



A cluster-randomized controlled trial to assess the impact of a nutrition intervention on dietary behaviors among early care and education providers: The Create Healthy Futures study

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ABSTRACT

Create Healthy Futures is a self-paced, web-based intervention on improving healthy eating behaviors among Early Care and Education (ECE) providers. We examined the impact of web-based Create Healthy Futures on diet quality measured by the Alternative Healthy Eating Index (AHEI) 2010, dietary behaviors, and related psychosocial and environmental factors among ECE providers. A cluster randomized controlled trial (CRCT) was implemented with baseline surveys administered from October 2019–January 2020, intervention implementation from April–May 2020, and post-intervention from May 2020–August 2020. Centered-based ECE programs under the Pennsylvania Head Start Association ($n = 12$) were recruited and randomized to intervention ($n = 5$) or comparison ($n = 7$) groups. A total of 186 ECE providers completed the post-intervention surveys (retention rate: 86.1%). At baseline, 31.5% of ECE providers were food insecure. Pre-to-post intervention demonstrated no significant within-or-between-group changes in the AHEI-2010 diet quality scores. ECE providers in the intervention group reported a significant decrease from baseline to post-intervention in the number of days eating out ($aMD = -0.8$, $CI: -1.6, -0.1$, $P = 0.03$). Process evaluation showed that 89.9% of the intervention group completed all online module, and 82.9% attended all of wellness session groups. Although the Create Healthy Futures intervention did not improve ECE providers' diet quality and dietary behaviors, it confirmed critical needs to provide health support to ECE providers. Future studies should employ strategies that improve access to healthy foods and nutrition education, and address social determinants of health such as food insecurity to improve diet quality and health in ECE provider population.

1. Introduction

In the U.S., approximately 60% of children under the age of 5 years attend some form of non-parental childcare, (Cui and Natzke, 2019) indicating the Early Care and Education (ECE) environment could be an essential venue to foster healthy behaviors in young children.

ECE centers rely on ECE providers to promote healthy nutrition behaviors and school readiness among children aged 0 to 5 years from low-income households (U.S Department of Health Human Services, 2020). ECE providers influence children's behaviors and classroom environment, (National Research Council. Transforming the workforce for children birth through age 8: A unifying foundation., 2015) and play an

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essential part as role models children to develop healthy eating behaviors. (Tovar et al., 2017; Hoelscher et al., 2004) However, a prior study has demonstrated that ECE providers have poorer health than a comparable U.S. national sample, with higher prevalence of obesity, pre-diabetes, and diabetes. (Whitaker et al., 2012) Additionally, prior studies have also reported high percentages of ECE providers engage in unhealthy eating behaviors, including low intake of fruits and vegetables, high intake of junk foods, (Hoelscher et al., 2004; Hartline-Grafton et al., 2009; Linnan et al., 2017; Ward et al., 2018; Bandura, 1991) and reported low nutrition knowledge. ECE providers' unhealthy eating habits and low nutrition knowledge could not only hamper their effectiveness to implement preschool-based nutrition programs for children, but also affect their own diet quality leading to increased risk of chronic conditions. (Whitaker et al., 2012; Erinoshio et al., 2012).

ECE providers often reported lack of time as a barrier to prevention programs targeting their own health. (Ling, 2018) Previous studies suggested online tools to be a promising avenue to reach ECE providers (Lang et al., 2020; Jayawardene et al., 2017) and can successfully sustain desired changes in the ECE environment. (Lang et al., 2020) However, few studies have evaluated the impact of such strategies on diet quality among ECE providers using a rigorous clinical trial study design.

The "Nourish Yourself, Create Healthy Futures: Your Journey to Wellness" (Create Healthy Futures) is a self-paced, five-chapter, web-based module plus peer support intervention on promoting healthy eating behaviors and improving nutrition environment among ECE providers. The purpose of our study was to assess the impact of the Create healthy Futures intervention on diet quality among ECE providers. We hypothesize the Create Healthy Futures will have positive effect on diet quality measured by Alternative Healthy Eating Index 2010 (AHEI-2010), dietary behaviors, and related psychosocial and environmental factors among Head Start ECE providers.

2. Materials and methods

2.1. Study design and recruitment

This cluster randomized controlled trial (CRCT) study conducted from May 2019 to August 2020 was designed to primarily test the impact of the Create Healthy Futures intervention on diet quality measured using the AHEI-2010; the AHEI is a dietary quality index developed to incorporate additional components, as compared to the Healthy Eating Index (HEI), that focus on food groups and nutrients that predict risks of chronic diseases (Chiuve et al., 2012). ECE providers' dietary behaviors and diet-related psychosocial factors were assessed as secondary outcomes. The program was pilot tested in 2017 in the State of Ohio for feasibility (Chuang et al., 2020).

A convenience sample of 12 ECE programs (centers) that were grantees of the Pennsylvania Head Start Association were recruited with a total of 39 sites. ECE providers in each site were invited to participate in the study if they: 1) were employed at the participating ECE sites at the time of recruitment, 2) could read and speak English; 3) had a working email address, and 4) provided care for children 0–5 years of age in a classroom setting.

Randomization: Randomization was conducted at the ECE center level. ECE centers were matched based on size and geographic location relative to the state of Pennsylvania (urban vs. rural). One center from each pair was randomly assigned to intervention and comparison. Since two centers had a N equivalent to one large center in a similar geographical region, they were matched 2:1 in a pair. After the ECE centers were recruited and randomized, all ECE providers within those centers were recruited to participate in the study. A total of 428 ECE providers from all 12 participating ECE programs were invited to take part in the study (intervention = 174, comparison = 254). A total of 216 ECE providers consented (intervention = 99, comparison = 117) and completed the baseline measurement (response rate: 50.5% across both groups). 186 providers completed the post-test with retention rate of

86.1% (intervention = 88.9%, comparison = 83.8%) (Figure 1).

Power analysis: We estimated that 182 providers were needed from a minimum of 16 Head Start sites to detect significant differences of at least 0.5 standard deviation units in the dietary outcome measured using AHEI-2010 with 80% power.

ECE programs and providers were unblinded to the treatment group after providing consent and completing baseline measurements. The UTHealth Committee for Protection of Human Subjects Institutional Review Board approved the study protocol, procedures, and materials. All participants provided electronic informed consent.

As incentives for participation, ECE providers who completed all measurements across 2-time points received a \$50 gift card and were entered into a raffle to win a blender per participating ECE program. ECE providers who completed the online intervention module could count it as a 4-hour continued education credit towards their ACT48 and Pennsylvania Quality Assurance System training hours, and were eligible to request free access to additional two 2-hour online professional development lessons housed on the Better Kid Care (BKC) on Demand system.

2.2. Adaptations due to the COVID-19 pandemic

The baseline measures were completed from October 2019 to January 2020, prior to the SARS-CoV2 virus reaching the U.S in March 2020, leading to preschool closures. The timeframe of intervention implementation and post-evaluation of the CRCT were after the preschool closure and stay-at-home order which started in March 2020. The following adaptations were made in response to the change: (a) we surveyed the ECE providers in the intervention group during the stay-at-home orders to confirm internet access and desire to continue the study, which 73% of them responded affirmatively, and (b) we pivoted the wellness group meeting method from in-person meetings to virtual meetings through platforms such as Zoom, phone calls, text messages, and emails.

2.3. Intervention description

The Create Healthy Futures program was developed by Penn State Extension Better Kid Care (<https://extension.psu.edu/programs/betterkidcare>) in collaboration with the UTHealth School of Public Health and consists of two components – (a) a web-based module with five chapters designed for the participants to complete individually and (b) six weekly peer-led wellness discussion groups facilitated by fellow ECE professionals from their ECE site (Care, 2021). The theoretical framework of Create Healthy Future is presented in Fig. 2. Grounded in the Social Cognitive Theory (Bandura, 1991) and the Social-Ecological Model, (Erinoshio et al., 2012) the Create Healthy Futures program aims to increase ECE providers' nutrition knowledge and understanding of how various factors at the personal, interpersonal, organizational, and environmental levels can affect ECE providers' dietary behaviors. The program also provides skill-building strategies to improve dietary behaviors and effective communication and modeling healthy eating for the children in the ECE setting. The targeted SCT constructs include: increased nutrition knowledge, improved behavioral capability and mindfulness during eating, self-efficacy towards choosing and eating healthy foods, decreased perceived barriers to healthy eating, and decreased barriers to promoting nutrition in an ECE classroom 17.

The program objectives include: 1) Influence of food culture, marketing, and industry: Identify how food marketing, food culture, and the food industry impact the ability to make healthy food choices; 2) Strategies for healthier food choices: List strategies to raise self-awareness about personal healthier food choices that can then be used to educate children and families to also recognize healthier food choices; 3) Food guidance: Examine how nutrition recommendations are established; 4) Relationship of food to health: Describe the importance of healthy food choices on overall well-being, chronic disease prevention, and long-term

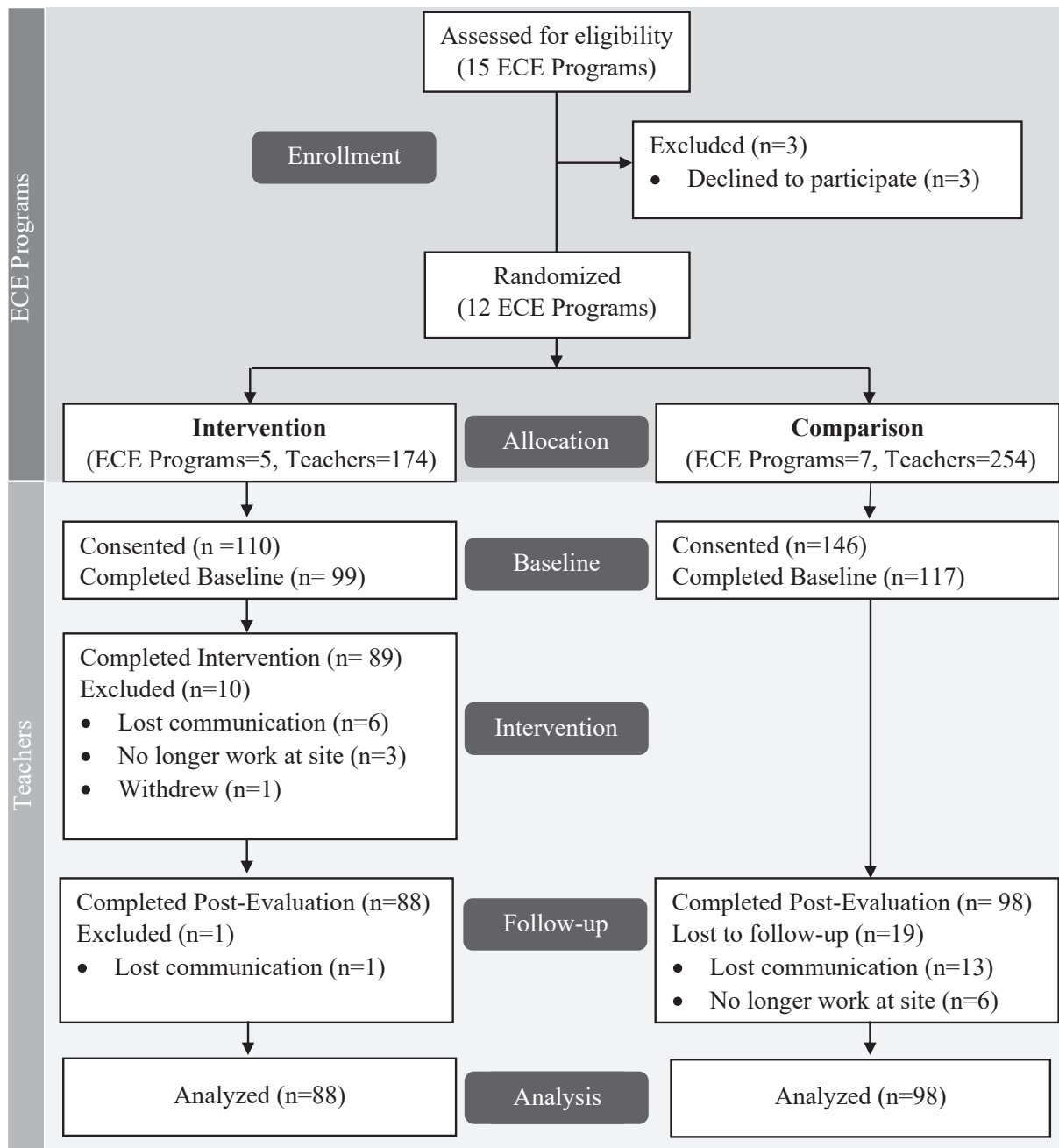


Fig. 1. ECE, Early Care and Education. CONSORT flow diagram describes the process of participant recruitment, enrollment, randomization, and analysis.

health; 5) Mindful eating: List one action step to adopt a more mindful approach to healthy eating; 6) Food culture and environment reform: Review existing evidence-informed methods to improve the food culture and environment within the ECE setting. 7) Healthy food environment action plan: Plan one activity to address environmental change within the ECE program including family engagement. 8) Personal health: Assess personal health practices that influence the well-being of the ECE professional; 9) Healthy eating action plan: Select one or two personal health goals with strategies for implementation; and 10) Impact on children: Relate the importance of personal health and wellness for the ECE professional to how it impacts the promotion of healthy choices for children. The intervention was implemented from March 2020 to May 2020.

2.3.1. Web-Based module

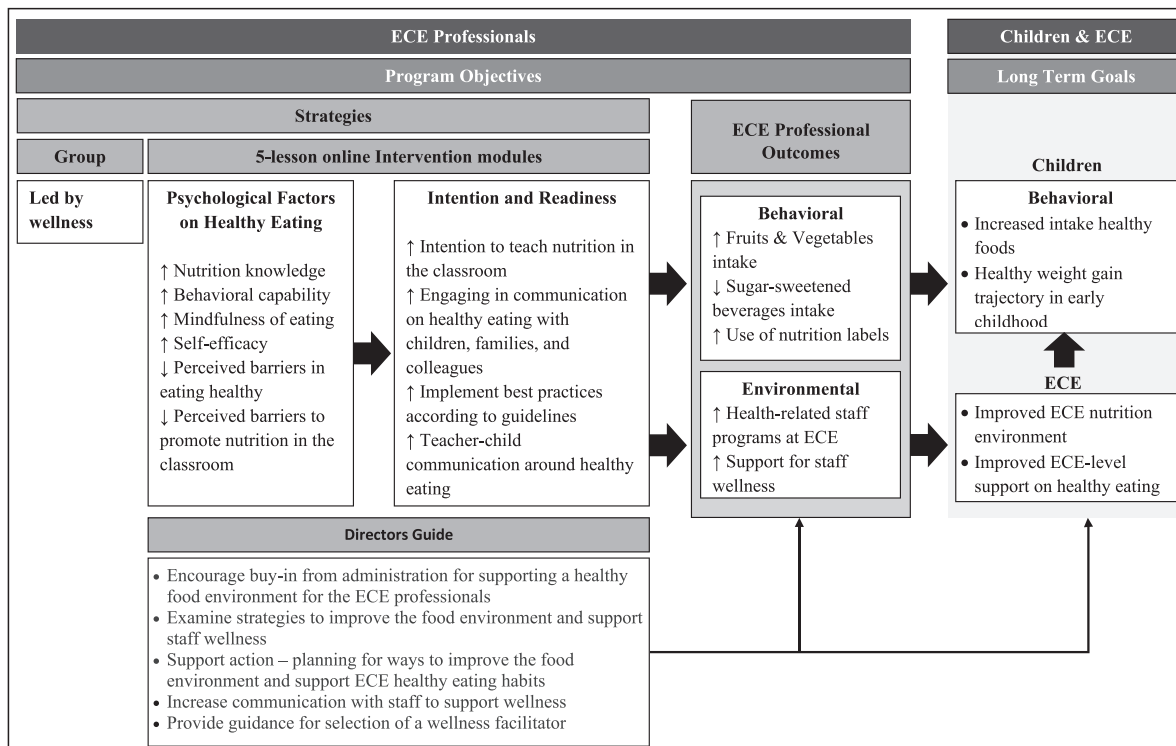
The Create Healthy Futures web-based module is self-paced utilizes

several educational methods to increase interactivity and engagement, including video footage of content experts, reflection activities, downloadable handouts, and action planning. The intervention was delivered on the Better Kid Care On Demand platform, (College of Agricultural Sciences and The Pennsylvania State University, 0000) an asynchronous learning management system that provides professional development training for ECE providers in all 50 states and 69 countries.

2.3.2. Peer-led weekly wellness groups

The director of the participating ECE center identified peer-facilitators at each intervention site according to the following criteria: a peer educator who is respected and well regarded by peers, a history of good working relationship with the director, who held their position for at least one year in the ECE center, interested in wellness, strong group facilitation skills, and comfortable with online learning to lead weekly group discussions. Penn State Better Kid Care conducted a

Logic Model Figure



Note: ECE: Early Care and Education

Fig. 2. Figure displaying the Logic Model of the Nourish Yourself, Create Healthy Futures: Your Journey to Wellness (Create Healthy Futures) program.

two-hour training for wellness facilitators and provided ongoing technical assistance as needed throughout the intervention period. Each wellness facilitator led a group of up to 15 ECE providers from their respective ECE centers, and each group met weekly for up to 60 min for six weeks. These wellness groups' goals were to: encourage members to complete a chapter of the module prior to the next meeting, set personal goals for healthy eating, discuss topics in the module, and share success stories and challenges related to healthy eating.

Data collection measures – All data were collected using electronic surveys administered to ECE providers through a HIPAA compliant web-based software, the Research Electronic Data Capture (REDCap) at two-time points; baseline (prior to intervention) from October 2019 to January 2020, and the post-intervention evaluation survey from May to August 2020 (post-test). All study participants provided informed consent electronically before baseline measurements.

We collected ECE site characteristics at baseline. Providers' socio-demographics were collected at baseline, these questions included: sex, current position at the ECE center, race/ethnicity, educational level, annual income from all sources, working status, and self-reported height and weight. The self-reported height and weight information were used to compute body mass index (BMI) categorized using cut-points adopted from the Centers for Disease and Control Prevention. (Centers for Disease Control and Prevention. Overweight and obesity. <https://www.cdc.gov/obesity/adult/defining.html>. Updated, 2020) Moreover, we measured years of teaching in an ECE center, years of experience, ECE program type, previous exposure to nutrition or healthy eating courses, age group of children under care, ECE providers age, and number of children under their care. We also measured food insecurity status within the past 2 months using the previously validated two-item Hunger Vital Sign (Cohen et al., 1983): "I worried whether our food would run out before we got money to buy more;" and "The food I bought just didn't last and I didn't have money to get more" with three

answer options ranging from never true to often true. Participants who responded positive answers (sometimes true or often true) to both questions were identified as food insecure (Hager et al., 2010). We measured perceived stress and concerns about life necessities; we also measured capacity to deal with life problems using one previously validated question. (Block et al., 1990) The research team then used concerns about life necessities and ECE providers' capacity to deal with life problems to develop a summative scale, "coping ability with life problems" with scores ranging from 0 to 4. This scale is computed by recoding the responses from the two questions into three categories, then reverse-coding capacity to deal with life problems, and aggregate the scores from both questions. A higher score indicates lower ability to cope with life problems.

2.4. Outcome measures

All outcome measurements were administered at baseline and post-intervention, including:

Diet quality: We measured ECE providers' diet quality using the Alternative Healthy Eating Index-2010 (AHEI-2010) score derived from a previously validated 127-item 2014 Block food frequency questionnaire (Block FFQ, NutritionQuest, Berkeley, CA). (McCullough et al., 2002) The Block FFQ measures frequency of intake of various foods and their quantities in the past month. The frequency of consumption is measured using a 9-point scale ranging from "Never" to "Every day," and the quantity is measured using standardized serving sizes alongside images to guide ECE providers. All Block FFQ data were analyzed by NutritionQuest (Berkeley, CA) and the nutrient database was then provided to study investigators for analysis. The AHEI-2010 was developed to incorporate additional components that focus on food groups and nutrients that predict risks of chronic diseases, (Täger et al., 2016) and consists of eleven components that produce a summative 110-maximum

score. (Sharma et al., 2020) Within the AHEI-2010, six components are considered favorable (i.e. healthy): total vegetables, total fruit, whole grain, nuts and legumes, fish fatty acids, and polyunsaturated fatty acids. One component, alcohol, is considered moderate, while four components are considered unfavorable (i.e. unhealthy): sugar-sweetened beverages, fruit juices, red and processed meat, and *trans*-fats.

2.4.1. ECE providers' nutrition-related behavioral and psychosocial factors

Meal Patterns and Caloric intake: We measured providers meal patterns and caloric in the past 7 days using five questions derived from the FFQ (McCullough et al., 2002).

Nutrition knowledge: We used 5-items to measure nutrition knowledge (Chuang et al., 2020) (e.g., "About how much of your plate should be fruits and vegetables?") Each question had four response options with one correct answer. Responses were recoded as 1 = correct and 0 = incorrect, and scores were summed and ranged from 0 to 5 to derive a summative Nutrition Knowledge Index score, with a higher score indicating higher nutrition knowledge.

Frequency of eating out: We used 1-item to measure frequency of eating out (Chuang et al., 2020): "In the past 7 days, how many times did you eat food from any type of restaurant? This includes restaurants such as fast-food, sit-down restaurants, buffet restaurants, taco shops, donut shops, and pizza places." with 4 response options ranging from "Never" to "1-2 times per day."

Grocery shopping decisions: We used 1-item to measure the use of nutrition labels to make grocery-shopping decisions (Chuang et al., 2020): "How often do you use the nutrition facts labels on foods and beverages to make your grocery purchasing decisions?" with responses ranging from 0="never" to 4="always."

Perceived wellness support at work: We used a single item to measure perceived wellness support in the work environment (Chuang et al., 2020): "How would you rate the support you receive for staff wellness in your work environment?" with response options ranging from 1="poor" to 5="excellent."

Perceived eating habits is measured using a single item (Chuang et al., 2020) "Compared to other adults my age, I would say that my eating habits are..." with 5-item Likert scale responses ranging from 1="much less healthy" to 5="much healthier."

COVID-19 related questions – These items were only measured in May 2020 as part of the post-test evaluation survey. We measured ECE providers' *perceived health during the pandemic* using 1-item (Chuang et al., 2020) ("In general, would you say your health is...") with 5 response options ("poor", "fair", "good", "very good", and "excellent"). We also assessed ECE providers' *participation in government assistance programs* and the *number of people living in the same household* (children, adults, and elderly) during this time. (Linnan et al., 2020).

We assessed ECE providers' *concerns due to the COVID-19 pandemic* using a 8-item measurement (Linnan et al., 2020): (e.g. Due to the coronavirus, are you concerned about any of the following in regard to you and your family?) and the 8-items listed included financial stability, employment status, availability of food, affordability of food, availability or affordability of housing, access to reliable transportation, access to childcare, and access to a clinic or physician. The participants could check all that apply. (Powers et al., 2020).

We measured ECE providers' *changes in food consumption behaviors during the pandemic* using 6 items (Linnan et al., 2020) (e.g., "Due to coronavirus, has your frequency of eating food from restaurants changed?") with 3 response options ("increased," "decreased," and "stayed the same"). Items included changes in consumption for 1) fresh fruits and vegetables, 2) canned fruits and vegetables, 3) frozen fruits and vegetables, 4) junk foods that are high in fat, salt, or sugar, and 5) sodas and other sweet drinks.

We also measured ECE provider's *grocery shopping behaviors during the pandemic* using 7 questions including: shopping frequency ("none", "less than once a month", "1–2 times per month", "1 time per week", "2 +

times per week"), shopping method (physical, curbside pickup, online delivery), and whether their shopping frequency of fresh fruits and vegetables, shelf-stable foods, and grocery expenses changed as a result of the pandemic ("increased", "decreased", "stayed the same") (Linnan et al., 2020).

Lastly, we developed four questions to measure ECE providers' *perceived support in a workplace during COVID-19* (e.g. Is your employer or peer workgroup available to provide the following support: ...to give you helpful health information?) with 3 response options "I do not need this support", "I need this support but don't have anybody from my employer/workgroup to provide it", and "I need support and am getting it from my employer/peer workgroup." The participants in the intervention group were asked one additional question ("How has your participation in the Create Healthy Futures project supported your sense of wellbeing during the pandemic?") with 4 response options ("no additional support", "somewhat", "a fair amount", "a great deal").

2.4.2. Process evaluation

For process evaluation, we recorded the number and percentage of ECE providers who accessed and completed the online Create Healthy Futures intervention modules, the percentage who completed the intervention in the 6-week designated period, and the number of wellness group sessions attended. Additionally, the ECE providers were asked the following questions upon completion of each module chapter: "How much did you learn in this professional development lesson?" Response options: 4 = a great deal; 3 = a fair amount; 2 = a little; 1 = not much; "How much of what you learned will you be able to use with the children or families in your care?" Response options: 4 = a great deal; 3 = a fair amount; 2 = a little; 1 = not much; Please share something that you learned from this lesson that you plan to use in your program (open ended).

2.5. Data analysis

We used STATA 15.0 statistical software (STATA Corp, College Station, TX) to conduct all analyses. We used the following descriptive analysis: frequency, mean, standard deviations (S.D.), and percentages for descriptive analysis for outcome variables and process evaluation. We used the Shapiro-Wilk test to assess the normality of distribution for continuous variables. Student's *t*-test and Mann-Whitney *U* test were used for continuous variables to evaluate the difference between intervention and comparison groups, whereas Pearson's Chi-squared test and Fisher's exact test were used for categorical variables. A significant *p*-value below 0.05 was used.

We assessed ECE providers' pre- to post-intervention behavioral and psychosocial changes and evaluated the intervention effect using a mixed-effects linear regression analysis with a random intercept for individuals. We estimated the adjusted mean difference (aMD) within each of the intervention and comparison groups at baseline and post-intervention from the mixed-effects models. To evaluate the program effectiveness, we observed the net group aMD, which compares the difference in aMD for within-group changes from baseline to post-intervention between the intervention and comparison group. We selected modifying variables after evaluating their relevance and then we adjusted all models for age, race, and coping abilities with life problems. Finally, we used a multivariable logistic regression analysis to assess the change in the predicted probability of perceived support from the work environment and perceived eating habits.

3. Results

Table 1 shows the baseline characteristics of participating ECE sites and providers. Overall, the majority of participants were female (97.7%), predominantly White (78.2%), had a college degree (56.0%), and had an annual income between \$20,000 and \$50,000 from all sources (59.5%). The majority of participating ECE providers were

Table 1
Baseline Characteristics of ECE Sites (N = 39) and ECE Providers (N = 216) Participating in the Create Healthy Futures Program between May 2019 and August 2020.

| Center Level Characteristics | | | | | | | |
|---|-------------------|-----------|---------------|-----------|---------------|-----------|----------------------|
| | Overall (n = 39) | | INTV (n = 11) | | CONT (n = 28) | | P-value ^a |
| | n | % | n | % | n | % | |
| Center has a Head Start Program (Yes) | 38 | 97.4 | 10 | 90.9 | 28 | 100 | 0.282 |
| Program Type | | | | | | | |
| Center Based | 29 | 74.1 | 8 | 72.7 | 21 | 75 | 1.000 |
| Home and Center Based | 9 | 23.1 | 3 | 27.3 | 6 | 21.4 | |
| Other | 1 | 2.6 | 0 | 0 | 1 | 3.6 | |
| ECE site participating in CACFP (Yes) | 32 | 82 | 9 | 81.8 | 23 | 82.1 | 1.000 |
| | Mean | SD | Mean | SD | Mean | SD | P-Value |
| Average number of employed teachers | 12.4 | 10.4 | 19.5 | 11.7 | 9.7 | 8.6 | 0.004 |
| Teacher working at the sites | | | | | | | |
| Teacher | 2.9 | 2.2 | 4.2 | 2.1 | 2.5 | 2 | 0.0235 |
| Teacher Assistant | 1.9 | 2.6 | 4.2 | 3.5 | 1 | 1.3 | 0.001 |
| Teachers working full time | 5.4 | 4.8 | 8.7 | 5.8 | 4.1 | 3.7 | 0.014 |
| Number of Children Under Teacher Care | | | | | | | |
| Infant and Toddlers | 6.2 | 4 | 8.7 | 4.7 | 5 | 3.1 | 0.020 |
| Preschoolers | 14.2 | 4.1 | 14.1 | 3.6 | 14.2 | 4.3 | 0.827 |
| ECE Providers Characteristics | | | | | | | |
| | Overall (n = 216) | | INTV (n = 99) | | CONT(n = 117) | | P-value ^a |
| | n | % | n | % | n | % | |
| Sex | | | | | | | |
| Male | 5 | 2.3 | 5 | 5.1 | 0 | 0 | 0.019 ^b |
| Female | 211 | 97.7 | 94 | 94.9 | 117 | 100 | |
| Current position | | | | | | | |
| Director/ Assistant | 1 | 0.5 | 0 | 0 | 1 | 0.9 | 0.001 ^b |
| Director/Site Manager/ Assistant Site Manager | | | | | | | |
| Teacher | 115 | 53.2 | 46 | 46.5 | 69 | 59 | |
| Assistant Teacher | 74 | 34.3 | 46 | 46.5 | 28 | 23.9 | |
| Classroom Aide | 5 | 2.3 | 3 | 3.0 | 2 | 1.7 | |
| Home visitor | 5 | 2.3 | 0 | 0 | 5 | 4.3 | |
| Other | 16 | 7.4 | 4 | 4.0 | 12 | 10.3 | |
| Race/ Ethnicity | | | | | | | |
| White | 169 | 78.2 | 76 | 76.8 | 93 | 79.5 | 0.629 ^β |
| Non-White | 47 | 21.8 | 23 | 23.2 | 24 | 20.5 | |
| Education: | | | | | | | |
| Some College | 95 | 44 | 49 | 49.5 | 46 | 39.3 | 0.133 ^β |
| Degree or Less | | | | | | | |
| College Degree | 121 | 56.0 | 50 | 50.5 | 71 | 60.7 | |
| Income^d | | | | | | | |
| ≤ 20,000 | 35 | 17.5 | 22 | 24.2 | 13 | 11.9 | 0.007 ^β |
| 20,000 – 50,000 | 119 | 59.5 | 56 | 61.5 | 63 | 57.8 | |
| greater than 50,000 | 46 | 23 | 13 | 14.3 | 33 | 30.3 | |
| Work time | | | | | | | |
| Full-time | 212 | 98.2 | 96 | 97 | 116 | 99.2 | 0.335 ^b |
| Part-time | 4 | 1.9 | 3 | 3.1 | 1 | 0.9 | |
| BMI Category | | | | | | | |
| Underweight (<18.5) | 4 | 1.9 | 3 | 3 | 1 | 0.8 | 0.270 ^b |

Table 1 (continued)

| Center Level Characteristics | | | | | | | |
|---|--------------------------|----------|----------------------|----------|----------------------|----------|----------------------------|
| | Overall (n = 39) | | INTV (n = 11) | | CONT (n = 28) | | P-value ^a |
| | n | % | n | % | n | % | |
| Normal Weight (18.5–24.9) | 53 | 24.5 | 22 | 22.2 | 31 | 26.5 | |
| Overweight (25–29.9) | 74 | 34.3 | 39 | 39.4 | 35 | 29.9 | |
| Obese (greater than 30) | 85 | 39.3 | 35 | 35.3 | 50 | 42.7 | |
| Duration of work at the ECE facility | | | | | | | |
| 1 Year | 51 | 23.6 | 22 | 22.2 | 29 | 24.8 | 0.654 ^β |
| 2–5 years | 77 | 35.7 | 37 | 37.4 | 40 | 34.2 | |
| 6–10 years | 36 | 16.7 | 19 | 19.2 | 17 | 14.5 | |
| More than 10 years | 52 | 24.1 | 21 | 21.2 | 31 | 26.5 | |
| Years of experience caring for children 0–5 years | | | | | | | |
| <1 year | 3 | 1.4 | 1 | 1.01 | 2 | 1.7 | 0.205 ^b |
| 1–5 years | 65 | 30.1 | 32 | 32.3 | 33 | 28.2 | |
| 6–10 years | 46 | 21.3 | 26 | 26.3 | 20 | 17.1 | |
| More than 10 years | 102 | 47.2 | 40 | 40.4 | 62 | 53 | |
| | Overall (n = 216) | % | INTV (n = 99) | % | CONT(n = 117) | % | P-value^a |
| Type of Program | | | | | | | |
| Center Based head-start | 173 | 80.1 | 81 | 81.8 | 92 | 78.6 | 0.559 ^β |
| Home-based head-start | 11 | 5.1 | 3 | 3.1 | 8 | 6.8 | 0.233 ^b |
| Pre-school/ Public Pre-K | 37 | 17.2 | 16 | 16.3 | 21 | 18 | 0.728 ^β |
| Other | 8 | 3.7 | 4 | 4.1 | 4 | 3.4 | 1.000 ^b |
| Previously taken courses related to nutrition/ healthy eating part of the ECE professional development credits (Yes) | 145 | 67.1 | 65 | 65.7 | 80 | 68.4 | 0.672 ^β |
| Age group of children under teachers care | | | | | | | |
| Infant/ Toddler (0 to 36 months) | 59 | 7.3 | 28 | 28.3 | 31 | 26.5 | 0.769 ^β |
| Preschoolers (4 and 5 years old) | 205 | 94.9 | 92 | 92.9 | 113 | 96.6 | 0.352 ^b |
| Food Insecure (Yes) | 68 | 31.5 | 34 | 34.3 | 34 | 29.1 | 0.405 |
| Perceived stress in the last month | | | | | | | |
| Never/ Almost Never | 16 | 7.4 | 9 | 9.1 | 7 | 6 | 0.538 |
| Sometimes/ Fairly Often | 144 | 66.7 | 67 | 67.7 | 77 | 65.8 | |
| Very often | 56 | 25.9 | 23 | 23.2 | 33 | 28.2 | |
| Concerns about life necessities | | | | | | | |
| Never / Rarely | 155 | 71.8 | 72 | 72.7 | 83 | 70.9 | 0.705 |
| Occasionally/ Frequently | 35 | 16.2 | 17 | 17.2 | 18 | 15.4 | |
| Very frequently / Always | 26 | 12 | 10 | 10.1 | 16 | 13.7 | |
| How sure are you that you can deal with | | | | | | | |

(continued on next page)

Table 1 (continued)

| Center Level Characteristics | | | | | | | |
|---|-------------------|------|---------------|------|----------------|------|----------------------|
| | Overall (n = 39) | | INTV (n = 11) | | CONT (n = 28) | | p-value ^a |
| | n | % | n | % | n | % | |
| problems that come up in your life | | | | | | | |
| Very unsure/ A little unsure | 28 | 13 | 18 | 18.2 | 10 | 8.5 | 0.021 |
| Neutral | 23 | 10.6 | 14 | 14.1 | 9 | 7.7 | |
| A little sure / Very sure | 165 | 76.4 | 67 | 67.7 | 98 | 83.8 | |
| | Overall (n = 215) | | INTV (n = 98) | | CONT (n = 117) | | p-value ^a |
| | Mean | SD | Mean | SD | Mean | SD | |
| Age | 41.08 | 11.9 | 40.1 | 12 | 41.8 | 11.7 | 0.4844 |
| Weight (kg) | 80.21 | 21.7 | 78.7 | 20.7 | 81.5 | 22.4 | 0.4181 |
| Height (meter) | 1.63 | 0.1 | 1.6 | 0.1 | 1.6 | 0.6 | 0.4839 |
| BMI (kg/m ²) | 30.09 | 8 | 29.4 | 7.4 | 30.7 | 8.4 | 0.3380 ^c |
| Number of children under my care | | | | | | | |
| Infant/ Toddlers (0 – 36 months) | 7 | 4.2 | 8.2 | 3.7 | 6 | 4.3 | 0.0146 ^c |
| Preschoolers (4–5 years old) | 16.6 | 9.64 | 16.7 | 10.1 | 16.6 | 9.3 | 0.1504 ^c |

Abbreviations: ECE, Early Care and Education, INTV, Intervention Group, CONT, Comparison Group, BMI, Body Mass Index, CACFP, Child and Adult Care Food Program, kg, Kilogram, SD, Standard Deviation

^a P value calculated by using a parametric Student's t-test or Chi-square test unless otherwise indicated

^b Fisher's Exact test

^c Mann-Whitney Test

^d Data missing for 16 ECE providers who refused to answer

overweight or obese (73.6%) and 31.5 % were food insecure. The mean reported age was 41.1 (SD = 11.9). There were statistically significant differences between the two groups: the intervention group had fewer females (94.9% vs. 100%, $p = 0.019$), more teaching assistants (46.5% vs. 23.9%, $p = 0.001$); more ECE providers in the intervention group had annual income below \$20,000 (24.2% vs. 11.9%, $p = 0.007$), and fewer had annual income greater than \$50,000 (14.3% vs.30.3%, $p = 0.007$) as compared to those in the comparison group. Moreover, ECE providers in the intervention group cared for a larger number of infants and toddlers on average (Mean \pm SD = 8.2 ± 3.7 vs. 6.0 ± 4.3 , $p = 0.015$) as compared to those in the comparison group.

For the AHEI-2010 score (Table 2), at baseline, after adjusting for age, race/ethnicity, and coping ability of life problems, ECE providers in the intervention group had an overall adjusted mean score of 51.9, similar to those in the comparison group with an overall adjusted mean score of 51.9. Pre-to-post-intervention demonstrated no significant within-group increase in the overall adjusted AHEI-2010 mean scores in the intervention group (adjusted mean difference [aMD] = 1.2, CI:-1.9, 4.3, $p = 0.440$), and between-group changes were also not statistically significant (net group aMD = 0.1, CI:-4.1,4.3, $P = 0.970$) (Figs. 3A and 3B).

For other dietary related behaviors (Table 2), pre-to-post-intervention demonstrated no significant within group or between group changes.

Table 3 shows the nutrition related behaviors and psychosocial factors of ECE providers. At baseline, the ECE providers in the intervention group, as compared to the comparison group, had slightly lower scores in Nutrition Knowledge Index (3.3 vs. 3.4; $p = 0.250$) and higher frequencies of eating food from restaurants (2.7 days/week vs. 2 days/week, $p = 0.102$). ECE providers in the intervention group showed a significant decrease in number of days eating out pre-to-post-intervention (aMD = -0.8, CI:-1.6, -0.1, $p = 0.030$). We did not observe pre-to-post within group changes among the comparison group, and no significant net differences of adjusted mean changes across the

two groups.

Table 4 outlines the results from COVID-19 related questions from 185 ECE providers. The most commonly reported concerns during COVID-19 were change in employment status (50.8%), followed by financial stability (49.7%) and affordability of food (44.9%). There were no statistically significant differences between the intervention and comparison groups in their fresh fruits and vegetables consumption, and consumption of junk food that are high in fat, salt or sugar, and sodas. However, lower percentage of ECE providers in the intervention group reported having the same consumption of canned fruit and vegetable consumption (52.3% vs 72.2%%, $p = 0.012$). Ninety three percent of the ECE providers from both groups reported shopping inside the grocery stores during this phase of the pandemic. Finally, 76% of ECE providers reportedly had good health, and 37.3% received more than one type of government assistance program.

3.1. Process evaluation

The study flow diagram (Fig. 1) highlights the recruitment and retention in the study. Overall, the response rate was 50.5% (intervention:56.9% vs. comparison: 46.1%, $p = 0.028$). Retention rate at post-intervention was 86.1% (intervention: 88.9% vs. comparison: 83.8%, $p = 0.278$). Among participants in the intervention group, 89.9% completed all online modules, and 82.9% attended all wellness session groups. In regards to the questions at the end of each module chapter, for “How much did you learn in this professional development lesson?”, the mean score across the five chapters was 3.54 out of 4 indicating that a majority of the respondents reportedly learned “a fair amount or a great deal”. The mean score for the question “How much of what you learned will you be able to use with the children or families in your care?” was 3.55 out of 4, indicating that a majority of the respondents reported motivations to put “a fair amount or a great deal” of the learned information into practice. For the open ended question “Please share something that you learned from this lesson that you plan to use in your program”, the three dominant responses were: 1) introducing fresh vegetables and fruits to children in the classroom and families through activities, such as color of the week or month, meatless Monday’s, taste tests, and sending home recipes to go with the vegetable or fruit introduced in the classroom; 2) creating healthy cooking opportunities – with children, with parents and ideas for parents to cook at home with their children; 3) educating and leading by example.

Directors from six out of the seven participating ECE programs in the comparison group reported implementing some forms of school-wide wellness initiatives concurrently with the Create Healthy Futures program in the 2019–2020 school year, whereas none of the intervention directors reported implementation of other wellness initiatives during the Create Healthy Futures program implementation period. These wellness initiatives implemented among the comparison group were open for ECE providers, including our participants, and had focus areas including exercise and yoga, cooking, mental health, and water consumption, and were administered in forms of weekly newsletters, workshops, activity challenges, and wellness programs.

4. Discussion

The results of our CRCT demonstrated no significant immediate effect of the Create Healthy Futures intervention on ECE provider’s diet quality. Within group analysis demonstrated minimal improvements in nutrition related behavioral and psychosocial factors among those in the intervention group; albeit between group changes were not statistically significant. Although minimal within-group changes can be viewed as encouraging, they should be interpreted with caution given that between-group changes, while trending in the direction hypothesized, were not statistically significant. Results from our study concur with another experimental study (Sirinides, 2020) by Linnan, et al. demonstrating that changing ECE providers health lifestyle is rather

Table 2
Changes in Dietary Quality, Meal Pattern, and Food Intake from baseline to post-test among ECE Providers in the intervention and comparison group participating in the Create Healthy Futures study between May 2019 and August 2020^a.

| Variables | Intervention | | | | | Comparison | | | | | Net Changes | | |
|--|--------------|---------------|-----------------------------------|--------|-------|--------------|---------------|-----------------------------------|---------------------|-------|-----------------------------------|--------|---------|
| | Pre (n = 88) | Post (n = 88) | Within Group Changes ^b | | | Pre (n = 98) | Post (n = 98) | Within Group Changes ^b | | | Pre Post Net Changes ^c | | |
| | Mean | Mean | Adjusted Mean Difference (aMD) | | Diff. | 95 % CI | Mean | Mean | pre-post difference | | Net difference (ND) across groups | | 95 % CI |
| Alternative Healthy Eating Index 2010^d | | | | | | | | | | | | | |
| Total Score | 51.9 | 53.1 | 1.2 | -1.9 | 4.3 | 51.9 | 53.0 | 1.1 | -1.8 | 4.0 | 0.1 | -4.1 | 4.3 |
| High intake is favorable | | | | | | | | | | | | | |
| Total Vegetables (not potato) | 3.1 | 3.1 | 0.0 | -0.6 | 0.6 | 2.6 | 2.7 | 0.1 | -0.5 | 0.6 | -0.1 | -0.9 | 0.7 |
| Total Fruit (not juice) | 3.2 | 3.6 | 0.4 | -0.4 | 1.3 | 3.8 | 3.8 | -0.0 | -0.8 | 0.8 | 0.4 | -0.8 | 1.6 |
| Whole Grains | 2.4 | 1.9 | -0.4 | -1.0 | 0.1 | 2.0 | 1.9 | -0.1 | -0.6 | 0.4 | -0.3 | -1.0 | 0.4 |
| Nuts and Legumes | 4.9 | 4.8 | -0.1 | -1.0 | 0.9 | 5.4 | 5.3 | -0.1 | -0.9 | 0.8 | -0.0 | -1.3 | 1.3 |
| DHA & EPA (fish fatty acids) | 3.3 | 2.9 | -0.4 | -1.2 | 0.4 | 3.3 | 3.2 | -0.1 | -0.9 | 0.7 | -0.2 | -1.3 | 0.8 |
| Polyunsaturated fat (oils) | 6.9 | 7.2 | 0.3 | -0.2 | 0.8 | 6.8 | 7.4 | 0.7** | 0.2 | 1.1 | -0.4 | -1.1 | 0.3 |
| Moderate Intake is favorable | | | | | | | | | | | | | |
| Alcoholic Drinks | 4.7 | 4.8 | 0.1 | -0.7 | 0.8 | 4.4 | 4.8 | 0.4 | -0.3 | 1.2 | -0.4 | -1.4 | 0.7 |
| Not favorable | | | | | | | | | | | | | |
| Sodium | 4.6 | 5.2 | 0.7 | -0.4 | 1.7 | 4.8 | 5.0 | 0.2 | -0.8 | 1.2 | 0.5 | -1.0 | 1.9 |
| Sugary Beverages | 4 | 4.3 | 0.3 | -0.9 | 1.5 | 4.1 | 4.2 | 0.0 | -1.1 | 1.1 | 0.3 | -1.3 | 1.9 |
| Red Meats | 4.9 | 5.2 | 0.3 | -0.6 | 1.1 | 5.2 | 5.4 | 0.2 | -0.6 | 1.0 | 0.1 | -1.1 | 1.3 |
| Trans-fat Percent | 8.8 | 9 | 0.1 | -0.2 | 0.4 | 8.7 | 8.7 | -0.1 | -0.3 | 0.2 | 0.2 | -0.2 | 0.6 |
| Meal Patterns | | | | | | | | | | | | | |
| How many vegetables eaten (Times per week) | 7.9 | 8.6 | 0.7 | -1.2 | 2.5 | 8 | 7.3 | -0.7 | -2.4 | 1.1 | 1.3 | -1.2 | 3.9 |
| How many fruits eaten (Times per week) | 6 | 7.1 | 1.1 | -0.7 | 3 | 6.6 | 6.8 | 0.3 | -1.4 | 2 | 0.8 | -1.7 | 3.3 |
| How often use fat/oil in cooking | 2.7 | 3.3 | 0.6 | -0.7 | 1.9 | 3 | 3.0 | 0.1 | -1.2 | 1.3 | 0.5 | -1.3 | 2.4 |
| How many meals per day | 2.8 | 2.6 | -0.1 | -0.3 | 0.1 | 2.9 | 2.7 | -0.2* | -0.4 | -0.0 | 0.1 | -0.2 | 0.3 |
| Calories | | | | | | | | | | | | | |
| Food energy, kcals | 1914 | 1816.3 | -97.6 | -485.9 | 290.7 | 1815.2 | 1946.6 | 131.4 | -236.5 | 499.2 | -229.0 | -763.9 | 305.9 |
| Food Group Intake | | | | | | | | | | | | | |
| Total Fruit (Cup eq.) | 1.2 | 1.2 | 0.1 | -0.2 | 0.4 | 1.1 | 1.2 | 0.0 | -0.2 | 0.3 | 0.0 | -0.4 | 0.4 |
| Whole Fruit (Cup eq.) | 0.8 | 0.9 | 0.1 | -0.1 | 0.4 | 0.9 | 0.8 | -0.0 | -0.3 | 0.2 | 0.2 | -0.2 | 0.5 |
| Added Sugars (tsp.eq.) | 13.4 | 12.6 | -0.9 | -5.1 | 3.4 | 14.3 | 14.9 | 0.6 | -3.5 | 4.6 | -1.4 | -7.3 | 4.4 |

Notes: * p < 0.05; ** p < 0.01.

Intervention Group had an increase in "Sugary Beverages" Score in Post "4.29", indicating a more favorable intake of beverage sugars in Post-evaluation period (i.e. Lesser intake of sugars).

^a Results from a Mixed Regression Model adjusted for age, race/ethnicity, and coping ability of life problems.

^b shows adjusted mean differences between pre and post evaluation scores, within each group. For example: (Intervention pre vs. Intervention post).

^c Shows net group adjusted mean differences between Intervention group (within group changes) and comparison group (within group changes).

^d AHEI –2010 components are scored from 0 (less favorable) to 10 (More favorable), thus a higher score indicated a favorable outcome. For example:

challenging. Linnan et al. reported positive intervention effects on some of the ECE provider's behaviors such as eating behaviors and the ECE environment; however, the intervention impacts were not statistically significant, similar to our findings.

Our previous pilot study (Chuang et al., 2020), as well as other previous studies on worksite wellness programs targeting ECE providers, suggested that childcare workers desired additional interactive intervention components such as peer support workgroups or on-site wellness champions, to accompany a regular health curriculum. (Sirinides, 2020; Flanagan et al., 2021) The Create Healthy Futures curriculum does incorporate a wellness peer group component; which was well received by participants, albeit no significant changes were observed in ECE providers' diet quality nor other dietary behaviors. A plausible explanation is the COVID-19 pandemic and lockdown policy announced in March 2020 (Cheval et al., 2020) that intersected with this study's intervention and post-evaluation period; which resulted in disruptions to the implementation and adoption of the wellness groups from in-person to virtual, and impacted the food environment of participants. Results of our process evaluation demonstrated that a significant proportion of our study population completed the online modules and attended the virtual peer group sessions. However, the impact of the onset of the pandemic on putting the learned practices in improving behavior is unclear. Results of our COVID-19 related questions also

identified significant personal stressors, including food insecurity, financial instability, etc., among a substantial proportion of participants which needs to be explored in future studies.

Moreover, the pandemic resulted in significant shifts to the home environment, food access, (Kwon et al., 2022) and financial, (Coleman-Jensen et al., 2019) as ECE providers were dealing with both work and home responsibilities, such as providing distance learning in addition to caring for their own children and maintaining the household (Linnan et al., 2017). Furthermore, the concurrent implementation of other wellness programs among ECE centers in the comparison group during the study period could also attenuate the intervention effect: these various wellness initiatives were implemented among the sites in the comparison group but not the intervention group. Finally, adoption of behavior change strategies takes time. Measures with longer follow-up terms are warranted in future studies.

Our results showed pre-to-post improvements in self-reported behaviors such as significant decrease in number of days eating out, and in nutrition knowledge and attitude changes toward healthy eating such as increased use of nutrition labels to make grocery purchasing decisions among those in the intervention group; albeit no significant between group changes observed. Our results concur with findings by Powers, et al. that showed a positive shift in ECE providers' healthy eating knowledge as result of a workplace wellness intervention (Flanagan

Figure 3-A. A Radar Plot for AHEI 2010 for the Intervention Group

| AHEI-2010 Components ^a | Pre-Evaluation (%) (Mean = 51.85) | Post-Evaluation (%) (Mean = 53.05) |
|-----------------------------------|---------------------------------------|--|
| Total Vegetables | 31 | 31 |
| Total Fruit | 31.7 | 35.8 |
| Whole Grains | 23.6 | 19.4 |
| Nuts and Legumes | 49.1 | 48.4 |
| Fish fatty acids | 32.7 | 28.9 |
| Polyunsaturated fat | 69 | 71.7 |
| Sodium | 45.7 | 52.2 |
| Sugary Beverages | 39.7 | 42.8 |
| Red Meats | 49.3 | 51.9 |
| Trans-fat Percent | 88.4 | 89.5 |

* for P<0.05, ** for P<0.01, and *** for P<0.001

Abbreviations: AHEI, Alternative Healthy Eating Index

^a Alcohol Subcomponent not included in the graph

Results from a Mixed Regression Model adjusted for age, race/ethnicity, and coping ability of life problems.

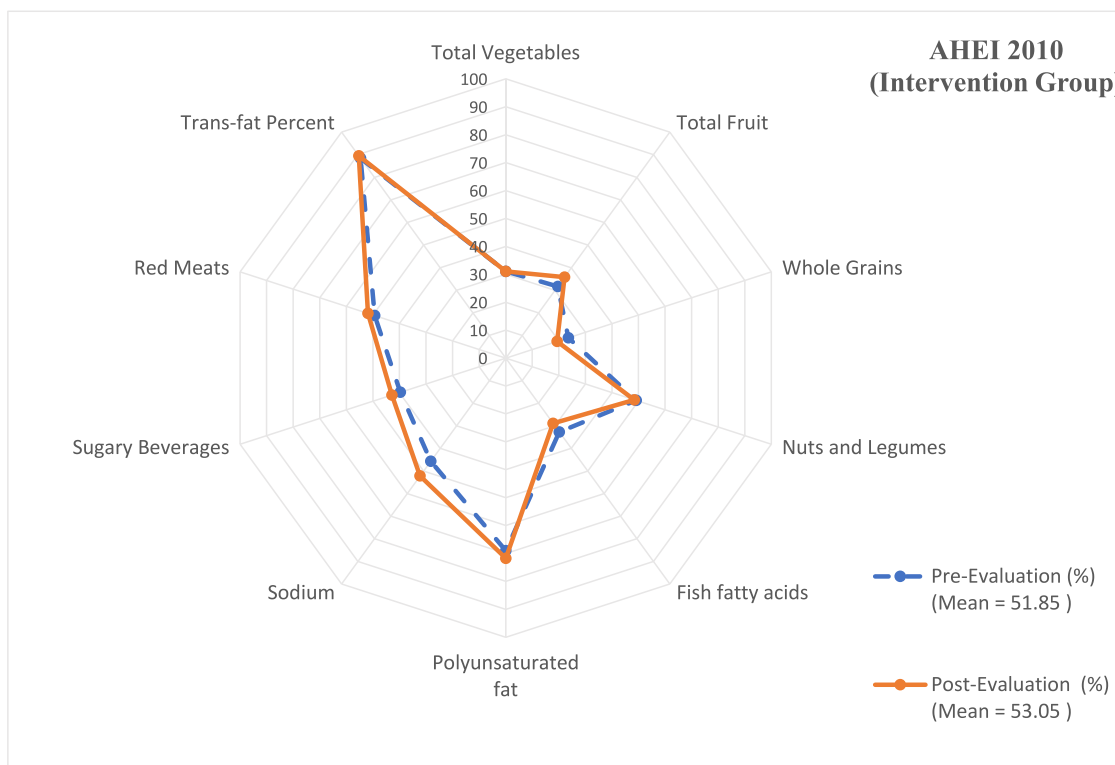


Fig. 3A. A Radar Plot for AHEI 2010 for the Intervention Group.

et al., 2021). Nevertheless, some findings of our study, such as number of days eating out, could be influenced by the pandemic thus should be interpreted with caution (Dhurandhar, 2016).

It is also important to note that the participating ECE providers reported rates of food insecurity three times the national average (Wang et al., 2014). With 73.6% of our participating ECE providers being either overweight or obese, it is crucial for future intervention strategies to address food insecurity, a social determinant of health that is suggested to be a contributing factor of obesity and unhealthy lifestyle behaviors (Sharma et al., 2013). Moreover, the AHEI-2010 scores of the participating ECE providers ranged from 51 to 53; although slightly higher than the United States population average in 2010 of 46.8, [39] reflect the need for improvement in ECE providers' dietary quality, especially

in the favorable food components such as total vegetables, total fruits, and whole grains. These findings concur with prior studies among ECE providers, which have demonstrated a low frequency of consumption of fruits and vegetables (Ling, 2018). Finally, 46.3% of our ECE providers reportedly perceived poor or fair wellness support available in their ECE environment at baseline. These results, along with those seen in prior studies, coupled with the exacerbation of social determinants of health needs and increased environmental stressors (financial instability, school closures etc.) as a result of the pandemic, warrant the urgent need for strategies that mitigate food insecurity and improve diet quality in this provider population.

Figure 3-A. A Radar Plot for AHEI 2010 for the Comparison Group

| AHEI-2010 Components ^a | Pre-Evaluation (%) (Mean = 51.92) | Post-Evaluation (%) (Mean = 53.04) |
|-----------------------------------|---------------------------------------|--|
| Total Vegetables | 25.8 | 26.7 |
| Total Fruit | 37.8 | 37.7 |
| Whole Grains | 20.1 | 18.7 |
| Nuts and Legumes | 53.5 | 53.1 |
| Fish fatty acids | 33 | 31.7 |
| Polyunsaturated fat* | 67.9 | 74.3 |
| Sodium | 48.3 | 50.3 |
| Sugary Beverages | 41.4 | 41.5 |
| Red Meats | 52.4 | 54 |
| Trans-fat Percent | 87.4 | 86.6 |

* for P<0.05, ** for P<0.01, and *** for P<0.001

Abbreviations: AHEI, Alternative Healthy Eating Index

^a Alcohol Subcomponent not included in the graph

Results from a Mixed Regression Model adjusted for age, race/ethnicity, and coping ability of life problems.

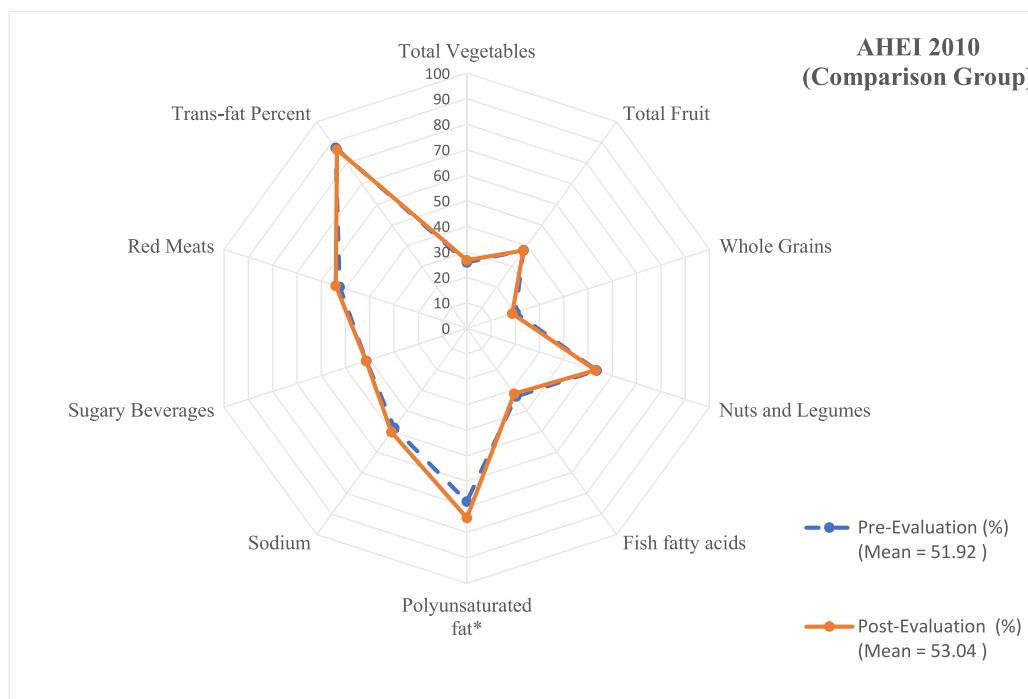


Fig. 3B. A Radar Plot for AHEI 2010 for the Control Group.

5. Strengths and Limitations

One of the strengths of this study is the high retention rate across both groups, decreasing outcome bias. Additionally, while intervention fidelity was strong (89.9% of the intervention ECE providers completed 100% of the online module and 82.9% attended all virtual wellness group sessions) along with the perceived positive impact of the program during the pandemic among those in the intervention group (almost 60% of intervention ECE providers reported being part of the Create Healthy Futures program helped with supporting their sense of well-being during the pandemic), this did not translate into significant behavior change for the participating providers. Moreover, this study demonstrated that web-based wellness interventions such as Create Healthy Futures could be viable strategies to address the issue of time being the major barrier for ECE providers to access wellness programs; since majority of Head Start teachers have access to computers or smartphones with internet access (Ling, 2018; Jayawardene et al.,

2017).

Other limitations of this study include using self-reported data for dietary behaviors that could be subject to social desirability bias. Although self-reported data may introduce some biases, this study used validated measurements, and the results are compatible from other studies. Moreover, the study was only able to continue among participants who had access to web-based materials and were willing to continue participating during the pandemic subjecting it to selection bias. Furthermore, we could not assess the magnitude of COVID-19 impact on participants, thus possibly overestimating the interventions effects; also, we were not able to follow up with participants who lost contact during the pandemic. However, given the study is designed with a comparison group, participants across both groups had similar exposure to the pandemic, so the environment effects could be considered as non-differential. Coping ability with life problems, nutrition knowledge index, and navigating the food environment measures demonstrate face validity, but were not previously validated items. Due to school closures

Table 3
Changes in Nutrition Related Behavioral and Psychosocial Factors from baseline to post-test among ECE Providers in the intervention and comparison group participating in the Create Healthy Futures Study from May 2019 to August 2020^{ab}.

| Variable | Intervention | | | | | Comparison | | | | | Net Changes | | |
|--|-------------------------------|-------------------------------|--|---------|-----------------------------------|-------------------------------|-------------------------------|--|---------|-----------------------------------|-----------------------------------|---------|------|
| | Pre (n = 88) | | Post (n = 88) | | Within Group Changes ^c | Pre (n = 98) | | Post (n = 98) | | Within Group Changes ^c | Pre-Post Net Changes ^d | | |
| | Mean or Predicted probability | Mean or Predicted probability | Adjusted Mean Pre- to Post- difference (aMD) | 95 % CI | | Mean or Predicted probability | Mean or Predicted probability | Adjusted Mean Pre- to Post- difference (aMD) | 95 % CI | | Net difference across groups (ND) | 95 % CI | |
| Nutrition Knowledge Index ^e | 3.3 | 3.6 | 0.2 | -0.1 | 0.5 | 3.4 | 3.5 | 0.1 | -0.2 | 0.4 | 0.2 | -0.3 | 0.6 |
| Times of eating food from any type of restaurant in the last 7 days | 2.7 | 1.8 | -0.8* | -1.6 | -0.1 | 2 | 1.8 | -0.1 | -0.7 | 0.6 | -0.7 | -1.8 | 0.4 |
| Frequency of using nutrition facts labels to make your grocery purchasing decisions ^f | | | | | | | | | | | | | |
| Never/Sometimes | 0.6 | 0.5 | -0.5 | -1.1 | 0.2 | 0.7 | 0.6 | -0.1 | -0.7 | 0.5 | -0.4 | -1.2 | 0.5 |
| Often / Always | 0.4 | 0.5 | 0.5 | -0.2 | 1.1 | 0.4 | 0.4 | 0.1 | -0.5 | 0.7 | 0.4 | -0.5 | 1.2 |
| Perceived Support from work environment ^f | | | | | | | | | | | | | |
| Poor/Good | 0.8 | 0.7 | -0.4 | -1.1 | 0.4 | 0.8 | 0.8 | -0.3 | -1.1 | 0.4 | -0.1 | -1.1 | 1.0 |
| Very Good/Excellent | 0.2 | 0.3 | 0.4 | -0.4 | 1.2 | 0.2 | 0.3 | 0.3 | -0.4 | 1.1 | 0.1 | -1.0 | 1.1 |
| Perceived their own eating habits compared to adults their age ^f | | | | | | | | | | | | | |
| Much less or about the same | 0.5 | 0.4 | -0.2 | -0.8 | 0.4 | 0.6 | 0.6 | 0.00 | -0.6 | 0.6 | -0.2 | -1.0 | 0.7 |
| Somewhat or Much healthier | 0.5 | 0.6 | 0.2 | -0.4 | 0.8 | 0.4 | 0.4 | 0.00 | -0.6 | 0.6 | 0.2 | -0.7 | 1.0 |
| Food Insecure (Yes) ^f | 0.32 | 0.21 | -0.011 | -0.23 | 0.01 | 0.31 | 0.24 | -0.07 | -0.18 | -0.05 | -0.05 | -0.21 | 0.12 |

* p < 0.05; ** p < 0.01.

Abbreviations, Early Childhood Education, aMD, adjusted Mean Difference, ND, net difference.

a Mixed multivariable linear Regression analysis reported means unless specified otherwise.

b All models adjusted for age, race/ethnicity, and coping ability of life problems.

c shows differences between pre and post evaluation scores, within each group. For example: (Intervention pre vs. Intervention post).

d Shows net differences between (intervention group within group changes) and (comparison group within group changes).

e The Nutrition Knowledge Index consists of 5 items. Coding Scheme: wrong answer = 0, and right answer choice = 1. A higher score indicated a Nutrition Knowledge, while a lower score indicates a lower nutrition knowledge.

f Predicted Probabilities, reported as percentages obtained from a logistic multivariable regression analysis.

during the pandemic, we were not able to assess environmental changes within the ECE setting as part of outcome evaluation, which limited our understanding of the intervention’s effect on organizational and community-level changes. Lastly, ECE providers adherence and responsiveness in the wellness group sessions were not measured or externally observed, which could introduce intervention bias.

6. Conclusions

Our study adds to the current body of literature on using rigorously designed studies to assess the impact of nutrition interventions on dietary outcomes among a Head Start ECE provider population. While the intervention strategies and program delivery were found to be feasible, acceptable, and improved ECE providers’ diet quality and related knowledge and behaviors, overall, these changes were not statistically significant. Future studies should consider strategies that improve access to healthy foods in addition to nutrition education to improve diet quality and health among ECE provider population, as well as longer

term follow up to determine impact on outcomes.

Research Snapshot

Research Question: Does Create Healthy Futures, a web-based nutrition intervention, improve diet quality, dietary behaviors and related psychosocial factors among early care and education providers?

Key Findings: Our cluster-randomized controlled trial demonstrated no significant impact of the intervention on diet quality, dietary behaviors and diet-related psychosocial factors among our Head Start ECE provider population.

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CRediT authorship contribution statement

Dania Mofleh: Investigation, Data curation, Formal analysis, Software, Writing – original draft, Writing – review & editing. **Ru-Jye Chuang:** Conceptualization, Methodology, Project administration, Validation, Investigation, Data curation, Formal analysis, Software,

Table 4
 Characteristics and Nutrition behavior of ECE Providers Participating in the Create Healthy Futures Study during the COVID-19 Pandemic in May 2020.

| | Overall (n = 185) | | INTV (n = 88) | | CONT(n = 97) | | p-value ^a |
|--|-------------------|------|---------------|------|--------------|------|----------------------|
| | n | % | n | % | n | % | |
| Concerns during COVID-19 Pandemic | | | | | | | |
| Financial Stability | 92 | 49.7 | 38 | 43.2 | 54 | 55.7 | 0.09 |
| Change in employment Status | 94 | 50.8 | 45 | 51.1 | 49 | 50.5 | 0.933 |
| Availability of food | 57 | 30.8 | 28 | 31.8 | 29 | 29.9 | 0.777 |
| Affordability of food | 83 | 44.9 | 41 | 46.6 | 42 | 43.3 | 0.653 |
| Availability and affordability of housing | 17 | 9.2 | 10 | 11.4 | 7 | 7.2 | 0.329 |
| Access to reliable transportation | 11 | 5.9 | 5 | 5.7 | 6 | 6.2 | 1 |
| Access to child care | 18 | 9.7 | 13 | 14.8 | 5 | 5.1 | 0.045 |
| Access to clinic or doctor | 54 | 29.2 | 24 | 27.3 | 30 | 30.9 | 0.585 |
| Other | 23 | 12.4 | 12 | 13.6 | 11 | 11.3 | 0.636 |
| Change in consumption of the following food as a result of the pandemic | | | | | | | |
| Fresh fruits and Vegetables | | | | | | | |
| Increased | 72 | 38.9 | 38 | 43.2 | 34 | 35 | 0.425 |
| Decreased | 37 | 20 | 18 | 20.4 | 19 | 19.6 | |
| the same | 76 | 41.1 | 32 | 36.4 | 44 | 45.4 | |
| Canned fruits and vegetables | | | | | | | |
| Increased | 33 | 17.8 | 18 | 20.4 | 15 | 15.5 | 0.012 |
| Decreased | 36 | 19.5 | 24 | 27.3 | 12 | 12.4 | |
| the same | 116 | 62.7 | 46 | 52.3 | 70 | 72.2 | |
| Frozen fruits and vegetables | | | | | | | |
| Increased | 45 | 24.3 | 24 | 27.3 | 21 | 21.6 | 0.269 |
| Decreased | 28 | 15.1 | 16 | 18.2 | 12 | 12.4 | |
| the same | 112 | 60.5 | 48 | 54.5 | 64 | 66 | |
| Junk food that are high in fat, salt or sugar | | | | | | | |
| Increased | 69 | 37.3 | 31 | 35.2 | 38 | 39.2 | 0.736 |
| Decreased | 56 | 30.3 | 29 | 32.9 | 27 | 27.8 | |
| the same | 60 | 32.4 | 28 | 31.8 | 32 | 33 | |
| Sodas and other sweet drinks | | | | | | | |
| Increased | 36 | 19.5 | 16 | 18.2 | 20 | 20.6 | 0.292 |
| Decreased | 63 | 34 | 35 | 39.8 | 28 | 28.9 | |
| the same | 86 | 46.5 | 37 | 42 | 49 | 50.5 | |
| Due to the coronavirus, currently how often do you buy or get fruits and vegetables and other groceries for the family from these locations | | | | | | | |
| Large grocery stores | | | | | | | |
| Never | 1 | 0.5 | 1 | 1.1 | 0 | 0 | 0.881 |
| Less than once a month | 10 | 5.4 | 4 | 4.5 | 6 | 6.2 | |
| 1–2 times per month | 61 | 33 | 31 | 35.2 | 30 | 30.9 | |
| 1 time per week | 88 | 47.6 | 40 | 45.4 | 48 | 49.5 | |
| 2 + times per week | 25 | 13.5 | 12 | 13.6 | 13 | 13.4 | |
| Small local grocery stores | | | | | | | |
| Never | 95 | 51.3 | 48 | 54.5 | 47 | 48.4 | 0.754 |
| Less than once a month | 24 | 13 | 10 | 11.4 | 14 | 14.4 | |
| 1–2 times per month | 29 | 15.7 | 15 | 17 | 14 | 14.4 | |
| 1 time per week | 25 | 13.5 | 11 | 12.5 | 14 | 14.4 | |
| 2 + times per week | 12 | 6.5 | 4 | 4.5 | 8 | 8.3 | |
| Farmers Market | | | | | | | |
| Never | 98 | 53 | 44 | 50 | 54 | 55.7 | 0.256 |
| Less than once a month | 36 | 19.5 | 18 | 20.4 | 18 | 18.6 | |
| 1–2 times per month | 31 | 16.8 | 13 | 14.8 | 18 | 18.6 | |
| 1 time per week | 13 | 7 | 10 | 11.4 | 3 | 3.1 | |
| 2 + times per week | 7 | 3.8 | 3 | 3.4 | 4 | 4.1 | |
| Food Bank / Food Pantry | | | | | | | |
| Never | 148 | 80 | 71 | 80.7 | 77 | 79.4 | 0.225 |
| Less than once a month | 11 | 5.9 | 4 | 4.5 | 7 | 7.2 | |
| 1–2 times per month | 15 | 8.1 | 6 | 6.8 | 9 | 9.3 | |
| 1 time per week | 7 | 3.8 | 6 | 6.8 | 1 | 1 | |
| 2 + times per week | 4 | 2.2 | 1 | 1.1 | 3 | 3.1 | |
| ECE Providers Shopping Method | | | | | | | |
| Physically shop inside the store | 173 | 93.5 | 83 | 94.3 | 90 | 92.8 | 0.672 |
| Online & Curbside Pick-Up | 60 | 32.4 | 28 | 31.8 | 32 | 33 | 0.865 |
| Online & Delivered to Home | 26 | 14 | 14 | 15.9 | 12 | 12.4 | 0.489 |
| Change in Shopping Habits due to the COVID-19 Pandemic | | | | | | | |
| ... amount of Fresh fruits and vegetables you buy? | | | | | | | |
| Increased | 81 | 43.8 | 43 | 48.9 | 38 | 39.2 | 0.382 |
| Decreased | 37 | 20 | 17 | 19.3 | 20 | 20.6 | |
| the same | 67 | 36.2 | 28 | 31.8 | 39 | 40.2 | |
| ... amount of Shelf-stable/packaged foods you buy? | | | | | | | |
| Increased | 73 | 29.5 | 32 | 36.4 | 41 | 42.3 | 0.714 |
| Decreased | 22 | 11.9 | 11 | 12.5 | 11 | 11.3 | |
| the same | 90 | 48.6 | 45 | 51.1 | 45 | 46.4 | |
| ... how much money you spend on food per month? | | | | | | | |
| Increased | 106 | 57.3 | 47 | 53.4 | 59 | 60.8 | 0.509 |
| Decreased | 21 | 11.3 | 12 | 13.6 | 9 | 9.3 | |
| the same | 58 | 31.3 | 29 | 32.9 | 29 | 29.9 | |

(continued on next page)

Table 4 (continued)

| | Overall (n = 185) | | INTV (n = 88) | | CONT(n = 97) | | p-value ^a |
|---|--------------------------|-----------|----------------------|-----------|---------------------|-----------|-----------------------------|
| | n | % | n | % | n | % | |
| Perceived Health | | | | | | | |
| Poor | 4 | 2.2 | 2 | 2.3 | 2 | 2.1 | 0.946 ^b |
| Fair | 40 | 21.6 | 20 | 22.7 | 20 | 20.6 | |
| Good | 90 | 48.6 | 43 | 48.9 | 47 | 48.5 | |
| Very Good | 46 | 24.9 | 20 | 22.7 | 26 | 26.8 | |
| Excellent | 5 | 2.7 | 2 | 2.4 | 2 | 2.1 | |
| Receive any Program Support | | | | | | | |
| WIC (Woman Infant & Children) | 8 | 4.3 | 5 | 5.7 | 3 | 3.1 | 0.308 ^b |
| SNAP Benefits | 21 | 11.3 | 11 | 12.5 | 10 | 10.3 | 0.639 |
| Double Dollars Incentive Program | 1 | 0.5 | 1 | 1.1 | 0 | 0 | 0.476 ^b |
| Medicaid | 20 | 10.8 | 10 | 11.4 | 10 | 10.3 | 0.501 ^b |
| Medicare | 16 | 8.6 | 5 | 5.7 | 11 | 11.3 | 0.199 |
| Free/ Reduced Meal at School | 28 | 15.1 | 12 | 13.6 | 16 | 16.5 | 0.588 |
| Children's Health Insurance Program | 27 | 14.6 | 15 | 17.1 | 12 | 12.4 | 0.245 |
| Other | 2 | 1.1 | 1 | 1.14 | 1 | 1 | 0.726 ^b |
| None | 110 | 59.5 | 50 | 56.8 | 60 | 61.9 | |
| Received at least one Support Program | | | | | | | |
| Yes | 69 | 37.3 | 33 | 37.5 | 36 | 37.11 | 0.957 |
| Number of people living in a household | | | | | | | |
| ... Children (17 years & below) | | | | | | | |
| None | 77 | 41.6 | 36 | 40.9 | 41 | 42.3 | 0.271 ^b |
| 1 child | 42 | 22.7 | 25 | 28.4 | 17 | 17.5 | |
| 2-3 children | 58 | 31.3 | 23 | 26.1 | 35 | 36.1 | |
| 4-6 children | 8 | 4.3 | 4 | 4.4 | 4 | 4.1 | |
| .. Adults (18-65 years) | | | | | | | |
| 0-1 Adult | 47 | 25.4 | 27 | 30.7 | 20 | 20.6 | 0.109 |
| 2-4 Adult | 132 | 71.4 | 60 | 68.2 | 72 | 74.2 | |
| 5-6 Adult | 6 | 3.2 | 1 | 1.1 | 5 | 5.2 | |
| ... Adults 65 & over | | | | | | | |
| 0 adults | 162 | 87.6 | 75 | 85.2 | 87 | 89.7 | 0.358 |
| 1-2 adults | 23 | 12.4 | 13 | 14.8 | 10 | 10.3 | |
| | Overall (n = 185) | | INTV (n = 88) | | CONT(n = 97) | | p-value ^a |
| | Mean | SD | Mean | SD | Mean | SD | |
| Number of people living in a household | | | | | | | |
| .. Children (17 years and below) | 1.1 | 1.2 | 1.1 | 1.1 | 1.2 | 1.3 | 0.6853 ^c |
| .. Adults (18-65 years) | 2.1 | 1.1 | 2 | 1 | 2.3 | 1 | 0.0792 ^c |
| .. Adults 65 & over | 0.1 | 0.4 | 0.2 | 0.5 | 0.1 | 0.4 | 0.3717 ^c |

Abbreviations: ECE, Early Care and Education, COVID-19, Coronavirus Disease 2019, INTV, Intervention Group, CONT, Comparison Group, SD, Standard Deviation.

^a Parametric Chi-square test or Student's t-test unless specified otherwise.

^b Fisher's Exact Test.

^c Mann-Whitney test.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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