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Original Research

Randomized Pilot Study Examining an Online Diet Intervention to Increase Intake of Fruits and Vegetables Among Healthy Adults

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ABSTRACT

International Journal of Exercise Science 17(2): 1618-1628, 2024. Intake of fruits and vegetables (F&V) is related to health outcomes. The purpose of the study was to test an online diet program promoting F&V intake among healthy adults. Twenty-three participants were randomly assigned to complete an 8-week intervention condition (#800gChallenge®) or wait-list control condition. In weeks 1-4, intervention participants were asked to interact with an application reporting (a) whether they met their daily 800g F&V goal, (b) if their 800g of F&V was from a variety of sources, and (c) reading of daily educational material. Weeks 1-4 included weekly Zoom check-in meetings. Weeks 5-8 were autonomous, wherein participants reported in the application information regarding their 800g F&V goal. At baseline, 4-weeks, and 8-weeks, the participants were prompted to complete three Automated Self-Administered Dietary Assessment tool (ASA24) 24-hour diet recalls for generating Healthy Eating Index (HEI) scores indicating diet quality. A two-way ANOVA was used to examine differences between the intervention and control groups in HEI total score, total vegetable, total fruit, and whole fruit component scores at baseline, 4-weeks, and 8-weeks. While no statistically significant differences in HEI scores were observed between groups, the intervention group showed promising improvements over the 8-week period. Notably, the intervention group increased their mean HEI total score, along with substantial gains in their total vegetable and total fruit consumption, indicating the intervention's potential for promoting healthier dietary patterns. These findings underscore the need for ongoing research to develop eHealth interventions of optimal duration and intensity that can drive meaningful improvements in the health of adults with poor diet quality.

Key Words: Diet quality, dietary assessment, Healthy Eating Index

INTRODUCTION

In 2022, the Centers for Disease Control and Prevention (CDC) reported that adults who eat a healthy diet live longer and have lower risk for cancers, obesity, and heart disease (3). The current Dietary Guidelines for Americans 2020-2025 (DGA) provide recommendations that address the core elements of a healthy dietary pattern which include vegetables of all types,

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fruits, grains, dairy, and protein foods (20). An individual's diet quality can be measured by scoring their food intake patterns and determining how closely they align with the national dietary guidelines (19). There is a strong association between the quality of a person's diet and their risk of development for certain diseases and mortality (19). Generally, studies focusing on dietary changes, aim to improve diet quality to reduce risk for morbidity and mortality.

Fruit and vegetable (F&V) intake among adults in the United States (U.S.) is generally low (3) and is an area of diet quality that can be improved by providing guidance that approximately half of your plate at each meal include F&V (20). Consumption of F&V provides many nutrients and eating high amounts of F&V has been shown to reduce risk for development of disease, such as the initiation of cancer, and decrease morality (18). A meta-analysis examined the association between the risk of cardiovascular disease, total cancer, and all-cause mortality with the intake of F&V and found that intake of 800g of F&V per day was associated with a reduction of relative risk (RR) for heart disease, stroke, cardiovascular disease, cancer, and all-cause mortality (1).

Adults report many barriers to consuming the recommended amounts of daily F&V, some of the most common barriers are cost, transportation, lack of quality and variety, changing food environment, and changing societal norms (7). Research has provided evidence that the more an individual is educated about the importance of diet and diet quality, the more the individual may put an effort to consume any sort of F&V (6). Behavioral interventions are one way to overcome barriers of intake of F&V's. One recent study examined change in dietary behaviors, self-efficacy, and social support for engaging in healthier diets following a structured 12-week behavioral intervention. Individuals in the intervention group significantly improved their F&V consumption and reduced their fast-food consumption from baseline to 3 months (16). Another study reviewed behavioral interventions to promote intake of F&V and found a significant increase in F&V intake when behavior-based interventions were employed, but the increases were small compared to the amount needed to reach the recommended intake levels which are 4.5 cups of F&V (17).

The results from the aforementioned meta-analysis (1) supported the creation of the #800gChallenge®. The #800Challenge® is a diet program aimed at increasing daily F&V intake. The underlying premise of the #800gChallenge® is prioritizing intake of at least 800g of F&V daily will increase satiety via increased fiber and water intake, which may lead to less consumption of low-nutrient/high-calorie foods. This current study examined the feasibility, acceptability, and preliminary efficacy of the #800gChallenge® in adults using a randomized control design. The primary objective of the study was to evaluate the feasibility of implementing this online #800gChallenge® intervention. This is particularly important as the intervention has not previously been tested in a rigorous setting. Feasibility testing is essential to determine whether the intervention can be successfully implemented and to refine the approach before undertaking a costly, fully powered efficacy study. The research team hypothesized that 24 participants would be able to be recruited for the study, acceptability scores of the program would all be above 3.5 out of 5, and the protocol would be deemed safe with no adverse events. Regarding preliminary efficacy, the research team hypothesized that

there would be a significant difference in diet quality measured using the Healthy Eating Index (HEI) between the intervention and control groups wherein a significant improvement in F&V intake would be seen in the intervention group and no change would be observed in the control group.

METHODS

Participants

Twenty-four faculty and staff employed at the University of North Texas (UNT) were recruited to participate in the study. The research team advertised the study through posting on bulletin boards, emails, and word of mouth. Participants were screened via telephone for eligibility before baseline assessment using a standard telephone script for the following inclusion criteria: (a) 18 years or older and (b) full-time employees at the UNT. All participants completed written informed consent prior to beginning the study, along with attaining approval from UNT Institutional Review Board and the study follows the ethical standard according to the Declaration of Helsinki. This research was carried out fully in accordance with the ethical standards of the *International Journal of Exercise Science* (12).

Study participants were asked to complete three in-person visits (baseline, four weeks, eight weeks).

Demographics Questionnaire - Participants completed a questionnaire self-reporting their current age, race, sex, education, marital status, employment status, and annual household income. The primary purpose of this questionnaire was to describe the study sample and provide a clear depiction of the demographic characteristics of the participants.

Feasibility - Feasibility in studies can be described as the process of investigating if and how an intervention can be done (8). The three feasibility measures in this study were recruitment, retention, and safety. Attainment of recruitment and retention benchmarks were tracked using a Microsoft Excel database and safety was defined by incidence of adverse events.

Acceptability Questionnaire - Participants in the intervention group were asked to complete a questionnaire about their experience with the diet program. The questions included quantitative ratings from 1-Poor to 5-Excellent. The questions included: Overall, how would you rate the diet program? How would you rate each diet program component: registration process, introductory call, weekly check-in calls, daily educational content, leaderboard, daily point tracking, and overall application function and usability? Participants were asked to complete the following open-ended questions: 1) What was the most valuable part of the 8-week program; 2) What was the most challenging part of the 8-week diet program; 3) Please provide suggestions for improving the diet; and 4) Please provide any additional feedback for the research team.

Diet Behavior - Participants were prompted to complete three Automated Self-Administered 24-Hour Dietary Assessment Tool (ASA24) dietary recalls during baseline, 4-weeks and 8-week assessments (i.e., 9 ASA24 diet recalls total). Participants were briefly guided through steps to

capture all food and beverage intake during the previous 24-hour period and asked to complete the ASA24 in person at each timepoint (baseline, 4-weeks, and 8-weeks) where a trained researcher was available to answer questions. All participants were then prompted via e-email or text to complete two additional ASA24 diet recalls within one week of their baseline, 4-week, and 8-week assessments on random, non-consecutive days. If participants couldn't complete their diet recall the date they were prompted, they were offered another opportunity if it aligned within the appropriate data collection window. Any days in which the mean reported energy intake was below 500kcals, the researchers excluded the data (10).

HEI scores were generated using ASA24 data. The HEI-2020 can be used to assess how well an individual's diet aligns with the dietary patterns and recommendations suggested by the DGA 2020-2025 (17). The HEI-2020 total score is based on 100 points where higher scores indicate better diet quality. In addition to total HEI-2020 score, three additional component scores (ranging from 1 to 5), which included total vegetable, total fruit, and total whole fruit were analyzed given the focus on F&V intake in the current study. To generate HEI-2020 scores, ASA24 daily means were averaged from the three collection days for each timepoint (baseline, 4 weeks, and 8 weeks), and participants were included if they had at least one valid, complete ASA24 for a timepoint.

Protocol

Baseline - Participants completed written informed consent prior to beginning the study. First, participants were asked to complete a demographics questionnaire using Qualtrics® and their first ASA24 diet recall questionnaire on an iPad in a private, quiet area. After collecting all baseline data, participants were randomly assigned to either the diet intervention or waitlist condition using 24 opaque envelopes. Participants randomized to the intervention were asked to complete the registration process of the #800gChallenge® application platform with assistance from the research team. Waitlist control group participants were asked not to alter their diet and granted access to the platform after the 8-week intervention assessment. During this assessment, all participants were given a food scale to measure their food.

4-Weeks - The ASA24 questionnaires were administered on iPads during the study's 4-week in-person visit through the ASA24 website.

8-Weeks - The ASA24 questionnaires were administered on iPads during the study's 8-week in-person visit through the ASA24 website. One additional questionnaire was given to the intervention group regarding the acceptability of the intervention and the application through Qualtrics ® administered on iPads at the end of the assessment.

#800gChallenge® Intervention - The #800gChallenge® intervention lasted for 8-weeks and was administered using the Wodify Challenge software. Intervention participants were emailed a Zoom link for an introductory call prior to starting the study. During the introductory call, the participants were provided instructions on how to register for the application, guidelines around consumption, and the study team answered any questions they might have before beginning the active study period. Participants were provided with two practice days prior to

the beginning of the formal challenge. Each day, participants were prompted to check off completion of the relevant tasks. The task list would change based on the day of the week, and the software would sum daily points associated with completed tasks in real-time for a cumulative score on a leaderboard (where participants could use an anonymous username, if desired). During weeks 1-4 participants reported in the app each day on the following metrics: (a) whether 800g of F&V was consumed, (b) whether the 800g of F&V was from a variety of sources (i.e., 6 or more), and (c) whether the daily educational material was reviewed. The daily educational material was presented in a blog format for the four weeks and focused on teaching simple nutritional education about the #800gChallenge®, dispelling nutrition myths, and tips for behavior change. For example, the content discusses the nutritional breakdown of typical 800g of mixed F&V in terms of calories, macronutrients, fiber, and micronutrients in relation to total daily caloric needs and classic American foods (e.g., cookie). Other content included topics like understanding sugar content in fruit and how to effectively plan a day's worth of meals to total to 800g. Educational content took ~5 minutes a day to review to reinforce better diet selections as well as help with program engagement. Participants could gain one additional point on Wednesdays and Fridays for posting a photo of a meal consumed with F&V on the group feed. Additionally, during weeks 1-4 the intervention participants were invited to a group check-in call once a week via Zoom with members of the study team. Weeks 5-8 were autonomous wherein interventions participants only interacted with the application and reported whether they had (a) met the daily 800g F&V goal, (b) if they reached their 800g F&V goals from a variety of sources, and (c) if they shared a meal idea on Wednesdays and Fridays.

Statistical Analysis

The planned sample size of 24 participants (i.e., 12 per group) was based on guidelines for pilot clinical trials when there is no a priori information for the sample size estimation (21). Data were analyzed using IBM SPSS Statistics for Windows, version 29 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including frequency and percentage, were calculated for the primary research questions regarding the feasibility and acceptability of the #800gChallenge®. Differences in HEI total score, total vegetable, total fruit, and whole fruit component scores between the groups were assessed using a two-way ANOVA with a p <0.05 indicating significance.

RESULTS

Participants - A total of 23 participants completed baseline assessments and enrolled in the study. There were 11 participants in the control group and 12 participants in the intervention group. Table 1 provides an overview of participant demographic characteristics. There were 15 participants who identified as female. A total of 17 participants were married, 17 identified as Caucasian, and 12 had master's degree or higher.

Feasibility - The research team was able to recruit, screen, and schedule baseline visits for 24 participants to this study, which met our *a priori* recruitment goal of 24 participants. One participant, however, did not participate in the study due to a scheduling conflict leaving a final sample of 23 participants. As a result of sustaining a wrist injury in week 2, one participant in

the intervention group dropped out of the study because they believed they could not fully participate in the intervention (i.e., prepare food and beverages). The final sample of the #800gChallenge® was 22 participants. Therefore, the overall retention rate was 96%, which surpassed the hypothesized benchmark of 80%. There were no adverse events reported throughout the study.

Table 1. Participant Demographic Characteristics for the #800gChallenge®.

Variable		Total Sample (n = 23)	Control Group (n = 11)	Intervention Group (n = 12)
Age (y)	*Mean ± SD*	44.8 ± 13.6	44.7 ± 14.4	44.9 ± 13.4
Sex	*N (%)*			
Male		8 (34.8)	4 (36.4)	4 (33.3)
Female		15 (65.2)	7 (63.6)	8 (66.7)
Marital Status	*N (%)*			
Married		17 (73.9)	8 (72.7)	9 (75.0)
Single		4 (17.4)	3 (27.3)	1 (8.3)
Divorced/Separated		2 (8.7)	0 (0)	2 (16.7)
Race	*N (%)*			
Black/African American		3 (13.0)	1 (9.1)	2 (16.7)
Caucasian		17 (73.9)	8 (72.7)	9 (75.0)
Latino/a		2 (8.7)	2 (18.2)	0 (0)
Other		1 (4.3)	0 (0)	1 (8.3)
Education	*N (%)*			
High School Graduate		2 (8.7)	1 (9.1)	1 (8.3)
1 – 3 years of college		2 (8.7)	0 (0)	2 (16.7)
College/University Graduate		2 (8.7)	1 (9.1)	1 (8.3)
Master's Degree		12 (52.2)	7 (63.6)	5 (41.7)
PhD or Equivalent		5 (21.7)	2 (18.2)	3 (25.0)
Annual Household Income	*N (%)*			
$20,000 – $44,999		2 (8.7)	1 (9.1)	1 (8.3)
$45,000 – $139,999		13 (56.5)	7 (63.6)	6 (50.0)
$140,000 or more		8 (34.8)	3 (27.3)	5 (41.7)

Acceptability - Table 2 provides the means and standard deviation (SD) for the items in the questionnaire and provides ratings for the components of the program on a scale of 1-5, with 1 meaning poor and 5 meaning excellent. An acceptability questionnaire was administered to intervention group participants after 8 weeks. Participants rated the overall quality of the diet program (mean±SD) of 3.8±0.6 out of 5. The three most highly rated components were the introductory call 4.1±0.5, the registration process 4.1±0.9, and daily educational content 4.1± 0.8. The overall application function and usability was rated 3.9±0.7. The open-ended questions indicated that the weekly calls, recording/tracking meals, and the educational content in the application were the most valuable elements of the study. Additionally, these resources provided participants with additional information on incorporating 800g of F&V per day into their diets. Participants reported logging/recording their food for that day and meal planning for the 800g goal as the most challenging parts of the study. Two participants suggested extending the number of weeks of the program and one participant suggested that future studies provide optional food plans. Lastly, one participant suggested allowing more time for task

compliance. They indicated that having more time to enter the points in the application and completing the pictures of the food would have been able to be easier if they were not asked to be completed in a specific time slot, but to allow more then 24 hours to provide the information.

Table 2. Acceptability Scores for the #800gChallenge®.

Variable Question:	*(Mean ±SD)*
Overall, how would you rate the diet program:	3.8 ± 0.6
Please rate each of the following components of the diet program:	
Introductory Call	4.5 ± 0.5
Registration Process	4.1 ± 0.9
Daily Education Content	4.1 ± 0.8
Weekly Check – in Calls	3.9 ± 0.8
Overall Application Function and Usability	3.9 ± 0.7
Leaderboard	3.5 ± 0.9
Daily Point Tracking	3.6 ± 0.9

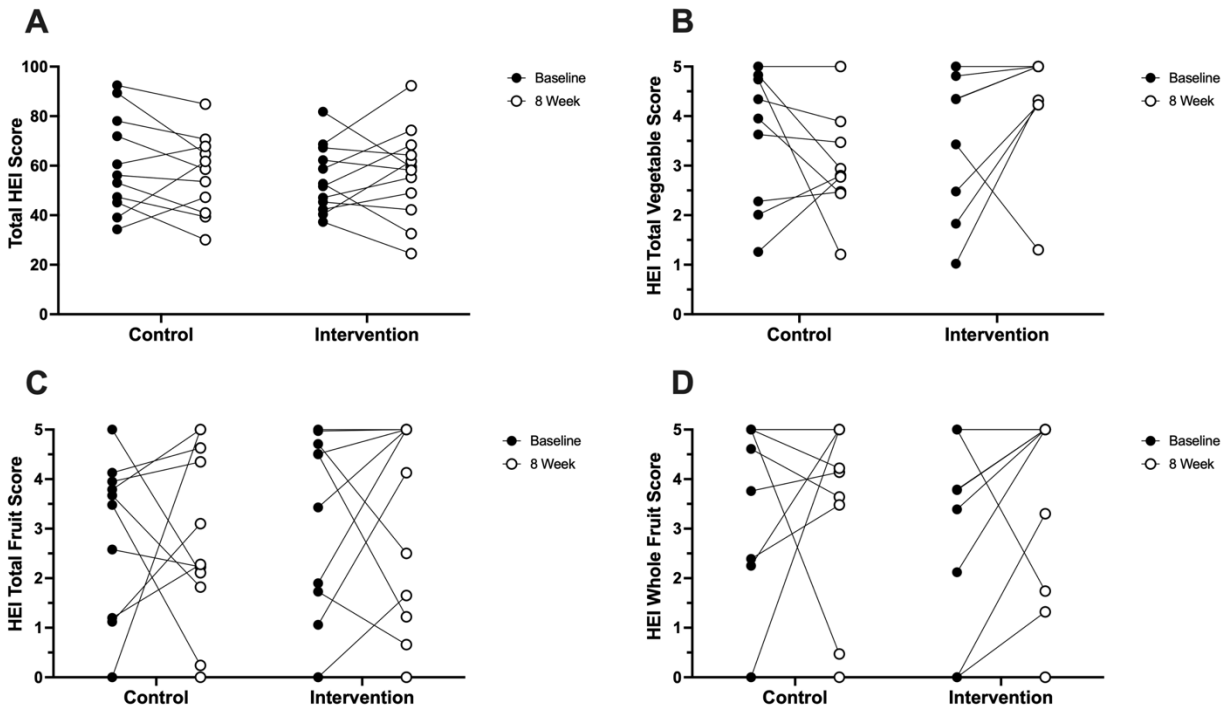

Figure 1. Healthy Eating Index scores for the #800gChallenge®.

Diet Behavior Change - There was no significant change in HEI total, total vegetable, total fruit, and whole fruit scores. A two-way ANOVA was conducted to examine the impact of time and group. The data was divided into 4 groups: HEI total scores (p = 0.47), HEI total vegetable score (p = 0.10), HEI total fruit (p = 0.23), and HEI whole fruit (p = 0.27). The interaction effect between time and group was not statistically significant. Figure 1 provides the directional change in each group with HEI total score, HEI vegetable score, HEI total fruit score, and HEI whole fruit score.

DISCUSSION

The purpose of the study was to examine the feasibility, acceptability, and preliminary efficacy of the #800gChallenge® among adults for promoting increased F&V intake. The hypotheses regarding feasibility (i.e., recruitment, retention, and safety) were confirmed with 24 participants recruited and 96% (n=22) retained throughout the 8-week study. There was strong evidence of safety with no adverse events reported throughout the course of the study. Regarding acceptability, participants rated the overall program and components favorably and provided constructive feedback to improve future iterations. There was no significant change in HEI scores as a measure of diet behavior change (i.e., preliminary efficacy). However, there appeared to be a non-significant increase in F&V intake based on mean change scores in HEI total from baseline (55.32) to 8 weeks (56.66), total vegetable baseline (3.84) to 8 weeks (4.46), total fruit baseline (2.48) to 8 weeks (3.08), and whole fruit baseline (2.55) to 8 weeks (3.60) component scores among participants in the intervention group.

The present study contributes to the growing body of literature on dietary interventions focusing on increasing F&V intake within the U.S. population. A recent study focused on increasing F&V intake through a dietary intervention that incorporated the provision of F&V to consume throughout the 12-week intervention period (4). Specifically, participants in the intervention group were provided about 480g of F&V twice a week to consume. Instructions on preparation, storing, and cooking were provided throughout the study through e-mail or telephone. Participants in this 20-week study consumed their habitual diet for two weeks, participated in a 12-week intervention, and then had a 6-week washout period without F&V provision. There was a significant increase in the intervention group by almost five servings of F&V after the 12-week period; however, during their washout period, the participants returned to their baseline levels of consumption on F&Vs (4). The driver of change in the study may have been the provision of resources (i.e., F&V). In the #800gChallenge®, participants were not provided F&V, which could be an approach to consider in future interventions; however, this is not a realistic solution for long-term behavior change.

The current study provided evidence that there is general interest in diet interventions focused on increasing F&V intake. Diet behavior change is a challenging, primarily from a behavioral perspective. One study was identified that aimed to increase F&V intake among adults with an emphasis on behavioral perspective (5). The study included 163 participants who were separated into either the control group, who received written information on nutrition, or 3 other intervention groups. The first intervention group was the implementation intentions, where the second one focused on self-efficacy, and the last group was a combination of both the implementation intentions and self-efficacy groups. The first intervention group received a total of four face-to-face interviews that spanned from 20-30 minutes each in which the participant identified barriers and how to overcome them. The second intervention group had 2-hour group meetings that mirrored the first group but added the factor of encouragement from group members. For the combination group, four 2-hour meetings were offered, and they combined the techniques used in the other intervention groups. The study results provided evidence that all intervention groups produced significant changes in their intention to consume F&V

throughout the day compared to the control group (5). The current #800gChallenge® study includes some behavior components such as self-monitoring and goal setting, which other studies have provided evidence to provide that significant changes can occur with consumption of F&V intake within the intervention group (9). However, there is a need to identify the most effective behavior change techniques that can support long-term F&V intake to support overall health.

Overall, the aim of this study was to assess the feasibility of the #800gChallenge®; however, certain limitations may have influenced the lack of significant findings in this preliminary research. It is possible that the 8-week length of the study was too short to detect significant changes in the HEI scores. A narrative review article published in 2015 provided a summary of some nutritional education interventions that yielded positive results, and only one intervention was 6 weeks while the rest of the nutritional interventions were 2 months or longer (13). A 2019 study investigated the intensity and duration of lifestyle interventions for long-term weight loss and their association with mortality. The findings demonstrated that interventions maintained for a year or more can yield significant results and contribute to a reduction in mortality during long-term follow-ups (15).

There are known limitations to validity of self-reported diet intake, but ASA24 and 24-hour diet recalls are considered the gold standard among available tools (2). Participants may have benefitted from an additional food diary to record the weight of F&V consumed with each meal daily. Additionally, future researchers could use the Veggie Meter®, which provides an objective marker of F&V intake by quantifying skin carotenoid concentrations (14). The research team recruited from a convenience sample, which may explain the non-significant results observed. Socioeconomic status (SES) is well-established as a significant driver of dietary behavior wherein lower SES populations often rely on inexpensive and readily available food options, as healthier choices, such as fresh fruits, tend to be more expensive (11). Future research should deliberately recruit larger and more diverse samples to better understand the impact of eHealth interventions for improving diet quality.

To enhance the effectiveness of the intervention, future research should explore the incorporation of additional strategies or components such as more personalized feedback within the app, increased interaction with facilitators, integration of social support mechanism, and the use of motivational techniques. By identifying and implementing these strategies, future interventions can boost adherence and engagement, ultimately leading to improved effectiveness and outcomes.

With recruiting 24 participants, and 22 completing the study, the feasibility and acceptability of conducting the #800Challenge® were demonstrated by positive participant feedback. Positive trends were observed in the intervention group in the #800gChallenge® with higher mean HEI total, total vegetable, and total fruit scores over time, but there was no significant difference in HEI scores between the groups. Future research should examine dietary interventions given within a community instead of individually administered along with biomarkers and psychosocial outcomes with non-restrictive approaches. As a result of the #800gChallenge®,

there is a need for further research to identify eHealth interventions and appropriate lengths and intensities that might improve diet quality among adults.

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