will get worse. (6)					

Q29 Please mark one answer per line to indicate your response as it applies to the past 7 days. FUNCTIONAL WELL-BEING

	Not at all (1)	A little (2)	Somewhat (3)	Quite a bit (4)	Very much (5)
I am able to work (include work at home). (1)					
My work (include work at home) is fulfilling. (2)					

I am able to enjoy life. (3)					
I have accepted my illness. (4)					
I am sleeping well. (5)					
I am enjoying the things I usually do for fun. (6)					
I am content with the quality of my life right now. (7)					

Q30 Considering a 7-day period (a week), how many times on the average do you do strenuous exercise for more than 15 minutes during your free time? STRENUOUS EXERCISE (HEART BEATS RAPIDLY) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)

Times Per Week (1)

Q31 On the days that you do any strenuous exercise, how many minutes per day are you typically doing these activities?

Minutes Per Day (1)

Q32 Considering a 7-day period (a week), how many times on the average do you do moderate exercise for more than 15 minutes during your free time? MODERATE EXERCISE (NOT EXHAUSTING) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

Times Per Week (1)

Q33 On the days that you do any moderate exercise, how many minutes per day are you typically doing these activities?

Minutes Per Day (1)

Q34 Considering a 7-day period (a week), how many times on the average do you do mild exercise for more than 15 minutes during your free time? MILD EXERCISE (MINIMAL EFFORT) (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)

Times Per Week (1)

Q35 On the days that you do any mild exercise, how many minutes per day are you typically doing these activities?

Minutes Per Day (1)

Q36 Considering a 7-day period (a week), during your leisure time, how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?
OFTEN (1)
SOMETIMES (2)
NEVER/RARELY (3)

Q37 Considering a 7-Day period (a week), how many times on the average do you do brisk walking for Exercise or Transportation for more than 15 minutes?   This would include walking outside, at an indoor facility, or on a treadmill.   If you did not spend any time in this week walking briskly, please enter 0.

Times Per Week (1)

Q38 On the days that you do any brisk walking for Exercise or Transportation, how many minutes per day are you typically doing these activities?

Minutes Per Day (1)

Q39 How many days a week of physical activity or exercise of at least moderate intensity are recommended for the average adult to stay healthy?

Days Per Week
0 (1) _____
1 (2)
2 (3)
3 (4)
4 (5)
5 (6)
6 (7)
7 (8)

Q40 On those days, how long should the average adult be physically active to stay healthy? (Enter total minutes OR hours, but not both.)
Minutes, OR (1)
Hours (2)

Q41 On a scale of 1-10, how confident are you that you can exercise five or more times per week for at least 30 minutes?
Not at all confident (1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
Very confident (10)

Q42 Do you currently exercise at least five times per week for 30 minutes or more?
Yes (1)
No (2)

Q43 How long have you been exercising at least five times per week for 30 minutes or more?
less than 1 month (1)
1-3 months (2)
4-6 months (3)
more than 6 months (4)

Q44 Are you thinking about starting to exercise five times per week?
Yes (1)
No (2)

Q45 Are you definitely planning to start exercising five times per week?
Yes (1)
No (2)

Q46 Have you smoked at least 100 cigarettes in your entire life?
Yes (1)
No (2)

Q47 How often do you now smoke cigarettes?
Every day (1)
Some days (2)
Not at all (3)

Q48 Thinking about increasing the amount of physical activity (exercise) you do, fill in the response that indicates how much you personally agree or disagree with these statements. (Please select one response for each statement.)

	Disagree (1)	Disagree a little (2)	Agree a little (3)	Agree (4)
I don't have the time to do more exercise. (1)				
Exercising costs too much. (2)				
I don't have any one to exercise with. (3)				
My family or friends worry about me overdoing it if I exercise more. (4)				
I don't have any place to exercise. (5)				
I don't have the will power to exercise. (6)				
I am uncomfortable with how I look while exercising or while wearing exercise clothing. (7)				
I provide care for others and have no one to watch them when I exercise. (8)				
I will have more energy if I exercise. (9)				

I will control my weight if I exercise. (10)				
I will feel less stressed if I exercise. (11)				
I will feel more attractive if I exercise. (12)				
I will improve my physical fitness if I exercise. (13)				
I will reduce my risk of cancer coming back if I exercise. (14)				
I will decrease my chances of getting some diseases if I exercise. (15)				
I will improve my health if I exercise. (16)				

Q49 Below is a list of things people might do while trying to increase or continue regular exercise. We are interested in exercises like running, swimming, brisk walking, bicycle riding, or aerobics classes. Whether you exercise or not, please rate how confident you are that you could really motivate yourself to do things like these consistently,   for at least six months.   (Please select one response for each statement.) How sure are you that you can do these things?

	I know I cannot (1)	(2)	Maybe I can (3)	(4)	I know I can (5)	Does not apply (6)
Get up early, even on weekends, to exercise. (1)						
Stick to your exercise program after a long, tiring day at work. (2)						

Exercise even though you are feeling depressed. (3)						
Set aside time for a physical activity program; that is, walking, jogging, swimming, biking, or other continuous activities for at least 30 minutes, 5 times per week. (4)						
Continue to exercise with others even though they seem too fast or too slow for you. (5)						
Stick to your exercise program when undergoing a stressful life change (e.g., divorce, death in the family, moving). (6)						
Stick to your exercise program when your family is demanding more time from you. (7)						
Stick to your exercise program when you have household chores to attend to. (8)						

Stick to your exercise program even when you have excessive demands at work. (9)					
Stick to your exercise program when social obligations are very time consuming. (10)					
Read or study less in order to exercise more. (11)					

Q50 If you tried to increase the amount of physical activity you do, who would be the most helpful to you?   (Please select one.)
Spouse or partner (1)
Other family members (2)
Friends (3)
People you work with (4)
Doctor/ Health care provider (5)
Other (Please specify): (6) _____
No one (7)

Q51 If you tried to increase the amount of physical activity you do, how much could you count on the people close to you to:

	Not at all (1)	Some (2)	A lot (3)	Does not apply (4)
Encourage you (1)				
Tell you about ways to increase your exercise (2)				
Help you free up time so you can exercise (3)				
Exercise with you (4)				

Q52 Below is a list of things people might do or communicate to someone who is trying to exercise regularly. If you are not trying to exercise, then some of the questions may not apply to you, but please read and give an answer to every question. Communications include things like emails, texts, posts on social networking sites, instant messages and things that people say to you. Please rate how often anyone in your family has communicated or done what is described during the past month.

	None (1)	Rarely (2)	A few times (3)	Often (4)	Very often (5)	Does not apply (6)
Exercised with me. (1)						
Offered to exercise with me. (2)						
Gave me helpful reminders to exercise ("Are you going to exercise tonight?"). (3)						
Gave me encouragement to stick with my exercise program. (4)						
Changed their schedule so we could exercise together. (5)						

Q53 For the purpose of this list, friends include people outside of your family that you are close to, roommates, neighbors, acquaintances, and coworkers. This does not include your friends on Facebook, on other social networking sites, or other members of groups you have joined on Facebook and other social networking sites. Please rate how often your friends have said or done what is described during the past month.

	None (1)	Rarely (2)	A few times (3)	Often (4)	Very often (5)	Does not apply (6)
Exercised with me. (1)						
Offered to exercise with me. (2)						

Gave me helpful reminders to exercise ("Are you going to exercise tonight?"). (3)					
Gave me encouragement to stick with my exercise program. (4)					
Changed their schedule so we could exercise together. (5)					

Q54 Please rate how often your friends on social networking sites have said or done what is described during the past month.

	None (1)	Rarely (2)	A few times (3)	Often (4)	Very often (5)	Does not apply (6)
Exercised with me. (1)						
Offered to exercise with me. (2)						
Gave me helpful reminders to exercise ("Are you going to exercise tonight?"). (3)						
Gave me encouragement to stick with my exercise program. (4)						
Changed their schedule so we could exercise together. (5)						

Q55 The following questions refer to how you set exercise goals and plan exercise activities. Please indicate the extent to which each of the statements below describes you.

	Does not describe (1)	(2)	Describes moderately (3)	(4)	Describes completely (5)
I often set exercise goals. (1)					
I usually have more than one major exercise goal. (2)					
I usually set dates for achieving my exercise goals. (3)					
My exercise goals help to increase my motivation for doing exercise. (4)					
I tend to break more difficult exercise goals down into a series of smaller goals. (5)					
I usually keep track of my progress in meeting my goals. (6)					
I have developed a series of steps for reaching my exercise goals. (7)					
I usually achieve the exercise goals I set for myself. (8)					
If I do not reach an exercise goal, I analyze what went wrong. (9)					
I make my exercise goals public by telling other people about them. (10)					

I mentally keep track of my exercise activities. (11)					
I record my exercise activities in a written or online record. (12)					

Q56 Has the amount you exercise changed since you were diagnosed with cancer?
Yes, I exercise more now (1)
Yes, I exercise less now (2)
No, I exercise the same amount now (3)

Q57 As far as you know, which of the following best describes the effect of physical activity or exercise on the chances of getting some types of cancer?
Physical activity increases chances of cancer (1)
Physical activity decreases chances of cancer (2)
Physical activity makes no difference (3)

Q58 To get the health benefits of physical activity, the most effective plan involves:
Muscle-strengthening activities (1)
Aerobic activities (2)
Combination of muscle-strengthening and aerobic activity (3)

Q59 I know my body is working at a moderate activity level if:
I can talk but not sing (1)
I can't say more than a few words without pausing for a breath (2)
I can sing a song (3)

Q60 What are the key components of physical activity that are important for improving your fitness?
Temperature, time, type of activity (1)
Frequency, intensity, duration (2)
Calorie intake, altitude, humidity (3)

Q61 Please provide the following contact information:
First Name (1)
Last Name (2)
Mailing address for your pedometer: Street address (3)
City (4)
State (5)
Zip Code (6)
Country (7)
Email address that you use for Facebook (8)

APPENDIX F. SCREENSHOTS OF FITNET MESSAGES ON FACEBOOK

Intervention Message

Intervention Group Posts

APPENDIX G. SCREENSHOTS OF FITNET WEBSITE

Homepage

>**About FITNET**

What Will I Do in the Program?

What are the Benefits of Participation?

Am I Eligible?

Contact Us

User Login

Username
Password
Login | Clear

Forgot Password

Welcome to FITNET... a physical activity program for young adult cancer survivors.

FITNET (Fostering Improvement Through Networking and Exercising Together) is a web-based research program designed to teach young adult cancer survivors strategies that can help them increase physical activity. The program is aimed at improving physical activity among young adult cancer survivors.

About FITNET

FITNET is a program funded by the University of North Carolina Lineberger Comprehensive Cancer Center that is designed to teach young adult cancer survivors ways to start a moderate-intensity exercise program (i.e., similar to a brisk walk) and increase their physical activity.

FITNET is also a research study that will test the feasibility and effectiveness of an exercise program delivered through Facebook to improve physical activity among young adult cancer survivors. If you are eligible and enroll, you will be randomly assigned into 1 of 2 groups (which means you can't choose your group):

- Facebook group and exercise website for 12 weeks
- Facebook group for 12 weeks

If you enroll, you will be one of approximately 100 men and women participating in the study.

Contact fitnet@unc.edu

Goal-Setting Page

Exercise Tracker

Exercise Tracker

Exercise Entry

05/11/2011

Activity   Aerobics/Fitness Classes

# of 10 min. blocks

Intensity Level   light

Submit

Weekly Exercise Log *

Date	Activity	Minutes	Intensity
05/09/2011	Aerobics/Fitness Classes	60 mins.	moderate
05/10/2011	Strength Training/Weightlifting	50 mins.	moderate
05/11/2011	Walking	40 mins.	light

Steps Entry

05/11/2011

# of Steps

Submit

Weekly Steps Log

Date	# of Steps
05/09/2011	5365
05/10/2011	7469

* You can enter exercise tracking for up to 7 days prior to the current day, and this will be added to your weekly progress. However, the exercise log will only display activities entered for the current week, which starts each Sunday.

Contact fitnet@unc.edu

My Shortcuts

Goal-Setting

>Exercise Tracker

Exercise Information

Study Information

Change Password

Logout

fitnet

fostering improvement through networking and exercising together

Feedback Page
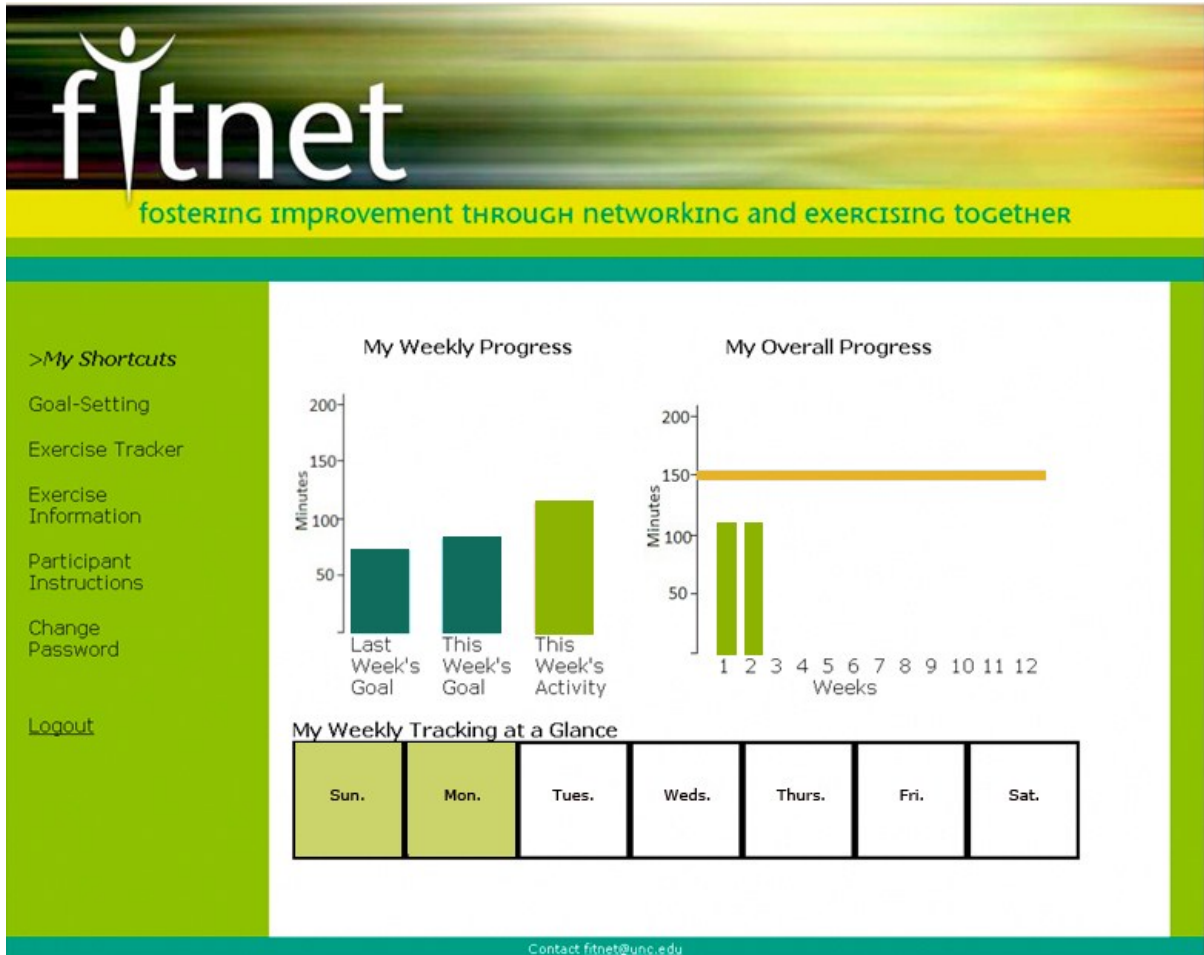
APPENDIX H. FITNET STUDY POST-INTERVENTION QUESTIONNAIRE (INTERVENTION)

Q1 Congratulations on completing the FITNET program! We are grateful to you for taking the time to be a part of this study, and we hope that we have given you information that has been useful to you. We would like to ask you some questions that will help us to know how and why this program works or does not work for you.   As one of the final steps before you receive your gift card, please complete this questionnaire, which should take approximately 30-45 minutes. Please answer each question. Your honest answers will provide the keys we need to create a program that meets your individual needs. The more we know, the more we can develop tools that make sense to you. The information you provide us will be kept confidential. Thank you, and we greatly appreciated having you as a participant.

Press the Next button to continue.

Q2 In general, would you say your health is…
Excellent (1)
Very good (2)
Good (3)
Fair (4)
Poor (5)

Q3 What was the date of your last cancer treatment – that is, surgery, radiation, chemotherapy, bone marrow, or stem cell transplant? Please DO NOT consider a bone marrow biopsy to be a bone marrow transplant.
Month (mm) (1)
Year (yyyy) (2)

Q4 To the best of your knowledge, are you now free of cancer?
Yes (1)
No (2)
Don't know (3)

Q5 In the last 3 months, have you gone to a doctor for any kind of health or medical care?
Yes (1)
No (2)

Q6 In the last 3 months, has your health kept you from being more physically active?
Yes (1)
No (2)

Q7 Was there anything about the past 7 days (a week) that made exercising especially different for you in terms of illness, injury, work travel or vacation?
Yes (1)
No (2)

Q8 During the last 7 days (a week), how many times on the average did you do strenuous exercise for more than 15 minutes during your free time? STRENUOUS EXERCISE (HEART BEATS RAPIDLY) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)

Times Per Week (1)

Q9 On the days that you did any strenuous exercise, how many minutes per day were you typically doing these activities?

Minutes Per Day (1)

Q10 During the last 7 days (a week), how many times on the average did you do moderate exercise for more than 15 minutes during your free time? MODERATE EXERCISE (NOT EXHAUSTING) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

Times Per Week (1)

Q11 On the days that you did any moderate exercise, how many minutes per day were you typically doing these activities?

Minutes Per Day (1)

Q12 During the last 7 days (a week), how many times on the average did you do mild exercise for more than 15 minutes during your free time? MILD EXERCISE (MINIMAL EFFORT) (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)

Times Per Week (1)

Q13 On the days that you did any mild exercise, how many minutes per day were you typically doing these activities?

Minutes Per Day (1)

Q14 During the last 7 days (a week), during your leisure time, how often did you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?
OFTEN (1)
SOMETIMES (2)
NEVER/RARELY (3)

Q15 During the last 7 days (a week), how many times on the average did you do brisk walking for Exercise or Transportation for more than 15 minutes? This would include walking outside, at an indoor facility, or on a treadmill. If you did not spend any time during the last week walking briskly, please enter 0.

Times Per Week (1)

Q16 On the days that you did any brisk walking for Exercise or Transportation, how many minutes per day were you typically doing these activities?
Minutes Per Day (1)

Q17 Below is a list of statements that other people with your illness have said are important. Please select one answer per line to indicate your response as it applies to the past 7 days.
PHYSICAL WELL-BEING

	Not at all(1)	A little bit (2)	Some what (3)	Quite a bit (4)	Very much (5)
I have a lack of energy. (1)					
I have nausea. (2)					
Because of my physical condition, I have trouble meeting the needs of my family. (3)					
I have pain. (4)					
I am bothered by side effects of treatment. (5)					
I feel ill. (6)					
I am forced to spend time in bed. (7)					

Q18 Please select one answer per line to indicate your response as it applies to the past 7 days. SOCIAL/FAMILY WELL-BEING

	Not at all(1)	A little bit (2)	Some what (3)	Quite a bit (4)	Very much (5)
I feel close to my friends. (1)					
I get emotional support from my family. (2)					
I get support from my friends. (3)					
My family has accepted my illness. (4)					
I am satisfied with family communication about my illness. (5)					
I feel close to my partner (or the person who is my main support). (6)					
Regardless of your current level of sexual activity, please answer the following question. If you prefer not to answer it, please go to the next section. I am satisfied with my sex life. (7)					

Q19 Please mark one answer per line to indicate your response as it applies to the past 7 days. EMOTIONAL WELL-BEING

	Not at all(1)	A little bit (2)	Some what (3)	Quite a bit (4)	Very much (5)
I feel sad. (1)					
I am satisfied with how I am coping with my illness. (2)					
I am losing hope in the fight against my illness. (3)					
I feel nervous. (4)					
I worry about dying. (5)					
I worry that my condition will get worse. (6)					

Q20 Please mark one answer per line to indicate your response as it applies to the past 7 days. FUNCTIONAL WELL-BEING

	Not at all(1)	A little bit (2)	Some what (3)	Quite a bit (4)	Very much (5)
I am able to work (include work at home). (1)					
My work (include work at home) is fulfilling. (2)					

I am able to enjoy life. (3)					
I have accepted my illness. (4)					
I am sleeping well. (5)					
I am enjoying the things I usually do for fun. (6)					
I am content with the quality of my life right now. (7)					

Q21 How many days a week of physical activity or exercise of at least moderate intensity are recommended for the average adult to stay healthy? Days Per Week
0 (1) _____
1 (2)
2 (3)
3 (4)
4 (5)
5 (6)
6 (7)
7 (8)

Q22 On those days, how long should the average adult be physically active to stay healthy? (Enter total minutes OR hours, but not both.)
Minutes, OR (1)
Hours (2)

Q23 On a scale of 1-10, how confident are you that you can exercise five or more times per week for at least 30 minutes?
Not at all confident (1)
(2)
(3)
(4)

(5)
(6)
(7)
(8)
(9)
Very confident (10)
Q24 Do you currently exercise at least five times per week for 30 minutes or more?
Yes (1)
No (2)

Q25 How long have you been exercising at least five times per week for 30 minutes or more?
less than 1 month (1)
1-3 months (2)
4-6 months (3)
more than 6 months (4)

Q26   Are you thinking about starting to exercise five times per week?
Yes (1)
No (2)

Q27 Are you definitely planning to start exercising five times per week?
Yes (1)
No (2)

Q28 Since you were diagnosed with cancer, did your doctor ever recommend that you exercise during your cancer treatment?
Yes (1)
No (2)
Don't know (3)

Q29 Since you were diagnosed with cancer, did your doctor ever recommended that you exercise after your cancer treatment?
Yes (1)
No (2)
Don't know (3)

Q30 Do you currently smoke cigarettes?
Yes (1)
No, but I am a former smoker (2)
No, I have never smoked (3)

Q31 Were you smoking cigarettes regularly at the time you were diagnosed with cancer?
Yes (1)
No (2)

Q32 Did you quit smoking cigarettes after you were diagnosed with cancer?
Yes (1)
No (2)

Q33 Thinking about increasing the amount of physical activity (exercise) you do, fill in the response that indicates how much you personally agree or disagree with these statements. (Please select one response for each statement.)

	Disagree (1)	Disagree a little (2)	Agree a little (3)	Agree (4)
I don't have the time to do more exercise. (1)				
Exercising costs too much. (2)				
I don't have any one to exercise with. (3)				
My family or friends worry about me overdoing it if I exercise more. (4)				
I don't have any place to exercise. (5)				
I don't have the will power to exercise. (6)				

I am uncomfortable with how I look while exercising or while wearing exercise clothing. (7)				
I provide care for others and have no one to watch them when I exercise. (8)				
I will have more energy if I exercise. (9)				
I will control my weight if I exercise. (10)				
I will feel less stressed if I exercise. (11)				
I will feel more attractive if I exercise. (12)				
I will improve my physical fitness if I exercise. (13)				
I will reduce my risk of cancer coming back if I exercise. (14)				
I will decrease my chances of getting some diseases if I exercise. (15)				
I will improve my health if I exercise. (16)				

Q34 Below is a list of things people might do while trying to increase or continue regular exercise. We are interested in exercises like running, swimming, brisk walking, bicycle riding, or aerobics classes. Whether you exercise or not, please rate how confident you are that you could really motivate yourself to do things like these consistently, for at least six months. (Please select one response for each statement.) How sure are you that you can do these things?

	I know I cannot (1)	(2)	Maybe I can (3)	(4)	I know I can (5)	Does not apply (6)
Get up early, even on weekends, to exercise. (1)						
Stick to your exercise program after a long, tiring day at work. (2)						
Exercise even though you are feeling depressed. (3)						
Set aside time for a physical activity program; that is, walking, jogging, swimming, biking, or other continuous activities for at least 30 minutes, 5 times per week. (4)						
Continue to exercise with others even though they seem too fast or too slow for you. (5)						
Stick to your exercise program when undergoing a stressful life change (e.g., divorce, death in the family, moving). (6)						

Stick to your exercise program when your family is demanding more time from you. (7)						
Stick to your exercise program when you have household chores to attend to. (8)						
Stick to your exercise program even when you have excessive demands at work. (9)						
Stick to your exercise program when social obligations are very time consuming. (10)						
Read or study less in order to exercise more. (11)						

Q35 If you tried to increase the amount of physical activity you do, who would be the most helpful to you?   (Please select one.)
Spouse or partner (1)
Other family members (2)
Friends (3)
People you work with (4)
Doctor/ Health care provider (5)
Other (Please specify): (6) _____
No one (7)

Q36 If you tried to increase the amount of physical activity you do, how much could you count on the people close to you to:

	Not at all (1)	Some (2)	A lot (3)	Does not apply (4)
Encourage you (1)				
Tell you about ways to increase your exercise (2)				
Help you free up time so you can exercise (3)				
Exercise with you (4)				

Q37 Below is a list of things people might do or communicate to someone who is trying to exercise regularly. Please read and give an answer to every question. Communications include things like emails, texts, posts on social networking sites, instant messages and things that people say to you. Please rate how often anyone in your family has communicated or done what is described during the past month.

	None (1)	Rarely (2)	A few times (3)	Often (4)	Very often (5)	Does not apply (6)
Exercised with me. (1)						
Offered to exercise with me. (2)						
Gave me helpful reminders to exercise ("Are you going to exercise tonight?"). (3)						
Gave me encouragement to stick with my exercise program. (4)						
Changed their schedule so we could exercise together. (5)						

Q38 For the purpose of this list, friends include people outside of your family that you are close to, roommates, neighbors, acquaintances, and coworkers. This does not include your friends on Facebook, on other social networking sites, or other members of groups you have joined on Facebook and other social networking sites. Please rate how often your friends have said or done what is described during the past month.

	None (1)	Rarely (2)	A few times (3)	Often (4)	Very often (5)	Does not apply (6)
Exercised with me. (1)						
Offered to exercise with me. (2)						
Gave me helpful reminders to exercise ("Are you going to exercise tonight?"). (3)						
Gave me encouragement to stick with my exercise program. (4)						
Changed their schedule so we could exercise together. (5)						

Q39 Please rate how often your friends on social networking sites have said or done what is described during the past month.

	None (1)	Rarely (2)	A few times (3)	Often (4)	Very often (5)	Does not apply (6)
Exercised with me. (1)						
Offered to exercise with me. (2)						

Gave me helpful reminders to exercise ("Are you going to exercise tonight?"). (3)					
Gave me encouragement to stick with my exercise program. (4)					
Changed their schedule so we could exercise together. (5)					

Q40 Please rate how often other FITNET participants have said or done what is described during the past month.

	None (1)	Rarely (2)	A few times (3)	Often (4)	Very often (5)	Does not apply (6)
Exercised with me. (1)						
Offered to exercise with me. (2)						
Gave me helpful reminders to exercise ("Are you going to exercise tonight?"). (3)						
Gave me encouragement to stick with my exercise program. (4)						
Changed their schedule so we could exercise together. (5)						

Q41 As far as you know, which of the following best describes the effect of physical activity or exercise on the chances of getting some types of cancer?
Physical activity increases chances of cancer (1)
Physical activity decreases chances of cancer (2)
Physical activity makes no difference (3)

Q42 To get the health benefits of physical activity, the most effective plan involves:
Muscle-strengthening activities (1)
Aerobic activities (2)
Combination of muscle-strengthening and aerobic activity (3)

Q43 I know my body is working at a moderate activity level if:
I can talk but not sing (1)
I can't say more than a few words without pausing for a breath (2)
I can sing a song (3)

Q44 What are the key components of physical activity that are important for improving your fitness?
Temperature, time, type of activity (1)
Frequency, intensity, duration (2)
Calorie intake, altitude, humidity (3)

Q45 The following questions refer to how you set exercise goals and plan exercise activities. Please indicate the extent to which each of the statements below describes you.

	Does not describe (1)	(2)	Describes moderately (3)	(4)	Describes completely (5)
I often set exercise goals. (1)					
I usually have more than one major exercise goal. (2)					
I usually set dates for achieving my exercise goals. (3)					
My exercise goals help to increase my					

motivation for doing exercise. (4)					
I tend to break more difficult exercise goals down into a series of smaller goals. (5)					
I usually keep track of my progress in meeting my goals. (6)					
I have developed a series of steps for reaching my exercise goals. (7)					
I usually achieve the exercise goals I set for myself. (8)					
If I do not reach an exercise goal, I analyze what went wrong. (9)					
I make my exercise goals public by telling other people about them. (10)					

I mentally keep track of my exercise activities. (11)					
I record my exercise activities in a written or online record. (12)					

Q46 During a typical 7-day period (a week) in the last month, how many days did you do strenuous exercise for at least 10 minutes at a time during your free time? STRENUOUS EXERCISE (HEART BEATS RAPIDLY) (e.g., running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)

Days Per Week (1)

Q47 On the days when you did strenuous exercise, how much total time (minutes per day) on average did you spend typically doing these strenuous exercises?

Minutes Per Day (1)

Q48 During a typical 7-day period (a week) in the last month, how many days did you do moderate exercise for at least 10 minutes at a time during your free time? MODERATE EXERCISE (NOT EXHAUSTING) (e.g., fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

Days Per Week (1)

Q49 On the days when you did moderate exercise, how much total time (minutes per day) on average did you spend typically doing these moderate exercises?

Minutes Per Day (1)

Q50 During a typical 7-day period (a week) in the last month, how many days did you do mild exercise for at least 10 minutes at a time during your free time? MILD EXERCISE (MINIMAL EFFORT) (e.g., yoga, archery, fishing from river bank, bowling, horseshoes, golf, snow-mobiling, easy walking)

Days Per Week (1)

Q51 On the days when you did mild exercise, how much total time (minutes per day) on average did you spend typically doing these moderate exercises?

Minutes Per Day (1)

Q52 During a typical 7-day period (a week) in the last month, in your leisure time, how often did you engage in any regular activity long enough to work up a sweat (heart beats rapidly)?

OFTEN (1)
SOMETIMES (2)
NEVER/RARELY (3)

Q53 During a typical 7-Day period (a week) in the last month, how many days did you do brisk walking for Exercise or Transportation for at least 10 minutes during your free time? This would include walking outside, at an indoor facility, or on a treadmill. If you did not spend any time during a typical week walking briskly, please enter 0.

Days Per Week (1)

Q54 On the days that you did any brisk walking for Exercise or Transportation, how much total time (minutes per day) on average did you spend doing these activities?

Minutes Per Day (1)

Q55 The next section is about your Facebook use and attitudes about Facebook.

Q56 How many hours a day do you spend online on a computer?
< 1 hour (1)
1-2 hours (2)
3-4 hours (3)
> 4 hours (4)

Q57 About how many total Facebook friends do you have?
Less than 100 (1)
100-200 (2)
201-300 (3)
301-400 (4)
401-500 (5)
501-600 (6)
601-700 (7)
More than 700 (8)

Q58 In the past week, on average, approximately how many minutes per day have you spent on Facebook?
Less than 10 minutes (1)
10-30 minutes (2)
31-60 minutes (3)
1-2 hours (4)
2-3 hours (5)
More than 3 hours (6)

Q59 Please indicate how much you agree with the following statements.

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
Facebook is a part of my everyday activity. (1)					
I am proud to tell people I'm on Facebook. (2)					
Facebook has become a part of my daily routine. (3)					
I feel out of touch when I haven't logged onto Facebook for a while. (4)					
I feel I am part of the Facebook community. (5)					
I would be sorry if Facebook shut down. (6)					
I use Facebook to learn more about other people living with cancer. (7)					

I use Facebook to keep in touch with other young adult cancer survivors. (8)				
I use Facebook to meet other young adult cancer survivors. (9)				

Q60 We'd like to know the specific ways you communicate with your friends using social networking sites (e.g., Facebook, MySpace). Do you ever do the following?

	Yes (1)	No (2)
Post comments to a friend's page or wall (1)		
Send a bulletin or group message to a group of your friends (2)		
Send private messages to a friend within the social networking site (3)		
Send IMs (instant messages) or text messages to a friend through the social networking site (4)		
Post comments to a friend's blog (5)		
Add comments to a friend's picture (6)		
Use your cell phone to browse or update your social networking profile (7)		

Q61 Thinking specifically about what you have done on social networking sites like Facebook and MySpace. Have you ever used these sites to do the following?

	Yes (1)	No (2)
Get health information (1)		
Start or join a health-related group (2)		
Follow your friends' personal health experiences or health updates (3)		
Post comments, questions or information about health or medical issues (4)		
Draw attention to a health-related issue or cause (5)		

Q62 Prior to starting the FITNET program, how often did you do the following on social networking sites, like Facebook or MySpace?

	Less Often or Never (1)	Every Few Weeks (2)	>1-2 Days a Week (3)	>3-5 Days a Week (4)	About Once a Day (5)	Several Times a Day (6)
Read messages or posts (1)						
Post comments (2)						
Send private messages (3)						

Q63 Did the ability to read posts from other FITNET participants motivate you to exercise more?
Yes (1)
No (2)
I don't know (3)

Q64 Did the ability to post comments or talk to other FITNET participants motivate you to exercise more?
Yes (1)
No (2)
I don't know (3)

Q65 The next questions are about Facebook messages.   Over the last twelve weeks, do you recall getting any Facebook messages from the study coordinator?
Yes (1)
No (2)

If No Is Selected, Then Skip To End of Block

Q66 How many of the Facebook messages do you remember receiving?
1-3 (1)
4-6 (2)
7-9 (3)
10-12 (4)
More than 12 (5)
None (6)

Q67 How much of the Facebook messages did you usually read?
None (1)
A little (2)
Some (3)
All/ most (4)

Q68 What topics did the Facebook messages cover?   (Please select all that apply.)
Physical activity (1)
Fruits and vegetables (2)
Cancer survivorship (3)
Other (Please specify): (4) _____
Don't remember (5)

Q69 Below is a list of statements about the Facebook messages sent by the study coordinator. Please mark one per line to indicate your response as it applies to the information in the Facebook messages. I found information in the Facebook messages to be…

	Not at All (1)	A little (2)	Somewhat (3)	Very Much So (4)	Completely (5)	Don't Know (6)
Designed especially for me and my needs (1)						
Important to me personally (2)						
Applies to						

my life (3)					
Caused me to become physically active (4)					
Motivating (5)					

Q70 How much did you trust that the information in the Facebook messages was accurate?
Not at all (1)
A little (2)
Somewhat (3)
A great deal (4)
Completely (5)
Don't know (6)

Q71 Do you feel the number of Facebook messages you received was:
Too few (1)
Just right (2)
Too many (3)
Don't know (4)

Q72 Do you feel the amount of cancer-related information in the Facebook messages you received was:
Too little (1)
Just right (2)
Too much (3)
Don't know (4)

Q73 How easy was it for you to access the Facebook messages sent by the study coordinator?
Very Difficult (1)
Difficult (2)
Easy (3)
Very Easy (4)

Q74 Where did you review the Facebook messages from the study coordinator? (Please select all that apply.)
At home (1)
At work (2)
On my phone (3)
On a computer (4)
On a tablet computer (e.g., iPad) (5)
Other (Please specify): (6) _____

Q75 Please answer the following questions on a scale of 1 (not at all) to 7 (very much).How motivated were you to read the weekly Facebook messages?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q76 To what extent did you try hard to think about the information in the weekly Facebook messages?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q77 How much would you say the information in the weekly Facebook messages held your attention?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q78 How much effort would you say you gave to evaluating the information in the weekly Facebook messages?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q79 To what extent did you feel you had enough time to think about the information given in the weekly Facebook messages?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q80 To what extent did you find the information in the weekly Facebook messages well organized and easy to follow?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q81 In your opinion, how logical and accurate was the information presented in the weekly Facebook messages?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q82 To what extent would you say the weekly Facebook messages made good points about exercising?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q83 The next questions are about the FITNET Facebook group wall.   Over the last twelve weeks do you recall any questions posted by the study coordinator on the FITNET group wall to prompt group discussion?
Yes (1)
No (2)

If No Is Selected, Then Skip To End of Block

Q84 How many of the Facebook group discussions do you remember reading?
1-5 (1)
6-10 (2)
11-15 (3)
16-20 (4)
More than 20 (5)
None (6)

Q85 Below is a list of statements about the group discussions prompted by questions the study coordinator posted to the FITNET group wall. Please mark one per line to indicate your response as it applies to the information in the Facebook group discussions. I found information in the Facebook group discussions to be…

	Not at All (1)	A little (2)	Somewhat (3)	Very Much So (4)	Completely (5)	Don't Know (6)
Designed especially for me and my needs (1)						
Important to me personally (2)						

Applies to my life (3)					
Caused me to become physically active (4)					
Motivating (5)					

Q86 How much did you trust that the information in the FITNET Facebook group discussions was accurate?
Not at all (1)
A little (2)
Somewhat (3)
A great deal (4)
Completely (5)
Don't know (6)

Q87 Do you feel the number of number of questions the study coordinator posted to prompt Facebook group discussions was:
Too few (1)
Just right (2)
Too many (3)
Don't know (4)

Q88 How easy was it for you to access group discussions posted to the FITNET Facebook group wall?
Very Difficult (1)
Difficult (2)
Easy (3)
Very Easy (4)

Q89 Where did you review the group discussions posted to the FITNET Facebook group wall? (Please select all that apply.)
At home (1)
At work (2)
On my phone (3)
On a computer (4)
On a tablet computer (e.g., iPad) (5)
Other (Please specify): (6) _____

Q90 Did any of the following concerns make you hesitant to post comments on the Facebook group wall?(Please select all that apply.)
I was concerned about my privacy. (1)
I did not have time. (2)
I couldn't figure out how to post. (3)
I don't think I am good at writing. (4)
I had nothing to add. (5)
It didn't interest me. (6)
I didn't know about the Facebook group. (7)
Other (Please specify): (8) _____

Q91 Over the last twelve weeks, how often did you do the following?

	Less Often or Never (1)	Every Few Weeks (2)	>1-2 Days a Week (3)	>3-5 Days a Week (4)	About Once a Day (5)	Several Times a Day (6)
Visit the FITNET Facebook group (1)						
See a post to the FITNET group in your Facebook News Feed (2)						
Read FITNET group discussions (3)						
Post responses to questions the study coordinator posted on the FITNET group wall (4)						

Post a status, comments, questions or information to the FITNET group wall (5)					
Click the 'like' button next to other people's comments on the FITNET group wall (6)					

Q92 Please indicate how much you agree with the following statements about the FITNET Facebook group.

	Strongly Disagree (1)	Disagree (2)	Neither Agree nor Disagree (3)	Agree (4)	Strongly Agree (5)
I feel I was part of the FITNET group. (1)					
I was interested in what went on in the FITNET group. (2)					
The FITNET group was a good place to interact with other young adult cancer survivors. (3)					
I would recommend the FITNET program to other young adult cancer survivors. (4)					
Interacting with members of the FITNET group made me want to try new things. (5)					
Interacting with members of the FITNET group made me feel like part of a larger community. (6)					

I was willing to spend time to participate in FITNET group discussions. (7)				
Interacting with members of the FITNET group gave me new people to talk to. (8)				
Interacting with members of the FITNET group reminded me that everyone in the world is connected. (9)				
The members of the FITNET group were motivating. (10)				
The members of the FITNET group were supportive. (11)				

Q93 The next questions are about the links to articles, resources and videos the study coordinator posted to the FITNET Facebook group wall.   Over the last twelve weeks do you recall reading any links to articles, resources or videos that the study coordinator posted on the Facebook group wall?
Yes (1)
No (2)

If No Is Selected, Then Skip To End of Block

Q94 How many of the links to articles, resources or videos do you remember reading or viewing?
1-3 (1)
4-6 (2)
7-9 (3)
10-12 (4)
More than 12 (5)
None (6)

Q95 How much of the articles, resources or videos did you usually read view/read?
None (1)
A little (2)
Some (3)
All/ most (4)

Q96 What topics did these articles, resources or videos cover? (Please select all that apply.)
Physical activity (1)
Fruits and vegetables (2)
Cancer survivorship (3)
Other (Please specify): (4) _____
Don't remember (5)

Q97 Below is a list of statements about the articles, resources or videos posted by the study coordinator. Please mark one per line to indicate your response as it applies to the information in the websites, articles, or videos. I found information in the websites, articles, or videos to be…

	Not at All (1)	A little (2)	Somewhat (3)	Very Much So (4)	Completely (5)	Don't Know (6)
Designed especially for me and my needs (1)						
Important to me personally (2)						
Applies to my life (3)						
Caused me to become physically active (4)						
Motivating (5)						

Q98 How much did you trust that the information in the websites, article or videos was accurate?
Not at all (1)
A little (2)
Somewhat (3)
A great deal (4)
Completely (5)
Don't know (6)

Q99 Do you feel the number of links to articles, resources or videos posted by the study coordinator was:
Too few (1)
Just right (2)
Too many (3)
Don't know (4)

Q100 Do you feel the amount of cancer-related information that the study coordinator posted was:
Too little (1)
Just right (2)
Too much (3)
Don't know (4)

Q101 How easy was it for you to access the articles, resources or videos posted by the study coordinator?
Very Difficult (1)
Difficult (2)
Easy (3)
Very Easy (4)

Q102 The next questions are about the FITNET website (www.fitnet-unc.org).   Please rate how often you viewed the following sections of the FITNET website.

	Never (1)	Once (2)	A Few Times (3)	Many Times (4)
My Shortcuts (1)				
Goal-Setting (2)				
Tips for Setting Goals (3)				
Exercise Tracker (4)				
Exercise Safety (5)				
Using Your Pedometer (6)				
Study Description (7)				
Facebook Privacy & Safety (8)				

Q103 Below is a list of statements about information on the FITNET website. Please mark one per line to indicate your response as it applies to the information on the FITNET website. I found information on the FITNET website to be…

	Not at All (1)	A little (2)	Somewhat (3)	Very Much So (4)	Completely (5)	Don't Know (6)
Designed especially for me and my needs (1)						
Important to me personally (2)						

Applies to my life (3)						
Caused me to become physically active (4)						
Motivating (5)						

Q104 How much did you trust that the information on the FITNET website was accurate?
Not at all (1)
A little (2)
Somewhat (3)
A great deal (4)
Completely (5)
Don't know (6)

Q105 Do you feel the amount of exercise-related information on the FITNET website was:
Too little (1)
Just right (2)
Too much (3)
Don't know (4)

Q106 How easy was it for you to access content on the FITNET website?
Very Difficult (1)
Difficult (2)
Easy (3)
Very Easy (4)

Q107 Where did you review or log your activity on the FITNET website?   (Please select all that apply.)
At home (1)
At work (2)
On my phone (3)
On a computer (4)
On a tablet computer (e.g., iPad) (5)
Other (Please specify): (6) _____

Q108 Please answer the following questions on a scale of 1 (not at all) to 7 (very much).
How important is the topic of physical activity to you personally?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q109 How motivated were you to read information on the FITNET website?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q110 To what extent did you try hard to think about information on the FITNET website?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q111 How much would you say the information on the FITNET website held your attention?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q112 How much effort would you say you gave to evaluating the information on the FITNET website?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q113 To what extent did you feel you had enough time to think about the information given on the FITNET website?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q114 To what extent did you find the information on the FITNET website well organized and easy to follow?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q115 In your opinion, how logical and accurate was the information presented on the FITNET website?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q116 To what extent would you say the information on the FITNET website made good points about exercising?

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Not at All: Very Much (1)							

Q117 Over the last twelve weeks, how often did you use the following tools on the FITNET website?

	Less Often or Never (1)	Every Few Weeks (2)	>1-2 Days a Week (3)	>3-5 Days a Week (4)	About Once a Day (5)	Several Times a Day (6)
Goal-Setting (1)						
Exercise Entry (2)						
Steps Entry (3)						

Q118 During this study, how motivating to you were the following activities on the FITNET website in terms of increasing your exercise?

	Not at all Motivating (1)	Slightly Motivating (2)	Somewhat Motivating (3)	Very Motivating (4)	Extremely Motivating (5)	I Never Did This (6)
Setting a weekly goal (1)						
Tracking my exercise minutes (2)						
Tracking my steps (3)						

Viewing my progress charts (4)						

Q119 Over the past twelve weeks, how useful to you were the following FITNET program activities:

	Not at all Useful (1)	Slightly Useful (2)	Somewhat Useful (3)	Very Useful (4)	Extremely Useful (5)	I Never Did This (6)
Weekly goal-setting (1)						
Weekly Facebook messages (2)						
Web page links in Facebook messages (3)						
Discussion questions the study coordinator posted to the FITNET group wall (4)						
Articles, resources or videos the study coordinator posted to the FITNET group wall (5)						
Reading comments, questions or information posted to the FITNET group wall (6)						

Posting comments, questions or information to the FITNET group wall (7)							
Wearing a pedometer (8)							
Online exercise tracker for exercise minutes (9)							
Online exercise tracker for steps (10)							
Online goal-setting (11)							
Working on changing the way you thought in order to increase physical activity (12)							

Q120 The next questions are about your perceptions of the overall FITNET study. Please rate the following statements about the FITNET study on a scale of 1 (strongly disagree) to 7 (strongly agree). I found that accessing information for the FITNET study was very easy.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Strongly Disagree: Strongly Agree (1)							

Q121 I found that accessing the information for the study was an effective way to get information about exercise.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Strongly Disagree: Strongly Agree							

(1)							

Q122 I enjoyed participating in this study.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)
Strongly Disagree: Strongly Agree (1)							

Q123 Please choose the reasons that prevented or reduced your participation in the FITNET Facebook group. (Please select all that apply.)
I forgot. (1)
I did not have time. (2)
I was concerned about my privacy. (3)
I did not want to share personal information. (4)
I was frustrated with changes to Facebook. (5)
I couldn't figure out how to post. (6)
I don't think I am good at writing. (7)
I had nothing to add. (8)
I didn't interest me. (9)
I did not want to interact with strangers. (10)
None (11)
Other (Please specify): (12) _____

Q124 Please choose the reasons that prevented or reduced your exercise goal setting and tracking on the FITNET website. (Please select all that apply.)
I did not exercise. (1)
I forgot. (2)
I did not have time. (3)
It was not important to me. (4)
I couldn't figure out how to use the website. (5)
Technical difficulties with the website. (6)
I was frustrated with the website being down for maintenance, due to weather, etc. (7)
It didn't interest me. (8)
None (9)
Other (Please specify): (10) _____

Q125 During this study, how many FITNET group members did you add as a Facebook friend?
None (1)
Less than 10 (2)
10-20 (3)
20-30 (4)
30-40 (5)
More than 40 (6)

Q126 Were you friends on Facebook with any of the participants assigned to other FITNET Facebook group of this study?
Yes (1)
No (2)
I don't know. (3)

Q127 During the study, did you hear from friends about activities they did in the other FITNET Facebook group?
Yes (1)
No (2)

Q128 At this time, do you feel you need more information about any of the following?

	I HAVE ENOUGH information (1)	I NEED SOME more information (2)	I NEED MUCH more information (3)	Does not apply (4)
Possible long-term side effects of cancer treatment (1)				
Handling concern about the cancer returning (2)				
Handling concern about getting another type of cancer (3)				
Managing stress (4)				
Staying physically fit or getting exercise (5)				
Nutrition and diet (6)				
Support for my caregiver(s) (7)				
Complementary and alternative treatments (such as acupuncture or herbal remedies) (8)				
How to talk about your cancer experience with family and friends (9)				
Meeting other young adult cancer patients/survivors (10)				
Any other need for information (please describe): (11)				

Q129 Which of the following do you consider the best ways to give health messages to young adult cancer survivors? (Please select all that apply.)
Social networking site (e.g., Facebook) (1)
Mobile app (2)
Twitter (3)
Text messages (4)
Email (5)
Videos (6)
Telephone counseling (7)
Website (8)
Print materials (9)
In-person (10)
Other (Please specify): (11) _____

Q130 What is your current occupational status?   (MARK ALL THAT APPLY.)
Part-time student (1)
Full-time student (2)
Working part-time (3)
Working full-time (4)
Unemployed (5)
Full-time homemaker or family caregiver (6)
Other (Please specify): (7) _____

Q131 In the past 3 months, has your school or employment status changed because of your cancer or its treatment? (MARK ALL THAT APPLY.)
It has not changed because of my cancer or its treatment (1)
I quit working completely (2)
I quit going to school completely (3)
I changed my work status from full-time to part-time or I reduced my hours (4)
I changed my school status from full-time to part-time (5)
I increased my work hours (from not working or part-time work to part- or full-time work) (6)
I increased my school attendance from none or part-time to part- or full-time (7)
I took more than 2 weeks total time off from work (8)
I took more than 2 weeks total time off from school (9)
Other (Please describe): (10) _____

Q132 What is your current marital status?
Single, never been married (1)
Married, or living as married (2)
Divorced (3)
Separated (4)
Widowed (5)

Q133 Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicaid?
Yes (1)
No (2)

Q134 About how much do you weigh without shoes? Pounds (1)

Q135 What is your zip code? Zip Code (1)

Q136 What was most difficult for you about getting study information through Facebook?

Q137 What was most helpful for you about getting study information through Facebook?

Q138 Would you recommend using Facebook to give health messages?
Yes (1)
No (2)
I don't know (3)

Q139 Please explain why or why not.

Q140 What type of discussions on the FITNET group wall did you find most helpful?

Q141 Please add any other comments that you think could help us improve the FITNET program.

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