Food Agency and Health Habits

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ABSTRACT

High ultra-processed food (UPF) consumption is associated with weight gain, obesity, metabolic syndrome, cardiovascular disease, all-cause mortality, and type 2 diabetes. “Food agency” refers to an individual’s food preparation attitudes and capabilities within a given social and physical food environment. Although there is an association between the ability to prepare certain dishes and higher cooking frequency with lower UPF intake, it is still unclear if cooking and food agency influences UPF consumption due to the lack of research in this area. To date, studies of food agency have not included detailed dietary analyses. This cross-sectional study included 40 adults (73% female, aged 39±15 years, body mass index [BMI] 25.8±4.9 kg/m^2) and aimed to determine the relationship between food agency and UPF intake. Food agency scores were calculated using the validated Cooking and Food Provisioning Action Scale (CAFPAS). Cooking behaviors and frequency were also collected. Dietary intake was assessed using three 24-hour dietary recalls with each item categorized by degree of processing using the NOVA classification system. Analyses included one-way ANOVAs between CAFPAS score quartiles [Q] and Pearson correlations between CAFPAS, cooking behaviors, and dietary intake. UPF intake was calculated in percent total calories and percent total grams to account for artificial sweeteners and other low calorie products that may be classified as UPFs. Low food agency was associated with a 14% higher UPF intake (% total calories) compared to high food agency (P=0.03). There were no differences between CAFPAS quartiles and UPF intake in % total grams. When age was

divided into three categories, UPF intake was significantly lower in older adults (60+ years) compared to adults aged 19-39 years and 40-59 years by 26.4% and 29.1% respectively (*P*=0.02). When analyzed using bivariate analysis, lunch (r=-0.482, *P*=0.002) and dinner (r=-0.385, *P*=0.014) cooking frequency, frequency of cooking a meal from scratch or fresh ingredients (r=-0.320, P=0.044), and CAFPAS self-efficacy (r= -0.369; *P*= .019) were negatively correlated with UPF intake (% total kcal). These findings provide support for the possibility of reducing UPF intake through cooking interventions aimed at improving components of food agency such as problem solving, skills to create a meal from what is available, and cooking confidence. Future studies should include a larger, heterogeneous population to provide more insight into dietary differences between levels of food agency and expand the diversity of research in this area.

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GENERAL AUDIENCE ABSTRACT

High ultra-processed food (UPF) consumption is linked to weight gain, obesity, metabolic syndrome, cardiovascular disease, all-cause mortality, and type 2 diabetes. "Food agency" refers to an individual's food preparation attitudes and capabilities within a given social and physical food environment. Although there is a link between the ability to prepare certain dishes and higher cooking frequency with lower UPF intake, it is still unclear if cooking and food agency influences UPF consumption due to the lack of research in this area. To date, studies of food agency have not included detailed dietary analyses. This study aimed to determine the relationship between food agency and UPF intake. Food agency scores were calculated using the validated Cooking and Food Provisioning Action Scale (CAFPAS). Cooking frequency and behaviors were also collected. Dietary intake was assessed using three 24-hour dietary recalls with each item categorized by degree of processing using the NOVA classification system. Participants with low food agency had higher UPF intake in percent total calories compared to those with high food agency. There were no differences between food agency and UPF intake in percent total grams. Adults aged 60 and over consumed less UPF compared to adults below the age of 60. Participants with higher food agency were more likely to make a meal from scratch or fresh ingredients. As frequency of cooking a meal from scratch or fresh ingredients, cooking dinner or lunch increased, and CAFPAS self-efficacy scores increased percent total calories from UPFs decreased. These findings provide support for the possibility of reducing UPF intake through cooking interventions aimed at improving

components of food agency such as problem solving, skills to create a meal from what is available, and cooking confidence. Future studies should include a larger, heterogeneous population to provide more insight into dietary differences between levels of food agency and expand the diversity of research in this area.

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CHAPTER 1 – Introduction

Defining Ultra-Processed vs. Unprocessed Foods

With the advancement of food science technology, manufacturers can improve shelf-life, food safety, nutrient profiles, and extract compounds with a variety of food processing techniques. These techniques have allowed for increased food production and availability to help sustain a growing population but have also led to the production of many ultra-processed foods.[1] Accompanying the changing food environment is the increased prevalence of overweight/obesity and health-related problems. There is growing evidence to suggest these could in part be attributed to the increased availability and consumption of ultra-processed foods.[2–4,4–10]

The degree to which a food item is processed can be measured using the NOVA (not an acronym) food classification system which was first introduced by Monteiro et al. in 2017.[11] Although other systems exist, NOVA is most widely used in nutrition research.[11,12] The NOVA system classifies foods into four groups based on the degree and purpose of processing, which are presented in Table 1.

Group 1 is unprocessed or minimally processed foods including fungi, algae, water, and edible parts of plants and animals. Group 1 processing techniques maintain food integrity. These include drying, grinding, roasting, boiling, pasteurization, non-alcoholic fermentation, vacuum packaging, and temperature control.

Group 2 is processed culinary ingredients including oils, butter, sugar, and salt. Foods in this category are not intended to be eaten alone. Instead, they are used as ingredients to prepare group 1 foods. Processing techniques include pressing, refining, grinding, milling, and drying.

Group 3 is processed foods including bottled vegetables, canned fish, cheese, and bread. This category combines group 1 and group 2 foods using additional processing techniques and can be eaten without the addition of other foods. Group 3 includes processing techniques and ingredients like salt (group 2) that extend the shelf-life of group 1 foods or enhance palatable

qualities. The processing techniques of this category include preservation, cooking methods, and non-alcoholic fermentation.

Group 4 is ultra-processed foods (UPF) including soft drinks, sweet/savory packaged foods, reconstituted meat, prepared frozen dishes, chemically modified oils, food extractives (casein, whey, gluten), preservatives, antioxidants, stabilizers, dyes, flavorings, sweeteners, and processing aids. Foods in this category are the least similar to their natural state with little group 1 ingredients intact.

NOVA Group	Food Items Assigned to Each Group	
Group 1 Unprocessed or minimally processed	• Fruits and vegetables that are fresh or have been squeezed, chilled, frozen, or dried • Grains and parboiled grains • Legumes • Root vegetables • Fungi • Meat, poultry, and seafood (whole or cut; stored chilled or frozen without added oil or salt) • Milk (pasteurized or powdered) • Nuts	• Fresh or pasteurized fruit and vegetables juices (without added sugar, sweeteners, or flavors) • Grits, flakes, or flour made from grains • Pasta without added salt and oil • Spices • Plain yogurt (with no added sugar/sweeteners or flavorings) • Tea and coffee with no added sugar/sweetener
Group 2 Processed culinary ingredients	• Vegetable oils from seeds and nuts (i.e. olive oil) • Butter and lard from milk and pork • Starches from corn and other plants	• Sugar and molasses from cane or beet • Honey • Maple syrup • Salt
Group 3 Processed foods	• Canned or bottled vegetables, fruits, and legumes • Salted or sugared nuts and seeds • Salted, pickled, cured or smoked meats	• Canned fish • Fruits in syrup • Cheese • Freshly made bread
Group 4 Ultra-processed foods	• Carbonated drinks • Sweet and savory packaged snacks • Ice cream • Chocolate	• Margarines and spreads • Processed cheese (e.g., American) • Meat and chicken extracts and ‘instant’ sauces

	• Candies • Packaged bread and buns • Cookies (biscuits), pastries, cakes and cake mixes • Breakfast cereals • 'Cereal,' 'energy,' and 'granola' bars	• 'Health' and 'slimming' products: powdered or 'fortified' meal and dish substitutes • Reconstituted meat products: poultry and fish 'nuggets' and 'sticks'

Table 1. Categorization of commonly consumed foods based on the NOVA system. Adapted from Monteiro et al. 2018 and Monteiro et al. 2019.

NOVA Classification System - Strengths and Limitations

The NOVA system acts as an objective tool to measure the degree of food processing based on the physical, biological and chemical processes that occur during transformation by a processing facility.[11] This tool has been used in several studies to evaluate the effects of UPF consumption on health outcomes. Only one study to date has used NOVA to assess intervention efficacy; this randomized controlled trial conducted in Brazil aimed to study the influence of an educational cooking intervention for parents on their children's UPF intake at dinner.[13]

The extensive research on NOVA has led to its incorporation into the dietary guidelines for Brazilian and Uruguayan populations.[14] The Dietary Guidelines for the Brazilian Population 2014 outlines each category of NOVA and the "Biological and Cultural" and "Social and Environmental" arguments for choosing a diet primarily of minimally processed food. The guidelines recommend choosing a diet composed primarily of unprocessed and minimally processed foods, using processed culinary ingredients sparingly, and avoiding processed and ultra-processed foods entirely.[15] However, avoiding ultra-processed foods entirely might not be feasible or necessary for individuals to optimize their health, especially those who live in food insecure households.

Many countries' dietary guidelines, such as the United States, recommend combinations of food groups based on animal or plant origin. The Dietary Guidelines for Americans 2015, for example, recommends eating a balanced diet of protein, fruits, vegetables, grains, and dairy. While this is a useful tool for primary nutrition education, foods in each category exist with

varying degrees of processing from minimally processed to ultra-processed, which has been associated with adverse health outcomes (explained below in "Health Risks of UPF Consumption"). The Advisory Committee of the Dietary Guidelines for Americans 2020 reviewed studies on UPFs, however, food groups and overconsumed nutrients - sugar, saturated fat, and sodium that are typically high in UPFs - remain the focus of the 2020 Guidelines.[16,17] Further research using the NOVA classification system to evaluate American dietary patterns will increase the body of evidence on UPF consumption and may help improve the guidelines for fruit, vegetable, grain, protein, and dairy consumption.

NOVA is a classification system that provides comprehensive, yet minimal definitions for each processing category which can be used with different diet analysis tools. The diversity of the tool may result in inconsistency between studies. Validated food frequency questionnaires (FFQ) have not been redesigned to code for specific degrees of processing and thus may not be feasible to use with NOVA. The lack of a validated tool requires NOVA to be used in conjunction with other tools, like 24-hour recalls and the Healthy Eating Index for a full evaluation of individual diet quality.[1] The lack of a validated diet analysis tool to use with NOVA makes the researcher responsible for correctly classifying foods into their corresponding NOVA categories which could lead to subjectivity and inconsistency between studies.[18] NOVA is not designed to evaluate processing involved in home cooking/culinary cooking or the effects processing has on the nutritional integrity of the food.[1] The NOVA classification system may be useful in evaluating associations between diet quality and other nutrition-related variables such as cooking skills.

Health Risks of UPF Consumption

Multiple adverse health outcomes are associated with high UPF consumption including weight gain, obesity, metabolic syndrome, cardiovascular disease (CVD), all-cause mortality, cancer, and type 2 diabetes (T2D).[3–10,19,20] Type 2 diabetes, heart disease, and cancer are among

the leading diet-related causes of death in the United States, taking over 1.3 million lives per year.[21,22] High UPF consumers may have a 44-62% increased risk for all-cause mortality compared to low UPF consumers.[6,7] Additionally, the highest quintile of UPF intake in a study of 6,385 US adults aged 20 and older, (> 71% kcals from UPFs) had a 28% higher prevalence for MetS compared to the lowest quintile of UPF intake (< 40% kcals from UPFs).[4] The association between high UPF consumption and adverse health outcomes in observational studies and one randomized control trial raises concern about UPF as a potential contributor to the declining health of the U.S. population.

The majority of food consumed by individuals in the United States (57.9%) is classified as ultra-processed using NOVA criteria based on 2009-2010 NHANES data.[23] High UPF consumption affects overall diet quality as it is associated with higher intake of sugar-sweetened beverages, fast food, and processed meats, and lower intake of fruits, vegetables, whole grains, yogurt, and nuts.[3,5,20,24] This dietary pattern could contribute to the significance of adverse health effects that accompany a high UPF diet.

An increase in UPF consumption by 10% is associated with a 12% increased risk for overall cancer, a 15% increased risk of T2D, and a 12%, 13%, and 11% increased risk for CVD, coronary heart disease, and cerebrovascular disease respectively.[3,20,24] A recent study by Juul et al. found additional negative risks of UPF consumption on cardiovascular health. Each additional daily serving of UPF was associated with increased risk of hard CVD (7%), overall CVD (5%), hard CHD (9%), and CVD mortality (9%).[25] Overall blood pressure and daytime peripheral systolic blood pressure has also been shown to increase by 0.25 mmHg and 0.32 mmHg with every 1% increase in UPF intake respectively.[26]

Compared to an unprocessed diet, a diet comprised of 80% UPFs (based on NOVA) with the same nutrient profile and consumed ad libitum led participants in a study by Hall et al. to increase caloric intake by ~ 500 kcal/day, resulting in ~1 kg weight gain over 14 days.[2] In contrast, the unprocessed diet resulted in ~1 kg weight loss over 14 days.[2] Hormones and other

biological markers were measured and showed significant changes between diets. PYY, an appetite-suppressing hormone, increased and ghrelin, a hunger hormone, decreased on the unprocessed diet from baseline, which could contribute to the significant differences in total caloric intake between diets. While the average American is not consuming a diet comprised of > 80% UPFs, these findings suggest that UPFs may be a contributing factor to the increasing prevalence of obesity.[23]

Drivers of Ultra-Processed Food Consumption

Ultra-processed convenience foods, such as microwave dinners, cereal, packaged bread, and fast food, are chosen over cooking meals from basic ingredients (NOVA - group 1) for many reasons including longer shelf-life, lack of time, money, cooking skills, food access, and high monetary value given to one's time.[1,27–29] Because many people have a high time priority making it costly to spend time making food, consumption of food away from home (FAFH) (*Figure 1* - point A) has increased from 44% to 50.2% in the last 30 years.[30] The shift to consuming more food away from home is inversely associated with fruit, vegetable, iron, calcium, and whole grain consumption and directly associated with higher sugar, sodium, and fat intake.[30–32] Energy-dense foods, like UPFs, tend to be less expensive in the United States than nutrient-dense foods like fruits and vegetables, making it less feasible for those of lower socioeconomic status (SES) to consume a diet low in processed foods. [32,33] *Figure 1* depicts how time (T), budget (M), and the importance one places on time (w_i) can all influence one's decision to eat at home or away from home. As primary food preparers for many families, women - on average - spend more time than men preparing food per day. From 1975-2006, the amount of time women spent preparing food per day declined from 92 minutes per day to 51 minutes per day.[34]

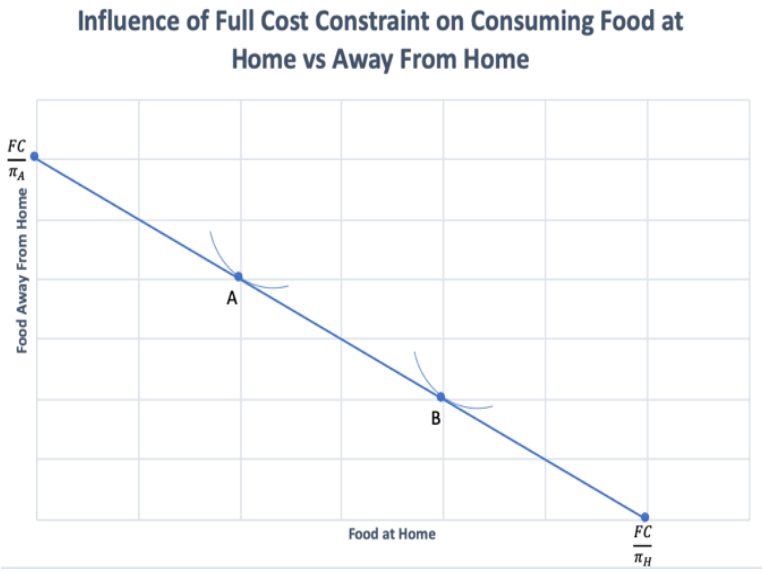

Figure 1. Influence of full cost constraint on consuming food at home compared to away from home. This figure shows the relationship between the amount of time to consume a food (T_i), the $ value per unit of time (w_i), total time (T), and total budget (M). FC = MT; $\boldsymbol{\pi_i = P_i + w_i T_i}$; P_i = food price. As any of the variables in the equation of the denominator increase/decrease, the available options for FAFH and food at home (FAH) decrease/increase as the line shifts to the left/right. Point A represents a higher preference for food away from home and point B represents a higher preference for FAH. The change in any variable will affect the steepness of the line and area under the line, however, this alone will not change a person's preferences for FAFH (point A) vs. FAH (point B). Adapted from Davis and Serrano.[29]

Benefits of Home Food Preparation

Cooking Frequency and FAFH Intake

Food consumed away from home (FAFH) is higher in fat, sugar, and sodium and is more likely to be ultra-processed compared to cooking food from scratch.[30–32] Cooking from scratch using mainly group 1 and 2 ingredients can be more costly than purchasing convenience and ultra-processed food, which could disproportionately affect the cooking ability of those with lower incomes.[2] Home food preparation is associated with a number of positive dietary behaviors and benefits including greater fruit and vegetable intake, greater vitamin C intake, lower BMI and body fat percentage, lower total energy intake, lower FAFH intake, and lower convenience food and frozen meal consumption.[28,35–37]

Spending < 1 hour per day preparing food is associated with a 1.8 increased likelihood of visiting a quick-service restaurant compared to spending ≥ 2 hours per day preparing food.[28] Contrastingly, spending > 2 hours/day preparing food was associated with consuming 2.3 and 3 times more fruit and vegetables per week, respectively than spending < 1 hour/day preparing food.[28] This evidence suggests that promoting home food preparation may help increase fruit and vegetable consumption. Cooking at home is also associated with a greater probability of having a normal BMI and less body fat. A study of 11,396 UK adults aged 29-64 with a slight female majority (53.3%), found that cooking at home > 5 times per week was associated with being 28% more likely to have a normal BMI and 24% less likely to have excess body fat compared to cooking < 3 times per week.[37]

Home food preparation encourages lower consumption of foods classified as ultra-processed by NOVA, but a lack of cooking skills may be a major barrier for those with low cooking frequency. Cooking skills, such as cooking techniques and knowledge of cooking processes, and food skills, such as meal planning, food budgeting, and food safety, are not only associated with increased likelihood of cooking at home, but also improved diet quality.[36,38] Those with higher diet quality have greater nutrition knowledge, consume less takeaway, and have higher cooking attitudes including perceptions of being a cook, food creativity, and enjoyment in trying new foods.[38] Without adequate cooking and food skills, shopping and preparing meals at home may seem like a difficult task, leading to greater consumption of ready to eat meals and food away from home. Demographic variables such as socioeconomic and employment status effect cooking frequency and should be considered when evaluating dietary patterns and UPF consumption.

Cooking Self-Efficacy and Diet Quality

Several studies to date have found that greater cooking skill confidence is associated with better diet quality.[38–43] A common measure of diet quality in these studies is the relative

consumption of convenience food which is often higher in calories, sodium, and sugar.[32] Higher cooking self-efficacy is associated with lower moderately and highly processed food consumption, FAFH consumption, higher diet quality, higher vegetable intake at meals, using less convenience foods in meals, and being less concerned with time constraints in preparing meals.[40–43]

Although multiple tools have reported similar results, there is no consensus on a validated tool to measure cooking skill confidence or the sociological factors that affect cooking ability. The limitation of not using a validated tool may have contributed to the prevalence of reported high cooking skill confidence in a study by Adams et al.[44] This data was deemed unusable for analysis of the relationship between cooking skills and diet quality or BMI by the authors for this reason.[44] Many tools used to measure cooking skill are limited to gathering the perceived cooking skill of participants and neglect important variables that impact cooking behavior. The Cooking and Food Provisioning Action Scale (CAFPAS) is based on sociological, anthropological, and psychological theories of agency giving the tool the strength to measure the dynamic interaction between the individual, society, and their environment.[45] Use of a validated tool, such as the CAFPAS, can ensure perceived cooking skills confidence reflects cooking skill behaviors and allows for evaluation of the relationship between home food preparation capabilities and diet quality. In addition, this tool could provide information on health behavior constructs that could be targeted in behavioral interventions.

Food Agency and the Cooking and Food Provisioning Action Scale (CAFPAS)

Previously conducted studies evaluating cooking skill self-efficacy neglect to measure perceived variables of cooking such as food attitude and structural barriers to cooking.[46] The CAFPAS is a validated tool that was developed to bridge the gap in current methods of evaluating cooking self-efficacy by assessing *food agency*. The term *food agency* was developed by Trubek et al. to encompass the complex variables associated with food related skills similar to the term

food literacy.[45] Food agency is defined as being motivated to plan and prepare meals in a given food environment and takes into account both individual and sociological factors.[45] This framework is incorporated into the CAFPAS as three subscales: (1) food self-efficacy, (2) food attitude, and (3) structure.[47]

As evident by the methods of previously cited studies, there are numerous ways to define and measure cooking self-efficacy.[48] This has resulted in a wide range of reported data in which confidence with cooking techniques, ability to prepare specific foods, cooking frequency, and ability to prepare a dish without help have been measured without a common validated tool. Evaluating cooking skills using these methods measures cooking knowledge and ability objectively. The CAFPAS, a validated tool, was developed to mitigate the limitations present in previous literature.

When the CAFPAS was evaluated for validity, a higher CAFPAS score in the combined validation and development samples of 943 adults (M = 506, F = 434, other = 3) with a mean age of ~35 years was associated with being more likely to cook meals at home. A 1-point increase in the CAFPAS score was associated with a 0.96 increase in meals cooked per week.[47] When age was categorized by decade, age and CAFPAS scores showed a positive linear relationship.[46,47] The relationship between older age and food agency aligns with findings from previous studies using different tools to measure cooking self-efficacy.

Results from other studies using the CAFPAS to measure food agency including associations between age, working status, and gender also align with results from similar studies measuring cooking and food skills.[46] Included in these studies is a cross-sectional analysis by Wolfson et al. conducted in the United States that measured a general adult sample (n = 1457) and a parent sample (n = 1399), both of which proportionally represented US adult population demographics.[46] Associations between CAFPAS scores and age, working status, parental status, and gender were found in the general adult population. Females had higher food agency (13.28) in both the general adult and parent samples compared to males (12.79).[46] This relationship is

seen across studies measuring cooking self-efficacy.[38,44,49] The relationship between food agency and gender should be explored further using the CAFPAS to better understand the factors that contribute to the discrepancy.

For statistical comparison, Wolfson et al. categorized CAFPAS scores into quartiles (Q4 > Q1) Those with higher food agency (Q4) were more likely to cook breakfast, lunch, and dinner, cook meals from scratch, and use less packaged products when cooking than those with lower food agency (Q1).[46] Higher food agency was also associated with positive dietary behaviors in the general adult group with greater fruit and vegetable intake (Q4 vs. Q1), and lower consumption of fruit juice (Q2 vs. Q1), fried potatoes (Q4 vs. Q1), other potatoes (Q2 vs. Q1), soda (Q2 vs. Q1), and other sugar sweetened beverages (Q4 vs. Q1).[46] However, this study used eight questions from the Behavioral Risk Factor Surveillance System rather than 24-hour recalls or comprehensive food frequency questionnaire to measure dietary intake, which was a limitation.

Cooking Self-Efficacy and UPF Consumption

Few studies to date have evaluated cooking self-efficacy and UPF consumption in adults. Evidence suggests that confidence with cooking select dishes and cooking at least five days per week is associated with a lower percentage of caloric intake from UPFs in both adults and their children.[50,51] Confidence with cooking techniques may be less relevant to the ability to cook from scratch compared to other aspects of cooking such as cooking attitude, confidence with food provisioning, and time-pressure that are subjectively measured using the CAFPAS.[47]

Studies have been conducted in other countries to evaluate the relationship between cooking self-efficacy and UPF consumption, but *no study to date* has evaluated this relationship in the United States using a validated tool to measure cooking self-efficacy and other sociological aspects of cooking.

The samples in studies that have evaluated the relationship between cooking self-efficacy and diet quality are composed primarily of highly educated women who are employed.[39–43,51–53]

Women are more likely to be the main food preparer in many households, to have greater cooking skill self-efficacy, and to cook more often.[35,38,44,49] This has resulted in disproportionate demographical data collected on cooking skills and diet quality. Another trend is the association between older age and greater cooking self-efficacy. Participants 45 and older have higher CAFPAS scores (13.57, 45-64 y; 13.42, $\geq$ 65 y) compared to younger adults (12.73, 18-29 y).[46] Evaluating the relationship between biological factors such as sex and age, key aspects of research rigor described by the National Institutes of Health (NIH), on cooking self-efficacy is necessary for understanding health impacts of lifestyle behaviors and for informing the development of interventions for specific target audiences.[54]

No studies to date have evaluated the relationship between food agency, or cooking skill self-efficacy, and UPF consumption in the United States. Of the studies presented evaluating UPF consumption and cooking self-efficacy, only one used a validated tool and was conducted in parent-child dyads in which the child's diet was analyzed.[51] Cross-sectional studies with validated tools for diet analysis and cooking self-efficacy in the adult population are lacking, but are necessary to establish food agency and/or cooking self-efficacy as a driver of UPF consumption. This investigation addressed this research gap.

Chapter 2 – Evaluating the Relationship Between Food Agency and Ultra-Processed Food Consumption

INTRODUCTION

The majority of food consumed by individuals in the United States (57.9% total energy) is classified as ultra-processed based on NOVA criteria using 2009-2010 NHANES data.[23] Ultra-processed food consumption (UPF) is associated with many adverse health outcomes including weight gain, obesity, metabolic syndrome, cardiovascular disease, all-cause mortality, and type 2 diabetes.[3–10,19] Type 2 diabetes and heart disease are among the leading causes of death in the United States and are common comorbidities associated with metabolic syndrome and obesity.[21,22] The associations between high UPF consumption and adverse health outcomes raises concern as a potential contributor to the declining health of the U.S. population. Determining drivers of high UPF consumption is essential to develop interventions that can support individuals in their efforts to lower UPF intake and improve diet quality.

Cross-sectional analyses have examined the association between cooking frequency and skills, and diet quality. Home food preparation is associated with greater fruit and vegetable (F&V) intake, greater vitamin C intake, lower body mass index [BMI] and body fat percentage, lower total energy intake, lower food away from home (FAFH) intake, and lower convenience food and frozen meal consumption.[28,35–37] Higher cooking self-efficacy is associated with similar dietary outcomes such as greater vegetable intake at meals and using less convenience foods in meals.[42] Many studies have evaluated cooking skills; however, this does not provide a comprehensive understanding of how cooking relates to diet quality as other environmental and sociological variables are at play.[45,47]

The Cooking and Food Provisioning Action Scale (CAFPAS), developed by Lahne et al. in 2017 measures *food agency* which is a combination of three subscales: food self-efficacy, food attitude, and food structure.[47] This tool measures one's perceptions of their skills, abilities, attitude, and environmental constraints to cooking. Higher CAFPAS scores are associated with

greater cooking frequency and healthy dietary behaviors such as greater fruit and vegetable intake.[46]

Although there is an association between the ability to prepare certain dishes and cooking more frequently with lower UPF intake, it is still unclear if cooking skill self-efficacy influences UPF consumption. Previous work in this area is limited due to the lack of validated tools used to measure home food preparation skill and behavior, and the use of food frequency questionnaires rather than 24-hour dietary recalls.[40,44,50] The limitations of previous work resulted in a lack of available data for complete dietary analysis and failed to provide a comprehensive evaluation of cooking and food provisioning. No studies to date have evaluated the relationship between food agency, or cooking skill self-efficacy, and UPF consumption in the United States. The objective of this research is to determine if there is an association between food agency and UPF consumption in adults by using the validated CAFPAS tool and multiple 24-hour recalls to assess usual dietary intake including UPF.

MATERIALS AND METHODS

This pilot study utilized a cross-sectional design to evaluate the relationship between food agency and UPF consumption in adults. Data were collected from October 2020 to January 2021. All data were self-reported and obtained using internet-based survey and interview methods. This study, #20-804, was approved by the Virginia Tech Institutional Review Board in October 2020 (Appendix A).

Recruitment and Screening

A convenience sample of 40 participants was recruited from southwestern Virginia using university email listservs.[55,56] Adults were eligible if they met the inclusion criteria for age (18+ years of age), lived in the southwestern Virginia region, had no underlying health condition that prevented them from performing usual activities of daily living such as cooking, and had

computer and internet access. Individuals who reside in campus dormitories, who have knowledge and training in cooking/culinary arts based on their profession, who are pregnant, who do not have convenient access to kitchens and who may use campus meal plans were excluded from participation. Efforts were made to include a diverse sample, with regard to age, sex, race, and ethnicity.

This sample size was determined based upon the preliminary nature of this observational study, the timeframe available for data collection, and the resources available to support this project. With a sample size of 40 and with 95% confidence, between 17.6% and 45.6% of participants are likely to have high cooking frequency with a margin of error of 14%. The potential for a substantial proportion of participants to have high cooking frequency will provide enough data to detect significance between food agency scores and cooking frequency. With 95% confidence, between 0.4% and 19.2% of participants will have both high cooking frequency and high diet quality with a 9.4% margin of error. The potential for few participants to have both high cooking frequency and high diet quality may not provide enough data to detect significant differences between food agency scores and low UPF consumption. These calculations were completed based on diet quality and cooking frequency data from sample of 6,384 adults evaluated by Astbury et al.[52] To account for the potential lack of participants who have both high cooking frequency and high diet quality, recruitment was stratified based on cooking habits in order to include individuals with a range of cooking frequency.

Study Protocol

After completion of an online eligibility survey, study staff generated a study ID number for the participant and provided them a link to complete the first set of questionnaires if they met the inclusion criteria. The study consisted of four sessions, with the three 24-hour dietary recalls completed within a 2-week period including two weekdays and one weekend day when possible:

Session 1: Completion of the informed consent (online), web-based Qualtrics survey (demographics, health history, the CAFPAS, and the Cooking Behavior Questionnaire (see Appendix B, C, D)). Participants were sent a reminder to save or photograph labels of foods consumed. They were also reminded to send a text message or email to staff with a digital image of body weight measurement if they had access to a scale and had not already sent an image.

Session 2: A trained interviewer completed the first 24-hour dietary recall over Zoom. Participants were sent a reminder to save or photograph labels of foods consumed. They were also reminded to send a text message or email to staff with a digital image of body weight measurement if they had not yet done so.

Session 3: A trained interviewer completed the second 24-hour dietary recall via phone call. Participants were sent a reminder to save or photograph labels of foods consumed. They were also reminded to send a text message or email to staff with a digital image of body weight measurement if they had not yet done so.

Session 4: A trained interviewer completed the third and final 24-hour dietary recall via phone call. Participants were sent a reminder to save or photograph labels of foods consumed. They were also reminded to send a text message or email to staff with a digital image of body weight measurement if they had not yet done so.

Post-study: Food labels were mailed (postage paid), emailed, or texted to study staff by participants. Compensation ($20 Kroger or Amazon gift card) was mailed to participants upon study completion.

Description of Measurements

Sociodemographic measures including age (18-29, 30-44, 45-64), income, employment status, race/ethnicity, education, marital status, household food insecurity, and gender were recorded in the web-based Qualtrics survey.[46] To measure household food insecurity, participants were asked a single question from the USDA Adult Food Security Module.[57] Anthropometrics were evaluated using Body Mass Index (BMI) and self-report height and weight taken on an at home scale, using reports from their last doctor's visit, or verbal confirmation of weight. To ensure accurate reporting of weight, participants were asked to email or text a photo to the researchers of their weight on the scale.[58] The method of weight and height collection was noted for each participant. Physical activity level was assessed using the Stanford Leisure Time Activity Categorical Item (L-Cat), a tool consisting of six descriptive categories (e.g., 1 = "Once or twice a week, I did light activities such as getting outdoors on the weekends for an easy walk or stroll. Or once or twice a week, I did chores around the house such as sweeping floors or vacuuming.") ranging from inactive (1 = did not do much physical activity) to very active (6 = almost daily, that is five or more times per week, I did vigorous activities).[59] Due to unavoidable lifestyle changes inflicted by COVID-19, participants were asked if their dietary habits have changed since the beginning of 2020 as a result of the pandemic.

Food agency was measured using the CAFPAS questionnaire (see Appendix B). The CAFPAS is based on sociological, anthropological, and psychological theories of agency giving the tool the strength to measure the dynamic interaction between the individual, society, and their environment.[45] This tool is a 28-item validated scale that uses a 7-point Likert scale with answers from 1 ("Strongly Disagree") to 7 ("Strongly Agree").[47] Thirteen items measure one's confidence in their cooking and provisioning abilities, or *food skill and self-efficacy*. Ten items measure one's perceived level of enjoyment in completing food-related tasks, or *food attitude*. Five items measure one's perception of external factors that inhibit them from completing food related tasks,

or *structure*.[47] Questions are asked as, "On a scale of 1-7 how much do you agree or disagree with the following statements?" Completion time of the CAFPAS questionnaire is ten minutes.[47] A CAFPAS score is calculated by summing the quotients of each subgroup and dividing by its standard deviation producing a scale in which a higher CAFPAS score represents greater food agency (Appendix C).[47]

Cooking behavior was measured by asking participants "how many times in the past seven days you did the following…" and "how many times in the past seven days someone in your household did the following…" cook breakfast, lunch, and dinner; make a meal from scratch/fresh ingredients (such as vegetables and raw meat); make a meal from packaged products (such as dried pastas and rice that require additional ingredients (butter or milk) and need to be heated); make a meal from frozen products (such as frozen vegetables, fish, or meat); and use a recipe to make a meal.[46,60] Response categories ranged from 1 to $\geq$ 7. Frequency of consumption of home cooked leftovers for breakfast, lunch, and dinner was also assessed.[60] These questions were utilized by Wolfson et al. 2020, based on NHANES questions, and were fielded previously (see Appendix C).[46,60,61] All scales related to cooking behavior and food skills were previously validated in the United States.[46,47] Only the participant's cooking frequency were used for this analysis as data were incomplete on household cooking frequency.

Dietary intake was assessed using three non-consecutive 24-hour recalls taken within a two-week period; the first was administered via Zoom to ensure accurate data collection and to familiarize participants with portion size estimation procedures. Participants were asked to have measuring cups on hand for session 2 and were sent a paper-based serving size chart for assessing portion sizes during a 24-hour recall over the telephone. The remaining two 24-hour recalls were collected via phone call. Each 24-hour recall session took between twenty and sixty minutes to complete.[62] Collecting three 24-hour recalls improves the accuracy of energy estimation as the first recall is subject to significant underreporting.[63] Compared to food frequency questionnaires, 24-hour recalls are less subject to underreporting of energy and protein, and more

comprehensively evaluate dietary intake making them the preferred method for evaluation of dietary habits.[64] The Multiple Pass Method (MPM), a 5-step validated method used by the interviewer, was used to reduce underreporting and improve the accuracy of dietary recalls (see Appendix D).[65] Recalls were analyzed using Nutrition Data System for Research 2020 (NDSR; University of Minnesota Nutrition Coordinating Center).

The NOVA (not an acronym) classification system was used to categorize foods by level of processing.[66] This system categorizes foods into four categories: unprocessed/minimally processed, processed culinary ingredients, processed foods, and ultra-processed foods. The unprocessed/minimally processed category includes foods from plants and animals that use minor processing techniques such as drying, freezing, and boiling (e.g., milk, coffee, chicken). Processed culinary ingredients include those that undergo processes such as pressing, refining, and grinding (e.g., salt, flour, sugar). The processed foods category includes methods such as canning and non-alcoholic fermentation (e.g., fresh bread, salted nuts, canned vegetables). Finally, ultra-processed foods (UPFs) include foods with the highest levels of processing. This category includes ingredients and industrial processing techniques that enhance the flavor, texture, or shelf-life of products such as chemical additives and modifications, emulsifiers, and protein isolates which would not be used in home cooking. Most cheeses were categorized as UPFs because they contained stabilizers and mold inhibitors as ingredients. Participants provided food labels of products consumed when possible so the dietary information could be cross-checked for nutritional accuracy and NOVA classification during the diet evaluation process.

Probing questions for information on degree of food processing were asked during the 24-hour recall including (1) type of processing (fresh, dried, frozen, etc.) (2) if the processing was performed before or after purchasing (3) brand and product names and (4) ingredient lists for hand-made dishes.[67] Products that have additives such as emulsifiers, natural and artificial flavors, and colors were classified as ultra-processed (Table 1).[66] Recipes were disaggregated when possible for homemade dishes that include a variety of processed foods with the processing

of individual ingredients treated separately from processing during recipe preparation.[67] Foods recorded from 24-hour recalls were manually categorized into one of the four NOVA groups using the Open Food Facts iOS application and NOVA classification criteria with the dietary analyses from NDSR 2020.[2,11,68–70] NOVA classifications were performed independently by two raters. Raters met to compare ratings and discuss discrepancies. Output file two from NDSR 2020, which provides nutrient information, weight, and calories for each food, were used to assess all three of the subject's 24-hour recalls for NOVA categorization. Average UPF intake of was calculated as both % energy from UPF and % gram weight of food from UPF. Output file two has whole food level information. Although alcohol is not officially part of the NOVA classification system, the recommendations of beer and wine as processed foods, and spirits and liquors as UPFs were used for scoring. Percent UPF intake was calculated as an exploratory analysis using the gram weight of foods, rather than kcals, since noncaloric UPF additives, such as artificial sweeteners, and artificially sweetened products, like diet food products, were not captured with the % total energy analysis.[3,8,20,24]

Statistical Analysis

Descriptive statistics including mean, frequency, and standard deviation were used to evaluate demographics and the distribution of food agency and each CAFPAS subgroup. Quartiles of CAFPAS scores were assigned and one-way ANOVAs were used to determine CAFPAS quartile differences in demographics, BMI, cooking frequency, and health history. One-way ANOVAs were also used to test differences between cooking frequency categories and UPF intake in % total kcals and grams. Tukey's post hoc test was used for one-way ANOVAs results that were significant. Chi-squared tests were used to determined differences between CAFPAS quartiles, physical activity, and categorical demographic variables.

To account for false positives due to chance (type 1 error), a Bonferroni correction was used for interquartile usual dietary intake and cooking behavior differences. Independent samples

t-tests were used to assess differences in UPF intake, macronutrients, energy, fiber, added sugar, trans fat, and food groups between high food agency (CAFPAS Q3 and Q4) and low food agency (CAFPAS Q1 and Q2) groups. Differences in food agency and dietary intake based with % total energy and % total grams from UPFs were examined using bivariate Pearson correlations.

Linear regression models were used to evaluate independent associations between variables correlated with the outcomes of interest. Previous research identified associations between age, gender, income, race/ethnicity, employment status, and food security with cooking self-efficacy, therefore, these variables were evaluated as potential confounding variables.[46,47] Statistical significance was considered at $P < 0.05$.

RESULTS

Sample Characteristics

A total of 48 individuals were enrolled and 40 participants completed the study (83% retention). Reasons for exclusion and dropouts are provided in Figure 2. Demographic characteristics for this study are presented in Table 2. The majority of the sample was female (72.5%), white, not of Hispanic origin (65%), and had completed an undergraduate or graduate degree (92.5%). The rest of the sample was comprised of Asian (20%), Hispanic (7.5%), black, not of Hispanic origin (7.5%), and "other" (2.5%). The sample had a mean reported UPF intake of 52.8% ($\pm$ 21.0) of total energy and 25.9% ($\pm$ 20.8) of total gram weight of food. Usual dietary intake is presented in Table 3. CAFPAS scores for the sample ranged from 8.09 to 18.25. Cooking frequency and CAFPAS scores are presented in Table 4.

The majority (60%) of participants reported that their dietary habits changed during the COVID-19 pandemic. Of the 16 participants that provided more information on how their diets changed, nine stated that they cooked more meals at home. There was a combination of both healthy changes, like experimenting with plant-based meals and eating more whole foods, and unhealthy dietary changes, like more snacking, stress eating, and alcohol consumption, as a result

of changes in lifestyle due to COVID-19. Most participants (95%) indicated being food secure. The majority of participants were either single (42.5%) or married (52.5%), with only 5% being divorced. Most participants were employed full-time (52.5%) or students (27.5%). The remaining 20% of participants were retired, a stay at home parent, self-employed, or unable to work. A little over half (55%) of the sample reported exercising in the Light-Intensity or Moderate-Intensity (~3 days/week) physical activity categories. The rest of the sample fell into the Moderate-Intensity (≥5-days/week; 12.5%), Vigorous-Intensity (~3-days/week; 10%), and Vigorous-Intensity (≥5-days/week; 22.5%) categories.

Table 2. Sample Characteristics

Sex		**Food Insecurity**	
Male	11	"We have enough of the foods we want to eat"	38
Female	29	"We have enough food, but not the kinds we want to eat"	1
Age		"Sometimes we don't have enough to eat"	1
Mean (years)	38.6	"We often don't have enough to eat"	0
SD	15.4		
		Change in Dietary Habits During COVID-19	
Household Income		Yes	24
Less than $20,000	8	No	16
$20,000 to $34,999	5		
$35,000 to $49,999	7	**Physical Activity**	
$50,000 to $74,999	6	Inactive	0
$75,000 to $99,999	5	Light-Intensity	11
Over $100,000	9	Moderate-Intensity (~3-days/week)	11
		Moderate-Intensity (≥5-days/week)	5
Education		Vigorous-Intensity (~3-days/week)	4
High School	3	Vigorous-Intensity (≥5-days/week)	9
College Degree	14		
Master's Degree	19	**Employment Status**	
Doctorate	4	Employed full time (40 or more hours per week)	21
		Employed part time (up to 39 hours per week)	3
Race/Ethnicity		Student	11
American Indian or Alaska Native	0	Retired	2
Asian or Pacific Islander	8	Stay at home parent	1
Hispanic	3	Self-employed	1
Black, not of Hispanic origin	3	Unable to work	1
White, not of Hispanic origin	26		
Other	1	**Body Mass Index (BMI)**	
		Mean (kg/m^2)	25.7
Marital Status		SD	4.86
Single (never married)	17		
Married, in a domestic partnership	21	**BMI by Category**	
Widowed	0	Underweight	1
Divorced	2	Normal	17
Separated	0	Overweight	13
		Obese Class I	6
		Obese Class II	3

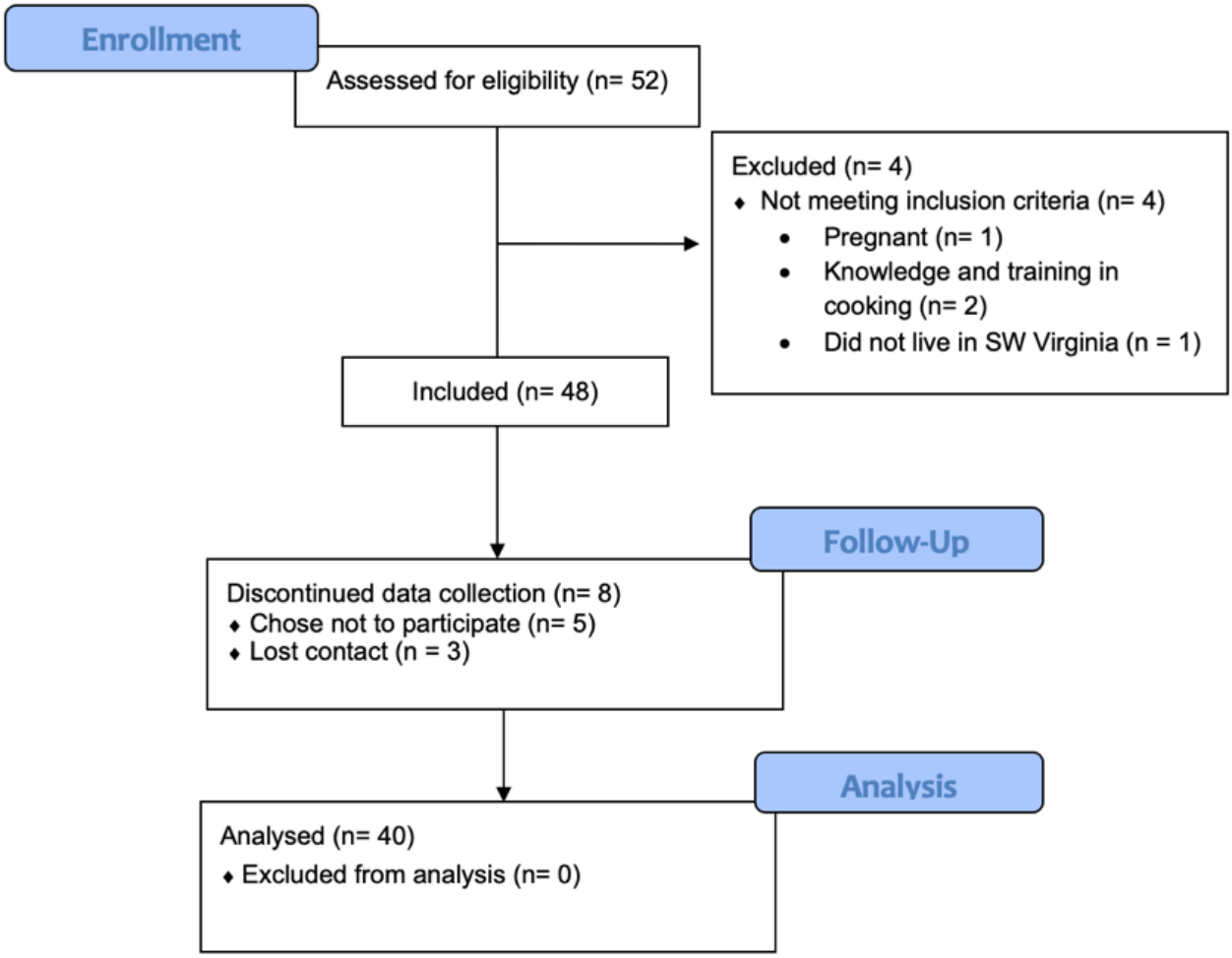

Figure 2. CONSORT Flow Diagram

Table 3. Usual dietary intake in the full sample and by quartiles of CAFPAS scores					
Nutrients	**Sample Mean (SD)**	**CAFPAS Q1 Mean (SD) (Low Score)**	**CAFPAS Q2 Mean (SD)**	**CAFPAS Q3 Mean (SD)**	**CAFPAS Q4 Mean (SD) (High Score)**
Energy (kcals)	1929 (454)	1982 (499)	1936 (504)	1944 (434)	1852 (437)
Total Protein (g)	82.4 (30.9)	98.3 (40.1)	79.5 (29.6)	77.4 (26.6)	74.2 (23.2)
% Calories from Protein (%)	17.0 (4.9)	20.2 (5.9)	16.0 (3.5)	15.4 (4.4)	15.9 (4.4)
Total Carbohydrates (g)	228.9 (62.6)	210.6 (69.1)	232.8 (56.9)	237.7 (69.7)	234.7 (60.1)
% Calories from Carbohydrates (%)	46.7 (9.2)	41.2 (7.5)	47.7 (10.1)	47.5 (8.2)	50.3 (9.6)
Added Sugar (g)	42.5 (37.1)	40.3 (32.6)	47.3 (43.8)	47.7 (51.2)	34.8 (14.7)
Total Dietary Fiber (g)	24.8 (10.6)	23.4 (11.1)	23.3 (8.9)	28.8 (13.9)	23.6 (8.3)
Sucralose (mg)	5.8 (14.3)	13.8 (22.2)	4.2 (8.0)	0.4 (0.8)	4.7 (14.8)
Maltose (g)	2.3 (1.8)	1.7 (1.5)	2.0 (1.5)	2.4 (1.7)	3.2 (2.2)
Glycemic Load (glucose reference)	115.5 (38.8)	107.1 (40.9)	120.3 (39.3)	115.1 (46.9)	119.3 (31.4)
Glycemic Load (bread reference)	165.1 (55.5)	153.2 (58.4)	172.0 (56.1)	164.5 (67.1)	170.6 (44.9)
Vitamin C (mg)	80.7 (53.4)	55.8 (24.1)	76.3 (58.6)	85.2 (45.9)	105.4 (69.4)
Vitamin B12 (mcg)	3.6 (1.7)	4.2 (2.0)	3.5 (1.8)	3.1 (1.7)	3.4 (1.5)
Natural Folate (mcg)	284.0 (126.6)	233.1 (86.1)	266.7 (110.8)	334.5 (182.1)	301.7 (101.1)
Beta-Cryptoxanthin (mcg)	387.6 (755.0)	710.9 (1240.0)	344.1 (512.6)	359.0 (656.5)	136.2 (222.6)
Retinol (mcg)	368.4 (228.0)	481.7 (353.9)	316.9 (155.2)	334.0 (185.1)	341.1 (149.6)
Sodium	3097.9 (1164.6)	3063.9 (1042.8)	3226.3 (1511.9)	2766.6 (1090.9)	3334.9 (1053.5)
Potassium	2767.3 (937.8)	2859.1 (933.9)	2590.3 (968.2)	2893.4 (1184.6)	2726.5 (731.2)
Calcium	904.2 (358.9)	1005.3 (427.6)	797.9 (317.4)	1010.8 (341.8)	802.7 (331.6)
Total Fat (g)	77.4 (25.1)	84.9 (23.1)	76.9 (31.3)	78.5 (22.8)	69.3 (23.9)
% Calories from Fat (%)	34.9 (7.1)	37.6 (4.1)	33.9 (9.2)	35.4 (8.5)	32.7 (5.5)
% Calories from SFA (%)	11.8 (3.5)	13.0 (2.4)	11.1 (3.8)	12.0 (4.9)	11.2 (2.8)
% Calories from MUFA (%)	12.5 (3.5)	13.2 (2.5)	12.8 (5.0)	12.8 (4.0)	11.4 (1.9)
% Calories from PUFA (%)	7.3 (1.9)	7.6 (1.5)	7.2 (1.8)	7.4 (1.9)	7.1 (2.5)
Total Trans Fatty Acids (g)	1.7 (1.1)	2.5 (1.4)[a]	1.6 (1.0)[ab]	1.1 (0.7)[b]	1.5 (0.9)[ab]
Trans 18:1 (g)	1.4 (1.0)	2.0 (1.2)[a]	1.3 (0.9)[ab]	0.9 (0.6)[b]	1.2 (0.8)[ab]
Total Conjugated Linoleic Acid (g)	0.1 (0.1)	0.2 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
Butyric Acid (g)	0.6 (0.4)	0.7 (0.3)	0.6 (0.4)	0.5 (0.4)	0.5 (0.5)
Caproic Acid (g)	0.4 (0.2)	0.5 (0.2)	0.3 (0.2)	0.3 (0.2)	0.3 (0.3)
Margaric Acid (g)	0.1 (0.1)	0.2 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)
Myristoleic Acid (g)	0.1 (0.1)	0.2 (0.1)	0.1 (0.1)	0.1 (0.1)	0.1 (0.1)

Palmitic Acid	13.4 (5.4)	15.1 (4.9)	13.7 (6.7)	12.0 (4.5)	12.6 (5.5)
% Calories from Alcohol	1.5 (3.0)	1.0 (2.4)	2.4 (3.9)	1.7 (3.9)	1.0 (1.6)
Food Groups					
Dairy Servings	1.6 (1.0)	1.9 (1.3)	1.4 (0.6)	1.7 (0.9)	1.3 (1.1)
Fruit Servings	1.7 (1.4)	1.5 (1.4)	1.9 (1.9)	1.5 (1.3)	1.8 (1.2)
Vegetable Servings	4.2 (2.4)	3.9 (1.3)	3.5 (2.0)	5.0 (3.6)	4.4 (2.3)
Grain Servings	5.8 (2.6)	5.3 (1.8)	6.3 (4.1)	5.4 (1.7)	6.1 (2.6)
Protein Servings	5.8 (3.4)	7.2 (5.0)	5.8 (3.7)	5.2 (1.5)	5.2 (2.6)
Fat Servings	4.6 (2.9)	5.3 (3.2)	5.0 (2.6)	3.8 (2.5)	4.4 (3.3)
UPF Intake	**Sample Mean (SD)**	**Q1 and Q2 Combined Mean (SD)**		**Q3 and Q4 Combined Mean (SD)**	
UPF Intake (% total kcals)	52.8 (21.0)	59.6 (19.9)[a]		46.0 (20.3)[b]	
UPF Intake (% total grams)	25.9 (20.8)	29.7 (21.3)		22.1 (20.0)	

[a-b] Mean value was significant different between means of a different letter at $P<0.05$ before Bonferroni adjustment of $P<0.0012$.

Table 4. Usual cooking frequency and CAFPAS scores in the full sample and by quartiles of CAFPAS

Measure	Sample Mean (SD)	CAFPAS Q1 Mean (SD) (Low Score)	CAFPAS Q2 Mean (SD)	CAFPAS Q3 Mean (SD)	CAFPAS Q4 Mean (SD) (High Score)
Cooking Frequency (out of 7 days)					
Breakfast	3.8 (2.1)	3.7 (2.5)	3.9 (2.3)	3.9 (1.6)	3.8 (2.4)
Lunch	3.8 (2.1)	3.5 (2.6)	3.9 (1.9)	4.0 (1.8)	3.9 (2.3)
Dinner	4.6 (1.8)	3.2 (2.2)[a]	5.2 (1.4)[c]	4.3 (1.2)[abc]	5.7 (1.5)[b]
Meal from scratch/fresh ingredients	4.3 (2.2)	2.7 (2.4)[b]	4.0 (1.4)[ab]	4.9 (1.8)[ab]	5.7 (2.0)[a]
Meal from packaged products	2.6 (1.7)	2.9 (2.1)	3.0 (0.9)	2.5 (2.2)	2.0 (1.5)
Meal from frozen products	2.4 (1.7)	2.7 (2.3)	2.6 (1.4)	2.5 (2.2)	1.9 (0.9)
Used a recipe to make a meal	2.9 (1.8)	2.3 (1.6)	2.7 (1.7)	3.2 (1.8)	3.2 (2.3)
Eat homemade leftovers for breakfast	2.1 (1.8)	2.1 (2.1)	2.6 (2.6)	2.1 (1.5)	1.7 (1.0)
Eat homemade leftovers for lunch	3.5 (1.6)	3.1 (0.8)	3.6 (2.0)	4.1 (1.6)	3.3 (1.6)
Eat homemade leftovers for dinner	3.0 (1.6)	2.6 (1.2)	3.4 (2.2)	3.5 (1.0)	2.2 (1.7)
CAFPAS Scores					
Total CAFPAS Score	14.1 (2.4)	10.8 (1.5)	13.6 (0.6)	15.3 (0.4)	16.7 (0.9)
Self-Efficacy Subscale	6.0 (1.0)	4.8 (1.0)	6.0 (0.4)	6.4 (0.5)	6.9 (0.3)
Attitude Subscale	4.5 (1.0)	3.3 (0.9)	4.3 (0.4)	5.2 (0.7)	5.2 (0.6)
Structure Subscale	3.6 (1.0)	2.7 (1.0)	3.3 (0.6)	3.7 (0.7)	4.6 (0.7)

[a-c] Mean value was significant different between means of a different letter at $P<0.05$ before Bonferroni adjustment of $P<0.004$.

[ab, abc] Means were not significantly different between groups.

CAFPAS and Dietary Intake

Habitual dietary intake did not vary across CAFPAS quartiles with a few exceptions. Total trans-fat and trans 18:1 intake was less in CAFPAS Q3 than Q1 ($P<0.05$). After adjusting the *P*-value using Bonferroni correction from 0.05 to 0.0012, dietary intake variables were not different across CAFPAS quartiles.

Additional independent samples t-tests were ran to determine group differences between high and low food agency and energy, macronutrients, dietary fiber, added sugar, trans-fat, and the food groups listed in Table 3. Of these variables only total trans-fat differed between groups ($P=0.04$) using a two-tailed analysis. High food agency was associated with consuming 0.71 fewer grams of trans-fat compared to the low food agency group.

The CAFPAS self-efficacy subscale score was negatively correlated with retinol (r= -0.461), vitamin B12 (r= -0.341), butyric acid (r= -0.381), caproic acid (r= -0.405), palmitic acid (r= -0.313), stearic acid (r= -0.351), margaric (r= -0.448) and myristoleic acid (r= -0.526), sucralose (r= -0.318), CLAs (r= -0.340), and dairy servings (r= -0.376) and positively correlated with natural folate (r=0.346; all $P<0.05$). The CAFPAS subscale attitude was negatively correlated with beta-cryptoxanthin (r= -0.335), and sucralose (r= -0.406) intake and the CAFPAS subscale structure was positively correlated with maltose (r=0.040), and negatively correlated with % calories from protein (r= -0.328; all $P<0.05$).

CAFPAS and Cooking Frequency

CAFPAS Q4 had greater frequency of making a meal from scratch or fresh ingredients (mean=5.7$\pm$2.0 days/wk) compared to Q1 (mean=2.7$\pm$2.4 days/wk; $P=0.009$) (Figure 3). Dinner cooking frequency also differed between CAFPAS quartiles with Q2 and Q4 cooking more frequently than Q1 ($P=0.007$)(Figure 4). Other categories of cooking frequency were similar across CAFPAS quartiles. After adjusting the *P*-value using Bonferroni correction from 0.05 to 0.004 cooking frequency did not differ across quartiles.

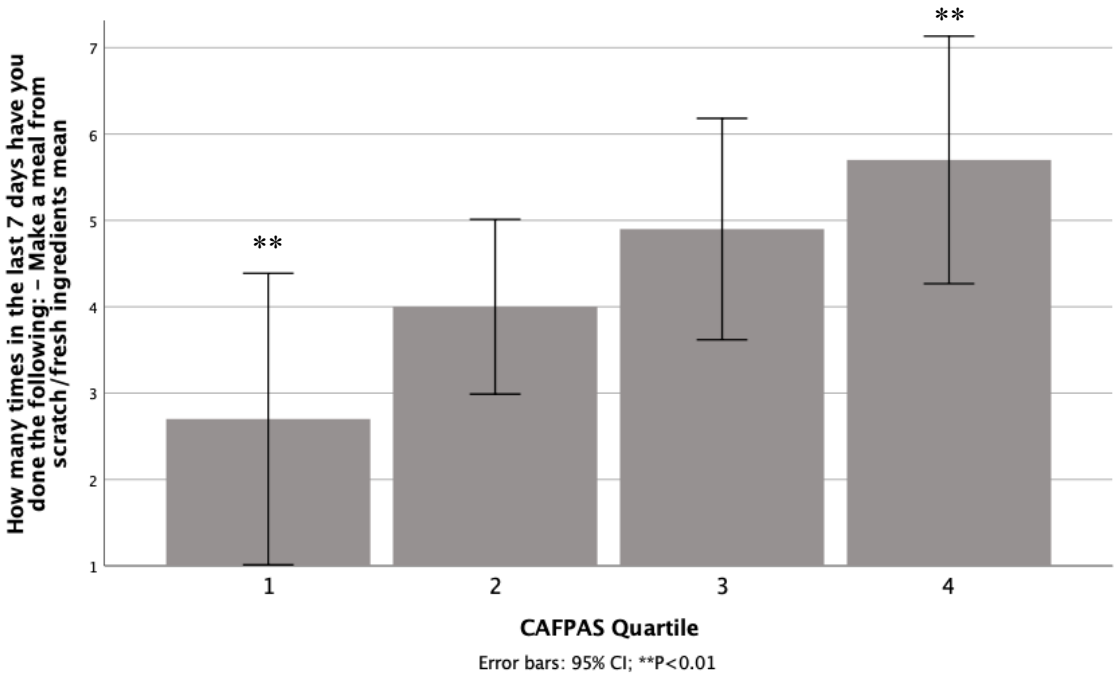

Figure 3. Mean cooking frequency for making a meal from scratch/fresh ingredients within the last 7 days by Cooking and Food Provisioning Action Scale (CAFPAS) quartile.

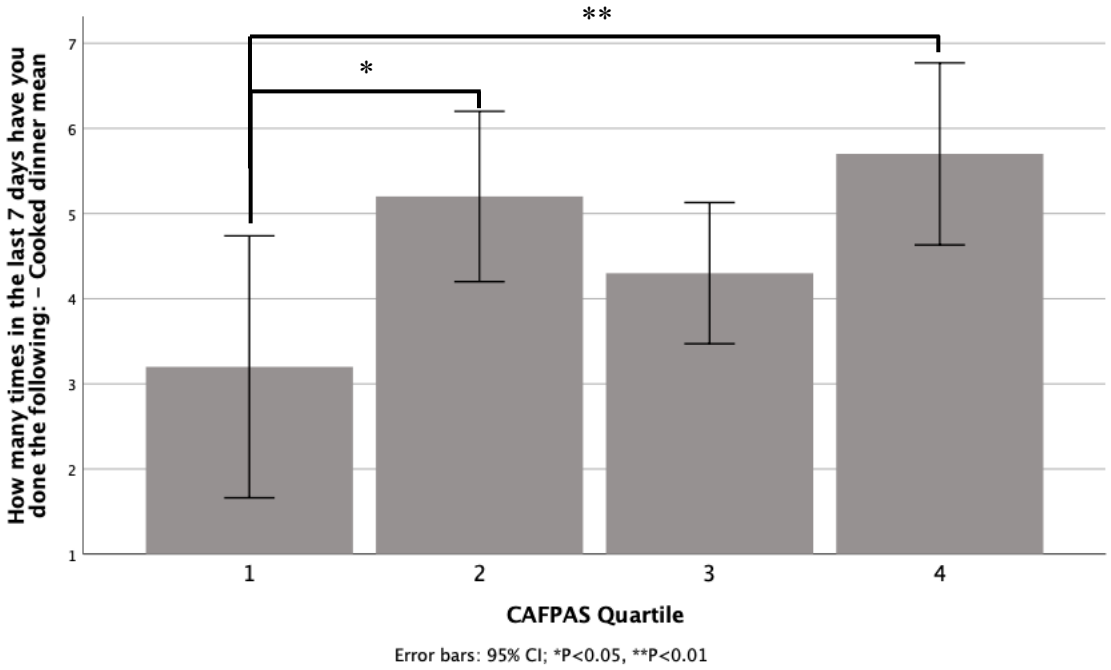

Figure 4. Mean cooking frequency for cooking dinner within the last 7 days by Cooking and Food Provisioning Action Scale (CAFPAS) quartile.

BMI was not different between CAFPAS quartiles (*P*=0.061). There were no differences between CAFPAS quartiles and age (*P*=0.644) using a one-way ANOVA test. Using a chi-squared test, there were no differences in CAFPAS quartile and household income (*P*=0.466), marital status (*P*=0.823), employment status (*P*=0.136), highest degree achieved (*P*=0.960), or food security (*P*=0.454). There was also no difference between UPF intake as % total kcals and age (*P*=0.069) measured using Pearson correlation or household income (*P*=0.838), marital status (*P*=0.602), highest degree achieved (*P*=0.808), or food security (*P*=0.529) measured using one-way ANOVAs. UPF intake as % total kcals differed between employment statuses (P=0.034), however, post hoc analysis was not performed because more than one group had fewer than two cases. Due to the lack of differences in these variables, they were not included in subsequent analysis as confounders or covariates.

CAFPAS, Subscales, and UPF

Participants in CAFPAS Q3 and Q4 on average consumed about 14% less UPF (% total kcal) compared to Q1 and Q2 (*P*=0.03) (Figures 5 A & B). There was no difference in % total gram from UPFs between CAFPAS quartiles. There were also no differences in UPF intake (% total kcal or g) between males and females. When age was divided into three categories (19-39 y, 40-59 y, 60+ y), UPF intake was lower in older adults (60+ y) compared to adults aged 19-39 y and 40-59 y by 26.4% and 29.1% respectively (*P*=0.02).

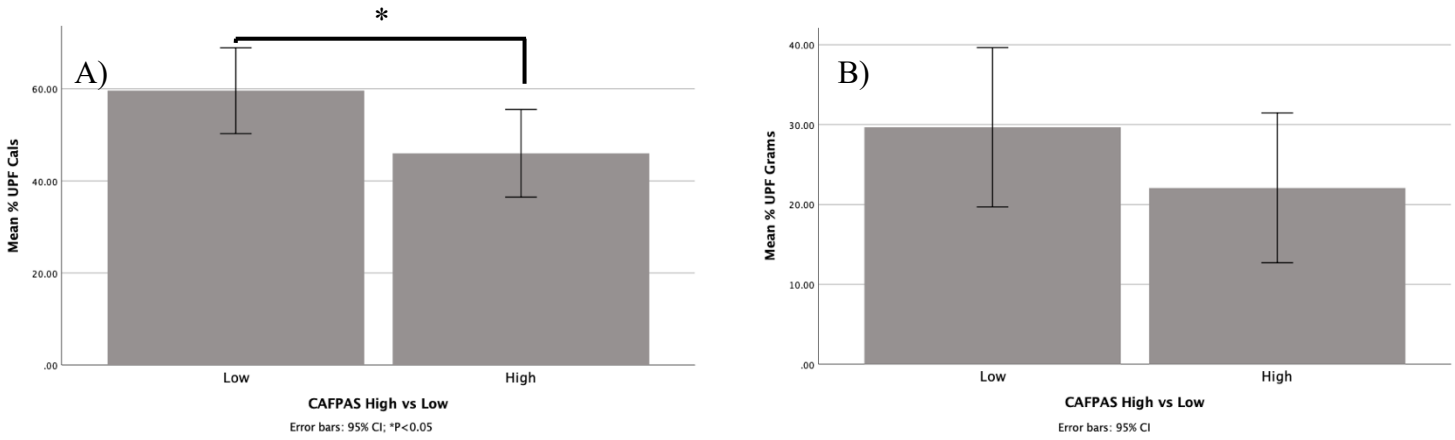

Figure 5. A) Mean % UPF of total calories by combined CAFPAS quartile. B) Mean % UPF intake of total grams by combined CAFPAS quartile. "Low" is the combined mean of Q1 and Q2, and "High" is the combined mean of Q3 and Q4.

Total CAFPAS score was not associated with UPF intake (% total kcal or g). When analyzed using one-way ANOVA, cooking lunch 6 or 7 days per week was associated with consuming 28-55% fewer kcals from UPFs compared to cooking lunch only 2 or 3 days per week (P<0.05). When analyzed using bivariate analysis, lunch (r=-0.482, P=0.002) and dinner (r=-0.385, P=0.014) cooking frequency, frequency of cooking a meal from scratch or fresh ingredients (r=-0.320, P=0.044), and CAFPAS self-efficacy (r= -0.369; P= .019) were negatively correlated with UPF intake (% total kcal). Percent UPF of total grams was positively correlated with % UPF of total calories (r = 0.727; P<0.01). However, there were no differences in % UPF total grams from UPFs between CAFPAS subscales or cooking frequency.

Predictors of UPF Consumption

Based on the results from a multiple linear regression model, 59% of the variance in UPF intake (% total kcals) can be attributed to CAFPAS self-efficacy, frequency of cooking lunch and dinner, and making a meal from scratch/fresh ingredients in the last 7 days. These variables are independent predictors of UPF intake; however, they are likely closely related to one another (R^2=0.59, F=4.74, P=0.004) (Table 6).

Table 5. Using behavioral and Cooking and Food Provisioning Action Scale (CAFPAS) subscale variables to predict Ultra-Processed Food (UPF) intake (% total kcals)

Variables	Units	β	*P*-Value
Cooking Frequency - lunch	Days/Week	-0.44	0.006
Cooking Frequency - dinner	Days/Week	-0.04	0.823
Cooking Frequency – meals from scratch/fresh ingredients	Days/Week	-0.06	0.82
CAFPAS Self-Efficacy	Score	-0.29	0.76
R^2		0.59	
P-Value		0.004	

No variables were significantly correlated with UPF intake in % total grams; thus, a multiple linear regression model was not used for analysis of variance or determination of independent predictors of this outcome.

DISCUSSION

In this preliminary study, UPF intake (% energy) when analyzed by quartiles was not associated with overall CAFPAS score, or food agency, but it was correlated with the CAFPAS subscale "food self-efficacy". When "high" food agency (Q3 and Q4) was compared to "low" food agency (Q1 and Q2), high food agency was associated with 14% lower UPF intake. These findings support our hypothesis that UPF intake would decrease with higher food agency.

The sample had a mean percent UPF intake of 52.8% which is similar to the average for Americans of 57.9%.[23] The 5% difference in scores could be due to the small sample size of the study and having a less diverse sample than NHANES. Similar to a study by Wolfson et al., these results demonstrated that higher food agency was associated with greater frequency of cooking a meal from scratch or fresh ingredients and cooking dinner.[46] In a larger sample (n=2856), Wolfson et al. also determined that people with greater food agency (Q4) were more likely to cook breakfast and lunch, and use less packaged products when cooking than those with lower food agency (Q1), but this was not found in this sample.[46] Although lunch cooking frequency was not different between quartiles, those who cooked lunch 6 or 7 days per week were more likely to consume a diet lower in UPFs compared to those who cooked lunch only 2 or 3 days per week.

Previous studies found that confidence with specific cooking techniques, like sautéing and baking, was not associated with UPF intake, however, in our study the association between the CAFPAS subscale food self-efficacy and UPF intake contrasts this result.[50] This finding reiterates that confidence with cooking techniques may be less relevant to the ability to cook from scratch compared to other aspects of cooking measured using the CAFPAS, such as problem solving, creating a meal from what is available, and cooking confidence that are subjectively.[47]

Variables that were presumed to be confounders in previous studies were not associated with CAFPAS score or UPF intake in this study, with the exception of age when divided into three categories and employment status. When age was categorized by decade by Lahne et al. and Wolfson et al., age and CAFPAS scores showed a positive linear relationship.[46,47] Despite age being associated with UPF intake,

the sample size was too small to determine differences in age and CAFPAS scores. Wolfson et al. found associations between CAFPAS scores and age, working status, parental status, and gender in the general adult population.[46] Leung et al. also determined that food security is a contributor to low food agency in the general population and the disproportionately large college student population living with food insecurity.[46,71] Food insecurity was not prevalent in the sample included in this study with only one participant reporting that they "sometimes did not have enough to eat." The study sample was pooled primarily from graduate students, university faculty/staff, and retired community members affiliated with the university with average household income falling between $34,000 and $74,999, well above the poverty level.[72] These factors could account for why food insecurity was not a significant predictor of UPF intake.

In contrast to the findings of Astbury et al., we did not find that sodium intake differed with food agency. Astbury et al. reported that sodium intake increased with less home food preparation.[52] Other notable differences in dietary habits and food self-efficacy are decreased intake of four saturated fatty acids and conjugated linoleic acid with greater food self-efficacy. Higher food agency was associated with lower total trans-fat and trans 18:1 intake. This builds upon previous studies that observed a greater intake of energy, saturated fatty acids, sugar and sodium, and a lower intake of dietary fiber in the highest consumers of UPFs.[3,5,20,24] Overconsuming sodium and fat, which are typically high in UPFs, has been associated with adverse health outcomes such as CVD, hypertension, and weight gain.[73,74]

Prior studies found that higher food agency was associated with a lower BMI.[44] However, in this study BMI was not different between CAFPAS quartiles. Prior studies also determined that women were more likely to cook than men, although that was not a finding in this study.[35,38,44,49] The small sample size with an unequal number male and female participants may have resulted in insignificant differences in cooking frequency between sexes.

Strengths and Limitations

To our knowledge this is the first study to evaluate the relationship between UPF intake and food agency or cooking self-efficacy in the United States. Prior studies evaluating cooking self-efficacy and dietary intake used unvalidated or non-comprehensive tools. The strengths of this study are that it used a validated and multi-scale questionnaire to determine food agency and recommended procedures to assess self-reported dietary intake such as collecting multiple 24-hour dietary recalls per participant. Rigorous procedures, such as collecting food labels and having a second rater, were also used to classify foods consumed into NOVA categories.

There are a few limitations of this study that should be addressed. The sample was small and limited in diversity similar to past studies evaluating cooking self-efficacy.[39–43,51–53] During NOVA coding, some meals could not be disaggregated which could have resulted in higher UPF intake than if coded separately. Future studies should strive for a more heterogeneous, larger sample and code all foods and beverages as their individual components if assembled or homemade.

CONCLUSION AND FUTURE DIRECTIONS

Low food agency was associated with a higher UPF intake (% total calories) compared to high food agency in this sample of adults. The CAFPAS subscale food self-efficacy was also correlated with UPF intake and some aspects of dietary intake. These findings provide support for the possibility of reducing UPF intake by improving food self-efficacy through cooking interventions aimed at improving problem solving, creating a meal from what is available, and cooking confidence. Future studies should include a larger and heterogeneous population to provide more insight into dietary differences between levels of food agency and expand the diversity of research in this area. This research could then help tailor future cooking interventions aimed at increasing food agency and lowering UPF intake.

Chapter 3 – Conclusions and Future Directions

In conclusion, high overall food agency was associated with lower UPF intake compared to low overall food agency. Additionally, age was associated with UPF intake with older adults consuming significantly less UPF. The CAFPAS subscale, food self-efficacy, was also associated with reduced intake of UPFs. Differences were observed in various components of diet quality and the CAFPAS sub-scales, and overall food agency and cooking frequency. This study emphasizes the importance of understanding the drivers of UPF consumption. To combat the adverse health effects of high UPF consumption, researchers could develop educational and hands-on cooking interventions aimed to improve all three subscales of the CAFPAS, food self-efficacy, food attitude, and structure. Future research is needed to further investigate food agency and UPF intake in a more diverse, larger sample that includes at risk groups for increased UPF intake or lower CAFPAS score such as younger adults and those that are food insecure.[3,5,20,24,71]

Evidence shows that CAFPAS scores increase linearly by decade in a larger sample (n= 943) and CAFPAS scores in a college population decreased with lower food security.[47,71] Prior evidence suggests that college-aged individuals, who as a whole are at greater risk for food insecurity and low food agency, might be a target population of interest for interventions aimed at improving food agency.[75] Additionally, younger adults born between 1981 and 1996 spend more of their food budget on prepared foods compared to older generations, which may put them at greater risk for increased UPF intake.[76]

Energy-dense foods, like UPFs, tend to be less expensive in the United States than nutrient-dense foods like fruits and vegetables, making it less feasible for those of lower socioeconomic status (SES) to consume a diet composed primarily of unprocessed foods.[32,33] A study of 15,977 U.S. adults found that participants in the highest quintile of UPF intake were more likely to a have family income <130% of the federal poverty level compared to participants in the lowest quintile.[18] This is reflective in cooking frequency as well, as an income > 130% federal poverty level is more likely to be associated with higher dinner cooking frequency ($\geq$ 6-7 times/week) compared to an income $\leq$ 130% federal poverty level.[35]

However, regardless of income, evidence suggests that expenditures on prepared food is surpassing that of foods purchased for home meal preparation.[77]

Home food preparation encourages lower consumption of foods classified as ultra-processed by NOVA, but a lack of cooking skills may be a major barrier for those with low cooking frequency. Cooking skills, such as cooking techniques and knowledge of cooking processes, and food skills, such as meal planning, food budgeting, and food safety, are not only associated with increased likelihood of cooking at home, but also improved diet quality.[36,38] Those with higher diet quality have greater nutrition knowledge, consume less takeaway, and have higher cooking attitudes including perceptions of being a cook, food creativity, and enjoyment in trying new foods.[38] Without adequate cooking and food skills, shopping and preparing meals at home may seem like a difficult task, leading to greater consumption of ready to eat meals and food away from home.

Food manufacturers have developed the technology to improve shelf-life, food safety, nutrient profiles, and extract compounds with a variety of food processing techniques to sustain a growing population.[1] With the growing abundance of convenience food options, it is not astonishing that even participants with the highest food agency scores had an average UPF intake of 46.9% of total calories. Staple foods in the American diet such as bread, peanut butter, and cheese, as well as some canned foods and condiments include ingredients like natural flavors and preservatives that classify them as UPFs making it difficult to eliminate all UPFs from the diet.[1] Multiple adverse health outcomes are associated with high UPF consumption including weight gain, obesity, metabolic syndrome, cardiovascular disease (CVD), all-cause mortality, cancer, and type 2 diabetes (T2D).[3–10,19,20] High UPF intake, especially among younger generations, causes concern as the latter conditions continue to increase in prevalence.[22] Prevention of these chronic conditions begins in young adulthood through dietary and lifestyle changes and reduction of UPF intake may be an integral intervention to preventative care.

Ultra-processed food intake has primarily been conducted using prospective cohorts, cross-sectional analyses, and longitudinal studies. Future randomized controlled trials evaluating the efficacy of a cooking intervention aimed to improve food agency could decrease UPF intake and teach sustainable

behaviors. Conducting this research with a healthy young adult population would allow for longitudinal follow-up in which data on health outcomes and changes in food agency throughout adulthood could be measured.

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Appendix A. IRB Approval Letter

Division of Scholarly Integrity and Research Compliance
Institutional Review Board
North End Center, Suite 4120 (MC 0497)
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-3732
irb@vt.edu
http://www.research.vt.edu/sirc/hrpp

MEMORANDUM

DATE:	October 6, 2020
TO:	Brenda Davy, Katelyn Ann Barker, Jacob Lahne, Valisa Ellen Hedrick
FROM:	Virginia Tech Institutional Review Board (FWA00000572, expires October 29, 2024)
PROTOCOL TITLE:	Food Agency and Health Habits
IRB NUMBER:	**20-804**

Effective October 6, 2020, the Virginia Tech Human Research Protection Program (HRPP) determined that this protocol meets the criteria for exemption from IRB review under 45 CFR 46.104(d) category (ies) 2(ii).

Ongoing IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit an amendment to the HRPP for a determination.

This exempt determination does not apply to any collaborating institution(s). The Virginia Tech HRPP and IRB cannot provide an exemption that overrides the jurisdiction of a local IRB or other institutional mechanism for determining exemptions.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

https://secure.research.vt.edu/external/irb/responsibilities.htm

(Please review responsibilities before beginning your research.)

PROTOCOL INFORMATION:

Determined As:	**Exempt, under 45 CFR 46.104(d) category(ies) 2(ii)**
Protocol Determination Date:	**October 6, 2020**

ASSOCIATED FUNDING:

The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.

Appendix B. Health History and Demographics Questionnaire

Virginia Tech
Department of Human Nutrition, Foods, and Exercise

HEALTH HISTORY AND DEMOGRAPHICS QUESTIONNAIRE

STUDY_____ **DATE**_____

SUBJECT ID #_____

PLEASE PRINT

1. Age:_____

To which gender identity do you most identify?
☐ Male
☐ Female
☐ Other:_____

Race and/or Ethnic Origin

☐ American Indian or Alaskan Native ☐ Asian or Pacific Islander ☐ Black, not of Hispanic Origin

☐ Hispanic ☐ White, not of Hispanic Origin

☐ Other

Height: ft. in. Weight: lbs* (please take digital image of weight measurement and send via text message to study staff).

2. **GENERAL MEDICAL HISTORY**

Do you have any current medical conditions? YES ☐ NO ☐ If Yes, please explain:

Have you had any major illnesses in the past? YES ☐ NO ☐ If Yes, please explain:

Have you been diagnosed with diabetes? YES ☐ NO ☐ If Yes, please explain:

Age at diagnosis_____

Are you currently taking any medications including over-the-counter products/supplements?
YES ☐ NO ☐ If Yes, please explain:

Medication/Supplement	Reason	Times taken per Day	Taken for how long?

6. **TOBACCO/ALCOHOL HISTORY** (check one)

None ☐
Quit ☐ (when)_____
Cigarette ☐
Cigar ☐
Pipe ☐
Chew Tobacco ☐
Snuff ☐

Total years of tobacco use_____

Do you consume alcohol? Drinks per day ____ Drinks per week ____

5. CARDIORESPIRATORY/METABOLIC HISTORY

	YES	NO
Are you presently diagnosed with heart disease?	☐	☐
Do you have any history of heart disease?	☐	☐
High blood pressure?	☐	☐
Do you have asthma?	☐	☐
Do you have high cholesterol? Or, low good (HDL) cholesterol?	☐	☐
Do you have thyroid problems?	☐	☐

6. **NUTRITIONAL HABITS**

Have you ever dieted? YES ☐ NO ☐

If YES, have you dieted within the past 12 months or are you currently on a diet?

YES ☐ NO ☐

If YES, please describe the diet:

a). Name (if applicable):_____

b). Prescribed by a Physician/nutritionist? YES ☐ NO ☐

c). Have you lost weight? YES ☐ NO ☐

d). Duration of diet_____

Which of the following best describes the situation in your household in the last month? (Check one)

We have enough of the kinds of foods we want to eat ☐

We have enough food, but not the kinds we want to eat ☐

Sometimes we do not have enough to eat ☐

We often do not have enough to eat ☐

Have your dietary habits changed in 2020 as a result of COVID-19 related events?

YES ☐ NO ☐

If YES, please describe these changes: _____

_____

7. **PHYSICAL ACTIVITY SURVEY**

During the past month, which statement best describes the kinds of physical activity you usually did? Do not include the time you spent working at a job. Please read all six statements before selecting one.

1. I did not do much physical activity. I mostly did things like watching television, reading, playing cards, or playing computer games. Only occasionally, no more than once or twice a month, did I do anything more active such as going for a walk or playing tennis.
2. Once or twice a week, I did light activities such as getting outdoors on the weekends for an easy walk or stroll. Or once or twice a week, I did chores around the house such as sweeping floors or vacuuming.
3. About three times a week, I did moderate activities such as brisk walking, swimming, or riding a bike for about 15–20 minutes each time. Or about once a week, I did moderately difficult chores such as raking or mowing the lawn for about 45–60 minutes. Or about once a week, I played sports such as softball, basketball, or soccer for about 45–60 minutes.
4. Almost daily, that is five or more times a week, I did moderate activities such as brisk walking, swimming, or riding a bike for 30 minutes or more each time. Or about once a week, I did moderately difficult chores or played sports for 2 hours or more.
5. About three times a week, I did vigorous activities such as running or riding hard on a bike for 30 minutes or more each time.
6. Almost daily, that is five or more times a week, I did vigorous activities such as running or riding hard on a bike for 30 minutes or more each time.

9. EDUCATION

Please check the highest degree obtained:

- Grade School ☐
- Junior High ☐
- High School ☐
- College Degree ☐
- Master's Degree ☐
- Doctorate ☐

10. HOUSEHOLD INCOME

- Less than $20,000 ☐
- $20,000 to $34,999 ☐
- $35,000 to $49,999 ☐
- $50,000 to $74,999 ☐
- $75,000 to $99,999 ☐
- Over $100,000 ☐

11. MARITAL STATUS/CHILDREN

- Single (never married) ☐
- Married, or in a domestic partnership ☐
- Widowed ☐
- Divorced ☐
- Separated ☐

Do you care for children at home? No ☐ If yes, please list their ages:_____

12. EMPLOYMENT STATUS

- Employed full time (40 or more hours per week) ☐
- Employed part time (up to 39 hours per week) ☐
- Unemployed and currently looking for work ☐
- Unemployed and not currently looking for work ☐
- Student ☐
- Retired ☐
- Stay at home parent ☐
- Self-employed ☐
- Unable to work ☐

Appendix C. Cooking and Food Provisioning Action Scale

Item Number	Content	Subscale Category
1	*I feel limited by my lack of cooking knowledge.*[†]	*Self-Efficacy*
2	*I can always manage to decide what I would like to eat at any given time.*	*Self-Efficacy*
3	*When preparing food, I am confident that I can deal with unexpected results.*	*Self-Efficacy*
4	*When preparing food, it is easy for me to accomplish my desired results.*	*Self-Efficacy*
5	*In preparing food, I can solve most problems with enough effort.*	*Self-Efficacy*
6	*I am comfortable preparing food.*	*Self-Efficacy*
7	*I know how to use the kitchen equipment I have.*	*Self-Efficacy*
8	*I am involved in daily meal preparation.*	*Self-Efficacy*
9	*When I shop for food, I know how I will use the ingredients I am purchasing.*	*Self-Efficacy*
10	*I am confident creating meals from the ingredients I have on hand.*	*Self-Efficacy*
11	*Before I start cooking, I usually have a mental plan of all the steps I will need to complete.*	*Self-Efficacy*
12	*When presented with two similar products to purchase, I feel confident choosing between them.*	*Self-Efficacy*
13	*I know where to find the ingredients I need to prepare a meal.*	*Self-Efficacy*
14	*I find cooking a very fulfilling activity.*	*Attitude*
15	*For me, cooking is just something to get through as quickly as possible.*[†]	*Attitude*
16	*Compared to other activities, cooking brings me little enjoyment.*	*Attitude*
17	*If I try making a new type of food and it does not come out right, I usually do not try to make it again.*[†]	*Attitude*
18	*I think a lot about what I will cook or eat.*	*Attitude*
19	*I prefer to spend my time on more important things than food.*[†]	*Attitude*

Item Number	Content	Subscale Category
20	*If everything else is equal, I choose to cook rather than have food prepared by someone else.*	*Attitude*
21	*I feel like cooking is a waste of effort.*†	*Attitude*
22	*I am inspired to cook for other people, like my family or friends.*	*Attitude*
23	*I feel burdened by having to cook for other people, like my family or friends.*†	*Attitude*
24	*I wish that I had more time to plan meals.*†	*Structure*
25	*I have a hard time finding enough time to prepare the food I'd like to eat.*†	*Structure*
26	*My family responsibilities prevent me from having time to prepare meals.*†	*Structure*
27	*My social responsibilities prevent me from having the time to prepare meals.*†	*Structure*
28	*My job responsibilities prevent me from having the time to prepare meals.*†	*Structure*

† These items should be scored in reverse.
Adapted from Lahne et al.[47]

Items scored using a 7 point Likert scale of 1 (“strongly disagree”) to 7 (“strongly agree) and input into this equation with *sd* being the standard deviation of the sample’s subscale score:

$$CAFPAS_i = \frac{Self-Efficacy_i}{sd(Self-Efficacy)} + \frac{Attitude_i}{sd(Attitude)} + \frac{Structure_i}{sd(Structure)}$$

Appendix D. Cooking Behavior Questionnaire

How many times in the past seven days you did the following…

	1	2	3	4	5	6	≥ 7
Cook breakfast	☐	☐	☐	☐	☐	☐	☐
Cook lunch	☐	☐	☐	☐	☐	☐	☐
Cook dinner	☐	☐	☐	☐	☐	☐	☐
Make a meal from scratch/fresh ingredients	☐	☐	☐	☐	☐	☐	☐
Make a meal from packaged products	☐	☐	☐	☐	☐	☐	☐
Make a meal from frozen products	☐	☐	☐	☐	☐	☐	☐
Use a recipe to make a meal	☐	☐	☐	☐	☐	☐	☐

How many times in the past seven days someone in your household did the following…

	1	2	3	4	5	6	≥ 7
Cook breakfast	☐	☐	☐	☐	☐	☐	☐
Cook lunch	☐	☐	☐	☐	☐	☐	☐
Cook dinner	☐	☐	☐	☐	☐	☐	☐
Make a meal from scratch/fresh ingredients	☐	☐	☐	☐	☐	☐	☐
Make a meal from packaged products	☐	☐	☐	☐	☐	☐	☐
Make a meal from frozen products	☐	☐	☐	☐	☐	☐	☐
Use a recipe to make a meal	☐	☐	☐	☐	☐	☐	☐

How many times in the past seven days you did the following…

1	2	3	4	5	6	≥ 7

Eat homemade leftovers for breakfast	☐	☐	☐	☐	☐	☐	☐
Eat homemade leftovers for lunch	☐	☐	☐	☐	☐	☐	☐
Eat homemade leftovers for dinner	☐	☐	☐	☐	☐	☐	☐