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OBSERVED COOKING BEHAVIORS OF FAMILIES WITH AND WITHOUT CHILDHOOD CANCER SURVIVORS AND THE DEVELOPMENT OF A HEALTHY COOKING ASSESSMENT TOOL

by

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SCHOOL OF PUBLIC HEALTH

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2018

DEDICATION

To Martin and Adele Raber

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by

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DOCTOR OF PUBLIC HEALTH

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OBSERVED COOKING BEHAVIORS OF FAMILIES WITH AND WITHOUT CHILDHOOD CANCER SURVIVORS AND THE DEVELOPMENT OF A HEALTHY COOKING ASSESSMENT TOOL

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Diet is a modifiable risk factor for several cancers and other chronic diseases. Cooking skills are a target for dietary intervention, with much of the general population reporting infrequent and inadequate home preparation of meals. Childhood cancer survivors (CCS) are a population at high risk of several chronic conditions including secondary cancers that may be influenced by home cooking behaviors. We conducted observations of food preparation practices in 29 parents of healthy school-aged children and 11 parents of CCS. Observations included an audio and video recording of one evening meal per family. Parents were asked to wear a small body camera unit (eButton) during the cooking session. Ingredient amounts were be observed and recorded during the video sessions and final prepared foods analyzed for micronutrient and macronutrient quantities. Resulting videos were coded for healthy cooking behaviors using the Healthy Cooking Score (HCS) coding system, based on a conceptual framework previously developed by the authors. Families were assigned HCS based on the video analysis. Parents filled out a healthy cooking behavior questionnaire constructed from the conceptual framework. Height and weight was assessed from children and general family demographics and parenting practices collected from parents. Observed and self-reported healthy cooking behaviors were shown to be significantly different, with nine HCS items responsible for the majority of discrepancy between self report and observed cooking behaviors. The eButton images were examined and compared to audio/video observations of the cooking sessions. The eButton closely approximated the audio/video observations, but failed to collect usable images in 5 out of 40 cases. CCS cooking habits were compared to non CCS families and showed similar cooking habits. Qualitative analysis of the CCS family cooking videos revealed four major meal planning values in the sample including health, budget, effort and preferences. Several of these values were impacted by the cancer experience. Taken together, this study provides preliminary data for the assessment and development of healthy cooking programming in CCS and the general population.

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BACKGROUND

Literature Review

Diet is a major target for cancer prevention as obesity remains a serious public health issue and adherence to nutrition recommendations remains low. [1,2] Cooking may influence cancer risk through its effect on dietary intake and carcinogenic compound development on food as it is being prepared. [3] Certain food preparation practices, such as preparing red meat using high temperatures / charcoal grilling can lead to the development of heterocyclic amines and polycyclic aromatic hydrocarbons. [4] Exposure to these human carcinogens has been shown to increase cancer risk. [5] Consumption of deep – fried foods is also associated with increased risk for several cancers, possibly due to the production of mutagenic compounds on the surface of fried food that are subsequently metabolized in the body. [6-9] Processing meats (such as bacon and beef jerky) through drying, curing, pickling, salting or smoking can lead to the development N-nitroso compounds (human/animal carcinogens) and increase stomach cancer risk. [10]

Cooking also influences cancer risk through its impact on nutrition intake, which in turn impacts weight status. The American Cancer Society estimates overweight / obesity, poor diet, and poor physical activity behaviors are responsible for nearly one third of all cancer-related deaths. [4] There is strong evidence that obesity increases risk for many cancers including colon (men), rectal (men), pancreatic, postmenopausal breast, endometrial, and kidney cancers as well as multiple myeloma. Further, there is highly suggestive evidence colon and liver cancer risk increases with higher BMI. [11]

Eating foods prepared in the home from basic ingredients, as opposed to eating out, has been linked to increased intake of fruits, vegetables, and whole grains [12-14]. Dietary patterns that are high in plant based foods and low in red / processed meat are associated with a reduced risk of several cancers. [15-17] Cooking skill development has been utilized for healthy diet promotion in research and community settings and has shown promise as a way to promote positive food attitudes and behaviors in children and adults. [18,19] Further, policy frameworks such as the NOURISHING framework from the World Cancer Research Fund have identified food preparation education as a target for cancer prevention programming. NOURISHING stands for: **N**utrition label standards and regulations on the use of claims and implied claims on foods, **O**ffer healthy foods and set standards in public institutions and other specific settings, **U**se economic tools to address food affordability & purchase incentives, **R**estrict food advertising and other forms of commercial promotion, **I**mprove nutritional quality of the whole food supply, **S**et incentives and rules to create a healthy retail and food service environment, **H**arness food supply chain & actions across sectors to ensure coherence with health, **I**nform people about food & nutrition through public awareness, **N**utrition advice and counseling in health care settings, **G**ive nutrition education and skills. [20]

Childhood cancer survivors (CCS) are an important population for dietary interventions as they are at increased risk for cardiovascular disease, obesity and secondary cancers, which may be impacted by dietary behaviors [21-23]. CCS are less likely than their healthy counterparts to meet U.S. dietary recommendations, consuming inadequate fiber, potassium, and vitamin D as well as excessive calories, saturated fat, and sodium. [24-26] Teaching healthy cooking classes or developing healthy cooking apps (e.g. with food preparation demonstrations) could be a feasible way to encourage healthy eating in diverse populations, although this strategy has not been formally explored in CCS or their families. [18,19]

Standardized definitions of healthy cooking, universal guidelines, and metrics of healthy cooking are all lacking in the current literature. Several approaches to measuring cooking behavior have been attempted, including additional supplements to Food Frequency Questionnaires (FFQ), traditionally developed to measure dietary intake. [18,19] The Meat Module Questionnaire developed by Sinha et al., which addresses meat preparation methods and doneness level is one example of a validated FFQ supplement. [27]

An additional approach includes self-report questionnaires of cooking behaviors, containing a range of items. The most common type of cooking behavior assessment is simple frequency (e.g., how often have you prepared meals in the last seven days?). [13,28-30] Another type of assessment targets an individual's capacity for preparing specific dishes (e.g., ability to prepare green salad, prepare soup, bake bread). [12,13,31] Validation of this approach is limited to test-retest reliability and internal consistency of items. [13,18,31] While these approaches are helpful in understanding some cooking behaviors, they are specific to certain types of recipes or ingredients, limiting their utility in understanding the diversity of modern food preparation approaches.

Psychosocial metrics are often used in cooking program evaluation, focusing on cooking confidence, self-efficacy, and attitudes. [19] Two published reviews explored cooking program outcomes in adults and children. While both noted promising improvements in confidence and attitudes, they also highlighted the variability in intervention design and the lack of consistent evaluation tools. [18,19] This gap in knowledge limits understanding of: i) what should be included in cooking class curricula, ii) the degree to which health promoting behaviors are being effectively taught, and iii) how to assess the food preparation behaviors of participants. Lack of information on actual cooking behaviors limits the value of current program evaluations as well as general nutritional and home food environment assessments.

More in-depth exploration of home cooking behaviors offers an opportunity to augment these types of measures and evaluation attempts. To address this issue, my mentors and I developed and published a conceptual framework of healthy cooking based on the extant literature, summarized in Figure 1 and further detailed in Table 1. [32] This project formed the basis of my MPH thesis, where it is described in detail. [33] Briefly, the framework was based on 59 studies from a range of disciplines informing five constructs of cooking behavior (frequency, techniques and methods, minimal usage, flavoring, and ingredient additions / replacements); these were further defined by a series of individual behaviors.

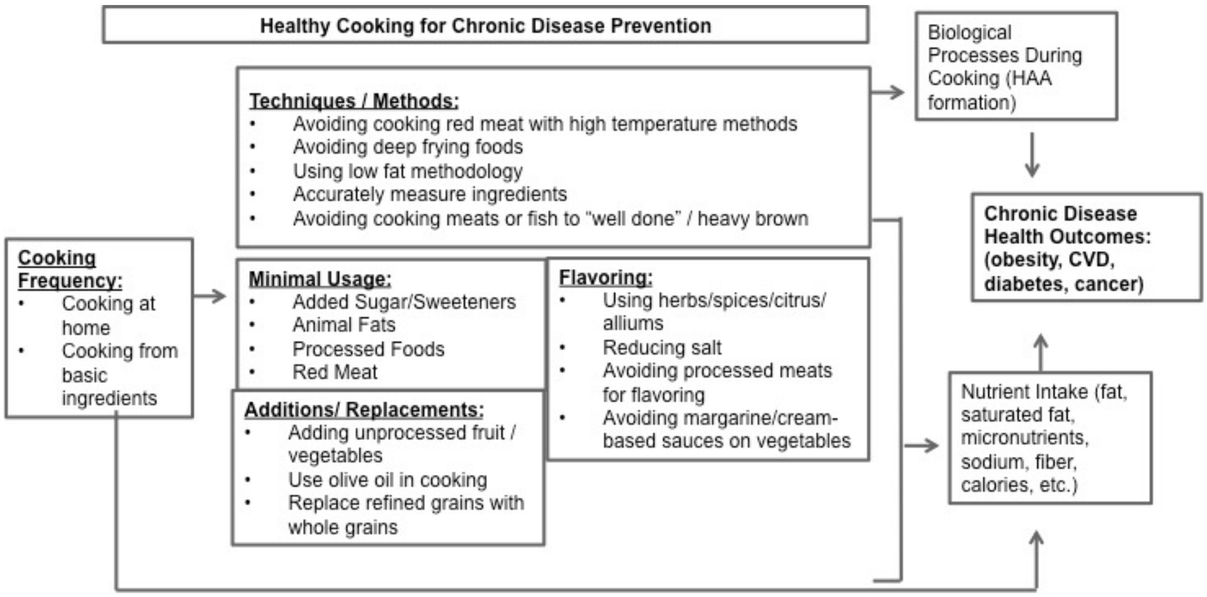


Figure 1: Conceptual Framework of Healthy Cooking (From Raber et al, 2016)

Table 1: Conceptual Framework defining behaviors

Construct		**Defining Behaviors (+ positive / - negative)**
Frequency	Cooking Frequency	Frequency of preparing meals in the home (+) Frequency and extent of preparing meals from "basic" ingredients (+)
Techniques/Methods	Avoid cooking red meat with high temp	Grilling, BBQ, broiling, frying red meat (-)
	Avoid deep frying foods	Foods fully submerged in high temperature liquid fat (-)
	Use low fat cooking methodology	Baking, boiling, steaming, grilling, microwaving (+)
	Accurately measure ingredients	Assign appropriate portions (as per USDA guidelines) (+) / Measure salt / oil (+)

	Avoid cooking meats to well done/well browned	Cook meat and fish to well done. (-) Fully browned surface of fried foods (-)
Minimal Usage	Limit red meat	Limit pork, lamb, beef, vary with plant based foods, eggs, fish or poultry (+)
	Limit/avoid processed foods	Limit or avoid all packaged/processed foods (+)
	Limit animal fats	Limit lard/bacon grease / chicken fat/ butter/ shortening, vary with liquid vegetable based oils (+)
	Limit sugar	Use less sugar baking or general cooking (+)
Additions/Replacements	Add unprocessed fruit/vegetables to main dishes	Incorporate fruit and vegetables into all dishes (not just veg side dishes) (+)
	Use olive oil	Use of olive oil for cooking (+)
	Replace refined grains with whole grains	Use of whole grains (+)
Flavoring	Using herbs/spices/citrus/alliums	Add herbs/ spices/orange/lemon/lime/onion/garlic/shallots while cooking (+)
	Reducing salt	Use low/no salt while cooking (+)
	Avoid processed meats when cooking	Bacon/ ham hocks/ jerky/ sausage, hotdogs (-)
	Avoid margarine/cream-based sauces on vegetables	On all vegetable preparations (-)

Table 1: Conceptual Framework defining behaviors (adapted from Raber, 2014)

Face validity of the constructs was supported by a small focus group of experts. While nutrition research continues to develop and trends are often shifting, the framework of healthy cooking represents the behavioral factors that influence food preparation quality based on the available, peer-reviewed research. The conceptual framework was used to develop a basic coding system of healthy cooking behaviors. An early version of this coding system was used to code a series of 24hr food recalls; however, it is not clear that assessment by 24hr food recall is an effective strategy for accurately measuring cooking behavior. As a verification of a measure of healthy cooking based on the framework, we propose using documentary video to observe food preparation behaviors in the home as well as a self-report questionnaire.

Public Health Significance

Obesity and poor diet increase cancer risk and negatively impact prognosis.[4] Therefore, lifestyle interventions impacting diet and weight management are key targets for cancer prevention efforts. Cooking education is currently being used in community programming, academic research and as a part of disease prevention policy initiatives.[18-20,34] Although these programs receive private and public support, standardized guidelines and widely used assessment tools of healthy cooking behaviors are lacking.[18,19,34] Qualitative research has been undertaken to better understand cooking habits through focus groups[35,36] and exploratory surveys[37], but not observations of actual food preparation in the home. As home food preparation has been a target for nutrition and weight management programming, it is imperative that valid behavioral assessments be developed, allowing for a better understanding of the connection between cooking habits, diet and weight. This study sets the foundation for future work exploring different aspects of teaching and measuring healthy cooking behaviors in CCS and the general population. The long-term goal of this work is to develop effective cooking interventions to improve diet and reduce cancer risk. Accepted guidelines and metrics of healthy cooking practices will offer both academic and community-based cooking programs avenues to synchronize their efforts, understand their impact, and improve health.

Specific Aims

The purpose of this study is to 1) compare self-reported and observed cooking practices based on the HCS, 2) examine the ability of a wearable body camera unit, the eButton, to approximate observed HCS behaviors and 3) explore differences in cooking practices between CCS and non-CCS families.

Aim 1 (primary)- To compare self-reported home cooking practices to in-home direct observations of cooking events using a novel assessment tool, the Healthy Cooking Score (HCS).

Hypothesis: We hypothesized that participants would be able to accurately self-report healthy cooking behaviors.

Aim 1 Impact: The completion of this aim allows for the further development and validation of a self-reported measure of cooking behavior. Self reported and observed cooking scores were shown to be significantly different and prone to social desirability bias. This is the first study of its kind to compare observed and self-reported cooking behavior. In doing so, it provides a better understanding of cooking behavior in general, which is of value to this developing literature. Non-profit organizations focusing on cooking programs are spreading rapidly in the US, such as Share our Strength's "Cooking Matters" program, which has reached over 260,000 people to date [38]. Low-cost, easy to use assessment tools are necessary for the development of research in this area both for community organizations and for academic research and evaluation. The completion of this aim elucidated which HCS items are most/ least accurately captured by the self-report questionnaire, which allows for further refinement of a future assessment tool.

Aim 2: To examine the feasibility of, and validate the accuracy of the eButton system to identify healthy cooking behaviors as measured using direct observation in a family home setting.

Hypothesis: We hypothesized that the eButton would be a feasible, and accurate measure of home cooking behaviors, compared to observations.

Aim 2 Impact: The completion of this aim offers preliminary data for the further development and use of wearable camera technology for cooking behavior assessment. This study demonstrated the accuracy of the eButton image sensor in identifying nutrition optimizing home cooking practices. The eButton images were collected during 35 out of 40 home cooking events and compared to audio/wide-angle video observations of the same events (gold standard). By examining differences in summative healthy cooking scores and individual cooking practices between the two methods, we found specific cooking behaviors were accurately assessed using the eButton unit when the sensor functioned properly. Certain practices, including measuring salt / fat and using certain types of fat were more prone to eButton recording error. No participants reported issues with the comfort of the eButton during cooking or removed the eButton during the cooking sessions. However, five participant eButton images were not usable in the analysis. Thus the eButton offers an objective, passive, and relatively non-invasive measurement tool of home cooking behavior that could be integrated into future studies.

Aim 3- To explore cooking behaviors among families with and without CCS.

Hypothesis: We hypothesized that cooking behaviors between families with and without CCS were similar and assessed parental healthy cooking score, types of dishes prepared, values and the impact of the cancer experience.

Aim 3 Impact: The completion of this aim revealed that CCS and non CCS have similar cooking habits in this small sample. CCS meal values include effort, budget, healthfulness and family preferences. Several of these values were impacted by the cancer experience, as revealed through qualitative research. These findings are important for pediatric survivorship research, as CCS tend to gain weight during the course of treatment and remain at a higher weight into survivorship, emphasizing the need for nutrition education interventions in this group at various time points. [23] The cancer experience can serve as a teachable moment for cancer patients and caregivers [42] and CCS have indicated interest in participating in healthy eating interventions with parents. [43] Given this background, CCS and their families could benefit from healthy cooking interventions. Our group recently conducted a randomized nutrition counseling study for pediatric patients undergoing maintenance therapy. [44] While overall calorie intake was reduced, weight was not impacted by the intervention, suggesting the broader eating environment, including food preparation, may need to be addressed in order to produce impactful change in this population. Previous literature has shown parents of CCS have overall normal long-term levels of distress, coping, and family functioning. [45,46] Qualitative research has suggested parents may demonstrate more overprotective or spoiling practices with regard to their ill children, but quantitative assessments are lacking and it is unclear if those differences impact food preparation. [46] This study offers increased insight into the cooking habits of families and aid in the development or adaptation of healthy cooking programming for the CCS population.

METHODS

Study Design

The overall design for these three aims will be an observational, mixed-methods study using self-reported questionnaires, video and audio recordings as well as direct in-person observation.

Study Setting

This study will take place in the homes (kitchens) of participants. Analysis will take place at UT School of Public Health, MD Anderson Cancer Center, and the Children's Nutrition Research Center at Baylor.

Study Subjects

Participants were parent-child dyads. The convenience sample included one parent with a CCS at least one year off all treatment (n=11). A sample of non CCS and their parents were also recruited for comparison (n=29). Participants were eligible if (a) children were aged 5 to 17, (b) parents could read and speak English, (c) parents self-reported preparing meals for their children at least one time per week on average, and (d) no one in the home had food allergies. Participants were recruited between September 2017 – June 2018. This study was approved by the University of Texas MD Anderson Cancer Center (PA16-0995).

Recruitment. CCS were recruited from the MD Anderson Children's Cancer Hospital. Research staff identified eligible survivors through the MD Anderson Survivorship Network, providers, and hospital events. A total of 109 CCS were identified as eligible for the study based on their medical record information and contacted for study participation. Contact methods included phone calls, provider visits, mailed letters from the study principal investigator, digital and paper flyers, and presentations at hospital events. Forty-five CCS parents responded to our recruitment attempts (41%). Of these 45, 21 declined due to impact from a recent hurricane in the region (n=11), general disinterest in the study (n=7), and discomfort being filmed in their homes (n=3). Six CCS parents were found to be ineligible during the screener. Eighteen parents requested more information or agreed to be in the study. Of the 18 that initially agreed, three did not respond to further contact attempts, and two reported being unable to participate in the study due to continued hurricane-related disruption. Eleven participants completed the study (24% of respondents). Non CCS families were recruited through paper and digital flyers posted in the greater Houston and Austin, Texas area. Thirty-four non CCS parents contacted study staff for more information after seeing the flyers. One was ineligible due to severe food allergies and four did not respond to further contact after completing the screener. Twenty-nine non CCS dyads completed the study.

Inclusion Criteria:

1. One parent with child aged 5 – 17 years (The age range has been kept broad to maximize recruitment options, this is a pilot study and therefore it is unclear how food preparation behaviors differ or change as children age. Age comparisons will be incorporated into the data analysis)
2. Pediatric cancer survivor or control (Survivor = at least 1 year off all treatment)
3. Able to read and speak English
4. Prepares main evening meal for child in the home at least 1 time per week (on average, self-reported)

Exclusion Criteria

1. Residents outside of the greater Houston / Austin Metroarea
2. Parents who do not prepare food in homes for recruited child at least once per week (on average, self-reported)
3. Inability to read / speak English
4. Unwillingness to have 2 evening food preparation sessions recorded in homes or complete other study requirements
5. Severe food allergies or related disorders of parent, child or other family members living in the same home.

Sample Size Calculation and/or Study Power

Eleven CCS and 29 non CCS were recruited for this study. A power calculation was not conducted, as this was developed as a pilot study.

Data Collection

Outcome Measures: Once a participant is enrolled in the study, a video session was scheduled and included surveys on basic demographics and parenting practices. Height/weight measurements using standardized instruments and methods will be collected from children for body mass index (BMI). These measures were only be taken once to establish characteristics of the study group. After the video session, parents were be asked to fill out a self-report survey of healthy cooking behaviors. Observers recorded the ingredients and amounts used during the video observations for nutritional analysis. Video sessions were scheduled according to participant availability.

Details of the demographic, parenting practices, healthy cooking and BMI measures:

- BMI were be calculated according to the formula kg/m^2 based on the height and weight measurements. To measure height, a wall-mount height board was used and weight was measured using a digital scale. A scale and wall mount height board was brought to participant homes for measurements and collected by trained project staff. BMI measurements were be compared to the CDC growth charts for children based on age and gender.

- Demographic questionnaires included items on parent age, gender, education, ethnicity, income level, marital status, and child age, gender and diagnosis (CCS only)

- Parent perceived fruit and vegetable feeding practices were assessed with a questionnaire adapted from the Fruit and Vegetable Parenting Practices Questionnaire used in previous studies. [49]

- The healthy cooking questionnaire was developed from the framework of healthy cooking behaviors developed by the authors. [32] The questionnaire was piloted with the mentoring committee and outside volunteers. Clarifications and alterations were made accordingly. The self-report questionnaire asked about food preparation practices used during the videotaped session in order to assess self-report immediately after the behavior. More general questions on typical food preparation behaviors were also included. Information on cooking frequency, ingredient usage, flavoring and cooking methods was collected. Questionnaire items mirror the HCS coding system.

Measurement of final meal nutrition profile: During video observations, observers estimated ingredient amounts and clarified the contents of certain ingredients with participants as necessary. The participants were also asked to report the number of servings yielded from each recipe. This information was analyzed using nutrition analysis software. Ingredient estimations approximate current dietary self-report measures commonly used in the field.

Video observations: After enrollment and consenting, parents were asked to prepare a typical meal during the video observation session. Specific recipes were not be given, but parents were instructed to prepare a typical dish as they would on a normal evening either by 1) cooking without a recipe or 2) selecting a recipe of that type that is available in their home or from their friends. At the start of the observation, parents were asked to briefly explain which dish they are making, what influenced their selection and how many adults and children they are cooking for (serving size). A video camera and lapel microphone was arranged so that general cooking behaviors and kitchen environment could be clearly observed and the participant clearly heard. Children or other family members that engaged in food preparation were given no instructions from staff regarding participation. The parents were instructed to explain their actions as they cook to supplement the video image.

E-Button Observations: Dr. Mingui Sun (U Pittsburgh) has developed a multisensory unit, the Sun E-Button, which attaches around the collar and to the shirt of the participant and includes a camera, an accelerometer, Geographic Positioning System (GPS), indoor/outdoor sensor, battery and storage. [52] The camera records pictures of everything in front of the wearer at 2 to 10 second intervals throughout the wearing period and have been used to assess child eating behaviors is a sample. [53] We have reviewed sample E-button images and determined this method is appropriate for determining food preparation behavior from the angle of the wearer. Participating parents were asked to wear the E-Button on their collar while participating in the video observation part of the study. The collected images provided researchers with an alternative approach to cooking behavior data collection.

Healthy Cooking Score (HCS): An evidence-based conceptual framework of healthy cooking was developed and published. [19] A novel assessment tool, the Healthy Cooking Score (HCS), operationalizes this framework. [19] The framework was developed from a systematic literature review, informing five main concepts (frequency, techniques/methods, minimal usage, additions/replacements, and flavoring), each defined by individual behaviors. Face validity of the framework was determined with a focus group of experts. [19] Subsequently, community-based participatory cooking classes based on the framework were undertaken to examine the real-world application of framework constructs in diverse communities, which was successfully conducted. [20] The framework behaviors were operationalized into the HCS coding system that scored -1 for negative behaviors and +1 for positive behaviors. The conceptual framework also formed the theoretical underpinning for the HCS self-report tool, a 21 item written questionnaire that included general cooking habits and specific food preparation practices used during the observed cooking session in order to assess self-report accuracy immediately after the event. The HCS Self-report questionnaire items mirror the HCS coding system. The HCS coding system creates an assessment scale from -9 to +11 that could be applied to both observational and self-report data, allowing for a comparison between multiple data types.

Training and Pretesting: All questionnaires, scale and height board were pretested with a small group of volunteers, recruited from the lab of the Principal Investigator, Joya Chandra. One to two research staff members were trained to conduct the observation sessions and record ingredients used during cooking. First, a manual of procedures detailing equipment set-up and a script for the video sessions was developed. Two full practice sessions were conducted in volunteer homes during evening meal preparation times. During these practice sessions, observers reviewed setting up equipment, taking notes on ingredients and amount used, and asking volunteer participants script questions and for clarification as necessary. Videos and notes of the practice sessions were reviewed to ensure compliance with manual of procedure guidelines. Issues were discussed and resolved between the two observers, and mediated by the principal investigator when necessary. Two observers were present for 25 percent of the video sessions and agreement between the two observers with regard to foods observed was high (95%). A practice height and weight collection was completed by both staff members on six volunteers, and calculated BMI measurements were within .12 between the two data collectors. A standardized approach to collecting height and weight data from children, how to set up the camera and e-button equipment and how to collect ingredient data during video sessions was outlined in the study manual of procedures. E-button and video analysis was guided by a codebook developed by Margaret Raber from previous research.

Data Analysis

A review of the statistical analysis proposed in this study can be found in Table 2 below.

Table 2: Statistical Analysis Plan

Aim	Measure	Analysis	Software
1) To compare self-reported home cooking practices to in-home direct observations of cooking events using a novel assessment tool, the Healthy Cooking Score (HCS).	Observed Cooking Behaviors Self-reported Cooking Behavior	HCS coding system PCA Cronbach's Alpha Inter Rater Reliability (coders) Nutrient Analysis	SPSS NDSR
	Agreement Observed vs Self Reported Cooking Behaviors	Percent Matches Independent sample t-test of differences Bland Altman Plot	SPSS
2) To examine the feasibility of, and validate the accuracy of the eButton system to identify healthy cooking behaviors as measured using direct observation in a family home setting.	eButton Images Observed Cooking Behaviors Agreement eButton v Observations	HCS coding system Inter Rater Reliability (coders) Independent Samples t-test of differences Bland Altman Plot Percent Matches	SPSS ImageBrowser

3) To explore cooking behaviors among families with and without CCS.	Differences in food preparation habits between CCS and non-CCS families	Independent samples t-test ANCOVA (control for group differences) Nutrient analysis	SPSS NDSR
	Demographics	Descriptive Statistics	SPSS
	CCS values and cancer experience	Inductive coding	NVIVO

Aim 1: Descriptive statistics were calculated for all demographic information as well as BMI data. Ingredient and amount information was analyzed using the Nutrient Data System for Research software (NDSR 2017, University of Minnesota, Minneapolis, MN). Principal Component Analysis (PCA) of the HCS was undertaken to identify distinct healthy cooking behavior patterns. The number of components extracted was based on the scree plot and varimax rotation used. Cronbach's alpha was calculated for the observed summative HCS to measure internal consistency of measure.

In order to identify and quantify discrepancies between observed and reported cooking behaviors, the HCS coding system described above was applied to directly observed (video sessions) and self-reported cooking behaviors as obtained by the HCS self-report tool. Forty percent of the observational data was coded by two research staff members, including one session observer and one non-observer; inter-rater reliability was calculated and agreement was high (Cohen's Kappa = .875, 92.8% agreement). [24] During coding, points were applied for each individual behavior, allowing for an examination of differences in observed and reported behaviors. Final scores were summative. Differences between self-reported and observed summative scores were assessed using a one-sample paired T test. A Bland Altman plot was constructed to estimate agreement between the self-report and observed measures. To assess validity, one researcher then paired behaviors from the observational and self-report records and classified them into three categories: a) matches at the item level (behavior reported and observed), b) intrusions (behavior reported but not observed), and c) omissions (behavior not reported but observed). Totals of each category formed percentages with the denominator as the sum of all items. Detailed notes and open-ended questions were used to elucidate the source of reporting errors. Individual items with errors in agreement over 90% were reviewed in depth for sources of discrepancy. This approach has been used in previous studies examining multiple assessments of diet-related behavior. [25]

Aim 2: Participant demographics were analyzed using descriptive statistics. The eButton image and observational data sets were coded using the Healthy Cooking Score (HCS) coding system described above. A summative HCS was calculated for each data set from each participant. The accuracy of the eButton was examined by comparison to the direct observational (gold standard) data. An independent one-sample t-test was used to determine differences between the summative healthy cooking scores of the two measures and a Bland Altman plot constructed to estimate agreement. One research staff member reviewed the coded data sets and classified individual items into matches (recorded by both eButton and observation) and non-matches (observed but not captured by the eButton). Totals of each category formed the percentage groups, with the denominator as the sum of all items. This approach has been adapted from previous studies. [29] Items with higher rates of non-matches were re-examined to identify major sources of error between the eButton images and observational footage of the cooking event. Overall issues concerning eButton feasibility including time needed for analysis were also reported.

Aim 3: Demographic and family characteristics, as well as cooking habits were examined by CCS status. Differences between categorical characteristics of the two groups were examined using chi-square tests. Types of ingredients and amounts used were examined using nutrient analysis software (NDSR). Nutrient profiles of meals including carbohydrate, fat, saturated fat, protein, sugar, fiber, calories and energy density were examined.

Resulting videos were coded for healthy cooking practices using the Healthy Cooking Score coding system. The coding of specific healthy cooking behaviors generated a summative, numerical score for each video session. Healthy Cooking Scores in CCS and non CCS families were initially compared using a two independent samples t-test. A one-way ANCOVA was then conducted to examine differences between the groups controlling for dissimilarities between the two groups including: number of children in the home and race. Frequency of individual behaviors from the Healthy Cooking Score were examined by group. Comparative and descriptive statistics were performed with SPSS (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp).

Video and audio data from meal preparation sessions were analyzed with an inductive coding technique utilized in other studies of CCS parent behavior. [30] All qualitative analyses used qualitative analysis software (SR International's NVivo 10 Software). This software allows users to embed video files with audio for storage, retrieval and coding. Parent or child mentions of factors that influenced family meal preparation including food shopping, cooking or eating behavior were coded. After initial review, codes were reviewed and aggregated into parent codes representing specific themes. These parent codes were then reviewed and aggregated into broader overarching themes, forming a coding hierarchy. Mind mapping was used to graphically explore the relationships within the coding hierarchy. [31] The mind map was created around the main parent codes, which branched into child and sibling codes, gaining specificity on outer branches. Two separate mind maps were developed, one focusing on CCS parent meal values, and the other focused on the cancer experience. The intersectionality of these topics was explored through the selection and presentation of representative participant quotes. CCS involvement in food preparation was documented and classified into 4 categories informed by previous research [32]: 1) no involvement, 2) involvement in mainly non-food preparation meal related tasks (i.e. setting table, cleaning, plating, fetching supplies) 3) child helped parent prepare meal component (e.g. child chopped nuts for salad) and 4) child independently prepared meal component (e.g. child made pasta). Descriptive statistics were completed for demographic and family characteristic data, as well as parenting practices. All quantitative analysis was completed using SPSS (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.).

Human Subjects, Animal Subjects, or Safety Considerations

This study was reviewed and approved by the institutional review board of the University of Texas MD Anderson Cancer Center (PA16-0995) with reciprocity from the University of Texas UTHealth School of Public Health (HSC-SPH-17-0403). The doctoral student (Margaret Raber) provided children and parents inquiring about the study with details including the purpose and procedures of the study and potential benefits and risks. All study personnel were trained in Human Subjects Research. A signed informed consent and assent document were obtained from parents and children in person by study personnel before participation in the study. This was a separate informed consent and assent from other research trials that the participant may have been a part of. Participants were free to withdraw from the study at any time and participation was voluntary. Personal information, including names, address, birthdates and other protected health information (PHI) was de-identified once data was obtained. Each participant was be assigned a specific number and information was be stored in a password-protected secure database and in locked cabinets with limited access available to authorized staff.

Potential benefits for participating in this study are: information collected may be beneficial for future populations by helping researchers understand how to assess cooking behavior, their impact on cancer prevention nutrition endpoints and differences between CCS and non-CCS families. Families were compensated for their time and effort with one $50 gift cards (CVS), offered at the end of the video session. Participants signed a reimbursement log upon receipt of compensation. Participants were also given healthy recipe cards and nutrition information from the MD Anderson Children's Cancer Center website resource: mdanderson.org/recipes. A potential risk for patients was feeling embarrassment of sharing personal cooking habits and home environments with study staff. To help alleviate this risk, participants were reminded that they were able to leave the study at any time and all information shared is strictly confidential.

JOURNAL ARTICLES

1) Title of Journal Article 1: Comparison of Self-Reported versus Observed Family Home Cooking Behaviors using a Novel Healthy Cooking Behavior Assessment Tool.
Proposed Journal for Article Submission: Journal of the Academy of Nutrition and Dietetics

2) Title of Journal Article 2: Feasibility and accuracy of the Sun eButton to identify nutrition optimizing home cooking behaviors.
Proposed Journal for Article Submission: Journal of the Academy of Nutrition and Dietetics

3) Title of Journal Article 3: Exploring Food Preparation Practices in Families with and without School-Aged Childhood Cancer Survivors.
Proposed Journal for Article Submission: ACTA Oncologica

4) Title of Journal Article 4: Meal planning values in families with school-aged childhood cancer survivors- a qualitative exploration and considerations for intervention development.
Proposed Journal for Article Submission: Supportive Care in Cancer

Title: Comparison of Self-Reported versus Observed Family Home Cooking Behaviors using a Novel Healthy Cooking Behavior Assessment Tool.

Target: Journal of the Academy of Nutrition and Dietetics

Background:

Diet is a major modifiable risk factor for many common chronic diseases, including obesity, cancer and heart disease. [1] Although several organizations offer dietary guidelines on food choice and portions[2,3], adherence to these recommendations is low. [4] Thus, offering dietary recommendations alone is unlikely to result in meaningful behavior change. [5] Hands-on nutrition education, including practical cooking classes, has been utilized in community and research interventions across multiple settings. [6-8] Cooking instruction has been integrated into K- 12 education, patient resources, community-based programming as well as graduate-level medical and dietetics training, highlighting the breadth of and increasing interest in food preparation education as a public health initiative.[6-8]

Despite the popularity of cooking programs, data linking specific cooking practices and health-related outcomes is limited. Three reviews exploring published cooking interventions reported modest positive impact on adult self-efficacy and diet, and mixed impact on child food-related attitudes and preferences. [6,7,9] These reviews highlighted methodological weaknesses across studies including limited evaluation using measures with non-validated metrics and variable intervention content.[6,7,9] Several approaches to measuring self-reported cooking behavior have been attempted, including supplements to traditional Food Frequency Questionnaires (FFQ). [6,9] Another approach includes questionnaire items assessing cooking frequency (e.g., how often have you prepared meals in the last seven days?). [10-13] Other assessments target an individual's perceived capacity for preparing specific dishes (e.g., ability to prepare green salad, prepare soup, bake bread). [10,14,15] Metrics assessing psychosocial aspects related to cooking, as opposed to behavioral assessments, are also used in cooking program evaluation and focus on self-perceived adequacy of skills, confidence, self-efficacy, and attitudes. [6,16] Validations of these self-report tools are typically limited to test-retest and internal consistency reliability of items. [9,10,15] While helpful, it is unclear how well currently available instruments reflect actual home cooking behavior, nor how these measures relate to dietary intake or downstream biological correlates of health.

Cooking is a multi faceted behavior that lacks a universal definition, and may vary considerably in practice. [17] A survey study using a nationally representative sample found three distinct ways Americans conceptualize the basic act of "cooking". [18] Broad interpretations of cooking practices may subject self-report tools to bias if individual items are not clearly operationalized, leading participants to interpret questions using dissimilar criteria. Objective data on home cooking practices, and how they are interpreted through self-report tools are lacking. By understanding how cooking behavior is reported relative to objective observations of cooking events, more accurate self-report tools can be developed.

The primary aim of this study was to compare self-reported home cooking practices to in-home direct observations of cooking events using a novel assessment tool, the Healthy Cooking Score (HCS). The secondary aim of this study is to identify areas for improvement to the HCS self-report tool.

Methods:

Setting and Participants: An observational study was conducted between August 2017 – June 2018 in Texas, mainly in the greater Houston and Austin areas. The study was designed to assess the accuracy of the HCS self-report tool against recorded audio/visual observations of meal preparation events. A convenience sample of 40 dyads (parents with children aged 5 - 17) was recruited for this study through paper flyers and emailed announcements. The inclusion criteria were: being a parent with a child 5 – 17 years old, being able to speak and read in English, no severe food allergies in the home, and parent must report preparing a meal for the child at least one time per week on average. All data collection sessions were conducted in participant homes. Parents completed and signed an informed consent document and child assent was obtained. The University of Texas MD Anderson Cancer Center Institutional Review Board approved this protocol PA16-0995. Families were compensated with a $50 gift card for their participation.

Video Observation Session Procedure: The study procedure included five main steps (Figure 1). During recruitment, parents completed pre-screening questions to ensure their eligibility, reported their top five most commonly made meals and proposed convenient times and dates for the video observation session in their home. Interested participants were emailed or mailed copies of the informed consent for their review. Observation sessions were scheduled for evening meal preparation times at the participant's convenience. Sessions were confirmed one week prior. During confirmation, participants were requested to make one of the common meals noted from the pre-screener or an alternative typical meal of their choice. Prior to arranging the video equipment, participants completed the informed consent process with research staff. At the start of the observation recording, parents briefly described the dish

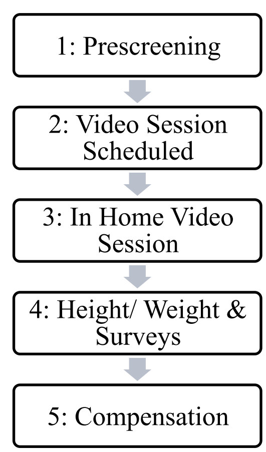


Figure 1: Study process for participants.

they were making, why they chose to make the specific dish, and for how many adults and children they were cooking. Parents were instructed to explain their actions as they cooked to supplement the video image. For example, a parent may describe browning beef as "now I am crumbling beef into a hot sauté pan". All audio was captured by the lapel microphone and used to supplement the video images during analysis. While participants cooked, ingredients and amounts were observed and recorded by one to two research staff members trained in nutrition assessment. Clarifications from the parent participant were requested as necessary. Participants were also asked to report the number of servings yielded from each recipe. Self-report questionnaires and anthropometric measurements were completed directly after the recording session in the participant's home. The participant was compensated for their time and offered recipe cards and nutritional information upon completion of the session.

Audio/Video Equipment: Video equipment were set up in the home prior to the start of food preparation. Equipment included a wide-angle camera on a tripod (Canon VIXIA HFR800), arranged to capture the entire kitchen area and a wireless lapel microphone (MOVO WMIC70) worn by the parent participants.

Questionnaires: Questionnaires were completed by parent participants directly after the cooking video session including demographics and cooking behavior. Demographic questionnaires included items on parent age, sex, education, ethnicity, income level, marital status, and child age and sex. Cooking behaviors were assessed using the HCS self-report questionnaire described below.

Healthy Cooking Score (HCS): There is no standardized definition of healthy cooking. To address this issue, an evidence-based conceptual framework of healthy cooking was developed and published. [19] A novel assessment tool, the Healthy Cooking Score (HCS), operationalizes this framework. [19] The framework was developed from a systematic literature review, informing five main concepts (frequency, techniques/methods, minimal usage, additions/replacements, and flavoring), each defined by individual behaviors. Face validity of the framework was determined with a focus group of experts. [19] Subsequently, community-based participatory cooking classes based on the framework were undertaken to examine the real-world application of framework constructs in diverse communities, which was successfully conducted. [20] The framework behaviors were operationalized into the HCS coding system that scored -1 for negative behaviors and +1 for positive behaviors. The conceptual framework also formed the theoretical underpinning for the HCS self-report tool, a 21 item written questionnaire that included general cooking habits and specific food preparation practices used during the observed cooking session in order to assess self-report accuracy immediately after the event (Table 1). The HCS Self-report questionnaire items mirror the HCS coding system. The HCS coding system creates an assessment scale from -9 to +11 that could be applied to both observational and self-report data, allowing for a comparison between multiple data types.

Table 1: Example Items from HCS Self-report Questionnaire based on the Conceptual Framework of Healthy Cooking			
Framework Concept[a]	Defining Behavior[a]	Example Item	Example Answer
Cooking Frequency	Cooking at Home	On average, how many days per week do you cook at least one of your meals?	1 to 7 days
Methods	Use Low Fat Cooking Methods (baking, grilling, boiling, steaming, slow cooker)	During the observation session, did you use any of the following cooking methods?	Baking / Grilling / Boiling / Microwaving / Steaming / Sautéing - Pan Frying / Slow Cooker
Flavoring	Use Herbs/Spices	During the observation period, did you use herbs or spices?	Yes (participant write in type/amount) / No / I Don't Know / Not Applicable
Minimal Usage	Minimize Sugar/Sweeteners	During the observation session, did you add any sugar or sweeteners while cooking?	Yes (participant write in type/amount) / No / I Don't Know / Not Applicable
Additions / Replacements	Add unprocessed fruit / vegetables	During the observation session, did you add fresh or plain frozen fruit or vegetables (meaning not canned or frozen with seasoning, sugar or sauce) to your meal?	Yes (participant list all F/V used) / No / I Don't Know / Not Applicable
a) The original conceptual framework consisted of five overarching concepts, each defined by a set of behaviors. Framework development has been detailed elsewhere.[19]			

Height and Weight Measures: Height/weight measurements were collected from children in their homes for body mass index (BMI) calculations by trained staff. Weight was recorded in kilograms (kg) to the nearest tenth kg, using the Seca 869 digital scale. Height was recorded in centimeters (cm) to the nearest tenth cm using a Seca 0123 stadiometer. These measures were taken to establish characteristics of the study group. BMI was calculated according to the formula kg/m^2 based on the height and weight measurements. BMI measurements were compared to the CDC growth charts for children based on age and sex. BMI was grouped into healthy, overweight and obese as per CDC guidelines.[23]

Training of Observers: One to two research staff members were trained to conduct the observation sessions and record ingredients used during cooking. First, a manual of procedures detailing equipment set-up and a script for the video sessions was developed. Two full practice sessions were conducted in volunteer homes during evening meal preparation times. During these practice sessions, observers reviewed setting up equipment, taking notes on ingredients and amount used, and asking volunteer participants script questions and for clarification as necessary. Videos and notes of the practice sessions were reviewed to ensure compliance with manual of procedure guidelines. Issues were discussed and resolved between the two observers, and mediated by the principal investigator when necessary. Two observers were present for 25 percent of the video sessions and agreement between the two observers with regard to foods observed was high (95%). A practice height and weight collection was completed by both staff members on six volunteers, and calculated BMI measurements were within .12 between the two data collectors.

Data Analysis: Descriptive statistics were calculated for all demographic information as well as BMI data. Ingredient and amount information was analyzed using the Nutrient Data System for Research software (NDSR 2017, University of Minnesota, Minneapolis, MN). Principal Component Analysis (PCA) of the HCS was undertaken to identify distinct healthy cooking behavior patterns. The number of components extracted was based on the scree plot and varimax rotation used. Component scores were calculated and Spearman correlation coefficients used to examine total HCS, and component scores relative to meal nutrient profiles. Cronbach's alpha was calculated for the observed summative HCS to measure internal consistency of measure.

In order to identify and quantify discrepancies between observed and reported cooking behaviors, the HCS coding system described above was applied to directly observed (video sessions) and self-reported cooking behaviors as obtained by the HCS self-report tool. Forty percent of the observational data was coded by two research staff members, including one session observer and one non-observer; inter-rater reliability was calculated and agreement was high (Cohen's Kappa = .875, 92.8% agreement). [24] During coding, points were applied for each individual behavior, allowing for an examination of differences in observed and reported behaviors. Final scores were summative. Differences between self-reported and observed summative scores were assessed using a one-sample paired T test. A Bland Altman plot was constructed to estimate agreement between the self-report and observed measures. To assess validity, one researcher then paired behaviors from the observational and self-report records and classified them into three categories: a) matches at the item level (behavior reported and observed), b) intrusions (behavior reported but not observed), and c) omissions (behavior not reported but observed). Totals of each category formed percentages with the denominator as the sum of all items. Detailed notes and open-ended questions were used to elucidate the source of reporting errors. Individual items with errors in agreement over 90% were reviewed in depth for sources of discrepancy. This approach has been used in previous studies examining multiple assessments of diet-related behavior. [25]

Results

Participants: Over the 11-month recruitment period, 40 dyads completed the study. Participant characteristics are shown in Table 2. The majority of child participants were younger (under 14 years (87.5%)), female (65%), White or Hispanic (67.5%), and within a healthy range for BMI (60%). Most parents who participated in the study were mothers (95%). The age range of parents was wide (28 – 56 years). Most parents were highly educated, completing college or post-graduate study (72.5%), and socioeconomically stable with the majority owning their homes (77.5%) and earning above 60,000 per year (75%) (median household income in Texas is $54,727).[26] Participants made a variety of dishes during the cooking observation sessions (Table 3).

Table 2: Demographic Characteristics of Participants (n=40).

Child Characteristics %(n)		
Age	5 to 8	42.5 (17)
	9 to 13	45 (18)
	14 to 18	12.5 (5)
Sex	Male	35 (14)
	Female	65 (26)
Child Race	White	40 (16)
	Hispanic	27.5 (11)
	Black	17.5 (7)
	Other	10 (4)
	Asian	5 (2)
BMI Classification[a]	Healthy	67.5 (27)
	Overweight	17.5 (7)
	Obese	12.5 (5)
Parent and Household Characteristics		
Age mean (range)	39.9 (28 - 56)	
Female	95 (38)	
# Children in Home mean (range)	2.28 (1-5)	
Parent Education	High School	2.5 (1)
	Some College	15 (6)
	Tech School	2.5 (1)
	College Grad	32.5 (13)
	Post Grad	40 (16)
	Other	7.5 (3)
Marital Status[a]	Married	75 (30)
Owns Home[a]	Yes	77.5 (31)
Household Income[a]	Less than 60K	25 (10)

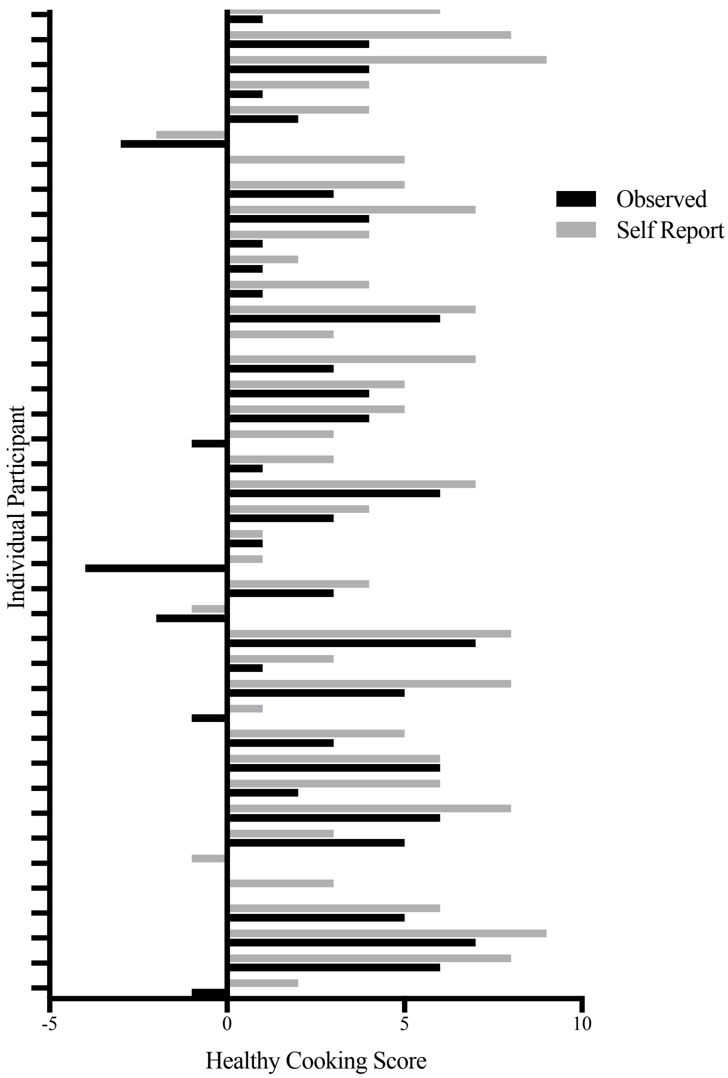
a) missing data n=39

Table 3: Dishes prepared resulting calories per serving and summative observed Healthy Cooking Score (n=40)

Dish Made (n)	Kcal per serving (range)	HCS (range)
Casserole (2)	*505 - 702*	*1 - 1*
Chicken w/ Sides (5)	*472 – 1410*	*-4 - 7*
Enchiladas (1)	*716*	*0*
Fish w/ Sides (4)	*309 – 618*	*4 - 7*
Hot Dogs (1)	*482*	*-3*
Pasta w/ Sauce (9)	*523 – 949*	*-1 – 6*
Pot Pie (2)	*498 – 518*	*1 - 4*
Stew/Chili (3)	*479 – 744*	*-2 – 6*
Stir Fry (6)	*304 – 986*	*1 – 6*
Stuffed Peppers (1)	*659*	*1*
Tacos / Tostadas (6)	*482 – 1034*	*-1 - 4*

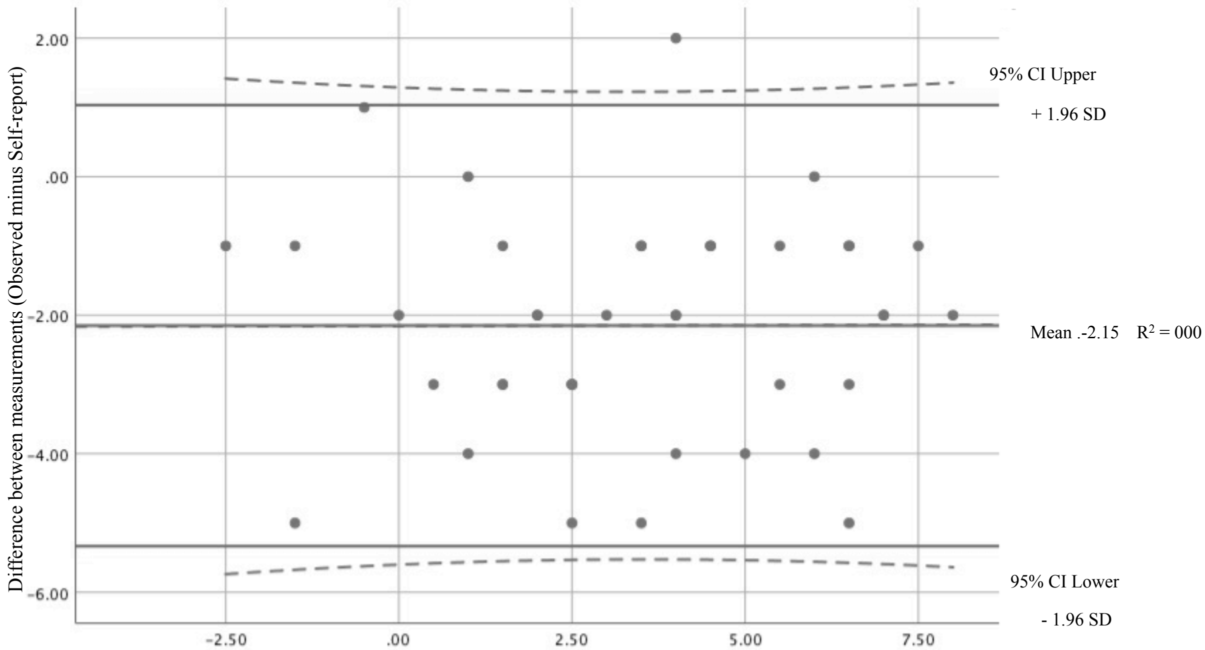
Observed versus Self Report HCS: Self-reported and observed healthy cooking scores were calculated for 40 participant dyads. Comparisons between the summative observed and self-reported HCS for each participant are shown in Figure 2. As a whole, differences between self-reported and observed HCS were significant ($t = -8.363$, $p < .001$). The difference between self-reported and observed healthy cooking scores are shown in the Bland Altman plot (Figure 3). No significant proportional bias was detected ($t=.020$). Only five percent of participants had perfect matches between self-report and observational summative HCS. Levels of discordance varied, with 30 percent of participants self-reporting scores within one point of their observational score, 25 percent of participants self-reported within two points of their observational score and 40 percent self-reported scores three or more points different than observed scores.

Figure 2: Participant Observed vs Self Report HCS



Observed versus Self Report HCS Items: Reporting errors were common for several HCS items. Most (95%) participants over-reported positive behaviors and/or under-reported negative behaviors, leading to higher self-reported HCS summative scores compared to observational data. Given the significant difference between self-reported and observed total scores, individual HCS items were categorized into matches, intrusions and omissions in order to identify errors in self-reporting (Table 4). Of the nineteen behaviors assessed by the HCS, nine had less than 90 percent agreement between self-reported and observed behaviors (Table 4, bottom grey). For negative behaviors, including preparing vegetables with creamy sauce, or using animal fats and processed foods, errors were more likely to be omissions, meaning the behaviors were observed in the home but were not reported. For positive behaviors, including measuring salt and fat, cooking from basic ingredients, errors were more likely to be intrusions, meaning the behaviors were reported by participants, but not observed during the cooking sessions. The sources of these errors are discussed below and presented in Table 4, along with possible modifications to the HCS self-report tool.

Figure 3: Bland Altman Plot Observed vs Self-Report HCS (n=40)



HCS Principal Component Analysis: Since it is unlikely that all the HCS items were independent of one another, we conducted a principal components analysis on the 19 observed HCS items to identify the structure of interdependencies. A scree plot was generated and revealed two potential factors, which were then extracted and varimax rotation applied (Table 5). One component (Health and Taste Enhancing) included adding fruit and vegetables, using alliums, citrus, herbs and spices, whole grains, processed foods, deep frying cooking methods, avoiding sweeteners and not measuring salt. The other component (Meat Focused) included cooking red meat at high temperatures to

Table 4: HCS item matches, omissions and intrusions.

Item Content	Match(%)	Intrusion	Omission
Deep Fry Method (-)	100	0	0
Red Meat at High Temp (-)	100	0	0
Used Red Meat (-)	98	0	2
Used Sweetener (-)	95	3	3
Used Processed Meat (-)	95	0	5
Used Alliums	95	3	3
Used Citrus	95	3	3
Used Low Fat Methods	93	3	5
Added Fruit/Veg	93	0	8
Used Olive Oil	90	5	5
Red Meat Well Done (-)	85	10	5
Used Whole Grains	85	8	8
Used Herbs and Spices	83	5	13
Prep Veg w/Creamy Sauce (-)	80	5	15
Used Animal Fat (-)	70	3	28
Measured Fat/Oil	53	45	3
Cooked from Basic	50	50	0
Used Processed Foods	50	3	48
Measured Salt	43	58	0

well done, using animal fat and processed meat, and measuring fat. Using basic ingredients, serving vegetables with creamy sauce and low fat cooking methods did not load on either factor. Using olive oil loaded similarly on both factors. Two component scores were calculated based on the observed HCS item scores for each participant, a "Health and Taste Enhancing" score and a "Meat Focused" score. Component scores, as well as the summative HCS, were compared to the nutrient composition of prepared meals (Table 6). The total observed HCS (r_s=-.315, p=.047) and the Meat Focused component score (r_s=-.376, p = .017) were negatively associated with saturated fat content of prepared meals. The Health and Taste Enhancing component score was positively associated with fiber (r_s=.435, p=.006), total servings of fruit (r_s=.365, p=.02) and servings of whole grains (r_s=.374, p=.017). The Cronbach's alpha score for the 19 items on the HCS was .628.

Table 5: Rotated Component Matrix[a]

HCS Item (Observed)	Component Health and Taste Enhancing	 Meat Focused
Add Fruit and Veg	**0.697**	0.215
Use Alliums	**0.679**	0.064
Deep Fry	**0.6**	0.14
Use Citrus	**0.543**	-0.165
Use Herbs and Spices	**0.498**	0.155
Use Processed Foods	**0.494**	-0.115
Use Whole Grain	**0.482**	-0.201
Add Sweetener	**-0.468**	0.146
Measure Salt	**-0.354**	-0.143
Use Red Meat	0.326	**0.877**
Cook Red Meat at High Temp	0.107	**0.845**
Cook Red Meat to Well Done	0.364	**0.71**
Use Animal Fat	-0.235	**0.499**
Use Processed Meat	0.231	**0.453**
Measure Fat	-0.043	**0.313**
Cook from Basic Ingredients	-0.072	0.179
Use Low Fat Methods	0.016	-0.068
Use Olive Oil	0.355	0.341
Serve Veg with Creamy Sauce	-0.221	-0.001
% variance accounted for	16.89	15.31

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 3 iterations.

Table 6: Correlations between total HCS, vegetable component score and meat component score with prepared meal macro/micro nutrients and total servings of key food groups

	Total HCS		Health and Taste Enhancing Score		Meat Focused Score	
	Rho[a]	Sig. (2-tailed)	rho	Sig. (2-tailed)	rho	Sig. (2-tailed)
Calories (Kcal)	-0.142	0.38	0.213	0.186	-0.098	0.548
Energy Density (kcal/g)	-0.101	0.534	-0.033	0.839	-0.077	0.639
Sugar (g)	-0.237	0.141	0.09	0.582	-0.169	0.298
Saturated Fat (g)	**-.315***	0.047	0.037	0.822	**-.376***	0.017
Fiber (g)	0.009	0.957	**.425****	0.006	-0.096	0.554
Carbohydrate (g)	-0.031	0.849	0.29	0.07	-0.052	0.752
Protein (g)	0.015	0.926	0.005	0.974	0.09	0.58
Total Servings of Fruit	0.052	0.751	**.365***	0.02	-0.178	0.273
Total Servings of Vegetables	0.009	0.954	0.156	0.337	-0.106	0.515
Total Servings of Whole Grain	0.068	0.676	**.374***	0.017	-0.103	0.528

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

a Spearman's rho correlation coefficient

Discussion:

This study examines the ability of school aged parents to self report cooking behaviors based on the Healthy Cooking Score, a tool for measuring the healthfulness of food preparations. The HCS is based on an existing conceptual framework of healthy cooking. The HCS coding system was used to quantify behaviors, and doubly-coded observations showed high agreement and inter-coder reliability. There were two main sets of healthy cooking behaviors determined by the PCA, one focused on meat products and another on vegetables and grains. The Cronbach's alpha score was relatively low, which was expected as the HCS was intended to measure different constructs relating to meal preparation.

The accuracy of the HCS self-report tool was assessed against recorded audio/visual observations of meal preparation events in 40 parent-child dyads. Our study found >90 percent agreement for 11 HCS items. However, we found significant differences between participant self-reported and observed summative healthy cooking scores. Self-reported healthy cooking scores were overall larger than observed scores. Negative behaviors were generally underreported, while positive behaviors were over-reported. In particular, nine items demonstrated less than 90% concordance between self-reported and observed practices. The secondary aim of this study was to identify areas for improvement to the HCS self-report tool. Therefore, a closer examination of these specific items was undertaken to elucidate potential modifications for the next iteration of the HCS. Table 7 describes the main sources of participant reporting errors, and offers potential modifications for the HCS.

Table 7: Sources of error for HCS items and potential modifications for the HCS Self-Report tool.			
Item (s)	**% error**	**Main Source of Error**	**Potential Modification**
Cooked from Basic Ingredients / Used Processed Foods	50	Did not report a range of foods as processed or "not basic", from minimally processed foods (pasta, cheese) to highly processed foods (salad dressing, heat-and-serve side dishes)	Offer a spectrum of types of ingredients used. Use the term "convenience foods. Remove questions about "basic ingredients" and "processed foods" or include a reference sheet.
Measured Fat/Oil / Salt	~48	Reported exact amount used, but did not measure or mention measure while cooking.	Reframe question to ask about using oil or salt more or less liberally
Used Animal Fat	30	Reported fat naturally present in protein as added fat (e.g. chicken fat), Did not report full fat cheese, sour cream, or butter as animal fat	Clarify the question to focus on added fats, not those naturally present in meat. Move dairy into a separate item
Prepared Vegetables with Creamy Sauce	20	Did not report creamy salad dressings used (e.g. ranch), Did not report mixed vegetable dishes in creamy sauce	Consider removing item as difficult to interpret and may be adequately covered by questions regarding animal fat usage
Used Herbs and Spices	17	Considered packaged, salty seasoning mixes as herbs and spices, Did not consider black pepper	Clarify purity of herbs and spices used and specify black pepper as spice
Red Meat Cooked to Well Done	15	Variability in definition of doneness with regard to pork sausage and ground beef	Offer visual representations of doneness specifically for ground red meats
Used Whole Grains	15	Did not report "corn" as a whole grain, Reported white rice as a whole grain, Mixed reported regarding newer pasta styles (e.g. high protein or veggie blend)	Clarify meaning of whole grain, Add language regarding grain products marketed as "healthy alternatives"

Red meat cooked at high temperatures and to higher doneness levels is associated with increased risk for certain cancers due to the production of two human carcinogens; heterocyclic amines and polycyclic amines. [27] However, meat doneness may be difficult for all home cooks to accurately identify. Offering visuals of meat doneness may help support more accurate reporting of this item. The Meat Module Questionnaire developed by Sinha et al., which addresses meat preparation methods and doneness level is one example of a FFQ supplement that includes visual aids to help clarify questions. [28] However, most participants in the current study used ground beef or sausage in pasta sauce or taco recipes as opposed to hamburgers or steaks. It may be more difficult to judge the doneness of ground meat products that are broken up during cooking, given the range of surface area exposed to heat during the cooking process.

Whole grain intake has been associated with reduced risk of certain cancers, diabetes and cardiovascular disease. [29] However, our sample demonstrated consumer confusion about whole grains, and which products contain them. White rice was confused for a whole grain by two participants, and corn was considered not a whole grain by three participants. Further, new pasta products, such as protein or vegetable enhanced pasta caused confusion regarding whole grain content and led to reporting errors. Future iterations of the HCS should consider innovative ways to clarify the meaning of whole grains beyond offering examples, such as offering a description of what makes a whole grain "whole". Further, packaged consumer products, such as pastas, are increasingly being labeled with whole grain symbols. More specific front of pack labeling may help consumers identify and report true whole grain products in an evolving era of "health food" advertising.

Saturated fat intake may be influenced by the use of animal fats, such as butter, during cooking. Although the recommendations on overall fat intake are shifting, most organizations, including the USDA and American Cancer Society still recommend limiting intake of animal-based saturated fat. [2,30] The use of animal fat was misreported in a portion of our sample, with a quarter of participants omitting animal fat usage. Despite being asked to respond yes or no to the use of various dairy products, these appeared to cause the most issues with eight participants omitting cheese usage, two omitting butter usage and two omitting sour cream usage. This may be due to the fact that these items were bundled with yes/no questions regarding other animal fats such as bacon fat, lard, and chicken fat. Separating out questions regarding dairy may encourage participants to report dairy usage more fully.

One of the biggest reporting issues included participant interpretation of terms including "basic ingredients" and "processed foods", which are not well defined in the current literature. [17] These two items measure similar constructs with slight variability in definition. Cooking completely from basic ingredients was defined in our study as "uses only: fresh, dry or frozen fruits or vegetables, grains, legumes, meat, fish and/or milk, salt, spices, unflavored oils". The item regarding processed foods asked if during the observation session, participants "cooked with processed foods (such as ready to heat meals, frozen pizza, bottled salad dressing, hamburger helper, pre-made dips?)". Despite these definitions and examples, approximately half of participants misreported cooking from basic ingredients and processed food usage. With regard to both questions, most misreporting was attributed to the use of processed, packaged ingredients. Seven participants did not report salty seasoning mixes (i.e. taco seasoning packets), seven did not report using pre-made bottled sauces, and six did not report ready to heat side dishes (i.e. frozen garlic bread) as processed foods or not basic ingredients. The term "basic ingredients" clearly has variability in meaning, even with a definition provided. Likewise, processed foods exist on a spectrum that may make it difficult for home cooks to report overall usage. Qualitative and survey studies on the concept of "basic ingredients" and "from scratch" cooking have shown similar variability in personal definitions. [17,18,31] Despite this variability among consumers, several evaluations of cooking behavior rely on items about "from scratch" or "basic ingredients", often with minimal definition provided. [7,32] Notably, when participants were asked to report if they cooked completely from basic ingredients during the observation session, half incorrectly reported they did; when asked if they cooked with processed foods 48% incorrectly reported they did not. Thus, there may be some value judgment associated with the terms "basic" and "processed". To help reduce this bias, and improve reporting, future versions of the HCS could offer a spectrum of ingredient usage from raw (i.e. raw chicken) to complete convenience foods (i.e. frozen pizza) and allow participants to select their level of convenience foods usage or remove these broad items completely. Other items from the HCS, including measuring fat and salt, and serving vegetables with creamy sauces could be reconsidered given their unclear impact on meal nutrient outcomes and difficulty of interpretation. Measuring ingredients in particular, seems to vary widely based on cooking style and experience.

This work provides a baseline for further development and revalidation of the HCS self-report tool, which could be used in the future to assess current family cooking habits, and evaluate cooking interventions. This is the first study that we are aware of to compare self-reported and observed cooking behaviors. There are several strengths to this project including the novelty of collecting observational cooking behavior data directly from families. This data offers a new perspective to existing qualitative research on the subject, which has, up to this point, depended on focus groups and exploratory surveys. [17,33] Another strength of this project includes the ethnically diverse, although small, sample. Finally, this study offers an in-depth analysis of healthy cooking behaviors and lays the groundwork for further testing of the HCS as an evaluation tool.

Limitations to this study include the limited sample size, wide range of participant demographics and use of a convenience sample. Age ranges and inclusion criteria were kept broad to maximize recruitment potential for this study. This study did not have adequate power to examine reporting errors by demographic characteristics, or cooking scores by demographics or child BMI status. The PCA was limited by sample size and future studies should consider conducting subsequent PCA with larger samples of preferably observed data. Together, these issues limit the ability to generalize results to the population overall. Further, this pilot study does not offer sufficient power to fully elucidate how demographic covariates impact cooking behavior or behavior recall.

In conclusion, this study offers novel findings regarding home cooking behaviors that will help support the further development of robust cooking program evaluation tools. By standardizing cooking behavior assessment, future research will be able to elucidate the transmission of cooking education through interventions, and the relationships between cooking practices, disease prevention and health.

Figure 1: Study process for participants. Scheme showing participant progress through the study. Study sessions lasted one evening for up to two hours, no follow up was conducted. The study consisted

of five major steps including prescreening, scheduling of the video sessions, conduct of video sessions, survey and height/weight completion and compensation.

Figure 2: Participant observed versus self-reported HCS. Bar graph showing self-reported (grey) and observed (black) summative healthy cooking scores by individual participant. Each participant is represented by a tick mark and two grouped bars. A HCS of zero shows no bar.

Figure 3: Bland–Altman plot showing the difference between the observational and self-report HCS. The horizontal axis represents the average of the scores measured by observation and the self-report method (possible range = -9 to +10). The vertical axis represents the difference between the two measurements (observed minus self-report). The middle solid line represents the mean difference, the other horizontal lines represent the limits of agreement, defined as the mean difference +/- 1.96 of the standard deviation. The middle dashed line represents the regression of the difference between measures. The two outer slanted grey lines represent the upper and lower bounds of the 95% confidence interval of the regression. Measures repeated at the same point are represented by a single marker.

Table 1: Example Items from HCS Self-report Questionnaire based on the Conceptual Framework of Healthy Cooking. Table showing main concepts from the conceptual framework used to inform the HCS self report tool. The first column shows the five main overarching concepts from the framework, each is defined by an example behavior in column 2. Column 3 shows the operationalized behavior as a questionnaire item and column 4 describes the responses offered to participants.

Table 2: Demographic characteristics of participants. Descriptive table of participants including children (top) and parents (bottom). Missing data was not included in analysis.

Table 3: Types of dishes prepared during study and resulting range of calories per serving and summative observed Healthy Cooking Score (n=40).

Table 4: Healthy cooking behavior item matches, omissions and intrusions. Table of individual HCS components with the percentage matches (both self-reported and observed), intrusions (self-reported but not observed) and omissions (not self-reported but observed). Cells with white background (top) show items with 90% or more agreement between self-report and observed scores. Cells with grey background (bottom) show items with less than 90% agreement.

Table 5: Table showing results of rotated principal component analysis. Bold numbers represent those items that load >.3 on a component, “Health and Taste Enhancing” or “Meat Focused”.

Table 6: Table showing correlations between total observed HCS, Health and Taste Enhancing component score and Meat Focused component score. Component scores were calculated using the observed HCS coded data and based on the PCA described above. Spearman correlations coefficients were calculated to examine associations.

Table 7: Sources of error for HCS items and potential modifications for the HCS Self-report. Table showing individual items from the Healthy Cooking Score coding system (column 1), the percentage of error in self-reporting (column 2), the main sources of errors (column 3) and potential modifications for future iterations of the HCS tool (column 4). All items with more than 10% error are included, and are ranked from least to most error. The items “measuring fat/oil” and “measuring salt/salty seasoning” were combined as sources of error were similar. The items “used processed foods” and “cooked from completely basic ingredients” were also combined due to similar issues in reported.

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Title: Feasibility and accuracy of the Sun eButton to identify nutrition optimizing home cooking behaviors.

Target: Journal of the Academy of Nutrition and Dietetics

INTRODUCTION:

Diet is a modifiable risk factor for several major diseases including obesity, diabetes, cardiovascular disease and many cancers. [1] Adherence to national nutritional guidelines, especially among children, is low; thus, healthy diet promotion efforts have increasingly focused on family nutrition education interventions. [2,3] As part of this effort, healthy home cooking and family meal preparation is being widely integrated into nutrition initiatives. [4-6] Home cooking, as opposed to eating out, has been associated with better diet quality and lower food costs. [7-10] Further, family meals are associated with better nutrition, lower rates of childhood obesity and improved adolescent emotional health. [11-13]

Several studies have examined the relationships between home cooking trends and cooking education interventions on various health-related outcomes. [4,6,7] However, robust assessment tools of cooking behaviors are lacking. Existing metrics tend to focus on self-reported psychosocial aspects of cooking such as confidence, perceived skills, and attitudes. [14-16] While helpful in understanding some constructs that may predict cooking behavior, these tools are not assessments of actual cooking behavior in the home. Thus, the relationship between cooking practices and health remains unclear. [4-6]

Direct observation has been used to objectively assess behaviors related to cooking such as parent feeding and family meal interactions. [17-19] While observational data may serve as a gold standard for this type of behavioral assessment, the approach requires substantial resources including time and staff. Novel wearable technologies, currently being piloted as more objective measures of diet, may offer a more accessible method for the objective evaluation of home cooking practices, especially as this technology becomes lower in cost and increasingly automated. [20-22]

One such device is the Sun eButton, a passive, chest-worn camera that takes a picture directly in front of the wearer at four-second intervals. [23] The eButton has shown promise in supplementing dietary recall and activity data in controlled settings. [24,25] The eButton could potentially be a valuable tool in the assessment of cooking behavior. However, the ability of the eButton to collect such program evaluation data in a natural, home setting has not yet been explored.

Our research group previously demonstrated that the eButton could be used to identify food preparation events in all-day images from a sample of preadolescents.[26] However, participants in the original study were not asked to prepare meals, and generally did not exhibit extensive food preparation behaviors. Further, a secondary assessment tool was not available to compare the eButton images to an alternative measure of cooking behavior, limiting conclusions regarding the eButton's ability to capture these practices. The current study builds on this preliminary work by examining the performance of the eButton during a single home-based food preparation event compared to observations of the same event. The observational data serves as the gold standard for examining the eButton's accuracy in capturing key cooking behaviors. The purpose of this study was to examine the feasibility and validity of the eButton system to identify healthy cooking behaviors against direct observation in a family home setting.

METHODS

This observational study was conducted between August 2017 and July 2018 in Texas, with a focus on the Houston and Austin metro areas.

Participants. A convenience sample of 40 parents, with one child aged 5 to 17 years, was recruited for this study. School-aged children were targeted given the likelihood that they still ate evening meals in the home. Paper and digital flyers were used to recruit families in the greater Houston and Austin areas over ten months. Inclusion criteria were: child aged 5 – 17, parents and children able to speak and read in English, no severe food allergies in the home, and parent reports cooking a meal for the child at least once a week on average. All study procedures took place in the participants' homes. Parental consent, permission and child assent were obtained. The University of Texas MD Anderson Cancer Center Institutional Review Board reviewed and approved the protocol (PA16-0995). Families were offered $50 gift cards as compensation at the end of their study participation.

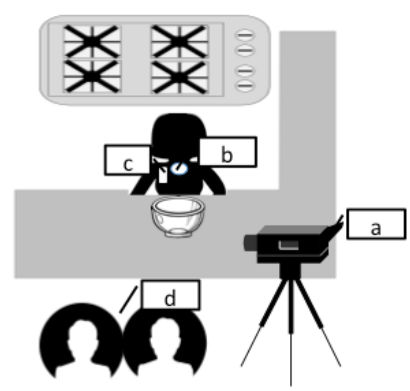


Figure 1: At Home Observation Session Set up. a) Wide Angle Video Camera captures the entire kitchen environment; b) eButton body camera device collects images in front of wearer at 4 second intervals; c) Wireless Lapel Microphone, participant explains preparation; d) Observers take notes on ingredients used and behaviors

Observation Procedures. A single observation / data collection session was conducted for each participant (Figure 1). Sessions took place in participants' homes, during normal family evening meal preparation times. At enrollment, families were instructed to report their most commonly made meals and were requested to make one of these typical dishes, or something similar, during the observation session. During the session, a digital video camera on a tripod was situated to capture the entire kitchen area (Figure 1a) and to ensure overall practices, environment, and assistance by children or others were adequately captured. The eButton units were activated by research staff and parents were instructed to place the eButton on the collar of their shirt (Figure 1b). Parent participants also wore a wireless lapel microphone (Figure 1c) and explained their actions as they performed them. One or two observers with expertise in nutrition took notes and asked questions and clarifications as needed (Figure 1d). Observer notes included ingredients and amounts used during the observation. Observers were trained to set up equipment and record notes through two full practice sessions undertaken before the start of study. After cooking was completed, parents removed the eButton and microphone and were asked to fill out three questionnaires covering demographics, cooking behavior and parenting practices.

eButton Procedures. The eButton is a wireless device worn on the collar or lapel. The unit consists of a camera, a 9-axis motion sensor, a barometer, a temperature sensor, and a light sensor (no audio). Data storage and a lithium-ion battery are built into the wearable unit. The eButton camera feature takes pictures of everything directly in front of and slightly below the wearer at four-second intervals during the wearing period. The eButton images are encrypted upon taking, and therefore can be stored safely until analyzed. During the data collection sessions, parents were asked to place the eButton on their collar (Figure 1b) before they began cooking and to leave the unit on until the food preparation event was complete. Parents were instructed to remove the eButton if it was uncomfortable or in the way during cooking. All issues with the resulting eButton data were documented during analysis. The eButton images were analyzed using specialized activity categorization software developed for the unit. The activity categorization software has been detailed elsewhere.[23] Briefly, the software allows researchers to view the images in clusters of events. When reviewing the images in the software viewer, the researcher can cut the string of images into smaller sets and drop image clusters into specified categories. In this study, the category settings were set to match a pre-determined coding system of food preparation behavior, the Healthy Cooking Score.[27] The software then outputs an excel file documenting which images fit into each category.

Healthy Cooking Score Coding. The Healthy Cooking Score coding system (Table 1), was applied independently to both the observational and eButton data. The Healthy Cooking Score coding system is based on a previously published, evidence-based conceptual framework of healthy cooking.[27] The framework was developed from a systematic literature review of peer-reviewed articles examining food preparation and health across multiple disciplines. Relevant food preparation practices were assembled into five overarching constructs defined by individual behaviors. These behaviors formed the individual points of interest for the resulting coding system, with -1 applied to negative behaviors demonstrated and +1 applied to positive behaviors demonstrated (Table 1). The possible summative healthy cooking score range is -9 to +10. Both observational data and eButton data sets were independently coded by one research staff member. Observational data included all video, audio, and observer notes combined to serve as the definitive, gold-standard of cooking behavior. The eButton data consisted of eButton images alone. Twenty percent of each data set was coded by two researchers as a quality control procedure. One reviewer was a doctoral level student with experience in coding eButton data for cooking behaviors; the second coder was a college student trained in use of the software. Neither coder was a registered dietitian, but both had experience in community nutrition programming. Between the two coders, inter-coder reliability as concordance and percent agreement was acceptable for both the observational data (k = .875, 92.8% agreement) and eButton data (k = .775, 89.8% agreement).[28] The HCS does not represent an exhaustive list of cooking practices, but rather focuses on behaviors from the extant literature that potentially impact the nutrition of prepared meals.[27]

Table 1: Healthy Cooking Score Codebook

Item	Description	Points
Basic Ingredients	Uses **only**: fresh, dry or frozen fruits or vegetables, grains, legumes, meat, fish and/or milk, salt, spices, and unflavored oils	+1
Low Fat Method	Any instance of the following: bake, grill, boil, microwave, steam, slow cook	+1
Measure Fat	Uses measuring spoon or describes measurement of oil or fat used, or does not add any/negligible amount of fat	+1
Measure Salt	Uses measuring spoon or describes measurement of salt or salty seasoning used or adds no/negligible amount of salt or salty seasoning	+1
Fruit & Vegetables	Adds any fresh or frozen (pure / unseasoned / unsweetened) fruits or vegetables	+1
Olive Oil	Uses olive oil	+1
Alliums	Uses garlic, onions, leeks, or shallots in any form (frozen, fresh, powder)	+1
Herbs & Spices	Uses any fresh or dried herbs or spices / salty seasoning mixes (i.e. seasoned salt) are not counted	+1

Citrus	Fresh or concentrated orange, lemon, grapefruit, lime in any form (fruit, juice or zest)	+1
Whole Grains	Brown rice, whole wheat flour/bread, quinoa, oats, corn, farro or other whole grains	+1
Cook with processed foods	Uses any foods that have undergone substantial processing including canned, jarred, or packaged products that are seasoned or sweetened. This includes salad dressings, seasoning mixes, canned soups, bottled sauces, ready to heat meals and side dishes and the like. This does not include minimally processed foods such as tortillas, breads, cheese, sour cream, jarred garlic, unseasoned, unsalted, and unsweetened canned/jarred products.	-1
Deep Fry	Any meal component is fully submerged in hot oil or grease	-1
Red Meat	Uses any beef, lamb, pork, veal	-1
Red Meat at High Temp	Red meat (above) is cooked by boiling, BBQ, grilling, broiling or pan sauté	-1
Red Meat to Well Done	Red meat cooked to well done (no pink in center) and/or dark browned if fried	-1
Sweetener	Adds sugar, honey, agave, stevia or other sweetener while cooking	-1
Animal Fat	Butter, chicken fat, lard, full fat cheese, bacon fat, cream or other animal fat	-1
Processed Meat	Any processed meat including pepperoni, salami, sausage, lunch meat, bacon, or similar	-1
Vegetables with Creamy Sauce	Prepares vegetables with creamy sauce including creamy dressing for salad, cheese sauce or other white sauce	-1

Table 1: Table showing items and points applied in the Healthy Cooking Score coding system. Final scores were summative and could potentially range from -9 to +10.

Data Analysis. Participant demographics were analyzed using descriptive statistics. The eButton image and observational data sets were coded using the Healthy Cooking Score (HCS) coding system described above. A summative HCS was calculated for each data set from each participant. The accuracy of the eButton was examined by comparison to the direct observational (gold standard) data. An independent one-sample t-test was used to determine differences between the summative healthy cooking scores of the two measures and a Bland Altman plot constructed to estimate agreement. One research staff member reviewed the coded data sets and classified individual items into matches (recorded by both eButton and observation) and non-matches (observed but not captured by the eButton). Totals of each category formed the percentage groups, with the denominator as the sum of all items. This approach has been adapted from previous studies.[29] Items with higher rates of non-matches were re-examined to identify major sources of error between the eButton images and observational footage of the cooking event. Overall issues concerning eButton feasibility including time needed for analysis were also reported.

Table 2: Participant Characteristics (n=35)

	Mean	Range
Parent Age (years)	40.4	28 - 56
Adults in Household (#)	2.14	1 - 5
Children in Household (#)*	2.24	1 - 5
Weekly Cooking Frequency (days)	5.11	3 - 7
	n (%)	
Female Parents	34 (94%)	
Child Ethnicity:		
Asian	2 (6%)	
Black	7 (20%)	
Hispanic	9 (26%)	
White	13 (37%)	
Other	4 (11%)	
Married	26 (74%)	
Income > 60K	27 (77%)	
Owned Home	26 (74%)	
Parent Highest Level of Education:		
High School Graduate or Less	0 (0%)	
Some College	4 (11%)	
Technical School	1 (3%)	
College Graduate	12 (34%)	
Post Graduate	15 (43%)	
Other	3 (9%)	

Table 2: Descriptive statistics of demographic information of parent participants and household. Missing data is excluded *N = 34.

RESULTS

Participants. A total of 40 parent participants completed this study. However, in five cases, eButton data were not usable. This was due to scrambled images (n=2) or the eButton producing no photos (n = 3). The demographic variables for included participants (n=35) are shown in Table 2. Most participants were female, and the average age was 40.4 years old. The range of ages was large, 28 to 56, although this was not surprising given the broad inclusion criteria regarding child age. While parent ethnicity was not collected, most participating children were White (37%) or Hispanic (26%). The majority of parent participants were married (74%), attained a college degree or beyond (77%), and owned their homes (74%). Nearly three quarters lived in households with incomes exceeding $60,000. The average family income in Texas is $56,565. [30]

Observed vs eButton Images. A one-sample t-test of differences showed no significant differences between the eButton vs observed cumulative healthy cooking scores (t = 1.346, p=.187). A Bland Altman plot (Figure 2) indicated a mean difference of .417 HCS points (95% CI -.21, 1.05) with a SD of 1.857. No significant proportional bias using simple linear regression (r^2=.07, SE = 1.817) was found. Differences in summative scores between the observed and eButton data sets for each participant demonstrated the eButton generally captured fewer HCS behaviors than the direct observation data, although some participants showed perfect agreement (n=8, 23%) (Figure 3)

Figure 2: Bland Altman Plot Observed vs eButton HCS (n=35)

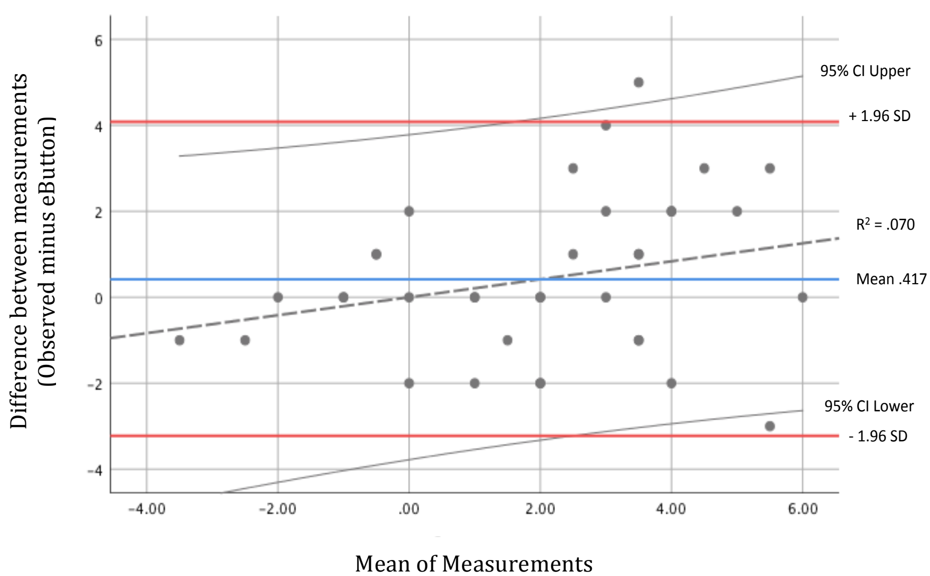
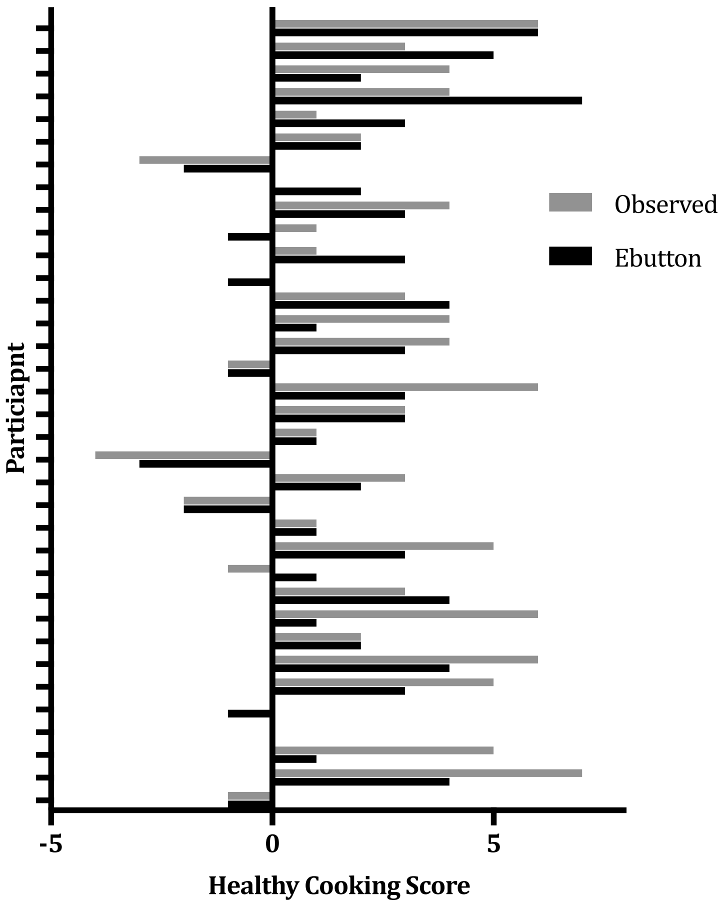


Figure 2: Bland–Altman plot showing the difference between the gold standard (observational) and eButton HCS. The horizontal axis represents the average of the scores measured by observation and the eButton method (possible range = -9 to +10). The vertical axis represents the difference between the two measurements (observed minus eButton). The middle solid line represents the mean difference, the other horizontal lines represent the limits of agreement, defined as the mean difference +/- 1.96 of the standard deviation. The middle dashed line represents the regression of the difference between measures. The two outer slanted grey lines represent the upper and lower bounds of the 95% confidence interval of the regression. Measures repeated at the same point are represented by a single marker.

Figure 3: Ebutton vs Observed HCS



To better understand which elements of the HCS were impacting score variability, each item was examined with regard to matches (observed and captured by eButton) and non-matches (observed but not captured by eButton) (Figure 4). Black dips on Figure 4 show increased item mismatch between eButton and observational data. The eButton had the most error in capturing low fat cooking methods (31% unmatched), processed food usage (34%), measurement of salt (40%)/fat (40%) and use of animal fat (40%)/olive oil (37%).

Figure 4: Ebutton versus Observed Score by Healthy Cooking Score Item

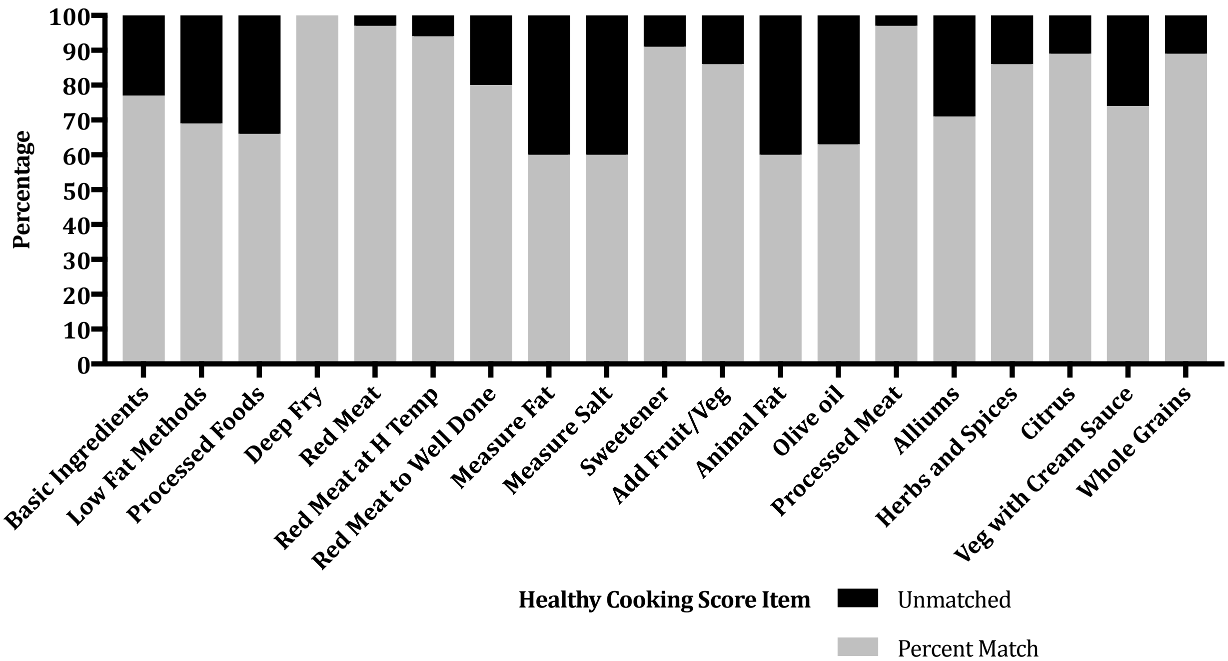


Figure 4: Bar chart depicting the percentage of matched (grey) and unmatched (black) by individual HCS item (n=35). All grey bars denote perfect agreement between eButton and the observed cooking practices. Larger black bars denote less agreement.

Feasibility of eButton. Five out of 40 participants had unusable eButton data. In two cases, the eButton images were scrambled together. This was most likely due to the previous images not being properly cleared from the mini SD drive. This could be potentially problematic because in the home environment, it is likely that researchers will want to capture multiple days of cooking. With that in mind, future versions of the eButton should consider making the units usable for multiple days in a row. Three participant eButtons failed to create any images. Although eButtons were tested prior to being used in the field, several failed over time. Other issues included blurry images, or loss of relevant images due to the eButton placement. Beyond the collection issues, eButton images were successfully analyzed by two independent coders, showing high inter-rater reliability. Using the image categorization software described above, a single set of participant images could be coded between fifteen minutes to one hour. This variability mirrored the range of preparation times of participants (8 to 120 min), and was similar to the time need to code the observational data. Participants were instructed to remove the eButton if it was in the way or uncomfortable during cooking. Although participants rarely adjusted the eButton during cooking, none removed the unit until food preparation was complete. No participants reported discomfort with the eButton.

DISCUSSION:

This study examined the accuracy of the eButton image sensor in identifying nutrition optimizing home cooking practices. The eButton images were collected during 35 out of 40 home cooking events and compared to audio/wide-angle video observations of the same events (gold standard). By examining differences in summative healthy cooking scores and individual cooking practices between the two methods, we found specific cooking behaviors were accurately assessed using the eButton unit when the sensor functioned properly. Certain practices, including measuring salt / fat and using certain types of fat were more prone to eButton recording or coding error. No participants reported issues with the comfort of the eButton during cooking or removed the eButton during the cooking sessions. However, five participant eButton images were not usable in the analysis. Thus the eButton offers an objective, passive, and relatively non-invasive measurement tool of home cooking behavior.

Assessment tools of home cooking behavior overall are lacking, leading to variability in cooking program evaluation and, in turn, challenging attempts to compare findings in this growing area of research. [4,5] Robust measures of cooking behavior should be both valid and equivalent in multiple contexts [31] , yet existing assessment tools of cooking behavior have relied on test-retest reliability and internal consistency of self report for validation. [15,16,32] One major limitation for cooking assessment tool development is the lack of a definitive measure of cooking behavior. To our knowledge, this is the first study to demonstrate accuracy of a cooking assessment tool relative to a gold standard measure (observed audio/wide angle video of cooking behaviors). Although the eButton image data were not perfectly matched with the audio/video observational data, differences were not significant and centered around measurement tool usage and specific fat usage. Given the eButton's ability to approximate video camera type observational data, the unit could be utilized as a validator of self-report cooking behavior metrics.

The assessment of cooking practices in general is challenged by the lack of standardized definitions of key terms including "from scratch", "basic ingredients" and even "cooking" itself. Recent qualitative and survey studies have found widely varying definitions of these concepts. [33-35] Despite this disconnect, studies rely on these terms for identifying cooking habits in the population. [7,8,10] Self-report tools that attempt to identify these behaviors in a population may suffer from variable conceptualizations of these terms by respondents. The eButton could supplement or supplant self-report cooking behavior data by offering insight into actual home practices.

Our study demonstrated the accuracy of the eButton in capturing cooking behaviors in a home environment, and low resistance to using the technology in our sample. The Mobile Food Record and similar tools such as the Food Record App [36] and Nutricam Dietary Assessment Method [37], rely on existing digital platforms, namely a mobile phone. [38] This approach may reduce research costs and improve participant adherence to home recording in the absence of observers. However, cooking is a dynamic activity that requires some level of movement and the use of one's hands. A wearable camera, such as the eButton, or a mechanism for video recording cooking behavior in real time on a mobile phone may be favorable for cooking assessment.

The identification of cooking practices may support dietary assessment by offering more detail on food preparation that may impact nutrient analysis. By focusing on cooking practices more broadly using an evidence-based coding system, our study also allows for a more flexible assessment of diet-related behaviors that does not rely on the limitations of current food composition databases. [39] Further, our study demonstrated that a simple coding system of behaviors (the HCS) could be used by two independent coders with relatively high agreement. Thus, the HCS offers a feasible approach to coding observed cooking behavior across different data collection methods (audio/video and eButton).

Wearable assessment tool technology will always have some error due to physical and technological issues such as placement, lighting and blurred images. The sources of eButton inaccuracy in this study were mainly related to the physical placement of the eButton. The eButton was designed to be worn in the center of the chest, the body type of some participants led to the eButton angle being pushed upwards. This led to repeated images of kitchen cabinetry, but failed to capture all cooking practices of interest. Obstruction by clothing and movement of the eButton to one side also led to missed practices. These issues may be resolved by reconstruction of the eButton to be worn in an alternative area of the body. Participants in this study were not told to wear specific clothing during cooking sessions. Requesting participants wear slimmer fitting tee shirts with high collars may reduce obstruction by clothing.

Other issues included the help of other family members during the cooking process. While easily captured by the wide-angle camera, the practices of assistants (children, spouses, etc.) are not shown in the eButton image files. One potential resolution to this issue would be offering multiple units for all of those helping in food preparation. However, as children or spouses often move in and out of the kitchen, helping only briefly, this may be difficult to achieve in the field. Fitting the eButton with a wider angle camera may improve the ability of the eButton to capture the cooking habits of surrounding family members.

Video data used in this study were supported by accompanying audio. The addition of audio capture in the eButton may support images in several ways. Participants could be instructed to recount what any assistants in the kitchen are doing in order to supplement the eButton images. During cooking observations, several participants noted what tasks assistants in the kitchen were completing, and stated measurements of fats and oils while cooking, but did not use formal measuring spoons or cups. The addition of audio would allow the capture of participant perception of quantities used. The placement of products and pre-prepping also limited the ability of the eButton to capture all cooking practices. Additional audio allowing participants to explain the products they are using and any pre-prepped tasks would allow for a more well-rounded account of cooking events.

This study has several limitations including the use of a small, non-representative convenience sample. Participants were predominantly White or Hispanic and well educated, which was not representative of the area. Observers were present during cooking events in order to observe and record home cooking practices. The observers also turned the eButton units on, and instructed the participants in where to place them on their clothing. It is unclear if participants would be able to use the eButton properly without instruction. Finally, the eButton failed to produce usable images for five out of the forty participants recruited for this study.

CONCLUSIONS:

The eButton offers an objective and passive measurement of home cooking behavior. Use of the eButton accurately identified key nutrition optimizing behaviors compared to video/audio observations. The eButton may serve as an objective reference measure for the creation and validation of cooking behavior assessment tools, and in the evaluation of cooking programming. Future iterations of the eButton should consider the addition of audio recording capabilities and alternative body placement of the unit to maximize the collection of cooking behaviors. As the technology develops, further automatic identification of food preparation behaviors may be wired into image-analyzing software to increase the wider utility of the eButton device.

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Title: Exploring Food Preparation Practices in Families with and without School-Aged Childhood Cancer Survivors.

Target: ACTA Oncologica

Introduction

The overall 5-year survival rate for childhood cancers has significantly improved over the last several decades and is currently at 84 percent. [1] Due to this high rate of survivorship, there has been an increased focus on the long term health and wellness of childhood cancer survivors (CCS). CCS are at increased risk for several late-effects of treatment including cardiovascular disease, obesity, and secondary cancers. [2,3] CCS tend to gain weight during the course of treatment and remain at a higher weight into survivorship, emphasizing the need for nutrition interventions throughout the cancer care continuum. [4]

CCS have been shown to eat inadequate whole grains, fruit and vegetables, and fiber while consuming an excess of meat and sodium. [5-7] The HEI-2010 is a measure of adherence to the USDA dietary guidelines for Americans. [8] One study among CCS diet through a one-year period used the HEI-2010 to determine diet quality. The authors reported mean HEI-2010 score was about 50, or half of the maximum score of 100. [5] A large, nationally representative survey among school aged American children, found a similar pattern with a mean HEI-2010 score close to 50. [9] A HEI-2010 score of 80 is considered a healthy diet. [9] Both CCS and non CCS reported inadequate total vegetable, whole grains, greens and beans intake. [5,9]

Several strategies to promote a healthier diet have shown promise among healthy (non cancer) children including family-based multi-component interventions. [10] Given that CCS and non CCS have similar intake inadequacies, survivors may benefit from interventions developed for the general population. Current CCS practices and needs must be considered as they may differ from the healthy population.

The stress of treatment and the emotional weight of being diagnosed with cancer may negatively impact food choices and dietary patterns of the entire family and patient. [11,12] After the completion of treatment, children and parents may struggle to break unhealthy habits created during this period. [4] Qualitative research has suggested CCS parents may demonstrate overprotective or “spoiling” feeding practices, and lack boundary setting. [13-15] Other research has suggested parents are more likely to use monitoring and restrictive food parenting practices with their CCS. [16] While this literature helps understand the emotional coping strategies of CCS parents, the translation of these feeding practices and coping mechanisms on actual food preparation practices is unknown. By understanding similarities and differences between CCS and non CCS family cooking habits, we may be more prepared to introduce and adapt family-based nutrition resources and interventions into the CCS population. The goal of this study is to describe specific food preparation practices of CCS and non CCS families. The results of this study offer insight into the practical dietary behaviors of CCS families to aid in the advancement of nutrition programing for this high risk population.

Methods

Setting and Study Participants

This study used an observational, cross-sectional, mixed-methods design. Participants were parent-child dyads. The convenience sample included one parent with a CCS at least one year off all treatment (n=11). A sample of non CCS and their parents were also recruited for comparison (n=29). Participants were eligible if (a) children were aged 5 to 17, (b) parents could read and speak English, (c) parents self-reported preparing meals for their children at least one time per week on average, and (d) no one in the home had food allergies. Participants were recruited between September 2017 – June 2018. This study was approved by the University of Texas MD Anderson Cancer Center (PA16-0995).

Procedure

CCS were recruited from the MD Anderson Children's Cancer Hospital. Research staff identified eligible survivors through the MD Anderson Survivorship Network, providers, and hospital events. A total of 109 CCS were identified as eligible for the study based on their medical record information and contacted for study participation. Contact methods included phone calls, provider visits, mailed letters from the study principal investigator, digital and paper flyers, and presentations at hospital events. Forty-five CCS parents responded to our recruitment attempts (41%). Of these 45, 21 declined due to impact from a recent hurricane in the region (n=11), general disinterest in the study (n=7), and discomfort being filmed in their homes (n=3). Six CCS parents were found to be ineligible during the screener. Eighteen parents requested more information or agreed to be in the study. Of the 18 that initially agreed, three did not respond to further contact attempts, and two reported being unable to participate in the study due to continued hurricane-related disruption. Eleven participants completed the study (24% of respondents). Non CCS families were recruited through paper and digital flyers posted in the greater Houston and Austin, Texas area. Thirty-four non CCS parents contacted study staff for more information after seeing the flyers. One was ineligible due to severe food allergies and four did not respond to further contact after completing the screener. Twenty-nine non CCS dyads completed the study.

Video Observations of Cooking Events. Each participant dyad scheduled and completed a video observation session during a normal evening meal preparation event. Video sessions were scheduled according to participant availability. Prior to video session scheduling, parents were asked to report their most commonly made dishes. Upon scheduling, parents were asked to select and prepare one of the commonly reported dishes or something similar. Parent informed consent and child assent were completed in the home before filming. Equipment was arranged in participant kitchens and included (a) a wide-angle camera on a tripod positioned to capture the entire kitchen area (Canon VIXIA HFR800), (b) a wireless, lapel worn microphone placed on the parent participant (MOVO WMIC70), and (c) a small, chest-worn body camera (Sun eButton) to provide another angle on cooking behaviors.[17,18] Parents were then instructed to prepare their planned meals, and to explain what they were doing and why into the microphone during the course of food preparation. One to two observers were present during the video sessions to take notes and ask for clarification as needed during the session. Prior to beginning preparation tasks, all parents were asked to state what dish they were making and why they chose to make the dish. Parents were also encouraged to talk about their general cooking practices and any factors impacting their cooking habits. Video session recordings were analyzed using a coding system of cooking behaviors, the Healthy Cooking Score, based on a previously developed conceptual framework of healthy cooking.[19]

Healthy Cooking Score

The Healthy Cooking Score (HCS) is an index of food preparation practices that applies points for specific behaviors, which are summed to create a composite score of cooking behavior. The practices identified by the HCS focus on five main constructs of cooking behavior including techniques/methods, general cooking frequency, ingredient additions/replacements, minimal usage, and flavoring. These five constructs are defined by a set of individual practices, both positive (i.e. using olive oil) and negative (i.e. deep frying). The HCS coding system applies a simple +1 for the demonstration of positive behaviors and -1 for the demonstration of negative behaviors. The construction of the conceptual framework underpinning the HCS is detailed elsewhere.[19]

The items on the HCS are relevant to CCS given their generally poor diet quality and increased risk of cardiovascular disease, unhealthy weight gain, and secondary neoplasms.[12,16,20] The HCS items fall under five domains and include 1) *Frequency of cooking from basic ingredients*, which includes meals made from fresh, dry or frozen vegetables, meats, grains, beans, spices, and unflavored oils. Frequency of cooking from basic ingredients has been positively associated with improved diet quality based on the HEI-2010.[21-23] 2) *Additions and replacements*, includes adding fruits and vegetables, using olive oil and replacing refined grains with whole grains. CCS have been shown to have poor diet quality in the areas of fruit and vegetable, whole grain and fatty acid intake. [5] Certain chemotherapies commonly used in the treatment of pediatric cancer, particularly of the anthracycline class, are known to cause cardiotoxicity and predispose pediatric patients to cardiovascular disease later in life. [24] Mediterranean diet staples such as unrefined cereals, olive oil, and fresh produce should be encouraged in this population given their potential for reducing cardiovascular risk. [25] 3) *Techniques and Methods* include practices that have been associated with increased risk of several cancers such as cooking red meat at high temperatures, cooking red meat to well done, and deep-frying [26-31]. This domain also covers measuring salt and fat, and using low fat cooking methods. 4) *Minimization* includes reducing sugar/sweeteners, animal fat, red meat, and processed foods during meal preparation. These are targets for survivorship interventions given that CCS not only consume excessive sodium, sugar and saturated fat after treatment, but may continue these habits into adulthood. [5,6,16] 5) *Flavoring* includes the reduction of sodium and excess calories by using fresh, dry or frozen alliums, herbs, spices, and citrus. This domain also encompasses the use of processed meats for flavoring, which (along with red meat) has been positively associated with increased cancer risk and cardiovascular disease. [32] Avoiding creamy sauces with vegetables is also included, as increasing vegetable intake alone is unlikely to have a positive impact on adiposity if consumed in conjunction with energy dense foods (e.g. ranch dressing on salad). [33]

Meal Nutrient Measures. During video sessions, observers estimated the ingredient amounts used in meals and clarified the contents of certain ingredients with participants as necessary. Participants were asked to report the number of servings yielded from each recipe. Nutrient compositions of final meals were analyzed using the Nutrient Data System for Research software (NDSR 2017, University of Minnesota, Minneapolis, MN). Estimates were made for one serving and assumed no seconds. Items used at the table, such as salt and pepper, but not during food preparation were not included.

Demographic Questionnaires. A demographics and family characteristics questionnaire included items on parent age, gender, education, ethnicity, income level, marital status, and child age and gender, as well as family meal habits. Time off treatment and diagnosis information were collected from CCS families.

Body Mass Index (BMI). BMI was calculated according to the formula kg/m^2 based on the height and weight measurements. To measure height, a wall-mounted height board (Seca 0123 stadiometer) was used; weight was measured using a digital scale (Seca 869 digital scale). The scale and stadiometer were brought to participant homes for measurements and collected by trained project staff. BMI measurements were compared to the CDC growth charts for children based on age and gender and BMI percentiles obtained. Based on these percentiles, children were categorized into healthy weight (<85th percentile), overweight (85th – 95th percentile) and obese (>95th percentile).[34]

Data Analysis Procedures

Demographic and family characteristics, as well as cooking habits were examined by CCS status. Differences between categorical characteristics of the two groups were examined using chi-square tests. Types of ingredients and amounts used were examined using nutrient analysis software (NDSR). Nutrient profiles of meals including carbohydrate, fat, saturated fat, protein, sugar, fiber, calories and energy density were examined.

Resulting videos were coded for healthy cooking practices using the Healthy Cooking Score coding system. The coding of specific healthy cooking behaviors generated a summative, numerical score for each video session. Healthy Cooking Scores in CCS and non CCS families were initially compared using a two independent samples t-test. A one-way ANCOVA was then conducted to examine differences between the groups controlling for dissimilarities between the two groups including: number of children in the home and race. Frequency of individual behaviors from the Healthy Cooking Score were examined

Table 1: Demographics and Family Characteristics of Participants

	CCS % within group (n)	Non-CCS	P value
Parent Gender			
Male	9.1 (1)	3.4 (1)	0.465
Female	90.9 (10)	96.6 (28)	
Parent Age			
35 and Under	18.2 (2)	17.2 (5)	0.984
36 to 45	63.6 (7)	62.1 (18)	
46 and Over	18.2 (2)	20.7 (6)	
Child Gender			0.911
Male	36.4 (4)	34.5 (10)	
Female	63.6 (7)	65.5 (19)	
Child Age			
5 to 8	18.2 (2)	51.7 (15)	0.159
9 to 13	63.6 (7)	37.9 (11)	
14 to 18	18.2 (2)	10.3 (3)	
Child Race			
White	45.5 (5)	37.9 (11)	**0.041**
Hispanic	36.4 (4)	24.1 (7)	
Black	0 (0)	24.1 (7)	
Asian	18.2 (2)	0 (0)	
Other	0 (0)	13.8 (4)	
Child BMI			
Healthy	63.6 (7)	69 (20)	0.421
Overweight	18.2 (2)	17.2 (5)	
Obese	9.1 (1)	0 (4)	
Number of Children in House			
1	50 (5)	10.3 (3)	**0.021**
2	20 (2)	55.2 (16)	
3 +	30 (3)	34.5 (10)	
Parent Married	90.9 (10)	69 (20)	0.349
Income > $60,000	63.6 (7)	75.9 (22)	0.515
Owns Home	100 (11)	69 (20)	0.111
Highest Household Education			
< College Grad	9.1 (1)	6.8 (2)	0.61
College Grad +	81.8 (9)	86.2 (25)	

by group. Comparative and descriptive statistics were performed with SPSS (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp).

Results:

Participant Demographic and Family Meal Characteristics

Characteristics of participants are shown in Table 1. Most parent participants were female, well educated, and between 36 – 65 years old. Child participants were majority female and under the age of 14. Differences between the CCS and non CCS group included child race, with the non CCS group being more racially diverse (p = .041). In both groups, however, children were predominately White or Hispanic (CCS = 81.9%; non CCS = 62%). The groups also differed significantly by number of children in household, with CCS households more likely to have only one child (CCS=50%; non CCS= 10.3%, p=.021). The majority of families in both groups owned their homes and earned more than $60,000 per year. The majority of CCS completed treatment between one and three years ago (63.6%).

Both CCS and non CCS parent participants reported similar family meal and cooking frequency habits. Parents reported having dinner together as a family on four or more evenings during a typical Monday to Friday (CCS = 72.7%; non CCS= 68.9%). Most parents noted evening meals were usually consumed in the home, as opposed to at a restaurant or another person's home. With regard to number of days parent cooked the child's evening meal, the majority of both groups reported cooking five or more days (CCS = 63.7%; non CCS =55.2%).

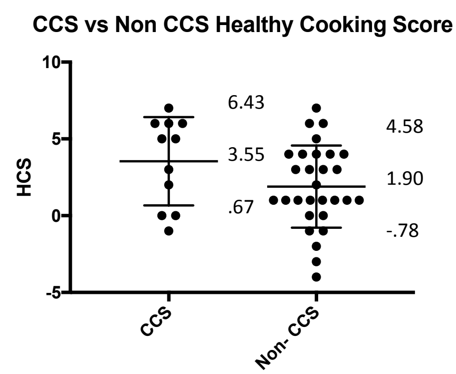

Figure 1: Scheme depicting summative Healthy Cooking Scores (HCS) among CCS and non CCS. Each dot represents a case (n=11; 29). Middle bars represent group means. Top and bottom bars represent standard deviations.

Participant Healthy Cooking Practices:

CCS summative Healthy Cooking Scores (possible range = -9 - +10) ranged from -1 to +7 (mean = 3.55, SD=2.876). Non CCS scores ranged from -4 to +7 (mean = 1.90, SD=2.677) (Figure 1). No significant difference was detected between the groups (t= -1.705, p= .096). These results were consistent when controlling for major between group differences (F(1.902) p=.175). Items from the healthy cooking score coding system were explored by group (Figure 2). Non CCS were slightly more likely to use processed meats (CCS = 0%; non CCS = 20.7%) and cook red meat to well done (CCS = 9.1%; non CCS = 31%). CCS were more likely to measure salt or salty seasonings (CCS = 54.5%; non CCS = 27.6%) as well as fat (CCS=72.2%; non CCS = 41.4%). High percentages of both groups used animal fats (CCS=72.7%; non CCS=79.3%), and processed foods (CCS = 81.8%; Non CCS= 72.4%). Lower percentages of both groups used whole grains (CCS=27.3%; Non CCS=31.0%) and cooked from basic ingredients (CCS=0%; non CCS=3.4%). Overall, CCS and non CCS participants demonstrated similar healthy cooking practices based on both the summative and component healthy cooking score items.

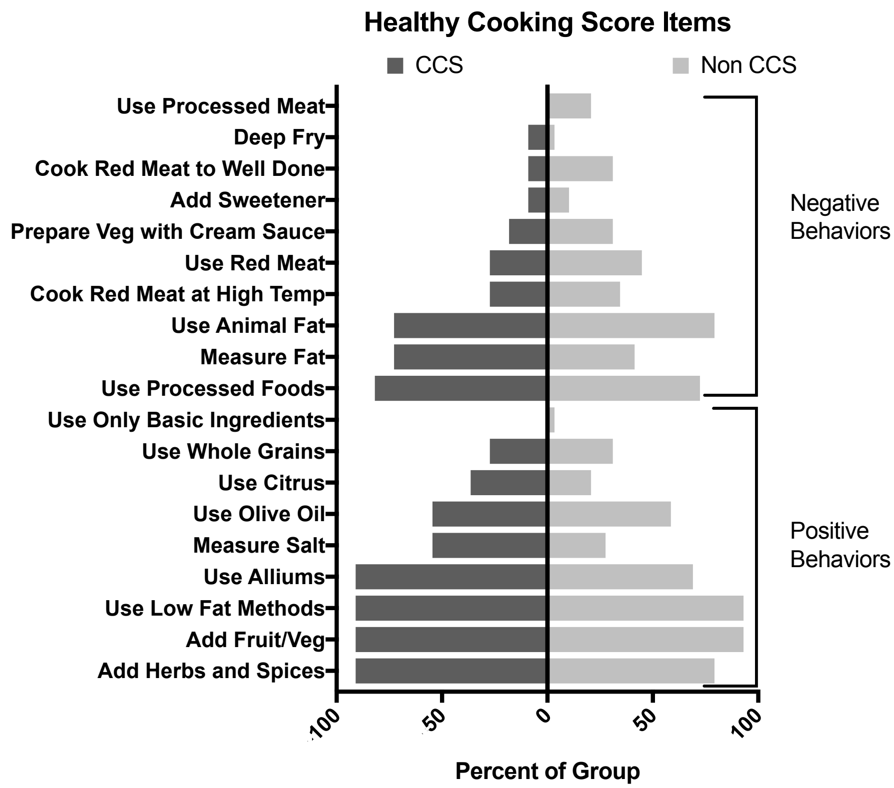

Figure 2: Tornado plot depicting percent of CCS (n=11) or Non CCS (n=29) that demonstrated a healthy cooking behavior from the healthy cooking score coding system. Darker grey bars represent CCS and lighter grey bars represent non CCS participant groups. Negative behaviors are shown on the top of the plot. Positive behaviors are shown on bottom of plot.

Nutrient analysis was conducted on the meals prepared during the video sessions to examine nutrient composition. Analysis revealed comparable meal nutrient compositions between the CCS and non CCS prepared meals. The sample was also comparable to US averages, and all groups demonstrated dinners

Table 3: Mean Meal Nutrient Profile (per serving of evening meal)

Nutrient	CCS (n=11)	Non CCS (n=29)	US Mean*	USDA RDI**
Total Calories	738.73	640.17	749.35	700
Energy Density (cal/g)	1.45	1.66	NA	NA
Sugar (g)	10.33	9.44	25.53	5.75
Total Fat (g)	34.78	30.20	30.67	28.78
Saturated Fat (g)	9.91	9.02	9.88	< 8.14
Fiber (g)	9.61	7.35	6.33	10.36
Carbohydrates (g)	71.38	61.36	78.43	40.3
Protein (g)	37.16	32.40	35.95	19.78

Mean nutrient amounts are reported per serving of dinner. Ingredients and amounts were taken from observer notes. *publically available data from U.S. Department of Agriculture, Agricultural Research Service. 2016. Nutrient Intakes from Food and Beverages: What We Eat in America, NHANES 2013-2014 **U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015 – 2020 Dietary Guidelines for Americans. 8th Edition. December 2015. Available at https://health.gov/dietaryguidelines/2015/guidelines/.

with more sugar, fat, saturated fat, carbohydrate and protein content per serving than recommended dietary intakes (Table 3).

Discussion

This study examined the food preparation habits of 11 CCS and 29 non CCS parent-child dyads through audio/video observation and questionnaires. In this small sample, CCS families did not show major differences to non CCS families with regard cooking frequency, family meal frequency, or meal nutrition. No major differences between CCS and non CCS families were shown with regard to healthy cooking practices. Our findings offer exploratory data of CCS family cooking practices and elucidate key areas for consideration when developing or adapting practical nutrition interventions for this population.

The nutrient composition of CCS prepared meals revealed that the average fiber content was 9.61 grams, close to the national recommended intake of 10.36 for a serving of dinner. However, meal nutrient compositions were higher in sugar, carbohydrates and fat than recommendations. Both CCS and non CCS families added fruit and vegetables while cooking, suggesting vegetable-focused nutrition interventions may benefit from incorporating information about lower sugar produce (e.g. berries). Participants were often observed using animal fats and processed foods, and not using whole grains during meal preparation. While attitudes about the role fat and sugar play in a healthy diet are shifting, it is important to promote heart healthy diets in CCS and the general population. [35] Healthy cooking intervention components focused on using whole grains, basic ingredients and olive oil in place of animal fats may help CCS families improve overall diet.

An important influence shaping a child's diet is the family food environment and family meals [36,37] In this study, parent participants reported commonly eating dinner together during the week at home, and cooking meals at least five days per week. This suggests home cooking practices and family meals may be an important target for nutrition interventions in the CCS population as home-prepared foods represents a large portion of eating events. Interest in cooking as a nutrition intervention target has increased in the past several decades, although the impact of interventions has varied. [38,39]

Adam et al assessed the impact of online cooking videos to increase cooking skills and meal behaviors among 7,422 adults across >80 countries. The authors found improved eating behaviors and meal composition, including fruit and vegetable intake, after the five-week intervention but did not have a control group for comparison. [40] Fulkerson et al developed the Healthy Home Offerings via the Mealtime Environment (HOME) Plus program, which consisted of 10 monthly in-person family education sessions and 5 goal-setting phone calls. The HOME Plus program curriculum focused on healthy eating, family meals, and cooking skill development. A randomized controlled trial of the program found participants in HOME Plus improved self-efficacy in identifying portion sizes compared to controls, but did not significantly improve other outcomes.[41] Intervention components including online modules and family based group classes may be applicable to the CCS population as survey studies suggest CCS are interested in computer-delivered interventions, and interventions with parents.[42,43]

There are several strengths to this project including the use of objective observational cooking data collected from participant homes, meal nutrient composition data, and the inclusion of a comparison group. This is the first study to explore food preparation practices in CCS families. Further, this study utilizes an evidence-based conceptual framework of healthy cooking behaviors to identify key cooking practices that are relevant to CCS long term wellbeing.[19]

Limitations to this study include the limited sample size and use of a convenience sample. Recruitment of CCS for this study was challenging due to a recent hurricane in the region, discomfort with home observations among survivors, and changing contact details as children transition to survivorship care after treatment. Participants may differ from the general population given their willingness to have researchers enter their homes and record their behaviors. Our sample was more educated and earned higher incomes that the average family in the area. Age ranges and inclusion criteria were kept broad to maximize recruitment potential for this study. This study was not powered to identify significant differences between the CCS and non CCS groups, therefore findings are exploratory. Further, this small study did not have sufficient power to fully elucidate demographic variables that may influence cooking behaviors. Finally, height and weight were collected from children, but ancillary data on conditions/medications that may influence weight were not collected.

This study is the first to offer detailed, observational data on CCS family cooking habits and compare these behaviors to non CCS families and sets the foundation for new lines of research. A fully powered study, with balanced samples, should be undertaken to compare CCS and non CCS family cooking habits. Interventions targeting food preparation should be adapted for CCS families, and the HCS may be used to examine the impact on these interventions.

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Title: Meal planning values in families with school-aged childhood cancer survivors- a qualitative exploration and considerations for intervention development.

Target: Supportive Care in Cancer

Introduction

Childhood cancer survivors (CCS), and their families, are important targets for nutrition intervention. The risk of dying from a cardiovascular disease is 13 times more likely to occur among CCS. [1,2] Common cancer treatments, including anthracyline-class chemotherapeutics can cause cumulative cardiotoxicity in pediatric patients and increase risk for future cardiovascular disease. [3] Although treatment related late effects are difficult to avoid, diet is a modifiable risk factor for cardiovascular disease, and good nutrition supports CCS well-being and heart health. [2] Currently, CCS have demonstrated poor adherence to dietary guidelines through survivorship and into adulthood. [4-6]

The cancer experience may serve as a teachable moment for both patients and caregivers to improve home food environments. [7] A survey of 170 CCS found the majority were "very" or "extremely" interested in diet related interventions including weight control programs, learning to eat more nutritiously, and getting in shape. [8] A complementary study including 114 parents of CCS found similarly high rates of interest in diet-related programs among parents, and most CCS favored interventions in which they could partner with a parent. [9]

Although nutrition interventions have the potential to benefit patients and survivors throughout the cancer care continuum [10], a recent review of existing interventions found no evidence that current approaches improved CCS dietary intake or reduced cardiometabolic risk. [11] Moreover, few nutrition interventions for CCS include parent involvement. [12] Our group recently conducted a randomized nutrition counseling study for pediatrics cancer patients undergoing maintenance therapy. [13] While overall caloric intake was reduced, weight was not impacted by the intervention, suggesting the broader eating environment, including food preparation, may need to be addressed in order to produce impactful change in this population.

Various behaviors related to meal patterns and planning habits have been associated with improved diet and health. Family meal frequency has been associated with improved emotional and physical well-being of children in the general population. [14-16] Beyond simply eating together, eating foods prepared in the home, as opposed to eating out, may support healthy dietary patterns. [17] The consumption of fast food and commercially-prepared meals is associated with increased body mass index (BMI) and body weight. [18-22] The cause for this association may relate to larger portion sizes, cooking preparations that cause an increased caloric value, or a combination of both factors. In contrast, frequent home cooking and family meals support increased nutrient intake, fruit and vegetable consumption, and better dietary choices. [23-25] Children have been shown to eat more vegetables when they participate in food preparation tasks. [26,27] Higher rates of reported involvement in food preparation have also been associated with better diet quality compared to children who reported lower food preparation involvement. [28,29]

Given this background, interventions promoting healthy family meals and targeting both CCS and parents may be a feasible approach to improving diet quality in survivor families. However, while the meal planning and preparation habits in the general population have been well-studied, there is a gap in the literature on understanding these behaviors among CCS families. The meal preparation habits of CCS families have not been well studied. A better understanding of CCS family meal planning values, the impact of the cancer experience on these values, and the inclusion of CCS in food preparation could reveal potential intervention targets, facilitators, and barriers for future interventions to improve dietary behaviors among CCS. The aim of this study was to qualitatively explore family meal values and behaviors in a sample of CCS parent-child dyads. Findings are discussed in relation to intervention development for this population.

Methods

This study was reviewed and approved by the institutional review board of the University of Texas MD Anderson Cancer Center (PA16-0995). All adult participants completed an informed consent document, minor participants completed a child assent document. Participants were compensated for their time.

Design and Participants

This observational and qualitative study utilized a convenience sample of 11 parent-CCS dyads. One parent with one CCS were recruited as a single dyad. Inclusion criteria were: CCS was between 5 and 17 years old and at least one year off all treatment; parents self reported preparing at least one meal for their child per week; and being able to speak and read in English. This age range was chosen as children between 5 – 17 years old are usually still in school and living at home with their parents. Exclusion criteria included anyone in the household having severe food allergies. Recruitment was conducted through the MD Anderson Children's Cancer Hospital Survivorship Network, providers, hospital events and posted flyers. Before enrollment into the study, participants completed a screener to ensure compliance with eligibility criteria.

Data Collection Procedure

Data collection was conducted in participant homes during a normal evening meal preparation event. Each dyad completed one meal preparation data collection session. Meal preparation sessions were scheduled according to participant availability and lasted approximately 45 minutes to 2 hours, depending on the meal prepared. During study recruitment, potential participants were asked to report their five most commonly made meals. Parents were then encouraged to prepare one of these reported meals or select an alternative typical meal to prepare for the session. One to two observers, trained in observational assessment and guided by a general data collection script, were present during the sessions to set up equipment, take notes and ask questions. The meal preparation sessions were recorded using a digital camcorder (Canon VIXIA HFR800), situated on a tripod and oriented to capture the entire kitchen environment. This allowed for a visual record of the parent cooking behavior as well as any tasks completed by CCS, spouses or other children. Parents were fitted with a wireless lapel microphone (MOVO WMIC70) that fed directly into the camera to supplement the image. During the session, observers asked for clarification as needed and prompted participants to discuss their motivation for using certain ingredients, cooking methods, and other factors relating to meal planning and preparation. A structured interview guide was not used, but a general script for the data collection was used at the start of the recording. At this time, parents were asked 1) what dish they were making that evening 2) why they chose to make that particular dish and 3) how many adults and children they were cooking for. Participants were instructed to describe their actions into the microphone as they performed them.

Family Characteristics

Demographic information was collected through a self-report questionnaire that included items on parent age and education, child age and race, as well as socioeconomic factors. Time off treatment and primary diagnosis were collected from parents and confirmed through the medical record. Parent reported top five most commonly made meals were documented during study screening.

Data Analysis Procedure

Video and audio data from meal preparation sessions were analyzed with an inductive coding technique utilized in other studies of CCS parent behavior.[30] All qualitative analyses used qualitative analysis software (SR International's NVivo 10 Software). This software allows users to embed video files with audio for storage, retrieval and coding. Parent or child mentions of factors that influenced family meal preparation including food shopping, cooking or eating behavior were coded. After initial review, codes were reviewed and aggregated into parent codes representing specific themes. These parent codes were then reviewed and aggregated into broader overarching themes, forming a coding hierarchy.[30] Mind mapping was used to graphically explore the relationships within the coding hierarchy.[31] The mind map was created around the main parent codes, which branched into child and sibling codes, gaining specificity on outer branches. Two separate mind maps were developed, one focusing on CCS parent meal values, and the other focused on the cancer experience. The intersectionality of these topics was explored through the selection

and presentation of representative participant quotes. CCS involvement in food preparation was assessed by the first author (MR) and classified into 4 categories informed by previous research [32]: 1) no involvement, 2) involvement in mainly non-food preparation meal related tasks (i.e. setting table, cleaning, plating, fetching supplies) 3) child helped parent prepare meal component (e.g. child chopped nuts for salad) and 4) child independently prepared meal component (e.g. child made pasta). Descriptive statistics were completed for demographic and family characteristic data, as well as parenting practices. All quantitative analysis was completed using SPSS (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.)

Results:

Participant Characteristics

Demographic characteristics of participants are shown in Table 1. The majority of parent participants were mothers over 35 years old, well educated, married and home owners. CCS participants were majority female and ranged from 6 to 16 years old. Most were only 1 to 3 years off cancer treatment. A range of diagnoses were reported among participants including germ cell tumors (n = 2), osteosarcoma (1), liver tumors (1), neuroblastoma (1), neuroendocrine tumors (1), rhabdomyosarcoma (1), and acute lymphoblastic leukemia (3). Information on foods prepared at family meals and child involvement are shown in Table 2. Several meals were noted as commonly prepared by multiple parents including chicken with sides, tacos and pasta with sauce. The majority of meals prepared during the data collection observation sessions used chicken as the main protein, with salad, pasta or rice as side dishes. Child involvement in food preparation ranged from no involvement to independent preparation of meal components by CCS. Over one third of CCS were not involved in food preparation (n= 4, 36.4%).

Table 1: Demographics and Family Meal Characteristics of Participants

Parent Female %(n)	90.9 (10)
Parent Age mean (range)	41.36 (34 – 51)
# of Children mean (range)	2.0 (1 – 5)
CCS Age mean (range)	10.91 (6 – 16)
CCS Gender %(n)	
Male	36.4 (4)
Female	63.6 (7)
CCS Race %(n)	
White	45.5 (5)
Hispanic	36.4 (4)
Asian	18.2 (2)
Years off Treatment %(n)	
1 – 3	63.6 (7)
3 – 5	9.0 (1)
5 – 10	18.2 (2)
More than 10	9.0 (1)
Parent Married %(n)	90.9 (10)
Income > $60,000 %(n)	63.6 (7)
Owns Home %(n)	100 (11)
Highest Household Education %(n)	
< College Grad	9.1 (1)
College Grad +	81.8 (9)

Table 2: Prepared and commonly reported family meals and CCS involvement.	
Most commonly reported evening meals % (n)	
Chicken with Sides	90.9 (10)
Tacos (tostadas etc)	72.7 (8)
Pasta with Sauce	63.6 (7)
Fish with Sides	54.5 (6)
Soups / Stews	45.5 (5)
Level of CCS Involvement % (n)	
None	36.4 (4)
Meal-related tasks	18.2 (2)
Helped prep meal component	27.3 (3)
Independently prep meal component	18.2 (2)
Dish prepared during observed meal preparation session	
Beef Tacos	18.2 (2)
Chicken with Pasta and Salad	18.2 (2)
Chicken with Rice and Asparagus	9.1 (1)
Chicken with Salad	9.1 (1)
Beef Enchiladas with Rice and Beans	9.1 (1)
Pasta and Salad (Vegetarian)	9.1 (1)
Chicken Curry with Rice	9.1 (1)
Shrimp Sinigang with Rice (stew)	9.1 (1)
Chicken Tostadas	9.1 (1)

CCS Family Meal Values

Meal preparation values and the impact of the cancer experience on these values was qualitatively explored through analysis of the CCS meal preparation audio/video tapes (n=11). Four major themes emerged form the data (Figure 1) including effort, budget, health and preferences.

Effort. Effort as a meal value encompasses time, difficulty, and child effort. When asked why parents chose to make certain dishes, eight out of eleven parents noted it was because the dish was "easy". Flexibility was also mentioned as an attractive quality in a recipe or meal idea, in the sense of being able to add "whatever is in the fridge" to a dish (n=4).

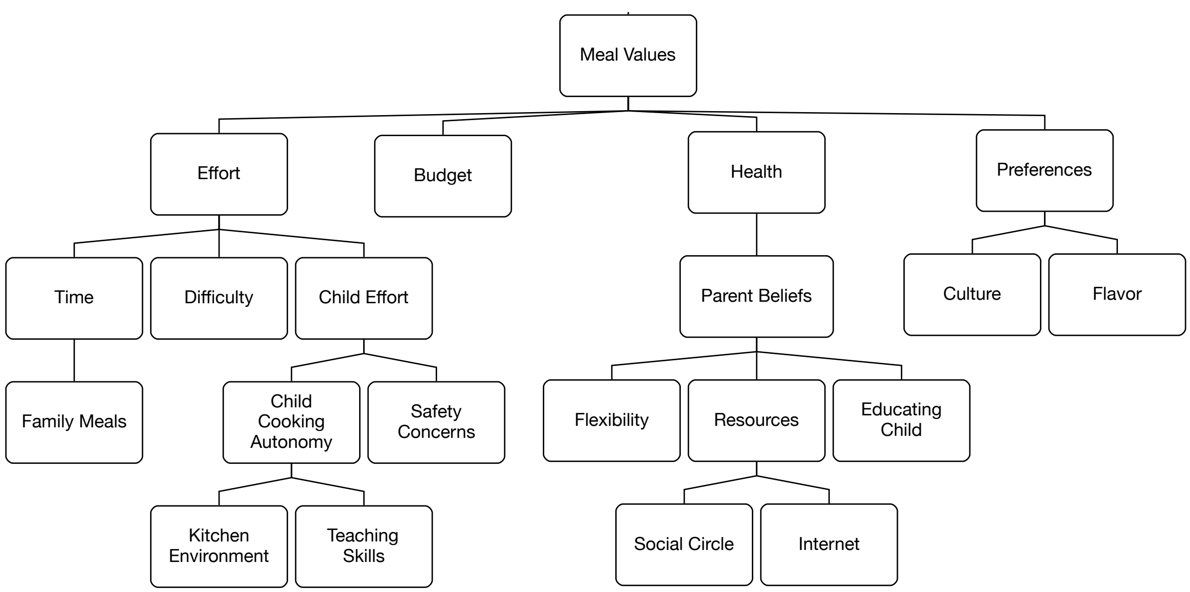

Figure 1: Mind map of overarching categories of meal values and hierarchy of parent and child codes. The mind map diagram is used to represent concepts arranged around a central research topic of interest. Each square represents a child or parent (aggregated) code. The top branches represent major themes, and gain in specificity on lower branches.

Time was also important to CCS parents with several noting time-saving shortcuts during cooking (n=5), and the need to prepare dishes in one evening that will yield leftovers for school lunches, work lunches and second meals (n=9). Time pressure was relieved by the use of convenience or store prepared foods (n=3), pre-prepping dinner during the day (n=3) and cooking more on weekends (n=2). Time impacts family meals and child involvement in food preparation as dinners need to be coordinated around multiple schedules (n=4). Child effort was also considered by parents, as several participants assigned children tasks to complete in order to help in meal preparation (n=8), although the level of involvement varied widely (Table 2), and the child involved was not necessarily the CCS. For example, in one family of four children, three of the four helped prepare dinner, but their CCS sibling did not.

Budget. Budget played an important role in family meal planning. Although our sample was higher income than the average family in Texas, participants noted sale items were important considerations when grocery shopping and planning meals (n=3). This appeared to be especially important with more than one child in the home. Budget concerns were noted as restricting one parent's willingness to buy organic products, focusing on organic berries and other produce. Another parent mentioned purchasing meat on sale that was close to the expiration date and cooking or freezing it immediately as a strategy to save on grocery costs.

Health. Healthfulness of meals was consistently mentioned by parent participants (n=6), although the definition of healthful meals varied from promoting vegetables (n=7) to reducing processed foods (n=4), sodium (n=7) and dairy (n=3). The resources that fueled these beliefs centered around the Internet and social circles (n=5). These two resources would sometimes collide, with family and friends posting recipes or nutrition related articles on social media, or in person advice being verified by the Internet. Parent beliefs were communicated to CCS through conversation (n=3) and through teaching children to prepare meals (n=5). Despite a perceived knowledge of healthy eating, many parents noted a measure of flexibility in the diet (n=6), to allow children to explore different foods and experiences.

Preferences. Preference was the most commonly given reason parents noted for preparing certain dishes (n= 10). These preferences tended to be influenced by culture and tastes. Cultural preferences and norms (especially by immigrant families) were mentioned as being important influencers on their cooking habits (n=4). Flavor preferences encompass the likes and dislikes of the family (n=9) including parents, their children, and their partners. Saltiness, spiciness and strongly flavored foods, such as olives, were avoided or added. Pickiness among CCS ranged, with some very willing to try new foods (n=3), and others more particular about which foods they wanted to eat (n=4).

Cancer Experience Impact on Meal Values

CCS parents were not asked directly about the cancer experience during the cooking video sessions. However, all eleven participant dyads naturally discussed the experience while preparing meals. Many discussed the experience in the past tense through recollections of CCS diets during treatment, as well as in the present tense (post treatment or current diet) (Figure 2). Example quotes of how the cancer experience intersected meal values is shown in Table 3.

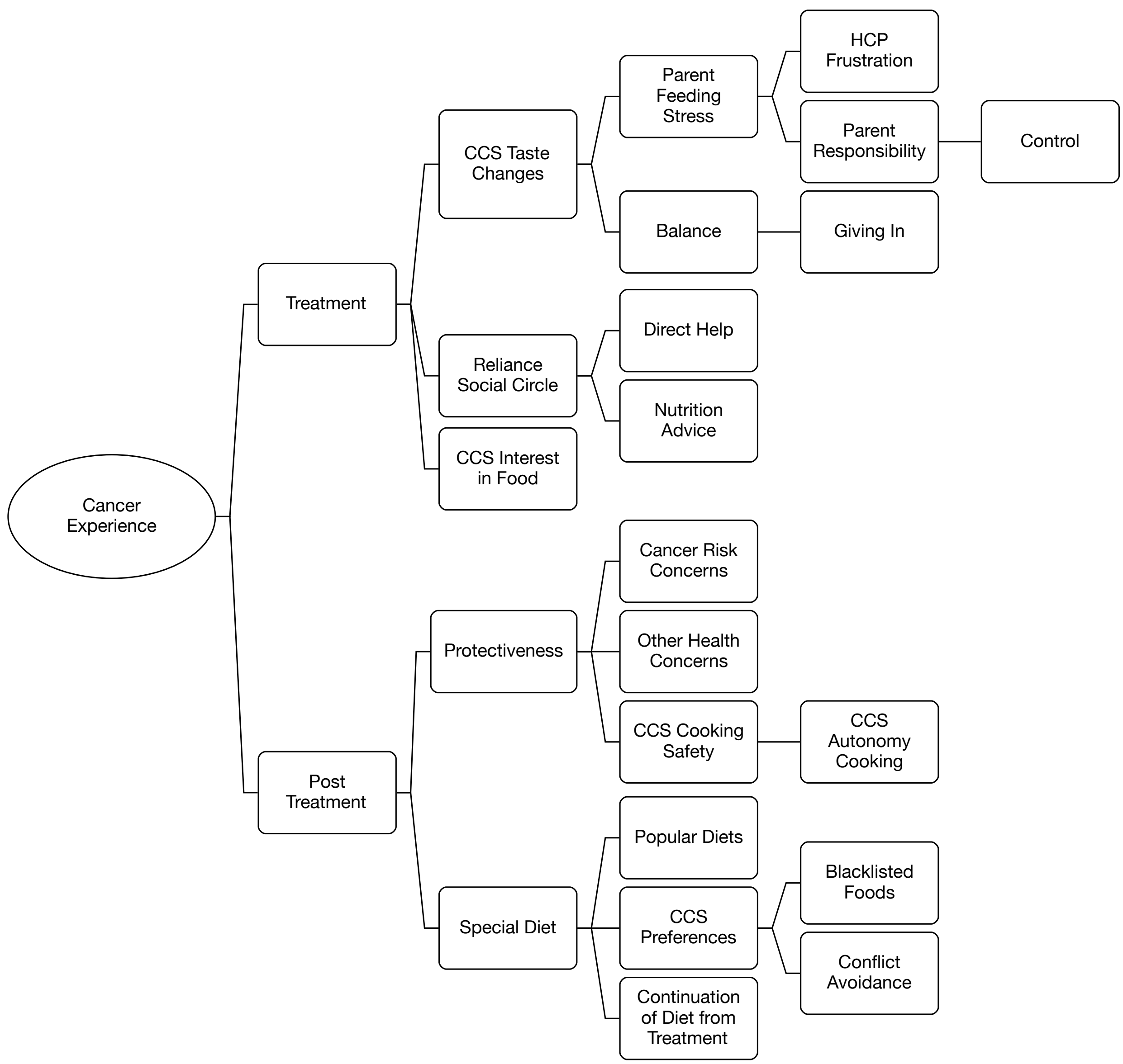

Figure 2: Mind map of cancer experience related codes and hierarchy of parent and child codes. The far left branches represent major themes, and gain in specificity on branches moving to the right.

Treatment. Parents noted taste changes during cancer treatment (n=4) (Table 5, P1), which often led to stress around feeding (n=4). For example, recalled interactions with physicians regarding CCS diet were a source of parent frustration (n=2). Physicians would generally respond to parent dietary concerns by encouraging parents to give CCS whatever they wanted during treatment (Table 5, H2), leading to a loss of control for parents and conflict with regard to the parent's understanding of food healthfulness. All parents expressed feeling responsible for their child's eating during treatment (Table 5, E2). This responsibility sometimes manifested as controlling feeding behaviors (Table 5, H3) such as force-feeding (n = 2), or in one case threatening insertion of a feeding tube as a deterrent to not eating. Other parents noted succumbing to CCS preferences as a perceived "giving in", making dietary adjustments to achieve balance between CCS wants and parent perceived needs (n=3) (Table 5, P2 & P3).

Parents also mentioned reliance on their social circle for help and dietary/nutrition advice (n=5) (Table 5, E1 & H1). One mother noted friends made meals for her family twice a week through nine months of treatment. Friends, family, and other CCS parents are important resources for nutrition and diet advice during and after treatment. While several parents noted their child's interest in cooking (n=9), one participant noted a growing interest in food and cooking specifically after cancer diagnosis (Table 5, E3). When asked about this by observers, the CCS mentioned her interest in cooking as a hobby increased after she was unable to participate in more active sports during treatment.

Post Treatment. Several parents expressed a level of protectiveness, often expressed as worry, over their child with regard to the current eating habits and child cooking autonomy (n=10) (Table 5, H5). The root of this protectiveness seemed to revolve around future risk with regard to cancer, but also other health concerns. Cancer risk concerns led to various avoidances including microwaving foods (n=2), baking potatoes (n=1), and drinking tap water (n=2). Other health concerns included the consumption of excessive sugar and refined grains (n=10). Some parents were particularly worried about neurological disease and inflammation in their child as a result of excessive sugar intake (n=2). Parent protective behavior also impacted CCS cooking autonomy, as parents had concerns regarding allowing children near heat or knives (n=8). These concerns were somewhat alleviated through modeling or formal classes, but some parents still preferred their children completely separated from food preparation (n=2) (Table 5, E4 & E5).

Parents also noted adhering to various special diets while preparing meals (n=3). These tended to stem from popular diet trends, current CCS preferences and the continuation of diets from treatment. With regard to popular diet trends, one parent noted moving her family into a completely paleo diet, avoiding sugar, dairy, legumes and grains (Table 5, H4). Another parent had a more relaxed approach to a paleo diet, noting general avoidance of sugar, refined grains and highly processed foods.

CCS preferences were often incorporated into meals, with parents cooking child favorites. However, parents also noted some food aversions among CCS or “blacklisted” foods (n=3). These are foods that were eaten during treatment but are no longer palatable to survivors (Table 5, P4). In order to avoid conflict, parents noted making dishes with components pickier CCS could eat around, purchasing foods the CCS expressly requested, or in one case making completely separate meals (Table 5, P5). In some cases, parents continued the diets from when their child was on treatment.

Table 3: Selected codes and quotes on cancer experience on meal values during diagnosis, treatment and survivorship (current).

	Effort	Health	Preferences
During Diagnosis and Treatment	E1. Code: Reliance on Social Circle *Quote: When you (re child) are first diagnosed everyone is like "what can I do? what can I do?. I told people just stick with us because we are going to need help 5 months from now not just this month. (female, 11 years old)*	H1. Source Advice from Friends *I (got nutrition information)…not from the doctors, mostly other parents, our family maybe or we heard, we read and then I would go and check (the internet) (female, 15 years old)*	P1. CCS Taste Changes *I don't know how things tasted to him, when he was on steroids but he was very definitive about what he did and didn't want...at one point he ate two dozen eggs, just the egg whites, and asparagus every single day. (male, 6 years old)*
	E2. Parent Responsibility *When (redacted) was in treatment, that's all I did…that was my full time job was just making sure he could eat well (male, 10 years old)*	H2. Frustration with Diet Advice of HCP *I called Dr. (name redacted) in a panic… I said I can't get him to eat real food, I said he's only eating beige food. He said, what do you mean? And I said he is eating cheese and goldfish and (chips) with mustard, like it was disgusting. And I said what can we do? And he said, there is nothing you can do just feed him what he wants (male, 6 years old)*	P2 Balance Diet and Preferences *We try to do the (low) histamine diet as much as possible with her just because of the carcinoid syndrome… So she can't have spinach… we didn't realize until they put her on it that that was one of the ones and she was eating a lot of it… and she really liked it, now she can't have it (female, 16 years old)*
	E3 CCS Interest in Food *Mom: She wasn't really interested in cooking really until after she was in treatment… (CCS name redacted) what changed? CCS: I think it is because I couldn't do as many like sports and athletic things, and it (cooking) was something that I was able to do (female, 11 years old)*	H3 Control *If you walked into that room you would think we were the most horrible parents ever because we were very forceful with her and we said this (eating) has to happen because she needed to survive this. Her body had to be healthy enough, robust enough to survive getting the chemo, and that included getting protein in you and keeping her calories up so she wouldn't lose weight (female, 11 years old)*	P3 Giving In *So I just gave in… that's what she (CCS) is asking for so I just have to buy onion ring…hot Cheetos, hot dog, oh my. I'm like, I can't take in those things but, that is what she would ask for (female, 13 years old)*
Current (Post Treatment)	E4 Safety Concerns CCS Cooking *I got really scared when I was cooking one day and (CCS name redacted), when she was little, she was behind me and I dropped something on her and after that I'm like, go away (from the kitchen), go play, let me do my thing (female, 15 years old)*	H4 Special Diets *It was (CCS name redacted) who had us go paleo, not that she knew it, but just with everything that her health encompasses and that she's gone through I started paying a little bit more attention to what we were putting the body through (female, 10 years old)*	P4 Blacklisted Foods *There is some stuff he used to eat that he just doesn't touch now. Like he used to eat salsa by the fistfuls, especially during treatment he would just pound salsa and now... it nauseates him (male, 11 years old)*

E5 CCS Autonomy Cooking *It was a scary thing (CCS cutting), but then when we started seeing those kid challenges shows and they are like 8 years old and just cutting away like anything I was like, ok I'll teach you (female, 7 years old)*	H5 Protectiveness *We never let him (CCS) buy school lunch because they serve like pasta and pancakes and spaghetti…there is not a lot of balance as far as nutrition goes there (male, 10 years old)*	P5 Avoid Conflict Regarding Food *Bottom line, he doesn't like to eat a lot of good food. We have to force him to eat... I told him, whatever you like, you can have it. If you want something else just let us know we can go grab something for you, and we can always give it to you (male, 10 years old)*

Discussion

This study examined the meal preparation habits of 11 CCS-parent dyads through audio/video observation and recording. Qualitative analyses revealed four major categories of meal values, several of which were impacted by the cancer experience both during and post treatment. Our findings offer insight into CCS family meal practices and elucidate potential areas for practical, family-based nutrition intervention in this population.

Effort, including time and difficulty, as well as budget, healthfulness and family preferences emerged as recurrent values impacting meal preparation that should be considered in intervention development. With regard to effort, parents noted that meals prepared one evening were often used for school lunches and subsequent evening meals, or as a component in a subsequent meal. This highlights the importance of home cooking practices as home-prepared foods may represent both dinner and lunch for some CCS. Our group created a cooking curriculum that focused on the repeated use of leftovers as a strategy for healthy meal planning, which was piloted among Hispanic overweight and obese children aged 6 to 11. The pilot study included 10 cooking demonstrations of "mother" recipes, which were then utilized as the main component of 3 "daughter" recipes. [33] This concept of base and daughter recipes may be attractive to CCS parents hoping to minimize time and effort in food preparation.

Health was noted as an important factor in meal planning by all participants. Refined carbohydrates, including added sugars, were a concern of several parents, with fat (particularly butter) being less of a concern. Two parents in particular noted trying to reduce grain overall to improve meal healthfulness. Both of these mothers prepared beef dishes and included no grains in meals. Recommendations regarding fat and refined carbohydrates have shifted in recent years due to continually emerging evidence that healthy fats are part of a balanced diet. [34] However, many CCS are at increased risk of cardiovascular disease, and the evidence linking the consumption of saturated fats, such as those found in beef and butter, with cardiovascular risk factors remains strong. [35] The Mediterranean or DASH (Dietary Approaches to Stop Hypertension) diets, which have been shown to improve cardiometabolic risk factors, could be utilized as guidelines for CCS intervention development. [36,37]

Another major consideration when meal planning was CCS and family preferences. Food preferences vary by both societal norms and individual tastes. [38] Dislike or inexperience with certain foods, textures and flavors may create a powerful barrier to dietary change in families.[39-41] Preferences should be carefully considered when developing interventions to target meal preparation behaviors in this population. One potential way to help mitigate this barrier is the use of a participatory design in intervention development. Participatory research engages end users throughout the research process, including intervention development.[42] Our group recently examined the feasibility and acceptability of participatory cooking classes targeting CCS.[43] Class participants requested recipes or dishes they wished to make (e.g. pizza, cookies), which were then optimized for nutrition using an evidence-based framework.[44] This approach was well received and may be utilized in future interventions to help ensure program elements are is in line with family norms and preferences.

CCS helped prepare meal components in slightly less than half of the sample (45.5%). The main reasons for not involving CCS included disinterest, scheduling, and worry regarding CCS safety. Given that involvement in meal preparation may improve diet quality in children[29], and other studies reporting that CCS prefer participating in interventions with parents[9], future interventions targeting CCS diet should consider promoting healthy eating through a family-based approach. Interventions should address parent concern with CCS safety, as this may form a barrier to program participation if parents are uncomfortable. Participants mentioned several strategies for reducing these safety concerns including the use of child-safe equipment, child cooking classes, and exposure to cooking show programs that include children. Our institution maintains an online cookbook of child-friendly recipes developed for CCS and their families. This site also contains cooking videos featuring pediatric patients preparing healthy recipes in a hospital-based kitchen.[45] This resource may be utilized in future interventions to help mitigate safety concerns of parents. Further, child-safe knives and other cooking equipment may make appropriate intervention give-aways to support program attendance and adherence.

In addition to meal values, analysis of CCS preparation events also revealed family food environment changes upon diagnosis, through treatment and into survivorship. These findings were similar to other qualitative studies of parent feeding practices in the context of childhood cancer, which reported changing CCS preferences and increased parent stress around CCS diet.[30,46] In our study, parents expressed frustration with their child's increasing preference for junk food during treatment, and lack of guidance from physicians. The time after diagnosis may be capitalized by providers to offer parents guidance and healthy feeding coping mechanisms[7,47] By addressing these concerns early in a child's treatment, positive habits can be established and carried on throughout survivorship.

This is the first study of which we are aware to qualitatively examine CCS family meal preparation habits. Limitations to this study include the use of a small convenience size. Participants were wealthier and more educated than the average family in the region, and may be different than other CCS given their willingness to have researchers record their home food habits. However, this study offered an in-depth examination of participant meal values, CCS involvement in meal preparation, and the impact of the cancer experience on family meals. Healthy meal preparation and family meal promotion offers a potentially feasible and impactful target for health promotion in CCS families. Future research should consider pilot testing interventions for CCS and families that focus on fast, easy meals that can be used for leftovers. Participatory design elements and peer modeling may also be important components of future interventions. The impact of the cancer experience must be considered when developing program content, particularly with respect to parent stress regarding CCS dietary intake, shifts in CCS preferences, and safety concerns. Changes in the home food environment have the potential to support diet quality in CCS, and in turn reduce the risk of future chronic disease in this population.

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CONCLUSION

Cooking behaviors form an important component of the home food environment, currently under-evaluated in nutritional interventions. This study offers a novel approach to cooking behavior assessment, the Healthy Cooking Score, and utilizes observational data, self report, and mobile body camera technology. The data generated by this study informs the development of novel assessment tools, and offers a rich base of information on modern cooking practices in childhood cancer survivor families. This study revealed significant discrepancies between self-reported and observed healthy cooking score behaviors, with nine items particularly subject to reporting error. The next step in the refinement of the self-report assessment tool will be to undertake qualitative research with diverse communities in order to develop items that can be clearly conceptualized, and more accurately answered by participants. This study also demonstrated the ability of a wearable camera, the Sun eButton, to approximate observations of cooking behaviors. Issues with the eButton included: 12.5% of the eButton image data sets were not usable, the eButton failed to capture types of fat used during cooking and measurement behaviors. The addition of audio and alternative placement of the eButton may help ameliorate these issues. These suggestions have been shared with the eButton developers, and future research should consider using the eButton to examine cooking behaviors in diverse populations. Finally, the Healthy Cooking Score was used to explore the cooking habits and areas for intervention among childhood cancer survivors, a group at high risk for nutrition-related disease. CCS and non-CCS families demonstrated similar cooking behaviors, and their meals had similar nutrient compositions. A qualitative exploration of the CCS observational data revealed four main meal planning values including effort, health, preferences, and budget. Better understanding of CCS practices will allow for the tailored development of evidence-based healthy cooking programming for this group.

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