The Effect of a Mental Health Intervention on Health Behaviors among Cancer Survivors: A Randomized Controlled Trial of Acceptance and Commitment Therapy for Anxious Cancer Survivors in Community Clinics

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Abstract

Background: Adherence to health behavior guidelines (i.e., limiting alcohol use, remaining physically active, maintaining a healthy diet, quitting smoking) for cancer survivors can reduce the risk of cancer recurrence, improve survival rates, and improve quality of life (QOL; WCRF/AICR, 2007; Demark et al., 2015; Wang et al., 2020). Adherence to health behavior guidelines among patients with cancer is low, ranging from 7-40% across health behaviors (Tollosa, 2019). **Methods:** The present study evaluated the effectiveness of an acceptance and commitment therapy (ACT) group intervention (Valued Living; VL) delivered by social workers in community oncology clinics designed to target anxiety, to improve health behaviors relative to enhanced usual care (EUC). One hundred thirty-five cancer survivors with moderate to high anxiety were randomized 1:1 to Valued Living (VL; a 7-session ACT-informed group) or EUC (usual onsite supportive care plus an emailed list of resources). Participants self-reported health behaviors (i.e., tobacco use, alcohol use, dietary risk behavior, and physical activity) at baseline, and 1-week post-intervention. **Results:** There was no statistically significant effect of treatment on health behaviors. Alcohol and tobacco use were not significantly correlated at baseline; physical activity was weakly, negatively correlated with fast food, snacks, or pizza consumption and moderately, positively correlate fruit and vegetable consumption. Fruit and vegetable consumption was weakly, negatively correlated with fast food, snacks and pizza consumption. Binge drinking was moderately positively correlated with soda and sweetened drink intake. Participant health behavior rates were: 9.02% reported tobacco use in the last 30 days; 20.30% binge alcohol use; 46.90% exercised 150 minutes or more each week. **Conclusions:** Interventions that integrate mental and behavioral health, and/or medical referrals for participants

that struggle with health behaviors are needed to improve study beneficence and utiliae a critical opportunity to provide care to people that need it. .

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Adherence to health behavior guidelines (i.e., limiting alcohol use, remaining physically active, eating a healthy diet, quitting smoking) for cancer survivors can reduce the risk of cancer recurrence, improve survival rates, and enhance quality of life (QOL; WCRF/AICR, 2007; Demark et al., 2015; Wang et al., 2020). Adherence to health behavior guidelines among patients with cancer is often low, ranging from 7-40% across health behaviors (Tollosa, 2019). Blanchard and colleagues (2008) found only 5% of cancer survivors met all three guidelines for physical activity, smoking, and dietary risk habits. As there were approximately 19.3 million cancer survivors in the US in 2022, an intervention that is both scalable and effective for health behavior change is needed (National Cancer Institute, 2022). A recent meta-analysis (Arnold et al., 2022) revealed that accceptance and commitment therapy (ACT) is effective for addressing both psychological distress and health behaviors, including when delivered by non-mental health professionals. This introduction begins with a background review of cancer rates and problems that cancer survivors face, research regarding adherence to health behaviors, and ACT's effectiveness in changing relevant health behaviors. The introduction concludes with the present study's aims and is followed by the methods, results, and a discussion of the study's findings as well as areas for future research.

Background

Cancer and Cancer Survivors

Cancer is the leading cause of death and disease burden worldwide and the global cancer burden is forecasted to continue to grow for at least the next 20 years (Global Burden of Disease 2019 Cancer Collaboration, 2022; WHO, 2020; Sung et. al, 2021). There were approximately 19.3 million cancer survivors in the US in 2022 and this number is projected to grow to more than 22.1 million by 2030 because of early diagnosis and treatment advances (National Cancer Institute, 2022; Miller et al, 2019; American Cancer Society, 2016). In 2019, global cancer deaths attributable to preventable risk factors were 4.45 million, accounting for 44.4% of all cancer deaths (Tran et al., 2022). Leading risk factors for both men and women were tobacco use (33.9% and 10.7%), followed by alcohol use in males (7.4%), dietary risks in both sexes (5.9% in males and 5.1% in females), and high BMI in both sexes (Tran et al., 2022).

Adherence to Health Behaviors

Tobacco use. Approximately 62% of patients recently diagnosed with cancer are current or former smokers (Karem-Hage et al., 2014). The rate of current cigarette smoking among cancer survivors is up to 46% of young cancer survivors (18-40 years) and 16.9% of older cancer survivors (Asfar et al., 2021; Salloum et al., 2019). The Surgeon General's 2014 report addressed adverse health consequences of continued smoking (e.g., premature death, liver cancer, tuberculosis, and impaired immune function) in cancer patients and survivors, and the need for assessing tobacco use in the high-risk population of cancer survivors (United States Surgeon General, 2014). Warren and colleagues (2013) found that current smoking in cancer patients increased risk of overall and disease-specific mortality.

Smoking cessation programs that are effective in the general population, such as counseling, nicotine replacement therapy (NRT), and medication-assisted treatments bupropion and varenicline, are significantly less effective for cancer survivors (Karem-Hage et al., 2014;

Nayan et al., 2013; Nayan et al., 2011; Sheeran et al., 2019). Continued use of tobacco products may contribute to worse outcomes in cancer treatment, other cancer diagnoses, and additional illnesses (Fahey et al., 2019). Smoking cessation improves the effectiveness of cancer treatment, increases survival rates, and improves quality of life (QOL; Gritz et al., 2006; Nayan et al., 2013; Nayan et al., 2011)

Alcohol use. A quarter of cancer survivors show risky alcohol use (Kim & Keegan, 2022). National Health Interview survey data report 34.9% of cancer survivors exceeding moderate drinking limits and 21.0% engaged in binge drinking (Oh, 2020; Sanford et al., 2020). Alcohol use after cancer diagnosis is a risk factor for several malignancies and cancer, mortality, and cancer recurrence (Thrift et al., 2012). In addition, risky drinkers are more likely to be current cigarette smokers, another risk factor for poor health outcomes (Kim & Keegan, 2022).

Physical activity. Many cancer survivors do not meet physical activity guidelines and do not show significant improvements in physical activity after diagnosis (Kim & Keegan, 2022; Friedenreich, 2020; Ligibel, 2012; Di Meglio et al., 2021; Blanchard et al., 2008). 47% percent of adults nationwide meet the guidelines for moderate-intensity physical activity (150 or more minutes per week), while the average for cancer survivors is lower, ranging from 17% to 47% (Elgaddal, 2022; Troeschel et al., 2018). Most cancer survivors are not active enough to experience the health benefits of moderate exercise (Troeschel et al., 2018). Cancer survivors are faced with an increased risk of declines in physical function and quality of life compared to healthy adults. Remaining active can improve cancer-related health outcomes including anxiety, physical functioning, and quality of life (Campbell et al., 2019).

Diet. Many cancer survivors also struggle with adherence to healthy dietary guidelines, especially recommendations for consumption of fruits and vegetables (Gan et al., 2022). Sodas

or sugary drinks are leading sources of added sugars in diets (CDC, 2022). Frequently drinking sugary beverages is associated with weight gain, obesity, type 2 diabetes, heart disease, and other physical health complications (CDC, 2022). Obesity and poor nutrition can negatively affect cancer treatment and survival, contributing to about 40% of cancer cases in the United States and 30% of cancer survivors have obesity (CDC, 2022). The American Cancer Society recommends limiting the intake of foods and drinks with added sugar; and consuming a variety of colorful vegetables and fruits for cancer survivors (Rock et al, 2020).

Correlations between health behaviors. Alcohol use, tobacco use, dietary habits, physical activity, and illegal drug use/prescription abuse are correlated. Alcohol and tobacco use are strongly correlated, with adults who binge drink more than twice as likely to be current smokers (Bobo & Husten, 2000). Data on physical activity suggests that it is weakly associated with not smoking, following a healthy diet (i.e., fewer sweets, more servings of fruits and vegetables), and moderate consumption of alcohol (Johnson et al., 1995; Joseph et al., 2011; Matthews et al., 1997). Thus, intervening to promote one health behavior may improve others. Adherence to health behavior guidelines is especially critical for cancer survivors because adherence to health behavior guidelines can reduce the risk of cancer recurrence, improve survival rates, and improve quality of life (QOL; WCRF/AICR, 2007; Demark et al., 2015; Wang et al., 2020). An effective behavioral health intervention to address health behaviors among current cancer patients and survivors is needed.

Acceptance and Commitment Therapy (ACT)

Acceptance and Commitment Therapy (ACT; Hayes et al., 1999, 2012) contains several components that may promote healthy behavior change. ACT incorporates acceptance, mindfulness, and values-based approaches to increase psychological flexibility, defined here as

the ability to change or persist in behavior that is aligned with longer term values rather than short term impulses. Through ACT, participants examine personal life values and commit to a aligning their behavior with their values. Valuing can be described as a behavioral process in which one responds to two or more stimuli in relation to one another. An example of valuing may be: "I value feeling healthy, thus quitting smoking is important and meaningful to me." Verbal relational framing may evoke motivational feelings of importance and meaning which are reinforcing valued behaviors (Blackledge et al., 2009). Through the process of relational framing, Relational Frame Theory (RFT; Hayes, D. Barnes-Holmes, & Roche, 2001), individuals thus reinforce their own behaviors through the act of valuing.

ACT and Health Behaviors

Tobacco use. ACT may hold promise as a tobacco cessation intervention. Bricker and colleagues (2013, 2020) found that a significantly greater number of participants were abstinent during an intervention that used an ACT smartphone-application than participants using the National Cancer Institute's cessation program, which taught avoidance of smoking triggers. Group-based ACT and group-based cognitive behavioral therapy (CBT) have shown similar long-term tobacco quit rates for cigarette smokers (McClure et al., 2020). Another study compared telephone-delivered ACT versus CBT therapy and found 9% higher (31% vs. 22%; odds ratio [*OR*] = 1.5, 95% confidence interval [CI] = 0.7-3.4) quit rates overall for ACT and 20% higher (33% vs. 13%; *OR* = 1.2, 95% CI = 1.0–1.6) quit rates among participants who were depressed at baseline (Bricker et al., 2014). ACT may be especially effective in the cancer survivor population as depression rates are approximately twice that of the general population and depression is a major predictor of smoking relapse (Mitchell et al., 2013). ACT may also be effective for mental health conditions that exist alongside behavioral health concerns (Byrne et

al., 2019). While studies have found ACT to be effective for healthy adults, research on ACT as an effective tobacco cessation intervention for cancer survivors is lacking.t

Alcohol use. ACT appears to outperform some established treatments and be comparable to CBT for the treatment of alcohol use disorder (AUD) (Levin and Hayes, 2009; Lee et al., 2015). 34.9% of cancer survivors exceed moderate drinking limits and 21.0% engaged in binge drinking which are considered alcohol use disorders (Oh, 2020; Sanford et al., 2020).

Physical Activity. A recent meta-analysis found that ACT was promising for increasing physical activity, and that further research on which behavior change techniques (e.g. exercise goals, purchasing healthy food) can be associated with ACT processes is needed (Pears & Sutton, 2021).

Diet. ACT may be effective for dietary risk behavior change as well. A controlled single session of ACT therapy found significant effects on dietary habits amongst a general population (Barreto et al., 2019). Further research is needed on the efficacy of ACT on tobacco use, alcohol use, physical activity, and dietary risk behaviors within cancer survivors.

Valued Living

Based on the ACT model, the Valued Living (VL) intervention was developed by Arch et al. (2021) for anxious cancer survivors to: practice developing an increased awareness of thoughts and emotions about cancer that participants may be avoiding; reduce the influence of inflexible distress-driven thoughts and beliefs about themselves, cancer, and cancer survivorship on behavior or actions; and to highlight personal values in order to commit to engaging in meaningful life activities, aligning with those personal values, including during periods of anxiety or distress. While health behaviors were not explicitly the focus of the present intervention, it is important to assess whether VL had a positive effect on health behaviors,

particularly given their relevance for cancer survivors, and to determine if incorporating health behavior goals into future interventions may be beneficial for cancer survivors.

Aims and Hypotheses

This study aims to: (1) report on rates of participant health behaviors in an ACT-based intervention for reducing cancer survivors' anxiety (2) exploratory aim: compare participant health behaviors to national health guidelines (3) assess correlations of measured health behaviors with alcohol and tobacco hypothesized to be highly positively correlated; physical activity hypothesized to be weakly negatively correlated with tobacco use, alcohol use, and dietary risk behaviors (4) assess if the intervention, Valued Living, had a significant effect on health behaviors such that participants in VL are hypothesized to display greater decreases in tobacco use, alcohol use, and dietary risk behaviors, and greater increases in physical activity frequency and duration than EUC

Method

Design

The present study is a secondary data analysis of a randomized controlled trial (Arch et al., 2021). It involves a pre/post assessment and two experimental groups, VL and EUC.

Participants

Potential participants were considered eligible if they met the following criteria: (1) participants had completed primary treatment for any cancer 1.5 to 24 months prior; (2) participants were now in remission or no longer showing evidence of disease; (3) showed evidence for anxiety or depressive symptoms as assessed by cut scores of $\geq$ 3 on the GAD-2 or the PHQ-2, a score of $\geq$5 on a 0-10 cancer survivorship anxiety scale (Arch & Mitchell, 2016), or $\geq$ 14 on the State-Trait Anxiety Inventory (Tluczek et al., 2009); (4) fluent in English; (5) had

not started new daily psychiatric medications in the last 2 months. Eligibility screening was conducted over the phone and medical charts were checked to confirm cancer status. Participants were considered ineligible if they were at high risk for suicide, had chronic post-traumatic stress disorder (PTSD) symptoms unrelated to cancer, or any suicide attempts or psychiatric hospital stays within the last 5 years. These individuals were referred to more intensive support resources. Suicidality was determined by a screener from the MINI International Neuropsychiatric Interview (MINI). Chronic PTSD symptoms and suicide attempts or psychiatric hospital stays were assessed via self-report.

Procedure

Participants were recruited from September 2015 to October 2018. Eligible cancer survivors were referred by oncology social workers from Rocky Mountain Cancer Centers (RMCC) or participants contacted the study team after viewing a flyer in clinic or receiving a targeted mailing. Recruitment goals for 10-12 participants per cohort, with half randomized to VL and half to EUC were met.

A sample size goal of 50 participants per condition was based on a power analysis for the primary analytic plan of determining the effect of VL (in comparison to EUC) on anxiety and depression among cancer survivors (see Arch et al., 2021 for details). High recruitment success (90.85% of referred and study-eligible participants consenting to participate) led to a sample size of 135.

Participant-reported health behaviors were assessed at baseline (before randomization), 1-week post-intervention (2 months post-randomization), and 6 months post-intervention. Measures were completed online in Qualtrics (Qualtrics Software, 2017; or by mail if participants lacked internet access), which allowed condition assignment to remain masked.

Health behavior assessment tools were obtained from Estabrooks et al.'s (2012) study on recording patient-reported health behaviors data. Participants were compensated for their time at $25 per Qualtrics assessment completed with a $10 bonus for completing it within 36 hours and $50 per clinical interview plus a $25 bonus for completing it within 1 week of the study team's outreach to schedule it.

Interventions

EUC

EUC was accomplished by encouraging participants to engage in the usual care provided by their oncology clinic and participants were offered a geographically tailored list of additional support resources. After completing the final study assessment, participants in EUC could choose to join and complete VL. Eleven participants joined VL after EUC; data were not collected or reported on these participants.

VL

VL consisted of 7 weekly group sessions for 2 hours each, with content adapted from ACT. VL participants were given the same list of additional support resources as EUC. VL groups took place onsite at RMCC. Content for sessions 1-2 focused on an adapted form of the ACT matrix for anxious cancer survivors (Polk & Shoendorff, 2014). The ACT matrix was used to teach participants about moving toward or away from their identified values through their behaviors. In particular, the relationship between participants' fears and worries and their behaviors was examined. Starting at session 2: sessions began with a short present-moment mindful awareness exercise with eyes closed; and participants were asked to identify a "valued behavior commitment," which was an achievable goal based on their identified values, to be pursued that week and shared in session following the mindfulness practice. Sessions 3-5 used

the ACT Passengers on the Bus metaphor (Hayes et al., 1999) to practice responding to challenging thoughts and feelings. Cognitive de-fusion was taught as a way for participants to separate themselves from thoughts and feelings that interfered with valued living. ACT-based acceptance was taught to challenge avoidance to cancer-related thoughts and feelings. Sessions 6-7 helped participants further clarify their values and align their behaviors with those values. A home practice assignment was given each week from the VL workbook and was discussed in the following session. The homework was not evaluated.

Measures

Sociodemographic Characteristics

Participants self-reported sex, age, race/ethnicity, educational attainment, household income, marital status, and number of children at baseline.

Medical Characteristics

Cancer treatment history, type, and stage were assessed at baseline via a medical chart check.

Health Behavior Outcomes

Tobacco use. Tobacco use was collected using the Centers for Disease Control and Prevention's (CDCP) Behavioral risk factor surveillance system (BRFSS) Questionnaire (2009) by asking the participants the following questions: "Have you used tobacco in the last 30 days?"; "Smoked cigarettes?"; "If yes, how many cigarettes?"; "Smokeless tobacco product?"; "If yes, how many servings of tobacco per day on average?"

Dietary risk behavior. Dietary risk data were collected via a modified eating pattern assessment (Estabrooks et al., 2012; Paxton et al., 2011) by asking participants the following questions: "Over the past 7 days:-How many times a week did you eat fast food or snacks or

pizza?"; "Over the past 7 days:-How many servings of fruits/vegetables did you eat each day?"; "Over the past 7 days:-How many soda and sugar-sweetened drinks (regular, not diet) did you drink each day?"

Alcohol use. Alcohol use data were collected via the single-item alcohol use screener recommended by the National Institute on Alcohol Abuse and Alcoholism (NIAAA; Smith et al., 2009) by asking participants the following questions: **"**One alcoholic drink is equivalent to a 12-ounce beer, a 5-ounce glass of wine, or a drink with one shot of liquor. A 40-ounce beer would count as 3 drinks, or a cocktail drink with 2 shots would count as 2 drinks. How many times in the past MONTH have you had 5 drinks if you are male or 4 drinks if you are female, or more in a day?"

Physical activity. Physical activity was collected (Sallis, 2011) by asking participants the following questions: **"**How many days of moderate to strenuous exercise, like a brisk walk, did you do in the last 7 days?"; "Over the past 7 days, on those days that you engage in moderate to strenuous exercise, how many minutes, on average, did you exercise at this level?"

Analytic Approach

The present study and all planned analyses were pre-registered with Open Science Framework (OSF) at https://doi.org/10.17605/OSF.IO/3DJY5.

Descriptive statistics were computed for all outcome variables. A Pearson correlation matrix was created. Analysis of Covariance (ANCOVA) was used to analyze the effect of treatment condition on health behaviors: dietary behaviors , alcohol use, and physical activity, controlling for the baseline level of the outcome. For the binary categorical variable regarding tobacco use ("Have you used tobacco in the last 30 days?") logistic regression was used to analyze the data with the baseline measure as a covariate, post-intervention response as the

outcome variable, and experimental condition as a predictor. The Benjamini-Hochberg (BH) multiple comparisons step-up correction method was used to adjust the p-value from using multiple ANCOVA tests. The false discovery rate was set to 0.20 and 0.05, and results for both were reported. Two-tailed tests were used for the following predictions: participants in VL were hypothesized to display greater decreases in tobacco use, alcohol use, dietary risk behaviors, and greater increases in physical activity frequency and duration than EUC.

Missing data were treated as missing completely at random (MCAR). Missing data were handled with pairwise deletion. A sensitivity analysis was used to examine the contribution of one outlying data point regarding alcohol use.

Results

The University of Colorado Boulder institutional review board and the University of Colorado Cancer Center approved the Valued Living Study. All participants provided written informed consent.

Sociodemographic characteristics.

Out of the 135 cancer survivors who completed the study, 133 participants completed the sociodemographic measures. There were no significant differences in sociodemographic and clinical characteristics between conditions at baseline (see Table 1). Participants was mostly non-Hispanic white (86.57%), female (88.06%), and had a mean age of 56.14 years. A little over half had breast cancer (58.96%), with many other forms of cancer present in the sample (see Table 2).

Missing Data and Outliers

One participant skipped baseline due to a health issue; their data was not collected at other time points, but they remained in the study. Missing data (Table 2 ranged from 1-4

participants at baseline and 17-21 at post-intervention due to participants not filling out the health behavior survey.

One outlier datapoint was removed from Q6 regarding alcohol use to perform a sensitivity analysis for the ANCOVA model.

Base Rates National Guidelines Comparisons for This Study Sample's Health Behavior Characteristics at Baseline

Tobacco Use

Participant tobacco use data was compared against the Surgeon Generals' no safe level of exposure to tobacco smoke and recommendation for cessation of nicotine use (United States Surgeon General, 2014). Across both treatment groups at baseline, 9.02% (n = 12) used tobacco in the last 30 days. This is less than the estimated national average of 20.8% amongst the general population and the 16.9% average amongst older cancer survivors (Cornelius et al., 2020; Salloum et al., 2019).

Alcohol Use

The National Institute of Health - National Institute on Alcohol Abuse and Alcoholism's (NIH - NIAAA) definition for heavy alcohol use is consuming more than 4 drinks for males, or more than 3 drinks for females on any day. The USDA's recommendation for adults is drinking in moderation: choosing not to drink or limiting intake up to 2 drinks or less in a day for men and 1 drink or less in a day for women (NIAAA, 2022; U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2020). One or more days of heavy drinking in the last month qualifies an adult as an at-risk drinker (NIDA, 2009). Across both groups at baseline, 20.30% (n = 27) of participants reported consuming more than the recommended guidelines (5 drinks if male or 4 drinks if female) at least one time in the past month. This is about the same as

the 21.0% national average for cancer survivors and lower than the national average of 25.8% of people age 18 and older (Oh, 2020; Sanford et al., 2020; SAMHSA, 2019).

Physical Activity

Participant physical activity was compared to the Center for Disease Control and Prevention (CDC) and the U.S. Department of Health and Human Services (U.S. DHHS) recommendations of 150 minutes of moderate-intensity physical activity each week, or about 30 minutes a day (CDC, 2022; U.S. DHHS, 2018). 46.9% of adults nationwide meet the guidelines for moderate-intensity physical activity, while the average for cancer survivors is usually lower ranging from 17% to 47% across studies (Elgaddal, 2022; Troeschel et al., 2018). In this study, 38.2% of participants across both groups met the 150 minutes of moderate-intensity physical activity each week at baseline placing this sample within and at the higher end of the norm for cancer survivors. Still, a majority of participants were not meeting activity guidelines, and falling short of the national recommended guidelines on average indicates the need for a targeted physical activity/exercise behavioral intervention for cancer survivors.

Diet

The U.S. DHSS, CDC, and USDA recommendations for a healthy diet are 1.5-2 servings of fruit and 2-3 servings of vegetables per day, with 1.5-2 cups of fruit and 2-3 cups of vegetables as the serving size for most fruits and vegetables (CDC 2017; USDA, 2020). Across both groups at baseline, the average combined servings of fruits and vegetables per day was a little over 3 (m = 3.27) which falls within, but at the lower end of the range, of the combined recommendation for 2.5-5 servings This study's sample appears to be more adherent regarding fruit and vegetable consumption guidelines than most cancer survivor populations (Gan et al., 2022). Participant soda and sugar-sweetened drink averages were between 0 and 1 per day (m =

0.54) which is in line with the CDC recommendation of limiting sugary drink intake as a healthy dietary pattern (CDC, 2022). Across both groups, participants consumed fast food, pizza, and snacks an average of 2-3 times per week (m = 2.56); however, there is not a sufficient guideline for their consumption.

Correlations between Health Behaviors

Alcohol and Tobacco Use

Alcohol and tobacco use were not significantly correlated at baseline (r = -0.06, p = 0.50, Table 4).

Physical Activity

Physical activity (exercise days; minutes exercised) was weakly, negatively associated with not smoking, however, it did not reach statistical significance (r = -0.13, p =0.15; r= -0.04, p=0.64). Physical activity (exercise days; minutes exercised) was weakly, negatively correlated with alcohol, but not statistically significant (r= -0.11, p=.45; r= -0.13, p=0.91). A small, statistically significant negative correlation was found between the number of days exercised and consumption of fast food, snacks, or pizza at baseline (r= -0.20, p<.05) and post-intervention (r= -0.22, p<.05). A moderate, significant positive correlation was found between days of exercise and consumption of fruits and vegetables (r= 0.34, p<.001). A small, significant positive correlation was found between minutes of exercise and consumption of fruits and vegetables at baseline (r= 0.28, p<.01). A large, significant positive correlation was found between exercise minutes and days of moderate to strenuous exercise at baseline (r= 0.57, p<.001) and post-intervention (r= 0.47, p<.001).

Diet

A small, significant negative correlation between fruit and vegetable consumption and fast food, snacks, and pizza consumption found at baseline (r= -0.23, p<.01) and post-intervention (r= -0.19, p<.05). A moderate, significant positive correlation was found between number of times in the past month a participant drank more than 5 if male (4 if female) alcoholic drinks in a day and how many soda or sugar sweetened drinks consumed per day at baseline (r= 0.36, p<.001) and post-intervention (r= 0.20, p<.05).

Effect of the Intervention on Change in Health Behaviors from Baseline to Post-Intervention

Table 6 presents statistical test results and Bejamini-Hochberg (BH) p-value correction comparisons (all determinations of significance were based on the BH correction method). There was no significant effect of treatment condition without the outlier removed ($F($1,106) =0.052, p=0.498) on how many times in the past month participants binge drank, controlling for baseline drinking. There was no significant effect of treatment condition with the outlier removed ($F($1,106) =0.462, p=0.498) on how many times in the past month participants binge drank, controlling for baseline drinking. There was no significant effect of treatment condition (b = -0.50, p = .451) on whether participants used tobacco in the last 30 days at post-intervention, controlling for baseline use of tobacco in the last 30 days. There was no significant effect of treatment condition ($F($1,111) =3.106, p=0.081) on fast food, snacks, and pizza dietary intake post-intervention, controlling for baseline consumption. There was no significant effect of treatment condition ($F($1,110) =1.159, p=0.284) on fruit and vegetable intake post-intervention, controlling for baseline consumption. There was no significant effect of treatment condition ($F($1,111) =0.293, p=0.589) on soda and sugar sweetened drinks intake post-intervention, controlling for baseline consumption. There was no significant effect of treatment condition

($F(1,111) = 0.338$, $p = 0.562$) on days of physical activity, controlling for baseline days of moderate to strenuous exercise. There was no significant effect of treatment condition ($F(1,108) = 1.212$, $p = 0.273$) on minutes of exercise, controlling for baseline .

The other tobacco-related measures ("Smoked cigarettes?"; "If yes, how many cigarettes?"; "Smokeless tobacco product?"; "If yes, how many servings of tobacco per day on average?") were not analyzed due to insufficient (less than 7 or 0) sample size. Almost all of the participants answered no to the primary questions resulting in no opportunity to answer the follow-up questions due to a survey condition (i.e., if a participant answered "no" to "Have you used tobacco in the last 30 days?", then they were not asked the other tobacco-related questions).

Discussion

This study's hypotheses that participants in VL would display greater decreases in tobacco use, alcohol use, and dietary risk behaviors, and greater increases in physical activity frequency and duration than EUC were not supported. The lack of an effect from the intervention may have been because the VL intervention did not address any health behaviors specifically. This study's sample also appeared to smoke less, consume more fruits and vegetables, and limit sugary drink intake as compared to other cancer survivor studies which may have limited the impact of the intervention on these health behaviors. Further details about this study sample's health behavior characteristics in comparison to national cancer survivor averages and national health guidelines are presented in the next section.

This study's hypotheses on the correlations between health behaviors were variously supported. The hypothesis that alcohol and tobacco use would be highly positively correlated was not supported, and this may have been because this study's sample had fewer tobacco users

compared to other cancer survivor studies. This study's hypothesis that physical activity would be weakly negatively correlated with dietary risk factors was supported by a significant negative correlation between the number of days exercised and consumption of fast food, snacks, or pizza at baseline; a moderate, significant positive correlation found between days of exercise and consumption of fruits and vegetables (r= 0.34, p<.001); and a small, significant positive correlation was found between minutes of exercise and consumption of fruits and vegetables at baseline (r= 0.28, p<.01). The hypotheses that physical activity would be weakly, negatively correlated with tobacco and alcohol use were not statistically significant although weak negative relationships were observed. This could be due to the sample containing fewer tobacco users than the average for cancer survivors and while also having a minority (38.2%) of participants engaging in 150 or more minutes of exercise each week. The results of this study indicate that many cancer survivors undergoing a mental health intervention may benefit greatly from a behavioral health screening and a targeted health behavior intervention for those not adhering to national health guidelines.

Limitations and Future directions

This study's sample appeared to smoke less, consume more fruits and vegetables, and limit sugary drink intake as compared to other cancer survivor studies, which may have created a ceiling effect that limited the impact of the ACT intervention on these health behaviors. Future studies may benefit from recruiting participants struggling with these health behaviors. The sample was not particularly diverse: primarily non-Latino white, female, and well-educated which limits the generalizability to other populations. Racial/ethnic disparities exist such that populations may differ in significant ways on health behaviors and disparities also exist within racial/ethnic groups; these disparities exist in part due to socioeconomic differences including

education differences (Anderson et al., 2004). A recruitment method that considers these disparities and can acquire a diverse sample set would increase the generalizability of findings.

In addition, the sample was of post-treatment cancer survivors with elevated levels of anxiety. Some studies suggest that greater overall psychological distress may predict less fruit and vegetable intake and physical activity, and greater sedentary behavior and cigarette use (St-Pierre et al., 2019). Perceived chronic stress may be related to eating palatable non-nutritious foods (pizza, sweetened drinks) (Groesz et al., 2012). Further examination of this study is warranted to determine if anxiety is a mediator of the relationship between treatment condition and health behaviors. Addressing health behaviors with individuals who are already receiving a mental health intervention may be particularly effective as patients' motivation for change is already elevated (Gritz et al., 2006).

Clinical Implications

Mental health interventions often do not collect or report on participants' health behaviors. Reporting health behavior data is essential for understanding the greater picture of participant health and providing feedback on how mental health interventions can synergize and improve both mental and physical health. This is especially important for cancer survivors, whose chronic condition may leave them more vulnerable to physical and mental health complications than the average adult; and who are more likely than the average adult to be in poor health (Naughton & Weaver, 2014). Collecting, reporting, and analyzing data on health behaviors for cancer survivors who have undergone mental-health-focused interventions is essential for understanding what health behaviors cancer survivors may struggle with, in what ways a mental-health-focused intervention may affect health behaviors, and whether incorporating physical health goals into mental health-interventions may be beneficial.

Future participants may benefit from a targeted medical referral for those that screen as non-adherent to national guidelines. While treatment is traditionally distinguished from clinical research, researchers are missing out on an opportunity to increase beneficence for their studies and clinical research participants are missing out on a critical opportunity to receive care. For example, in the present study 20.3% (n = 27) of participants reported binge drinking in the last month and only 38.2% (n = 51) of participants were meeting the national health guideline for minutes of exercise per week. These participants could have been offered a targeted alcohol abuse or physical activity resource, such as a follow-up with a local provider, or additional intervention after the study was completed. Further research is needed on what alcohol abuse resource may be most effective for cancer survivors, but ACT holds promise as an effective intervention that can be delivered by non-mental health professionals or clinical social workers (Levin and Hayes, 2009; Lee et al., 2015; Arch et al., 2021). Likewise, additional research is needed on what physical activity resources are most effective for cancer survivors, but ACT may be promising for increasing physical activity (Pears & Sutton, 2021).

References

American Cancer Society. (2016). Cancer treatment & survivorship facts & Figs. 2016–2017. American Cancer Society, Atlanta. https://www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/cancer-treatment-and-survivorship-facts-and-figures/cancer-treatment-and-survivorship-facts-and-figures-2016-2017.pdf. Accessed 7 Sep 2022

Appelbaum, M., Cooper, H., Kline, R. B., Mayo-Wilson, E., Nezu, A. M., & Rao, S. M. (2018). Journal article reporting standards for quantitative research in psychology: The APA publications and communications board task force report. American Psychologist, 73(1), 3–25. https://doi.org/10 .1037/amp0000191

Arch, J. J., & Mitchell, J. (2016). An acceptance and commitment therapy group intervention for cancer survivors experiencing anxiety at reentry. Psycho-Oncology, 25(5), 610–615. https://doi.org/10.1002/pon.3890

Arch, J. J., Mitchell, J. L., Genung, S. R., Judd, C. M., Andorsky, D. J., Bricker, J. B., & Stanton, A. L. (2021). Randomized trial of acceptance and commitment therapy for anxious cancer survivors in community clinics: Outcomes and moderators. *Journal of Consulting and Clinical Psychology*, *89*(4), 327–340. https://doi.org/10.1037/ccp0000630

Arch, J. J., Mitchell, J. L., Genung, S. R., Fisher, R., Andorsky, D. J., & Stanton, A. L. (2019). A randomized controlled trial of a group acceptance-based intervention for cancer survivors experiencing anxiety at re-entry ("Valued Living"): Study protocol. BMC Cancer, 19(1), Article 89. https://doi.org/10.1186/s12885-019-5289-x

Arnold, T., Haubrick, K. K., Klasko-Foster, L. B., Rogers, B. G., Barnett, A., Ramirez- Sanchez, N. A., Bertone, Z., & Gaudiano, B. A. (2022). Acceptance and Commitment Therapy

informed behavioral health interventions delivered by non-mental health professionals: A systematic review. *Journal of Contextual Behavioral Science*, *24*, 185–196. https://doi.org/10.1016/j.jcbs.2022.05.005

Asfar, T., Koru-Sengul, T., Annane, D., McClure, L. A., Perez, A., Antoni, M. A., Brewer, J., & Lee, D. J. (2021). Reach versus effectiveness: The design and protocol of randomized clinical trial testing a smartphone application versus in-person mindfulness-based smoking cessation intervention among young cancer survivors. *Contemporary Clinical Trials Communications*, *22*, 100784. https://doi.org/10.1016/j.conctc.2021.100784

Barreto, M., Tran, T. A., & Gaynor, S. T. (2019). A Single-Session of Acceptance and Commitment Therapy for Health-Related behavior change: An Open Trial with a nonconcurrent matched comparison group. *Journal of Contextual Behavioral Science*, *13*, 17–26. https://doi.org/10.1016/j.jcbs.2019.06.003

Blackledge, J. T., Ciarrochi, J., & Deane, F. P. (2009). *Acceptance and Commitment Therapy: Contemporary Theory Research and Practice*. Australian Academic Press.

Blanchard, C., Courneya, K., & Stein, K. (2008). Cancer Survivors' Adherence to Lifestyle Behavior Recommendations and Associations With Health-Related Quality of Life: Results From the American Cancer Society's SCS-II. *Journal of Clinical Oncology : Official Journal of the American Society of Clinical Oncology*, *26*, 2198–2204. https://doi.org/10.1200/JCO.2007.14.6217

Bobo, J. K., & Husten, C. (2000). Sociocultural Influences on Smoking and Drinking. *Alcohol Research & Health*, *24*(4), 225–232.

Bricker JB, Bush T, Zbikowski SM, Mercer LD, Heffner JL. (2014). Randomized trial of telephone-delivered acceptance and commitment therapy versus cognitive behavioral

therapy for smoking cessation: a pilot study. Nicotine Tob Res. 2014 Nov;16(11):1446-54. doi: 10.1093/ntr/ntu102. Epub 2014 Jun 16. PMID: 24935757; PMCID: PMC4200023.

Bricker JB, Watson NL, Mull KE, Sullivan BM, Heffner JL.(2020). Efficacy of Smartphone Applications for Smoking Cessation: A Randomized Clinical Trial. *JAMA Intern Med.* 2020;180(11):1472–1480. doi:10.1001/jamainternmed.2020.4055

Bricker J, Wyszynski C, Comstock B, Heffner JL. (2013). Pilot randomized controlled trial of web-based acceptance and commitment therapy for smoking cessation. Nicotine Tob Res. 2013 Oct;15(10):1756-64. doi: 10.1093/ntr/ntt056. Epub 2013 May 23. PMID: 23703730; PMCID: PMC3768336.

Byrne, S. P., Haber, P., Baillie, A., Costa, D. S. J., Fogliati, V., & Morley, K. (2019). Systematic Reviews of Mindfulness and Acceptance and Commitment Therapy for Alcohol Use Disorder: Should we be using Third Wave Therapies? *Alcohol and Alcoholism*, *54*(2), 159–166. https://doi.org/10.1093/alcalc/agy089

Campbell, K. L., Winters-Stone, K. M., Wiskemann, J., May, A. M., Schwartz, A. L., Courneya, K. S., Zucker, D. S., Matthews, C. E., Ligibel, J. A., Gerber, L. H., Morris, G. S., Patel, A. V., Hue, T. F., Perna, F. M., & Schmitz, K. H. (2019). Exercise Guidelines for Cancer Survivors: Consensus Statement from International Multidisciplinary Roundtable. Medicine and science in sports and exercise, 51(11), 2375–2390. https://doi.org/10.1249/MSS.0000000000002116CDC. (2022). Move More; Sit Less. Centers for Disease Control and Prevention. https://www.cdc.gov/physicalactivity/basics/adults/index.htmCDC. (2022). *Move More; Sit Less*. Centers for Disease Control and Prevention. https://www.cdc.gov/physicalactivity/basics/adults/index.htm

CDC. (2022). *Sugar Sweetened Beverage Intake*. Centers for Disease Control and Prevention. https://www.cdc.gov/nutrition/data-statistics/sugar-sweetened-beverages-intake.html

CDC Newsroom. (2016). CDC. https://www.cdc.gov/media/releases/2017/p1116-fruit-vegetable-consumption.html

Centers for Disease Control and Prevention. (2009). *Behavioral risk factor Surveillance system (BRFSS) Questionnaire*. Atlanta, Georgia: US DHHS.

Cornelius, M. E., Wang, T. W., Jamal, A., Loretan, C. G., & Neff, L. J. (2020). Tobacco Product Use Among Adults—United States, 2019. *MMWR. Morbidity and Mortality Weekly Report*, *69*(46), 1736–1742. https://doi.org/10.15585/mmwr.mm6946a4

Di Meglio, A., Gbenou, A. S., Martin, E., Pistilli, B., Ligibel, J. A., Crane, T. E., Flaysakier, J.-D., Minvielle, E., Vanlemmens, L., Guenancia, C., Rigal, O., Fournier, M., Soulie, P., Mouret-Reynier, M.-A., Tarpin, C., Boiffard, F., Guillermet, S., Everhard, S., Martin, A.-L., … Vaz-Luis, I. (2021). Unhealthy behaviors after breast cancer: Capitalizing on a teachable moment to promote lifestyle improvements. *Cancer*, *127*(15), 2774–2787. https://doi.org/10.1002/cncr.33565

Demark-Wahnefried W, Rogers LQ, Alfano CM, Thomson CA, Courneya KS, Meyerhardt JA, et al. (2015). Practical clinical interventions for diet, physical activity, and weight control in cancer survivors. CA Cancer J Clin. 2015;65(3):167–89

Elgaddal, N. (2022). *Physical Activity Among Adults Aged 18 and Over: United States, 2020*. *443*.

Estabrooks, P. A., Boyle, M., Emmons, K. M., Glasgow, R. E., Hesse, B. W., Kaplan, R. M., Krist, A. H., Moser, R. P., & Taylor, M. V. (2012). Harmonized patient-reported data elements in the electronic health record: supporting meaningful use by primary care action

on health behaviors and key psychosocial factors. *Journal of the American Medical Informatics Association : JAMIA*, *19*(4), 575–582. https://doi.org/10.1136/amiajnl-2011-000576

Fahey, M.C., Bursac, Z., Ebbert, J.O. *et al.* (2019). Prevalence and correlates of dual tobacco use in cancer survivors. *Cancer Causes Control* **30**, 217–223 https://doi.org/10.1007/s10552-019-1132-6

Friedenreich, C. M., Stone, C. R., Cheung, W. Y., & Hayes, S. C. (2020). Physical Activity and Mortality in Cancer Survivors: A Systematic Review and Meta-Analysis. *JNCI Cancer Spectrum*, *4*(1), pkz080. https://doi.org/10.1093/jncics/pkz080

Gan, T., Cheng, H.-L., & Tse, M. M. Y. (2022). Feasibility, acceptability, and effects of behavior change interventions for improving multiple dietary behaviors among cancer survivors: A systematic review. *Supportive Care in Cancer*, *30*(3), 2877–2889. https://doi.org/10.1007/s00520-021-06582-2

Global Burden of Disease 2019 Cancer Collaboration. (2022). Cancer Incidence, Mortality, Years of Life Lost, Years Lived With Disability, and Disability-Adjusted Life Years for 29 Cancer Groups From 2010 to 2019: A Systematic Analysis for the Global Burden of Disease Study 2019. *JAMA Oncology*, *8*(3), 420–444. https://doi.org/10.1001/jamaoncol.2021.6987

Grant, B. F., Hasin, D. S., Chou, S. P., Stinson, F. S., & Dawson, D. A. (2004). Nicotine Dependence and Psychiatric Disorders in the United States: Results From the National Epidemiologic Survey on Alcohol and RelatedConditions. *Archives of General Psychiatry*, *61*(11), 1107–1115. https://doi.org/10.1001/archpsyc.61.11.1107

Gritz, E.R., Fingeret, M.C., Vidrine, D.J., Lazev, A.B., Mehta, N.V. and Reece, G.P. (2006). Successes and failures of the teachable moment. Cancer, 106: 17-27. https://doi.org/10.1002/cncr.21598

Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). *Relational Frame Theory: A Post-Skinnerian Account of Human Language and Cognition*. Springer Science & Business Media.

Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (1999). Acceptance and commitment therapy: An experiential approach to behavior change. Guilford Press.

Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (2012). Acceptance and commitment therapy: The process and practice of mindful change (2nd ed.). Guilford Press.

Heffner, J. L., Kelly, M. M., Waxmonsky, J., Mattocks, K., Serfozo, E., Bricker, J. B., Mull, K. E., Watson, N. L., & Ostacher, M. (2020). Pilot Randomized Controlled Trial of Web-Delivered Acceptance and Commitment Therapy Versus Smokefree.gov for Smokers With Bipolar Disorder. *Nicotine & Tobacco Research*, *22*(9), 1543–1552. https://doi.org/10.1093/ntr/ntz242

Johnson, N. A., Boyle, C. A., & Heller, R. F. (1995). Leisure-time physical activity and other health behaviours: Are they related? *Australian Journal of Public Health*, *19*(1), 69–75. https://doi.org/10.1111/j.1753-6405.1995.tb00300.x

Joseph, R. J., Alonso-Alonso, M., Bond, D. S., Pascual-Leone, A., & Blackburn, G. L. (2011). The Neurocognitive Connection between Physical Activity and Eating Behavior. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, *12*(10), 800–812. https://doi.org/10.1111/j.1467-789X.2011.00893.x

Karem-Hage M, Cinciripini PM, Gritz ER. (2014). Tobacco use and cessation for cancer survivors: an overview for clinicans. CA Cancer J Clin 64(4):272–290

Kim, J., Keegan, T.H. (2022). Characterizing risky alcohol use, cigarette smoking, e-cigarette use, and physical inactivity among cancer survivors in the USA—a cross-sectional study. *J Cancer Surviv*. https://doi-org.colorado.idm.oclc.org/10.1007/s11764-022-01245-5

Lee, E. B., An, W., Levin, M. E., & Twohig, M. P. (2015). An initial meta-analysis of Acceptance and Commitment Therapy for treating substance use disorders. *Drug and Alcohol Dependence*, *155*, 1–7. https://doi.org/10.1016/j.drugalcdep.2015.08.004

Levin, M., & Hayes, S. C. (2009). Is acceptance and commitment therapy superior to established treatment comparisons. *Psychotherapy and psychosomatics*, *78*(6), 380.

Ligibel, J. (2012). Lifestyle Factors in Cancer Survivorship. *Journal of Clinical Oncology*, *30*(30), 3697–3704. https://doi.org/10.1200/JCO.2012.42.0638

Löwe, B., Kroenke, K., & Gräfe, K. (2005). Detecting and monitoring depression with a two-item questionnaire (PHQ-2). *Journal of Psychosomatic Research*, *58*(2), 163–171. https://doi.org/10.1016/j.jpsychores.2004.09.006

Mantar, A., Yemez, B., & Alkın, T. (2011). Anxiety sensitivity and its importance in psychiatric disorders. *Turk Psikiyatri Dergisi = Turkish Journal of Psychiatry*, *22*(3), 187–193.

Matthews, C. E., Hebert, J. R., Ockene, I. S., Saperia, G., & Merriam, P. A. (1997). Relationship between leisure-time physical activity and selected dietary variables in the Worcester Area Trial for Counseling in Hyperlipidemia. *Medicine and Science in Sports and Exercise*, *29*(9), 1199–1207. https://doi.org/10.1097/00005768-199709000-00013

McClure, J. B., Bricker, J., Mull, K., & Heffner, J. L. (2020). Comparative Effectiveness of Group-Delivered Acceptance and Commitment Therapy versus Cognitive Behavioral

Therapy for Smoking Cessation: A Randomized Controlled Trial. *Nicotine & Tobacco Research*, *22*(3), 354–362. https://doi.org/10.1093/ntr/nty268

Miller, K.D., Nogueira, L., Mariotto, A.B., Rowland, J.H., Yabroff, K.R., Alfano, C.M., Jemal, A., Kramer, J.L. and Siegel, R.L. (2019). Cancer treatment and survivorship statistics, 2019. CA A Cancer J Clin, 69: 363-385. https://doi-org.colorado.idm.oclc.org/10.3322/caac.21565

Mitchell, A. J., Ferguson, D. W., Gill, J., Paul, J., & Symonds, P. (2013). Depression and anxiety in long-term cancer survivors compared with spouses and healthy controls: A systematic review and meta-analysis. *The Lancet Oncology*, *14*(8), 721–732. https://doi.org/10.1016/S1470-2045(13)70244-4

National Cancer Institute. (2022). https://www.cancer.gov/about-cancer/understanding/statistics. Accessed 13 Sep 2022.

Naughton, M. J., & Weaver, K. E. (2014). Physical and mental health among cancer survivors: considerations for long-term care and quality of life. *North Carolina medical journal*, *75*(4), 283–286. https://doi.org/10.18043/ncm.75.4.283

Nayan S, Gupta MK, Strychowsky JE, Sommer DD. (2013). Smoking cessation interventions and cessation rates in the oncology population. Otolaryngol Head Neck Surg 149(2):200–211. https://doi.org/10.1177/0194599813490886

Nayan, S., Gupta, M. K., & Sommer, D. D. (2011). Evaluating smoking cessation interventions and cessation rates in cancer patients: a systematic review and meta-analysis. *International Scholarly Research Notices*, *2011*.

NIAAA. (n.d.) *Drinking Levels Defined | National Institute on Alcohol Abuse and Alcoholism (NIAAA)*. Retrieved September 29, 2022, from https://www.niaaa.nih.gov/alcohol-health/overview-alcohol-consumption/moderate-binge-drinking

NIDA. (2009). NIH Publication No. 11-7384 Printed April 2009 Revised December 2011

Otto, M. W., & Smits, J. A. J. (2018). Anxiety Sensitivity, Health Behaviors, and the Prevention and Treatment of Medical Illness. *Clinical Psychology : A Publication of the Division of Clinical Psychology of the American Psychological Association*, *25*(3), e12253. https://doi.org/10.1111/cpsp.12253

Paxton AE, Strycker LA, Toobert DJ, et al. (2011) Starting the conversation: performance of a brief dietary assessment and intervention tool for health professionals. *Am J Prev Med* 2011;40:67–71

Pears, S., & Sutton, S. (2021). Effectiveness of Acceptance and Commitment Therapy (ACT) interventions for promoting physical activity: a systematic review and meta-analysis. *Health psychology review*, *15*(1), 159–184. https://doi.org/10.1080/17437199.2020.1727759

Polk, K. L., & Schoendorff, B. (2014). The ACT matrix: A new approach to building psychological flexibility across settings and populations. Con- text Press.

Rock, C.L., Thomson, C., Gansler, T., Gapstur, S.M., McCullough, M.L., Patel, A.V., Andrews, K.S., Bandera, E.V., Spees, C.K., Robien, K., Hartman, S., Sullivan, K., Grant, B.L., Hamilton, K.K., Kushi, L.H., Caan, B.J., Kibbe, D., Black, J.D., Wiedt, T.L., McMahon, C., Sloan, K. and Doyle, C. (2020), American Cancer Society guideline for diet and physical activity for cancer prevention. CA A Cancer J Clin, 70: 245-271. https://doi-org.colorado.idm.oclc.org/10.3322/caac.21591

SAMHSA, Center for Behavioral Health Statistics and Quality. (2019). National Survey on Drug Use and Health. Table 2.20B – Binge Alcohol Use in Past Month among Persons Aged 12 or Older, by Age Group and Demographic Characteristics: Percentages, 2018 and 2019.

Sheeran, P., Jones, K., Avishai, A., Symes, Y. R., Abraham, C., Miles, E., Wright, C. E., Mayer, D. K., & Ribisl, K. M. (2019). What works in smoking cessation interventions for cancer survivors? A meta-analysis. *Health Psychology, 38*(10), 855–865. https://doi.org/10.1037/hea0000757

Smith, P. C., Schmidt, S. M., Allensworth-Davies, D., & Saitz, R. (2009). Primary Care Validation of a Single-Question Alcohol Screening Test. *Journal of General Internal Medicine, 24*(7), 783–788. https://doi.org/10.1007/s11606-009-0928-6

Sung, H, Ferlay, J, Siegel, RL, Laversanne, M, Soerjomataram, I, Jemal, A, Bray, F. (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2021: 71: 209- 249. https://doi.org/10.3322/caac.21660

U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. (2014). The health consequences of smoking—50 years of progress: a report of the surgeon general. http://www.surgeongeneral.gov/library/reports/50-years-of-progress/full-report.pdf.

Thrift, A.P., Nagle, C.M., Fahey, P.P., Russell, A., Smithers, B.M., Watson, D.I., and Whiteman, D.C. (2012). The influence of prediagnostic demographic and lifestyle factors on esophageal squamous cell carcinoma survival. Int. J. Cancer, 131: E759-E768. https://doi-org.colorado.idm.oclc.org/10.1002/ijc.27420

Tluczek, A., Henriques, J. B., & Brown, R. L. (2009). Support for the Reliability and Validity of a Six-Item State Anxiety Scale Derived From the State-Trait Anxiety Inventory. *Journal of Nursing Measurement, 17*(1), 19–28. https://doi.org/10.1891/1061-3749.17.1.19

Tollosa DN, Tavener M, Hure A, James EL. (2019). Adherence to multiple health behaviours in cancer survivors: a systematic review and meta-analysis. J Cancer Surviv. Jun;13(3):327-343. doi: 10.1007/s11764-019-00754-0. Epub 2019 Apr 16. PMID: 30993648.

Tran, K. B., Lang, J. J., Compton, K., Xu, R., Acheson, A. R., Henrikson, H. J., Kocarnik, J. M., Penberthy, L., Aali, A., Abbas, Q., Abbasi, B., Abbasi-Kangevari, M., Abbasi-Kangevari, Z., Abbastabar, H., Abdelmasseh, M., Abd-Elsalam, S., Abdelwahab, A. A., Abdoli, G., Abdulkadir, H. A., … Murray, C. J. L. (2022). The global burden of cancer attributable to risk factors, 2010–19: A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, *400*(10352), 563–591. https://doi.org/10.1016/S0140-6736(22)01438-6

U.S. Department of Agriculture and U.S. Department of Health and Human Services. (2020). Dietary Guidelines for Americans, 2020-2025. 9th Edition. Available at DietaryGuidelines.gov

U.S. Department of Health and Human Services. (2018). Physical Activity Guidelines for Americans, 2nd edition. Washington, DC: U.S. Department of Health and Human Services.

Wang, F., Cai, H., Gu, K., Shi, L., Yu, D., Zhang, M., Zheng, W., Zheng, Y., Bao, P., & Shu, X.-O. (2020). Adherence to Dietary Recommendations among Long-Term Breast Cancer Survivors and Cancer Outcome Associations. *Cancer Epidemiology, Biomarkers & Prevention*, *29*(2), 386–395. https://doi.org/10.1158/1055-9965.EPI-19-0872

Warren, G. W., Kasza, K. A., Reid, M. E., Cummings, K. M., & Marshall, J. R. (2013). Smoking at diagnosis and survival in cancer patients. *International journal of cancer*, *132*(2), 401–410. https://doi.org/10.1002/ijc.27617

WCRF/AICR. (2007). Food, nutrition, physical activity, and the prevention of cancer: a global perspective. In.: World Cancer Research Fund/American Institute for Cancer Research.

World Health Organization (WHO). (2020). *Global Health Estimates 2020: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2019*. WHO; 2020. Accessed December 11, 2020. who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death

Appendix

Supplemental Table 1

Baseline sociodemographic and medical characteristics of randomized participants (Arch et. al, 2021)

	Total (n=134)[1]	*Valued Living Condition (n=67)*	*Enhanced Usual Care Condition (n=67)*	*t or* χ^2	*P value*
Female	88.06% (118/134)	85.07% (57/67)	91.04% (61/67)	1.14	.29
Age (in years, Range: 21-75)	*M*=56.14 (*SD*=11.57)	*M*=56.19 (*SD*=11.20)	*M*=56.09 (*SD*=12.02)	-0.05	.96
Race/Ethnicity[2]	White/Caucasian & Non- Latino/a: 86.57% (116/134)	White/Caucasian & Non- Latino/a: 88.06% (59/67)	White/Caucasian & Non- Latino/a: 85.07% (57/67)	0.26	.61
	Hispanic/Latino/a: 7.46% (10/134)	Hispanic/Latino/a: 7.46% (5/67)	Hispanic/Latino/a: 7.46% (5/67)		
	Biracial: 2.24% (3/134)	Biracial: 1.49% (1/67)	Biracial: 2.99% (2/67)		
	Asian American: 1.49% (2/134)	Asian American: 1.49% (1/67)	Asian American: 1.49% (1/67)		
	Other: 1.49% (2/134)	Other: 1.49% (1/67)	Other: 1.49% (1/67)		
	Black/African American: 0.75% (1/134)	Black/African American: 0.00% (0/67)	Black/African American: 1.49% (1/67)		
Education (median)	Associate's degree	Associate's degree	Associate's degree	0.79	.43
Household income (median)	$41,000 – 60,000	$41,000 – 60,000	$41,000 – 60,000	1.19	.24
Married or partnered	68.66% (92/134)	67.16% (45/67)	70.15% (47/67)	0.14	.71
Children (1 or more)	76.12% (102/134)	77.61% (52/67)	74.6% (50/67)	0.16	.69
Cancer treatment history					
Months between end of active cancer treatment and study enrollment	*M*=8.70 (*SD*=6.33)	*M*=8.45 (*SD*=5.79)	*M*=8.95 (*SD*=6.87)	0.46	.65
% who had received: 1) Surgery 2) Chemotherapy/ Targeted Therapy 3) Radiation	1) 77.61% (104/134) 2) 68.66% (92/134) 3) 55.97% (75/134)	1) 80.60% (54/67) 2) 65.67% (44/67) 3) 56.72% (38/67)	1) 74.63% (50/67) 2) 71.64% (48/67) 3) 55.22% (37/67)	1) 0.69 2) 0.56 3) 0.03	1) .41 2) .46 3) .86

% who currently took: 1) Endocrine Therapy 2) Maintenance Chemotherapy	1) 44.78% (60/134) 2) 7.46% (10/134)	1) 40.30% (27/67) 2) 7.46% (5/67)	1) 49.25% (33/67) 2) 7.46% (5/67)	1) 1.09 2) .00	1) .30 2) 1.00
Cancer type					
Breast	58.96% (79/134)	56.72% (38/67)	61.19% (41/67)	0.28	.60
Blood	13.43% (18/134)	14.93% (10/67)	11.94% (8/67)		
Gastrointestinal	9.70% (13/134)	7.46% (5/67)	11.94% (8/67)		
Gynecologic	4.48% (6/134)	0.75% (1/134)	3.73% (5/134)		
Lung	3.73% (5/134)	7.46% (5/67)	0.00% (0/67)		
Head and neck	3.73% (5/134)	2.99% (2/67)	4.48% (3/67)		
Prostate or testicular	2.99% (4/134)	2.99% (2/67)	2.99% (2/67)		
Other	2.99% (4/134)	5.97% (4/67)	0.00% (0/67)		
Cancer stage[3] (solid tumor cancers)					
0	3.45% (4/116)	5.26% (3/57)	1.69% (1/59)	2.92	0.71
I	39.66% (46/116)	38.60% (22/57)	40.68% (24/59)		
II	25.86% (30/116)	28.07% (16/57)	23.73% (14/59)		
III	25.86% (30/116)	22.81% (13/57)	28.81% (17/59)		
IV	4.31% (5/116)	3.51% (2/57)	5.08% (3/59)		
Unknown	0.86% (1/116)	1.75% (1/57)	0.00% (0/59)		

[1]This table reports on the 134 participants with baseline data. Of the 135 randomized participants, one dropped out immediately after randomization and did not complete any study measures.

[2]The chi-square test compared the conditions on the portion of White/Caucasian, non-Latino/a participants vs. minority participants.

[3] Cancer stage was confirmed via chart review for 110 of the 116 patients with solid tumor cancer; 1 chart noted solid tumor cancer of "unknown" stage but not stage IV. (Arch et. al, 2021)

Table 2

Means (Standard Deviations) for Self-Report Outcomes at Each Assessment Point

Measure and condition	Pre-treatment	Post-treatment
Over the past 7 days:-How many times a week did you eat fast food or snacks or pizza?		
VL	3 (3.28), n = 67	3.04 (2.36)
EUC	2.11 (1.99), n = 64	2.27 (2.37)
Over the past 7 days:-How many servings of fruits/vegetables did you eat each day?		
VL	3.05 (1.99), n = 66	3 (2.38)

EUC	3.5 (3.2), n = 65	3.04 (2.28)
Over the past 7 days:-How many soda and sugar sweetened drinks (regular, not diet) did you drink each day?		
VL	.7 (1.26)	0.47 (1.06)
EUC	.36 (0.8)	0.54 (1.25)
Over the past 7 days:-How many days of moderate to strenuous exercise, like a brisk walk, did you do in the last 7 days?		
VL	3.28 (2.39)	3.02 (2.29)
EUC	3.22 (2.19)	3.06 (2.3)
Over the past 7 days:-On those days that you engage in moderate to strenuous exercise, how many minutes, on average, did you exercise at this level?		
VL	32.23 (31.13)	41.95 (78.69)
EUC	29.25 (22.95)	44.63 (84.18)
One alcoholic drink is equivalent to a 12 ounce beer, a 5 ounce glass of wine, or a drink with one shot of liquor. A 40 ounce beer would count as 3 drinks, or a cocktail drink with 2 shots would count as 2 drinks. How many times in the past MONTH have you had 5 drinks if you are male or 4 drinks if you are female, or more in a day?		
VL	1.42 (4.33), n = 65	1.1 (3.9), n = 60
EUC	.49 (1.76), n = 65	0.45, (1.47) n = 58
Have you used tobacco in the last 30 days?		
VL	7/67, 10.45% yes; 89.55% no	5/60, 8.33% Y
EUC	5/66, 7.58% yes; 92.42% no	3/62, 4.84% Y
How many times in the past month have you used an illegal drug or used a		

prescription medication for non-medical purposes?		
VL	0(0), n = 66	0(0), n = 66
EUC	0(0), n = 67	0(0), n = 67

Table 3 cancer survivors		
Missing Data at Baseline and Post-Intervention		
Question #	Baseline	Post-Intervention
Q1: Over the past 7 days:-How many times a week did you eat fast food or snacks or pizza?" "Over the past 7 days:-How many times a week did you eat fast food or snacks or pizza?"	3	18
Q2: "Over the past 7 days:-How many servings of fruits/vegetables did you eat each day?"	3	17
Q3: "Over the past 7 days:-How many soda and sugar sweetened drinks (regular, not diet) did you drink each day?"	3	17
Q4: "Over the past 7 days:-How many days of moderate to strenuous exercise, like a brisk walk, did you do in the last 7 days?"	2	18
Q5: "Over the past 7 days:-On those days that you engage in moderate to strenuous exercise, how many minutes, on average, did you exercise at this level?"	4	20
Q6: "One alcoholic drink is equivalent to a 12 ounce beer, a 5 ounce glass of wine, or a drink with one shot of liquor. A 40 ounce beer would count as 3 drinks, or a cocktail drink with 2 shots would count as 2 drinks. How many times in the past MONTH have you had 5 drinks if you are male or 4 drinks if you are female, or more in a day?"	4	21
Q7: "Have you used tobacco in the last 30 days?"	1	17

Table 4						
Correlations with significance values of health behavior outcomes at baseline (b)						
Variable	1	2	3	4	5	6
1. fast-food_b						
2. fr_veg_b	-0.23**					
3. soda_b	0.07	-0.04				
4. exr_days_b	-0.20*	0.34***	-0.11			
5. exr_min_b	0.00	0.28**	-0.09	0.57***		

6. alcohol_b	0.09	-0.08	0.36***	-0.07	-0.01	
7. tbco_b (1=Y,2=2)	0.07	-0.22*	-0.17*	-0.13	-0.04	-0.06
* indicates p<.05. ** indicates p<.01. *** indicates p<.001.						

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Table 5

Correlations with significance values of health behavior outcomes at post-intervention (pi)

Variable	1	2	3	4	5	6
1. fast-food_pi						
2. fr_veg_pi	-0.19*					
3. soda_pi	0.08	-0.07				
4. exr_days_pi	-0.22*	0.16	-0.13			
5. exr_min_pi	-0.11	0.13	-0.12	0.47***		
6. alcohol_pi	0.04	-0.04	0.20*	-0.11	-0.13	
7. tbco_pi	0.14	-0.12	-0.22*	-0.12	-0.09	-0.03
* indicates p<.05. ** indicates p<.01. *** indicates p<.001.						

Table 6			
Multiple test comparison p-value correction via the Benjamini-Hochberg Procedure			

P-Value Rank	P-value	20% (0.20) false discovery rate BH comparison value	5% (0.05) false discovery rate BH comparison value
1	0.081	0.029	0.007
2	0.273	0.057	0.014
3	0.284	0.086	0.021
4	0.451	0.114	0.029
5	0.4984	0.143	0.036
6	0.562	0.171	0.043
7	0.589	0.200	0.050

Table 3 cancer survivors		
Missing Data at Baseline and Post-Intervention		
Question #	Baseline	Post-Intervention
Q1: Over the past 7 days:-How many times a week did you eat fast food or snacks or pizza?" "Over the past 7 days:-How many times a week did you eat fast food or snacks or pizza?"	3	18
Q2: "Over the past 7 days:-How many servings of fruits/vegetables did you eat each day?"	3	17
Q3: "Over the past 7 days:-How many soda and sugar sweetened drinks (regular, not diet) did you drink each day?"	3	17
Q4: "Over the past 7 days:-How many days of moderate to strenuous exercise, like a brisk walk, did you do in the last 7 days?"	2	18
Q5: "Over the past 7 days:-On those days that you engage in moderate to strenuous exercise, how many minutes, on average, did you exercise at this level?"	4	20
Q6: "One alcoholic drink is equivalent to a 12 ounce beer, a 5 ounce glass of wine, or a drink with one shot of liquor. A 40 ounce beer would count as 3 drinks, or a cocktail drink with 2 shots would count as 2 drinks. How many times in the past MONTH have you had 5 drinks if you are male or 4 drinks if you are female, or more in a day?"	4	21
Q7: "Have you used tobacco in the last 30 days?"	1	17