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The Impact of a Virtual Educational Cooking Class on the Inflammatory Potential of Diet in Cancer Survivors

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Featured Application: One month after completing an educational cooking class, participants significantly changed their diet-derived inflammation scores, which became more anti-inflammatory, while also significantly improving subjective measures of cognitive function. Diet factors, including changes in calories, may be associated with improved changes in cognition, and cooking classes may be an effective intervention strategy for cancer survivors.

Abstract: (1) Background. Cognitive dysfunction is prevalent among cancer survivors. Inflammation may contribute to impaired cognition, and diet represents a novel strategy to mitigate cognitive decline. The purpose was to (1) assess the impact of an educational cooking class on cancer survivor eating habits and their inflammatory potential and (2) determine the relationship between diet and cognitive function. (2) Methods. This was a non-randomized interventional study of a virtual educational cooking class in post-treatment, adult cancer survivors. Energy-adjusted Dietary Inflammatory Index (E-DII™) scores and subjective cognitive function were assessed at baseline and 1 month post-intervention. (3) Results. Of 22 subjects, all were female, White, and primarily had breast cancer (64%). There was a significant decrease in E-DII scores, which became more anti-inflammatory, one month after intervention (−2.3 vs. −2.7, $p = 0.005$). There were significant increases in cognition, including perceived cognitive impairment (COG-PCI, $p < 0.001$), comments from others (COG-OTH, $p < 0.001$), and quality of life (COG-QOL, $p < 0.001$). A change in calories was a significant predictor of a change in perceived cognitive ability (COG-PCA) after adjustment ($\beta = 0.007$, $p = 0.04$; 95% CI (0.000, 0.014)). (4) Conclusions. Educational cooking classes may be an effective way to impact diet-derived inflammation; additional research is needed to assess the long-term effects of dietary changes on cognition.

Keywords: cooking class; cancer survivorship; diet; fiber; inflammation; cognition

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1. Introduction

While cancer continues to be a prevalent disease, early detection methods and improved cancer treatments have allowed those with cancer to live longer lives, with, currently, over 19 million cancer survivors in the United States [1]. Unfortunately, about 90%

of cancer survivors face long-term effects from cancer treatments, with deficits including decreased strength and mobility, increased fatigue, and chronic pain [2–4]. An important, yet understudied, consequence of cancer treatment is cognitive dysfunction. While up to 75% of cancer survivors report both immediate and long-term cognitive deficits and cite these sequelae as distressing [5–8], no gold-standard treatment exists to mitigate these effects [9,10]. This knowledge gap has greatly limited our ability to provide counseling for the protection of long-term health in cancer survivors, causing an urgent need to identify potential mechanisms and related modifiable risk factors.

Suggested mechanisms for cognitive decline in cancer survivors include oxidative damage and dysregulation of inflammation, with dietary factors as a key contributor to an inflammatory environment [11,12]. Cancer survivors are vulnerable to nutrient-poor diets, with cancer treatments commonly resulting in high rates of anorexia, dysgeusia, and dysphagia, leading to malnutrition [2–4]. These side effects may predispose patients to choose foods that accommodate their symptoms or can be easily prepared, with the focus shifting often to adequate calories and protein; these foods may be less nutrient-dense [13,14]. Shifts to poorer diet quality in response to treatment have been associated with reduced treatment tolerance, and lower survival rates [15–18]. This presents an opportunity for post-treatment cancer survivors to optimize food choices to reduce the inflammatory potential of their diets.

Nutrient-rich, plant-based diets have been studied for their role in attenuating inflammation. Diets high in refined carbohydrates and saturated fats have been shown to be pro-inflammatory, while diets focusing on whole grains, legumes, fruits, and vegetables reduce inflammatory markers and modify growth factors involved in cancer pathogenesis [19–24]. A key feature of anti-inflammatory diets is how the foods are rich in fiber, which has additionally been associated with decreasing inflammation and lowering the risk of developing several types of cancer, heart disease, diabetes, and more [25,26]. Evidence such as this led the American Institute for Cancer Research (AICR) to recommend consuming 30 g of fiber per day for cancer prevention [27]. Current observational research on high-fiber diet patterns and cognitive function has indicated an association with less cognitive decline in non-cancer populations [28,29], providing a basis to explore the relationship in cancer survivors. As diet can impact inflammation, it represents a novel therapeutic target for the management of cognitive decline in cancer survivors [30].

One such method of measuring the inflammatory potential of diet is the Dietary Inflammatory Index (DII®) [31]. While the DII has been shown to be related to cancer development [32], and has shown preliminary associations with cognition in older adults [33], more intervention-based data need to be collected, especially in the context of cancer survivorship. Therefore, the purpose of this study is to (1) assess the impact of an educational cooking class on cancer survivor eating habits, including changes in inflammatory potential, as measured by the DII, and (2) evaluate the association between the inflammatory potential of diet and cognitive function, as measured by the Functional Assessment of Cancer Therapy–Cognitive Function (FACT-Cog) questionnaire. Our overarching hypothesis is that cancer survivors who participate in an educational cooking class, focusing on actionable dietary changes and promoting a high-fiber, anti-inflammatory diet pattern, will have improved DII and FACT-Cog scores, compared to the baseline.

2. Materials and Methods

2.1. Study Design

This study was a non-randomized interventional pilot study assessing the impact of a virtual educational cooking class on dietary changes and subjective cognitive function over one month. The virtual educational cooking class, led by Registered Dietitian Nutritionists (RDNs), focused on actionable dietary changes that promoted an anti-inflammatory diet pattern, including fiber-rich foods, based on the AICR diet recommendations [27]. Data collection timepoints included a baseline and one-month post-intervention (within +1 week).

The study was approved by the Institutional Review Board (0548-22-EP) of the University of Nebraska Medical Center, and informed consent was obtained from all participants.

2.2. Recruitment, Screening, and Enrollment

This study was conducted in partnership with a midwestern cancer center, where advertisement for the cooking class was facilitated through the cancer survivorship program via printed and e-mailed flyers, and social media accounts. At the time of class registration (offered October 2022 or January 2023), potential participants were asked if they were interested in participating in the research study and provided permission to be contacted for eligibility criteria screening. Cooking class registrants were screened via an online survey or telephone call for the following eligibility criteria: (1) adults (>/= 19 years) with a first-time, primary diagnosis of cancer; (2) post-surgery and completed primary adjuvant treatments (i.e., radiation and/or chemotherapy) at least six months prior to study enrollment (current hormonal therapy eligible); (3) have a computer, tablet, or smartphone with internet access; (4) ability to provide informed consent. Potential participants were excluded if they (1) were scheduled to receive surgery/treatment during the study; (2) had a second cancer diagnosis (excluding non-invasive skin cancers); or (3) were currently pregnant. Those who were at least six months post-primary treatments were sought to allow recovery from any treatment effects (e.g., nausea/vomiting, poor appetite, diarrhea) as these would impact full participation in a diet-based intervention. Participants that were non-English speaking were not enrolled due to our inability to provide a translated consent process or intervention in other languages.

2.3. Study Intervention

The study intervention was a virtual, educational cooking class with companion electronic educational materials. The educational cooking class included basic cooking and nutrition information with an emphasis on choosing foods shown to be related to decreasing inflammation (i.e., increasing fiber via fruits and vegetables and whole grains) [19,25,34]. The cooking class was structured as a 30 min, virtual class wherein the first five minutes educated on foundational knowledge of anti-inflammatory dietary patterns, followed by 20 min of a cooking demonstration with additional education provided about the specific recipes and five minutes of participant questions and discussion. Recipes used during the cooking class were from the AICR website [35] and were chosen to have customizable options and provide ease of preparation to encourage adoption. Companion educational content focusing on the benefits of fiber and key sources, along with examples of meals and snacks that could be consumed to reach the AICR guideline of 30 g of fiber per day, were provided to participants after the class.

2.4. Data Collection

Dietary Assessment: The Diet History Questionnaire (DHQIII) is a validated food frequency questionnaire [36] and was used to assess diet intake at a baseline (pre-intervention) and one month post-intervention (within +1 week) to capture sustained dietary changes after the cooking class. The DHQIII generates absolute intake values based on the average intake of energy, 219 nutrients, dietary constituents, and food groups. The results from the DHQIII were reviewed and analyzed for total dietary intake of kilocalories (kcal), total fiber (grams), and the main sources of fiber-rich foods of fruits (cup/day), vegetables (cup/day), whole grains (oz/day), nuts and seeds (oz/day), and legumes (oz/day). These dietary components were chosen for analysis based on the key principles of education included in the cooking class.

Dietary Inflammatory Index (DII): From the DHQIII, DII scores were calculated. The DII has been previously validated with various inflammatory markers and has been used in several cancer populations [37–39]. A complete description of the DII scoring system has been previously published [31]. The DII includes up to 45 food parameters with individual inflammatory effect scores, which are summed for an overall DII score for each participant.

Valid DII scores typically contain at least 25–30 parameters [40]. For the present study, a total of 30 parameters were available from the DHQIII for score calculation (Table 1). In this study, energy-adjusted DII (E-DII™) scores were calculated for each participant to account for caloric intake in relation to the amount of nutrients consumed. E-DII scores are calculated per 1000 calories of food consumed, utilizing the energy-standardized version of the world database used to calculate the food effect scores [40]. Possible DII scores range from −8.87 to 7.98, where a higher, more positive, E-DII score designates a more pro-inflammatory diet, whereas smaller, more negative E-DII values indicate more anti-inflammatory diets. In this analysis, the change in E-DII scores was the primary outcome.

Table 1. DII components available for calculation of the DII score [1].

Alcohol	Cholesterol	Magnesium	PUFA	Vitamin A
Vitamin B12	Energy (kcal)	MUFA	Riboflavin	Vitamin C
Vitamin B6	Total fat	Niacin	Saturated fat	Vitamin D
β-Carotene	Fiber	n-3 fatty acids	Selenium	Vitamin E
Caffeine	Folic acid	n-6 fatty acids	Thiamin	Zinc
Carbohydrate	Iron	Protein	Trans fat	Isoflavones

[1] Thirty of forty-five components available for calculation. Components not available for calculation: eugenol, garlic, ginger, onion, saffron, turmeric, green/black tea, flavon-3-ol, flavones, flavonols, flavonones, anthocyanidins, pepper, thyme/oregano, rosemary. Abbreviations: DII: Dietary Inflammatory Index; MUFA: monounsaturated fatty acid; n-3 fatty acids: omega-3 fatty acids; n-6 fatty acids: omega-6 fatty acids; PUFA: polyunsaturated fatty acids.

Cognitive Assessment: The secondary outcomes examined were the Functional Assessment of Cancer Therapy–Cognitive Function (FACT-Cog) sub-scores, as the measure of subjective cognitive impairment assessment. The FACT-Cog was administered electronically at baseline and one-month post-intervention (within +1 week). The FACT-Cog includes 37 items assessing cognitive function across four scales: perceived cognitive impairments (COG-PCI; 20 items; 0–72 score range), impact on quality of life (COG-QOL; 4 items; 0–16 score range), comments from others (COG-OTH; 4 items; 0–16 score range), and perceived cognitive abilities (COG-PCA; 9 items; 0–28 score range) [41,42]. Participants are asked to respond how frequently, on a scale of 0–4, they experienced various symptoms in the previous seven days. Items are summed to calculate scores for each sub-scale. The average time for completion is 10–15 min. The FACT-Cog sub-scores, COG-PCI, COG-QOL, COG-OTH, and COG-PCA, were analyzed, and the COG-PCI was considered the primary score [42–44]. The higher the score, the better the cognitive function, as well as the lower the impact on the patients' quality of life [45].

2.5. Covariate Assessment

Additional participant demographic and clinical history data were captured at baseline via a self-report questionnaire. The questionnaire asked self-reported baseline demographic and clinically relevant questions including about age, sex (male/female), race (White/non-White), ethnicity (Hispanic/Latinx or Non-Hispanic/Latinx), highest degree of education (some high school, no diploma; high school diploma or GED equivalent; some college, no degree; associate's degree; bachelor's degree; and master's, professional or doctoral degree), height, weight, weekly physical activity, cancer type, cancer treatment history, and previous counseling with an RDN (yes/no). Height and weight were used to calculate Body Mass Index (BMI) using the formula kilograms per meter squared (kg/m^2). Weekly physical activity was captured by asking participants questions adapted from the International Physical Activity Questionnaire (IPAQ) [46]. From the provided activity amount, the total Metabolic Equivalent of Task (MET) minutes per week were calculated using the following formula: total MET-minutes per week = (4 × moderate minutes/week) + (8 × vigorous minutes/week) [46–48]. MET-minutes were also categorized into ≥500 or <500 per week, based on the threshold for meeting the Physical Activity Guidelines for Americans [49].

2.6. Statistical Analysis

Descriptive statistics were calculated to characterize patient demographics, clinical variables, and score distributions for the E-DII and FACT-Cog. Those with incomplete DHQIII records or records containing DHQIII results with remarkably high or low energy estimates, defined as <600 or >3500 kcal [50], were excluded from analysis. Normality of dietary and cognitive data were assessed with Shapiro–Wilk tests and Q-Q plots. Due to the skewness of the primary outcomes, medians and interquartile ranges (IQR) were calculated for continuous variables, and frequencies and percentages for categorical variables. All analyses were based on intent-to-treat principles, regardless of intervention participation.

To determine if an educational cooking class changed dietary factors, including intake of calories, total fiber, and fiber-rich foods (fruit, vegetables, whole grains, nuts, seeds, and legumes), and the inflammatory potential of the participants' diet (E-DII scores), baseline values were compared to those at one-month post-intervention via a Wilcoxon signed-rank test. A McNemar test was used to evaluate the difference in proportions of those who did and did not meet at least 75% of the AICR fiber intake goal (22.5/30 g fiber) at baseline and follow-up. A Wilcoxon signed-rank test was used to analyze the change in cognition via FACT-Cog categories between timepoints. Spearman correlations were performed to assess the relationship between dietary factors and cognitive outcomes.

Univariate and multiple linear regression was used to identify if dietary factors (at baseline, one-month post-intervention, and the change scores) were a predictor of cognitive function. Change scores were calculated as the value at one month minus the value at baseline. Dietary intake models were adjusted for age, BMI, education, physical activity category (< or $\geq$500 MET-min), RD visit prior to cooking class, cancer type, and energy intake. E-DII models were adjusted for the same, except for energy, as this was already accounted for in the E-DII calculation. Race/ethnicity or sex were not included in the final model, due to homogeneity in the study population. The confounders were chosen in an a priori fashion, based on clinical knowledge. All tests were two-sided, and a p-value < 0.05 was considered statistically significant. Statistical analyses were completed using the Statistical Package for Social Sciences (SPSS™) software version 26.

Power and sample size analysis: few studies exist examining the change in DII scores over time, or within the study population of cancer survivors. Therefore, this study serves to provide key information with an adequate sample size for future investigations. Based on previous research, a sample size of 20 was determined to achieve 80% power to detect a change in DII scores [23,51]. Therefore, the goal for recruitment was set at 24 participants to account for a 20% attrition rate.

3. Results

3.1. Study Population

Out of the 188 people registered for the cooking class, 55 granted permission to be contacted for eligibility screening. Of the 55 persons screened, 24 subjects were enrolled in the study (see Figure 1 for exclusion details). From those enrolled, two subjects were excluded from the final analysis for either missing data (n = 1) or an extremely low-calorie intake of less than 600 calories (n = 1). Hence, a total of 22 subjects were included in the analysis, and all participated in the cooking class intervention.

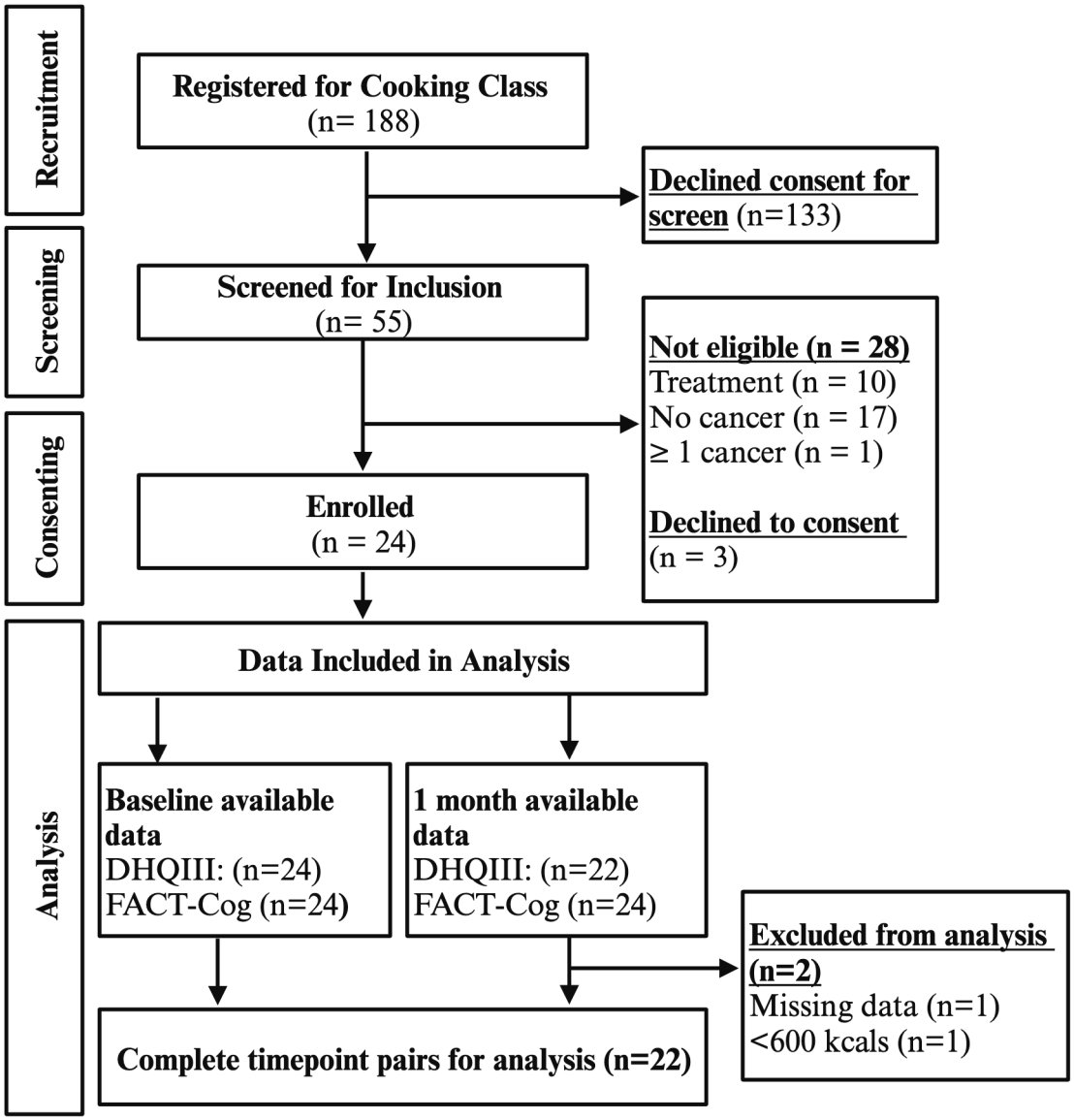


Figure 1. Flowchart of participant inclusion. Abbreviations: DHQIII: Diet History Questionnaire; FACT-Cog: Functional Assessment of Cancer Therapy–Cognitive Function.

3.2. Baseline Characteristics

All 22 subjects were female and White, with one subject reporting Hispanic/Latinx ethnicity. The median (IQR) age was 61.5 (19.0) years, with a median BMI of 28.4 (14.2) kg/m^2. The median MET-minutes/week were 590.0 (1065.0), or 118% of the Physical Activity Guidelines for Americans [49]. Most of the population was highly educated, with 87% holding a bachelor's degree or higher. The predominant cancer type was breast cancer (64%), followed by blood and bone marrow cancers (18%). Half of the subjects received 1–2 treatment modalities for their cancer, with the most common treatments being surgery (n = 18, 82%), chemotherapy (n = 16, 73%), and radiation (n = 11, 50%). Forty-one percent had previously met with a dietitian at least once prior to the cooking class. Further details on subject demographics are shown in Table 2.

Table 2. Baseline characteristics of cancer survivors (N = 22).

Continuous Variables	**Median (IQR)**
Age (Years)	61.5 (19.0)
BMI (Kg/m^2)	28.4 (14.2)
Physical Activity (MET-Minutes/Week)	590.0 (1065.0)
Categorical Variables	n (%)
Sex	
Female	22 (100)
Male	0 (0)
Race	
White	22 (100)
Other	0 (0)
Ethnicity	
Non-Hispanic/Latinx	21 (96)
Hispanic/Latinx	1 (4)
Education	
High school or GED	2 (9)
Associate's degree	1 (4)
Bachelor's degree	9 (41)
Master's, professional, or doctoral degree	10 (46)
Cancer Type	
Breast	14 (64)
Endometrial/ovarian/uterine	1 (4)
Leukemia/lymphoma/multiple myeloma	4 (18)
Other	3 (14)
Number of Treatments	
1–2 treatments	11 (50)
≥3 treatments	11 (50)
Previous Dietitian Encounter	
Yes	9 (41)
No	13 (59)
Physical Activity (≥500 Met-Minutes/Week)	
Yes	11 (50)
No	11 (50)

Abbreviations: BMI: Body Mass Index; IQR: interquartile range; MET: Metabolic Equivalent of Task; GED: General Educational Development Test.

Median values of baseline dietary factors and cognitive scores are presented in Table 3. Median (IQR) dietary intakes at baseline consisted of 1513.7 (452.3) calories, 16.8 (11.7) g of fiber, 1.0 (1.0) cup of fruit, 1.4 (1.7) cups of vegetables, 0.7 (0.8) oz of whole grains, and 1.1 (1.6) oz of nuts/seeds/legumes. Therefore, at baseline, participants consumed 56% of the AICR recommended amount of fiber. The median (IQR) inflammatory potential of diet via the E-DII score was −2.3 (4.3). The median baseline cognitive factor scores of COG-PCI, COG-PCA, COG-OTH, and COG-QOL were 17.5 out of 72, 22 out of 28, 0 out of 16, and 4 out of 16, respectively.

Table 3. Changes in dietary factors and cognitive factors from baseline to one-month post-intervention.

Diet Factors	Baseline	Follow-Up	*p*-Value [1]
E-DII	−2.3 (4.3)	−2.7 (2.9)	0.005
Energy intake (kcals)	1513.7 (452.3)	1212.1 (475.3)	0.02
Fiber (g)	16.8 (11.7)	15.3 (12.6)	0.04
Fruit (cups)	1.0 (1.0)	0.9 (0.9)	0.14
Vegetables (cups)	1.4 (1.7)	1.6 (1.3)	0.22
Whole grains (oz)	0.7 (0.8)	0.5 (0.4)	0.09
Nuts/seeds/legumes (oz)	1.1 (1.6)	1.1 (1.7)	0.73
Cognitive factors			
COG-PCI	17.5 (19.0)	55.5 (17.0)	<0.001
COG-PCA	22.0 (7.0)	22.5 (9.0)	0.07
COG-OTH	0 (1)	16 (1)	<0.001
COG-QOL	4.0 (8.0)	14.0 (5.0)	<0.001

Presented as median (IQR). [1] Wilcoxon signed-rank test for paired data. Abbreviations: E-DII: energy-adjusted Dietary Inflammatory Index; COG-PCI: perceived cognitive impairments; COG-PCA: perceived cognitive abilities; COG-OTH: comments from others; COG-QOL: quality of life.

3.3. Impact of an Educational Cooking Class

Changes between baseline and one-month follow-up, post-cooking class intervention are presented in Table 3. There was a significant decrease in E-DII scores, which became more anti-inflammatory one-month post-cooking class (−2.3 vs. −2.7, $p = 0.005$). There was a significant difference in the median calories and fiber intake between the baseline and follow-up, where participants ate 301.6 fewer calories ($p = 0.02$) and 1.5 g less fiber ($p = 0.04$) at follow-up. There were no differences in the consumption of high-fiber foods—fruit, vegetables, whole grains, and nuts/seeds/legumes—post-cooking class education.

Over 30% of the study population (n = 7, 32%) demonstrated an increase in their fiber intake at follow-up of any amount compared to baseline. At baseline, 27% met at least 75% of the fiber recommendation. There was no significant difference in the proportion of the cohort who met at least 75% of the fiber recommendation at baseline versus follow-up ($p = 1.00$). Of those who met at least 75% of the fiber recommendation at baseline, 83% continued to adhere to high fiber consumption at follow-up. Conversely, 94% of those who did not meet at least 75% of the fiber goal at baseline continued to not adhere to the fiber recommendation.

There were significant increases in the FACT-Cog sub-scores following the cooking class intervention, including COG-PCI ($p < 0.001$), COG-OTH ($p < 0.001$), and COG-QOL ($p < 0.001$). COG-PCI increased by 38 points; COG-OTH increased by 16 points, and COG-QOL increased by 10 points. COG-PCA did not change significantly post-cooking class ($p = 0.07$).

3.4. Dietary Factors and Cognition

3.4.1. E-DII Scores

The baseline E-DII was significantly related to the baseline COG-QOL (r = 0.433; $p = 0.04$), but this relationship was not evident between follow-up E-DII and follow-up COG-QOL (r = −0.265; $p = 0.23$) (Figure 2). There were no other significant correlations between E-DII and cognitive variables, at baseline or follow-up, or in terms of change.

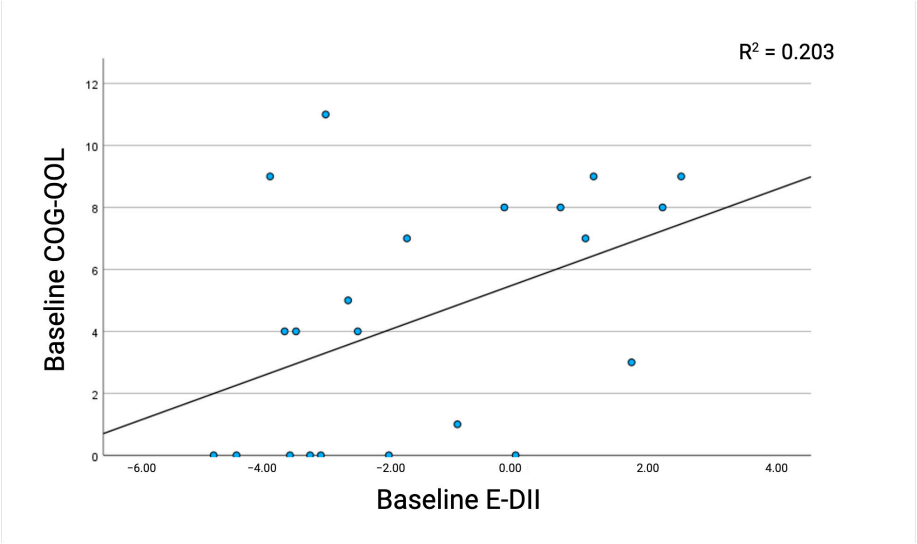


Figure 2. Scatterplot and line of best fit for the correlation of E-DII and FACT-Cog quality of life sub-score. Abbreviations: E-DII: energy-adjusted Dietary Inflammatory Index; COG-QOL: quality of life.

Univariate linear regression demonstrated a significant relationship between the baseline E-DII and baseline COG-QOL scores (β = 0.746, p = 0.04; 95% CI (0.056, 1.436)), change in E-DII and follow-up COG-OTH scores (β = 0.626, p = 0.046; 95% CI (0.011, 1.240)), and change in E-DII and change in COG-OTH scores (β = 1.830, p = 0.04; 95% CI (0.103, 3.556)), but significance was not maintained after adjustment for any model (Table 4).

Table 4. Results of univariate and multiple linear regression of E-DII, dietary intake, and cognitive factors.

	β	95% CI	*p*-Value
Baseline E-DII			
Baseline COG-QOL			
Univariate	0.746	0.056, 1.436	0.04
Adjusted [1]	0.442	−0.558, 1.441	0.36
Change in E-DII			
Follow-up COG-OTH			
Univariate	0.626	0.011, 1.240	0.046
Adjusted [1]	0.109	−0.691, 0.908	0.29
Change in COG-OTH			
Univariate	1.830	0.103, 3.556	0.04
Adjusted [1]	0.333	−1.938, 2.604	0.79
Change in Fiber			
Change in COG-PCA			
Univariate	0.658	0.161, 1.154	0.01
Adjusted [2]	0.493	−0.103, 1.088	0.10
Change in Calories			
Change in COG-PCA			
Univariate	0.007	0.001, 0.014	0.03
Adjusted [2]	0.007	0.000, 0.014	0.04

[1] Adjusted for age, BMI, education, physical activity category (< or ≥500 MET-min), RD visit prior to cooking class, cancer type. Energy adjusted for within E-DII calculation. [2] Adjusted for age, BMI, education, physical activity category (< or ≥500 MET-min), RD visit prior to cooking class, cancer type, and energy intake. Abbreviations: E-DII: energy-adjusted Dietary Inflammatory Index; COG-PCI: perceived cognitive impairments; COG-PCA: perceived cognitive abilities; COG-OTH: comments from others; COG-QOL: quality of life.

3.4.2. Dietary Intake

The change in intake of calories (r = 0.476, p = 0.03) and change in fruit (r = 0.482, p = 0.02) were positively correlated with the change in COG-PCA scores (Figure 3A,B). There was a trend toward the significance of changes in fiber intake (r = 0.418, p = 0.05) and changes in whole grain intake (r = 0.389, p = 0.07) (Figure 3C,D). There were no significant correlations between cognition scores and fiber-related factors at either baseline or follow-up.

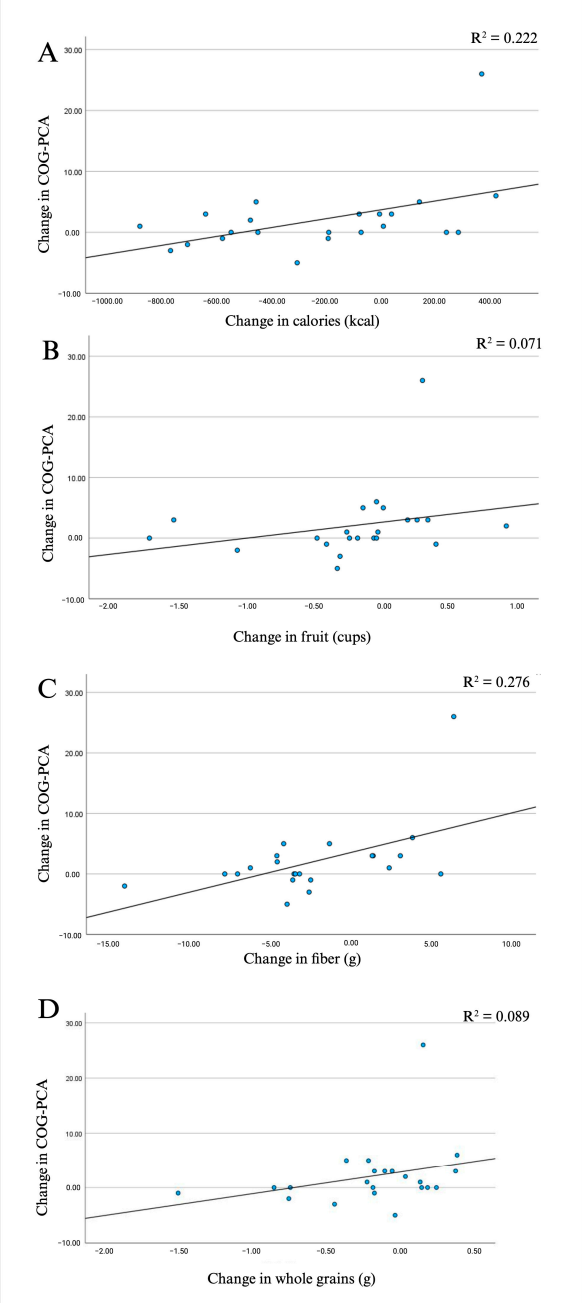


Figure 3. Scatterplots and line of best fit for correlations of diet intake and FACT-Cog perceived cognitive abilities sub-score. (**A**) The correlation between change in calories and change in COG-PCA; (**B**) The correlation between change in fruit and change in COG-PCA; (**C**) The correlation between change in fiber and change in COG-PCA; (**D**) The correlation between change in whole grains and change in COG-PCA. Abbreviations: COG-PCA: perceived cognitive abilities.

Univariate linear regression demonstrated a significant relationship between the change in fiber and change in COG-PCA scores (β = 0.658, $p = 0.01$; 95% CI (0.161, 1.154)) and change in calories and change in COG-PCA (β = 0.007, $p = 0.03$; 95% CI (0.001, 0.014)), but no significant relationship was found between change in COG-PCA in either fruit ($p = 0.23$) or whole grain intake ($p = 0.18$). After controlling for covariates, there was a significant relationship between calorie intake and change in COG-PCA (β = 0.007, $p = 0.04$; 95% CI (0.000, 0.014), but there was no significant relationship between change in fiber intake and change in COG-PCA (β = 0.493, $p = 0.10$; 95% CI (−0.103, 1.088)) (Table 4).

4. Discussion

In this pilot interventional study, cancer survivors were able to significantly decrease their inflammatory potential of diet and improve cognitive function scores after one-month post-educational virtual cooking class. Notably, our study is among the first interventional studies to bridge the interconnected areas of diet, inflammation, and cognition, in the context of cancer survivors, where applied education models of improving diet may represent a feasible and accessible intervention for improving cognitive deficits. When examining specific dietary changes related to the education provided, participants were able to maintain a consistent intake of key dietary components, including fruit, vegetables, whole grains, and nuts/seeds/legumes, while creating a significant calorie deficit. Additionally, specific areas of subjective cognitive function were correlated with dietary factors of calorie intake, fiber, fruit, and E-DII scores. After adjustment, change in calorie intake over one month was a predictor of a participant's improvement in perceived cognitive abilities.

Our findings show short-term improvement in the inflammatory potential of diet, through a decrease in E-DII scores after one month. Of the sparse interventional DII studies, there has been one investigation incorporating cooking classes to impact health outcomes. Turner-McGrivey et al. designed an intervention consisting of weekly nutrition education and cooking classes vs. printed educational materials with the objective of improving dietary inflammation (DII scores), systemic inflammation (CRP levels), and lipid levels in adults without chronic disease [23]. In this population, the intervention group was able to improve their DII scores after three months of weekly active education, although this was not sustained at a follow-up in month 12. These findings suggest that further research should investigate the optimal duration of nutrition and cooking education to create sustainable changes in dietary inflammatory potential over time.

While statistically, there was a 1.5 g decrease in fiber intake between the baseline and one month post-intervention, this may not represent a clinically relevant deficit, as it would be similar to the fiber content of one-third of an apple [52], and, therefore, may be interpreted as consistent intake. Similarly, when analyzing the pattern of change in fiber intake, it was found that most participants with a high consumption of fiber at the baseline continued this intake level at one-month post-intervention, and the majority of those who had lower baseline fiber consumption continued to have a low fiber intake. Despite the consistent fiber consumption patterns, it is worth noting that over 30% of the study population was able to increase fiber in any amount after the cooking class. While our study did not significantly improve fiber, fruit, vegetable, whole grain, or nuts/seeds/legume intake, there was a significant reduction in calories, without compromising the intake of these nutrient and fiber-rich foods. The AICR recommends maintaining a healthy weight after a cancer diagnosis while promoting adherence to nutrient-rich dietary patterns [27]. It is known that excess body weight is a risk factor for cancer recurrence, an overall higher mortality risk, and other chronic disease development, like diabetes and heart disease [53,54]. As our cohort was primarily overweight, our intervention may represent a way to promote modest calorie reduction while preserving nutrient-rich food intake, for the promotion of healthy weight attainment. Conversely, it is essential to emphasize that while dietary intake, including fruit and vegetable consumption, was maintained and was similar to the national average intake [55,56], these values still fall short of the recommended Dietary Guidelines for Americans [57] and AICR cancer prevention guidelines [27], providing

further evidence that this population is at nutritional risk and can benefit from further nutrition interventions. These results suggest the efficacy of virtual cooking class-based nutrition education; however, the magnitude of the change in diet may have been limited by the provision of one class over multiple class sessions. Additional longitudinal investigation should be completed to observe the long-term impact of these dietary changes, and if changes can be sustainably adopted.

After one-month post-intervention, our cohort demonstrated significant improvement in self-reported cognitive function in the areas of perceived cognitive impairments, comments from others, and quality of life. However, there was no significant increase in perceived cognitive ability. Bell et al. previously sought to define clinically significant changes in FACT-Cog scores among adult cancer survivors after they received a 15-week cognitive training program [58]. Here, a mean change (standard deviation) in COG-PCI of at least 4.6 (6.5) points was considered a clinically meaningful change, with a mean change of 17.9 (12.7) points indicating a much better performance six months post-intervention [58]. In the present study, the median COG-PCI score increased by 38 points one month after the intervention, suggesting this was a clinically meaningful change in COG-PCI, and this should be confirmed with quantitative cognitive assessment in future studies.

The baseline E-DII was correlated with a baseline cognition-driven quality of life, wherein a higher baseline COG-QOL was correlated to more pro-inflammatory E-DII scores. However, our study did not find a relationship between cognitive function and E-DII score after adjustment in cancer survivors. While this relationship has had minimal investigation overall, and predominantly within an older adult population, our finding contradicts previous findings. Most recently, a 2022 meta-analysis of nine observational studies found a 46% elevated risk of cognitive impairment in those with more pro-inflammatory DII scores (OR = 1.46, 95% CI = 1.26, 1.69) [59]. Based on the literature and predominant observations, a cause-and-effect relationship between DII and cognitive impairment cannot be established. This study was not specifically powered to determine a relationship between E-DII and cognition; thus, our sample size could have impacted our findings. Therefore, larger studies of populations at risk of cognitive decline, including cancer survivors, should be further evaluated.

Dietary factors, including changes in calorie and fruit intake, were significantly and positively correlated with changes in perceived cognitive abilities. After adjustment, a change in calorie intake was a significant predictor of a change in perceived cognitive abilities, where for every 100-calorie increase in the change in calorie intake, we expect the change in COG-PCA to increase by 0.7 points. This indicates that those who had positive increases in calorie intake had more positive changes in perceived cognitive ability. This finding may be explained by the overall relatively lower calorie intake seen in this cohort, where those with increased calorie changes may be eating more nutrients to provide for better outcomes once a threshold for impact is reached. The body's response to nutrients is often sigmoidal, meaning low exposure results in a minimal response, while progressively increasing exposure will show an increased response, followed by a plateaued effect once the physiological norm is met [60]. These findings may also align with previous research identifying the risk of undernutrition and cognitive status, such as the development of dementia in non-cancer populations [61,62]. In addition to calorie changes, changes in fiber intake trended toward significance after adjustment, where for every 1 g increase in fiber, we expect the change in COG-PCA to increase by 0.49 points. This means those with more positive changes in fiber intake had improved perceived cognitive abilities. However, this finding may be limited by our sample size and should be repeated in a larger, more diverse cohort.

Another novel aspect of our study is the evaluation of a virtual delivery of an educational cooking class, compared to previous literature predominately studying in-person instruction. Health disparities in cancer care have been well documented, including the lack of access to healthcare providers and public health resources [63]. It is also important to note that virtual classes may offer additional benefits such as attending to the safety

of those who are immunocompromised, have limited access to transportation, or have mobility issues. Telehealth and remote care delivery models have emerged as viable options to provide healthcare services in these situations and have expanded rapidly due to the global COVID-19 pandemic. With an increasing cancer survivor population, paired with increasing barriers to care, nutrition interventions are cost-effective and non-invasive adjunctive treatments that can be delivered via telehealth. However, few studies have evaluated a live, remote instruction model for cooking classes. One 2021 study evaluated the effectiveness of education and cooking classes for diabetes management via an in-person or telehealth model [64]. Both delivery modes were able to improve hemoglobin A1c levels, demonstrating an equivalent positive impact and providing a basis for the continued use of virtual education models. While our study did not have an in-person comparison, it does provide evidence that virtual delivery can impact dietary changes, which could lead to broader education dissemination reach and improve access to healthcare. There have been no interventional studies utilizing cooking classes to improve cognitive health, beyond mental health or confidence measures [65,66]. Therefore, our study provides preliminary support for the use of cooking classes as an effective education technique to improve cognitive dysfunction, which could contribute to well-rounded lifestyle interventions.

Strengths, Limitations, and Future Directions

Our pilot study is among the first to assess and evaluate the impact of an educational cooking class on dietary inflammatory potential and its relationship with subjective cognitive function in cancer survivors. While we were able to meet our sample size requirement to detect a change in DII scores, observations of significant relationships between DII scores and cognition may have been limited by sample and effect sizes. With our findings demonstrating positive changes in inflammatory potential over one month, a longer longitudinal design with an additional methodology for health behavior change, as compared to a control group, is warranted. This will provide further insight into the sustainable adoption of behavior change. It is important to note other key study limitations of bias from self-reported measures, including the food frequency questionnaire and weight, as well as subjective measures of cognitive function. Research has demonstrated that highly educated women may more often exhibit self-reporting bias due to social desirability factors and may underestimate true dietary intake [67–69]. In the present study, our population was highly educated and had fair previous exposure to a dietitian prior to the cooking class, which may have similarly impacted the extent of dietary changes. The measures of cognitive function were subjective, and additional quantitative assessments should be included going forward. Future studies should aim to include more diverse populations and capture additional sociodemographic factors that can impact both dietary intake and cognition, such as food and financial security and healthcare access. We acknowledge that there is an intestinal relationship between fiber and water that may influence its absorption and function. An analysis of water intake was out of the scope of this project but should be investigated in future research.

5. Conclusions

Our pilot investigation represents a starting point for exploring the relationship between diet, inflammation, and cognition in cancer survivors, a thematic area of minimal prior investigation. The use of a virtual educational cooking class shows promise as an engaging, low-cost, non-invasive intervention for improving the inflammatory potential of diet and preserving the intake of fiber-rich foods. While the results are limited, our findings suggest a relationship between changes in dietary factors and subjective cognition status, including perceived cognitive abilities. Though preliminary, these findings may promote funding for larger studies with quantitative measurements to validate the results obtained. Further research should also explore the longitudinal impact of educational cooking classes and evaluate the need for repeat exposure for sustainable action adoption in a larger, more diverse population.

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Conflicts of Interest: The Dietary Inflammatory Index (DII®) is a registered trademark of the University of South Carolina. J.R.H. owns a controlling interest in Connecting Health Innovations, LLC (CHI), a company planning to license the right to his invention of the DII from the University of South Carolina in order to develop computer and smartphone applications for patient counseling and dietary intervention in clinical settings. C.H. is funded by a Veteran's Affairs Merit Award. D.E. is funded by NIH/NCI R37CA252060. M.K.J., L.B., M.A., L.G-A., S.P., R.B. have no conflicts or disclosures to report. No other disclosures were reported. The funders of the study had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

References

1. Siegel, R.L.; Miller, K.D.; Wagle, N.S.; Jemal, A. Cancer statistics, 2023. *CA Cancer J. Clin.* **2023**, *73*, 17–48. [CrossRef]
2. Beckjord, E.B.; Reynolds, K.A.; van Londen, G.J.; Burns, R.; Singh, R.; Arvey, S.R.; Nutt, S.A.; Rechis, R. Population-Level Trends in Posttreatment Cancer Survivors' Concerns and Associated Receipt of Care: Results from the 2006 and 2010 LIVESTRONG Surveys. *J. Psychosoc. Oncol.* **2014**, *32*, 125–151. [CrossRef]
3. Hébuterne, X.; Lemarié, E.; Michallet, M.; de Montreuil, C.B.; Schneider, S.M.; Goldwasser, F. Prevalence of Malnutrition and Current Use of Nutrition Support in Patients with Cancer. *J. Parenter. Enter. Nutr.* **2014**, *38*, 196–204. [CrossRef]
4. Neil-Sztramko, S.E.; Kirkham, A.A.; Hung, S.H.; Niksirat, N.; Nishikawa, K.; Campbell, K.L. Aerobic capacity and upper limb strength are reduced in women diagnosed with breast cancer: A systematic review. *J. Physiother.* **2014**, *60*, 189–200. [CrossRef]
5. Argyriou, A.A.; Assimakopoulos, K.; Iconomou, G.; Giannakopoulou, F.; Kalofonos, H.P. Either called "chemobrain" or "chemofog", the long-term chemotherapy-induced cognitive decline in cancer survivors is real. *J. Pain Symptom Manag.* **2011**, *41*, 126–139. [CrossRef]
6. Janelsins, M.C.; Kesler, S.R.; Ahles, T.A.; Morrow, G.R. Prevalence, mechanisms, and management of cancer-related cognitive impairment. *Int. Rev. Psychiatry* **2014**, *26*, 102–113. [CrossRef]
7. Janelsins, M.C.; Heckler, C.E.; Peppone, L.J.; Kamen, C.; Mustian, K.M.; Mohile, S.G.; Magnuson, A.; Kleckner, I.R.; Guido, J.J.; Young, K.L.; et al. Cognitive Complaints in Survivors of Breast Cancer after Chemotherapy Compared with Age-Matched Controls: An Analysis from a Nationwide, Multicenter, Prospective Longitudinal Study. *J. Clin. Oncol.* **2017**, *35*, 506–514. [CrossRef]
8. Wefel, J.S.; Kesler, S.R.; Noll, K.R.; Schagen, S.B. Clinical characteristics, pathophysiology, and management of noncentral nervous system cancer-related cognitive impairment in adults. *CA Cancer J. Clin.* **2015**, *65*, 123–138. [CrossRef]
9. Henneghan, A. Modifiable factors and cognitive dysfunction in breast cancer survivors: A mixed-method systematic review. *Support. Care Cancer* **2016**, *24*, 481–497. [CrossRef]
10. Huang, Z.; Guo, Y.; Ruan, Y.; Sun, S.; Lin, T.; Ye, J.; Li, J.; He, L.; Wang, S.; Shi, Y.; et al. Associations of Lifestyle Factors with Cognition in Community-Dwelling Adults Aged 50 and Older: A Longitudinal Cohort Study. *Front. Aging Neurosci.* **2020**, *12*, 601487. [CrossRef]
11. Bagnall-Moreau, C.; Chaudhry, S.; Salas-Ramirez, K.; Ahles, T.; Hubbard, K. Chemotherapy-Induced Cognitive Impairment Is Associated with Increased Inflammation and Oxidative Damage in the Hippocampus. *Mol. Neurobiol.* **2019**, *56*, 7159–7172. [CrossRef]
12. Conroy, S.K.; McDonald, B.C.; Smith, D.J.; Moser, L.R.; West, J.D.; Kamendulis, L.M.; Klaunig, J.E.; Champion, V.L.; Unverzagt, F.W.; Saykin, A.J. Alterations in brain structure and function in breast cancer survivors: Effect of post-chemotherapy interval and relation to oxidative DNA damage. *Breast Cancer Res. Treat.* **2013**, *137*, 493–502. [CrossRef]

13. American Cancer Society. Benefits of Good Nutrition during Cancer Treatment. Available online: https://www.cancer.org/treatment/survivorship-during-and-after-treatment/coping/nutrition/benefits.html (accessed on 1 June 2023).
14. Conigliaro, T.; Boyce, L.M.; Lopez, C.A.; Tonorezos, E.S. Food Intake During Cancer Therapy: A Systematic Review. *Am. J. Clin. Oncol.* **2020**, *43*, 813–819. [CrossRef]
15. Haskins, C.P.; Champ, C.E.; Miller, R.; Vyfhuis, M.A.L. Nutrition in Cancer: Evidence and Equality. *Adv. Radiat. Oncol.* **2020**, *5*, 817–823. [CrossRef]
16. Jain, R.; Handorf, E.; Khare, V.; Blau, M.; Chertock, Y.; Hall, M.J. Impact of Baseline Nutrition and Exercise Status on Toxicity and Outcomes in Phase I and II Oncology Clinical Trial Participants. *Oncologist* **2019**, *25*, 161–169. [CrossRef]
17. Paccagnella, A.; Morello, M.; Da Mosto, M.C.; Baruffi, C.; Marcon, M.L.; Gava, A.; Baggio, V.; Lamon, S.; Babare, R.; Rosti, G.; et al. Early nutritional intervention improves treatment tolerance and outcomes in head and neck cancer patients undergoing concurrent chemoradiotherapy. *Support. Care Cancer* **2010**, *18*, 837–845. [CrossRef]
18. Wen, Z.-Y.; Liu, C.; Liu, F.-H.; Wei, Y.-F.; Xu, H.-L.; Wang, R.; Li, X.-Y.; Li, Y.-Z.; Yan, S.; Qin, X. Association between pre-diagnostic dietary pattern and survival of ovarian cancer: Evidence from a prospective cohort study. *Clin. Nutr.* **2022**, *41*, 452–459. [CrossRef]
19. Chrysohoou, C.; Panagiotakos, D.B.; Pitsavos, C.; Das, U.N.; Stefanadis, C. Adherence to the Mediterranean diet attenuates inflammation and coagulation process in healthy adults: The ATTICA Study. *J. Am. Coll. Cardiol.* **2004**, *44*, 152–158. [CrossRef]
20. Schwingshackl, L.; Schwedhelm, C.; Galbete, C.; Hoffmann, G. Adherence to Mediterranean Diet and Risk of Cancer: An Updated Systematic Review and Meta-Analysis. *Nutrients* **2017**, *9*, 1063. [CrossRef]
21. Tosti, V.; Bertozzi, B.; Fontana, L. Health Benefits of the Mediterranean Diet: Metabolic and Molecular Mechanisms. *J. Gerontol. A Biol. Sci. Med. Sci.* **2018**, *73*, 318–326. [CrossRef]
22. Roager, H.M.; Vogt, J.K.; Kristensen, M.; Hansen, L.B.S.; Ibrugger, S.; Maerkedahl, R.B.; Bahl, M.I.; Lind, M.V.; Nielsen, R.L.; Frokiaer, H.; et al. Whole grain-rich diet reduces body weight and systemic low-grade inflammation without inducing major changes of the gut microbiome: A randomised cross-over trial. *Gut* **2019**, *68*, 83–93. [CrossRef] [PubMed]
23. Turner-McGrievy, G.M.; Wirth, M.D.; Shivappa, N.; Dunn, C.G.; Crimarco, A.; Hurley, T.G.; West, D.S.; Hussey, J.R.; Hebert, J.R. Impact of a 12-month Inflammation Management Intervention on the Dietary Inflammatory Index, inflammation, and lipids. *Clin. Nutr. ESPEN* **2019**, *30*, 42–51. [CrossRef] [PubMed]
24. Wood, A.D.; Strachan, A.A.; Thies, F.; Aucott, L.S.; Reid, D.M.; Hardcastle, A.C.; Mavroeidi, A.; Simpson, W.G.; Duthie, G.G.; Macdonald, H.M. Patterns of dietary intake and serum carotenoid and tocopherol status are associated with biomarkers of chronic low-grade systemic inflammation and cardiovascular risk. *Br. J. Nutr.* **2014**, *112*, 1341–1352. [CrossRef] [PubMed]
25. Milesi, G.; Rangan, A.; Grafenauer, S. Whole Grain Consumption and Inflammatory Markers: A Systematic Literature Review of Randomized Control Trials. *Nutrients* **2022**, *14*, 374. [CrossRef] [PubMed]
26. Veronese, N.; Solmi, M.; Caruso, M.G.; Giannelli, G.; Osella, A.R.; Evangelou, E.; Maggi, S.; Fontana, L.; Stubbs, B.; Tzoulaki, I. Dietary fiber and health outcomes: An umbrella review of systematic reviews and meta-analyses. *Am. J. Clin. Nutr.* **2018**, *107*, 436–444. [CrossRef] [PubMed]
27. World Cancer Research Fund; American Institute for Cancer Research. *Continuous Update Project Expert Report 2018: Recommendations and Public Health and Policy Implications*; American Institute for Cancer Research: Arlington, VA, USA, 2018.
28. Morris, M.C.; Tangney, C.C.; Wang, Y.; Sacks, F.M.; Barnes, L.L.; Bennett, D.A.; Aggarwal, N.T. MIND diet slows cognitive decline with aging. *Alzheimers Dement.* **2015**, *11*, 1015–1022. [CrossRef]
29. van den Brink, A.C.; Brouwer-Brolsma, E.M.; Berendsen, A.A.M.; van de Rest, O. The Mediterranean, Dietary Approaches to Stop Hypertension (DASH), and Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) Diets Are Associated with Less Cognitive Decline and a Lower Risk of Alzheimer's Disease—A Review. *Adv. Nutr.* **2019**, *10*, 1040–1065. [CrossRef]
30. World Cancer Research Fund; American Institute for Cancer Research. *Continuous Update Project Expert Report 2018: The Cancer Process*; American Institute for Cancer Research: Arlington, VA, USA, 2018.
31. Shivappa, N.; Steck, S.E.; Hurley, T.G.; Hussey, J.R.; Hebert, J.R. Designing and developing a literature-derived, population-based dietary inflammatory index. *Public Health Nutr.* **2014**, *17*, 1689–1696. [CrossRef] [PubMed]
32. Fowler, M.E.; Akinyemiju, T.F. Meta-analysis of the association between dietary inflammatory index (DII) and cancer outcomes. *Int. J. Cancer* **2017**, *141*, 2215–2227. [CrossRef]
33. Vicente, B.M.; Lucio Dos Santos Quaresma, M.V.; Maria de Melo, C.; Lima Ribeiro, S.M. The dietary inflammatory index (DII®) and its association with cognition, frailty, and risk of disabilities in older adults: A systematic review. *Clin. Nutr. ESPEN* **2020**, *40*, 7–16. [CrossRef]
34. Barbaresko, J.; Koch, M.; Schulze, M.B.; Nöthlings, U. Dietary pattern analysis and biomarkers of low-grade inflammation: A systematic literature review. *Nutr. Rev.* **2013**, *71*, 511–527. [CrossRef] [PubMed]
35. American Institute for Cancer Research. AICR Recipes. Available online: https://www.aicr.org/cancer-prevention/recipes/ (accessed on 1 June 2023).
36. National Cancer Institute. Diet History Questionnaire III (DHQ III). Available online: https://epi.grants.cancer.gov/dhq3 (accessed on 1 June 2023).
37. Shivappa, N.; Blair, C.K.; Prizment, A.E.; Jacobs, D.R.; Hebert, J.R. Prospective study of the dietary inflammatory index and risk of breast cancer in postmenopausal women. *Mol. Nutr. Food Res.* **2017**, *61*, 1600592. [CrossRef] [PubMed]
38. Shivappa, N.; Blair, C.K.; Prizment, A.E.; Jacobs, D.R., Jr.; Hebert, J.R. Dietary inflammatory index and risk of renal cancer in the Iowa Women's Health Study. *Eur. J. Nutr.* **2018**, *57*, 1207–1213. [CrossRef] [PubMed]

39. Tabung, F.K.; Steck, S.E.; Ma, Y.; Liese, A.D.; Zhang, J.; Lane, D.S.; Ho, G.Y.F.; Hou, L.; Snetselaar, L.; Ockene, J.K.; et al. Changes in the Inflammatory Potential of Diet Over Time and Risk of Colorectal Cancer in Postmenopausal Women. *Am. J. Epidemiol.* **2017**, *186*, 514–523. [CrossRef] [PubMed]
40. Hebert, J.R.; Shivappa, N.; Wirth, M.D.; Hussey, J.R.; Hurley, T.G. Perspective: The Dietary Inflammatory Index (DII)—Lessons Learned, Improvements Made, and Future Directions. *Adv. Nutr.* **2019**, *10*, 185–195. [CrossRef] [PubMed]
41. Wagner, L.I.; Sweet, J.J.; Butt, Z.; Lai, J.S.; Cella, D. Measuring patient self-reported cognitive function: Development of the functional assessment of cancer therapy-cognitive function instrument. *J. Support. Oncol.* **2009**, *7*, W32–W39.
42. FACIT. Functional Assessment of Cancer Therapy—Cognitive Function (FACT-Cog) Scoring Guidelines. Available online: https://www.facit.org/measures/FACT-Cog (accessed on 1 October 2023).
43. Dyk, K.V.; Crespi, C.M.; Petersen, L.; Ganz, P.A. Identifying cancer-related cognitive impairment using the FACT-Cog perceived cognitive impairment. *JNCI Cancer Spectr.* **2020**, *4*, pkz099. [CrossRef] [PubMed]
44. Henneghan, A.M.; Van Dyk, K.; Kaufmann, T.; Harrison, R.; Gibbons, C.; Heijnen, C.; Kesler, S.R. Measuring Self-Reported Cancer-Related Cognitive Impairment: Recommendations from the Cancer Neuroscience Initiative Working Group. *J. Natl. Cancer Inst.* **2021**, *113*, 1625–1633. [CrossRef] [PubMed]
45. Hajj, A.; Salameh, P.; Khoury, R.; Hachem, R.; Sacre, H.; Chahine, G.; Kattan, J.; Rabbaa Khabbaz, L. Psychometric properties of the 37-item Functional Assessment of Cancer Therapy-Cognitive Function (FACT-Cog) scale. *Future Oncol.* **2022**, *18*, 3741–3753. [CrossRef]
46. IPAQ Research Committee Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ)-Short and Long Forms. 2005. Available online: https://sites.google.com/view/ipaq/score (accessed on 1 October 2023).
47. Craig, C.L.; Marshall, A.L.; Sjostrom, M.; Bauman, A.E.; Booth, M.L.; Ainsworth, B.E.; Pratt, M.; Ekelund, U.; Yngve, A.; Sallis, J.F.; et al. International physical activity questionnaire: 12-country reliability and validity. *Med. Sci. Sports Exerc.* **2003**, *35*, 1381–1395. [CrossRef]
48. Ainsworth, B.E.; Haskell, W.L.; Whitt, M.C.; Irwin, M.L.; Swartz, A.M.; Strath, S.J.; O'Brien, W.L.; Bassett, D.R., Jr.; Schmitz, K.H.; Emplaincourt, P.O.; et al. Compendium of physical activities: An update of activity codes and MET intensities. *Med. Sci. Sports Exerc.* **2000**, *32*, S498–S504. [CrossRef] [PubMed]
49. Tucker, J.M.; Welk, G.J.; Beyler, N.K. Physical activity in U.S.: Adults compliance with the Physical Activity Guidelines for Americans. *Am. J. Prev. Med.* **2011**, *40*, 454–461. [CrossRef] [PubMed]
50. Park, Y.; Dodd, K.W.; Kipnis, V.; Thompson, F.E.; Potischman, N.; Schoeller, D.A.; Baer, D.J.; Midthune, D.; Troiano, R.P.; Bowles, H.; et al. Comparison of self-reported dietary intakes from the Automated Self-Administered 24-h recall, 4-d food records, and food-frequency questionnaires against recovery biomarkers. *Am. J. Clin. Nutr.* **2018**, *107*, 80–93. [CrossRef] [PubMed]
51. Killeen, S.L.; Phillips, C.M.; Delahunt, A.; Yelverton, C.A.; Shivappa, N.; Hebert, J.R.; Kennelly, M.A.; Cronin, M.; Mehegan, J.; McAuliffe, F.M. Effect of an Antenatal Lifestyle Intervention on Dietary Inflammatory Index and Its Associations with Maternal and Fetal Outcomes: A Secondary Analysis of the PEARS Trial. *Nutrients* **2021**, *13*, 2798. [CrossRef] [PubMed]
52. USDA. Food Sources of Dietary Fiber. Available online: https://www.dietaryguidelines.gov/resources/2020-2025-dietary-guidelines-online-materials/food-sources-select-nutrients/food-0 (accessed on 1 September 2023).
53. Campbell, N.J.; Barton, C.; Cutress, R.I.; Copson, E.R. Impact of obesity, lifestyle factors and health interventions on breast cancer survivors. *Proc. Nutr. Soc.* **2023**, *82*, 47–57. [CrossRef] [PubMed]
54. Shaikh, H.; Bradhurst, P.; Ma, L.X.; Tan, S.Y.C.; Egger, S.J.; Vardy, J.L. Body weight management in overweight and obese breast cancer survivors. *Cochrane Database Syst. Rev.* **2020**, *12*, Cd012110. [CrossRef] [PubMed]
55. Hoy, M.; Goldman, J. Fiber Intake of the U.S. Population: What We Eat in America, NHANES 2009–2010. In *FSRG Dietary Data Briefs*; Data Brief No. 12; United States Department of Agriculture (USDA): Beltsville, MD, USA, 2014.
56. Hoy, M.K.; Clemens, J.C.; Martin, C.L.; Moshfegh, A.J. Fruit and Vegetable Consumption of US Adults by Level of Variety, What We Eat in America, NHANES 2013–2016. *Curr. Dev. Nutr.* **2020**, *4*, nzaa014. [CrossRef] [PubMed]
57. U.S. Department of Agriculture; U.S. Department of Health and Human Services. *Dietary Guidelines for Americans, 2020–2025*; U.S. Department of Agriculture: Washington, DC, USA; U.S. Department of Health and Human Services: Washington, DC, USA, 2020.
58. Bell, M.; Dhillon, H.; Bray, V.; Vardy, J. Important differences and meaningful changes for the functional assessment of cancer therapy-cognitive function (FACT-Cog). *J. Patient-Rep. Outcomes* **2018**, *2*, 48. [CrossRef]
59. Jia, Y.; Yan, S.; Sun, M.; Yang, Y.; Wang, L.; Wu, C.; Li, P. Association between dietary inflammatory index and cognitive impairment: A meta-analysis. *Front. Aging Neurosci.* **2022**, *14*, 1007629. [CrossRef]
60. Lappe, J.M.; Heaney, R.P. Why randomized controlled trials of calcium and vitamin D sometimes fail. *Dermato-Endocrinol.* **2012**, *4*, 95–100. [CrossRef]
61. Sanders, C.L.; Wengreen, H.J.; Schwartz, S.; Behrens, S.J.; Corcoran, C.; Lyketsos, C.G.; Tschanz, J.T. Nutritional Status is Associated with Severe Dementia and Mortality: The Cache County Dementia Progression Study. *Alzheimer Dis. Assoc. Disord.* **2018**, *32*, 298–304. [CrossRef] [PubMed]
62. Ward, N.A.; Reid-McCann, R.; Brennan, L.; Cardwell, C.R.; de Groot, C.; Maggi, S.; McCaffrey, N.; McGuinness, B.; McKinley, M.C.; Noale, M.; et al. Effects of PROtein enriched MEDiterranean Diet and EXercise on nutritional status and cognition in adults at risk of undernutrition and cognitive decline: The PROMED-EX Randomised Controlled Trial. *BMJ Open* **2023**, *13*, e070689. [CrossRef] [PubMed]

63. Blake, K.D.; Moss, J.L.; Gaysynsky, A.; Srinivasan, S.; Croyle, R.T. Making the Case for Investment in Rural Cancer Control: An Analysis of Rural Cancer Incidence, Mortality, and Funding Trends. *Cancer Epidemiol. Biomark. Prev.* **2017**, *26*, 992–997. [CrossRef]
64. Cross, S.; Kurmas, N.; Byrne, C.; Julius, M.; Burant, C.; Utech, A.; Aoun, A. Diabetes Self-Management Education Support Healthy Teaching Kitchen Cooking Classes Delivered Using a Telehealth Technology. *Sci. Diabetes Self Manag. Care.* **2021**, *47*, 199–206. [CrossRef] [PubMed]
65. Dexter, A.S.; Pope, J.F.; Erickson, D.; Fontenot, C.; Ollendike, E.; Walker, E. Cooking Education Improves Cooking Confidence and Dietary Habits in Veterans. *Diabetes Educ.* **2019**, *45*, 442–449. [CrossRef] [PubMed]
66. Silver, J.K.; Finkelstein, A.; Minezaki, K.; Parks, K.; Budd, M.A.; Tello, M.; Paganoni, S.; Tirosh, A.; Polak, R. The Impact of a Culinary Coaching Telemedicine Program on Home Cooking and Emotional Well-Being during the COVID-19 Pandemic. *Nutrients* **2021**, *13*, 2311. [CrossRef] [PubMed]
67. Hebert, J.R. Social Desirability Trait: Biaser or Driver of Self-Reported Dietary Intake? *J. Acad. Nutr. Diet* **2016**, *116*, 1895–1898. [CrossRef] [PubMed]
68. Hebert, J.R.; Ebbeling, C.B.; Matthews, C.E.; Hurley, T.G.; Ma, Y.; Druker, S.; Clemow, L. Systematic errors in middle-aged women's estimates of energy intake: Comparing three self-report measures to total energy expenditure from doubly labeled water. *Ann. Epidemiol.* **2002**, *12*, 577–586. [CrossRef]
69. Hebert, J.R.; Ma, Y.; Clemow, L.; Ockene, I.S.; Saperia, G.; Stanek, E.J., 3rd; Merriam, P.A.; Ockene, J.K. Gender differences in social desirability and social approval bias in dietary self-report. *Am. J. Epidemiol.* **1997**, *146*, 1046–1055. [CrossRef]

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