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An evidence-based conceptual framework of healthy cooking

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ABSTRACT

Eating out of the home has been positively associated with body weight, obesity, and poor diet quality. While cooking at home has declined steadily over the last several decades, the benefits of home cooking have gained attention in recent years and many healthy cooking projects have emerged around the United States. The purpose of this study was to develop an evidence-based conceptual framework of healthy cooking behavior in relation to chronic disease prevention. A systematic review of the literature was undertaken using broad search terms. Studies analyzing the impact of cooking behaviors across a range of disciplines were included. Experts in the field reviewed the resulting constructs in a small focus group. The model was developed from the extant literature on the subject with 59 studies informing 5 individual constructs (frequency, techniques and methods, minimal usage, flavoring, and ingredient additions/replacements), further defined by a series of individual behaviors. Face validity of these constructs was supported by the focus group. A validated conceptual model is a significant step toward better understanding the relationship between cooking, disease and disease prevention and may serve as a base for future assessment tools and curricula.

1. Introduction

Diet is a modifiable risk factor of particular concern for chronic disease prevention as the US faces an obesity epidemic and population adherence to national diet recommendations remains dismally low (Levi et al., 2013). Diet impacts risk for several major chronic diseases including cancer, heart disease, diabetes and obesity (Micha et al., 2012; Kushi et al., 2012). Cooking could influence disease risk through its effect on weight status and diet quality as well as carcinogen development during food preparation (WCRF / AICR, 2007). For example, cooking red meat at high temperatures or charcoal grilling facilitates the development of heterocyclic amines and polycyclic aromatic hydrocarbons (Kushi et al., 2012); exposure to these carcinogens may increase cancer risk (Zheng & Lee, 2009). Domestic (as opposed to industrial) cooking processes also impact the bioavailability of some antioxidants in fruits and vegetables (Harasym & Oledzki, 2014).

Eating out of home (OH) foods has been positively associated with body weight, obesity, and poor diet quality (Smith et al., 2013; Bezerra et al., 2012; Lachat et al., 2012). An international review of 29 studies found those that consumed high amounts of OH foods also had higher percentages of calories from fat in the diet and lower intakes of iron, calcium and vitamin C (Lachat et al., 2012). Eating foods cooked at home from basic ingredients, however, has been linked to increased intake of fruits, vegetables, and whole grains, reduced BMI, and improved general health (Larson et al., 2006; Laska et al., 2012; McLaughlin et al., 2003). A study of young adults found those that cooked more frequently were more likely to achieve nutrition guideline goals for fat, calcium, whole grain, fruit and vegetable intake (Larson et al., 2006). Another study found cooking classes increased intake of fruit and vegetables and improved food safety behaviors (Brown & Hermann, 2005).

Cooking at home has declined steadily over the last 40 years, decreasing by almost a quarter (23%) from 1965 to 2008 (Smith et al., 2013). The benefits of home cooking have gained attention in recent years, however, and many health-promotion cooking projects have emerged. These include international programs such as Jamie Oliver's "Ministry of Food" in the UK and Australia and national programs such as First Lady Michelle Obama's "Let's Move: Chefs Move to Schools" (Let's Move: Chefs Move to Schools, n.d.) campaign and Share our Strength's "Cooking Matters" (Share Our Strength: Cooking Matters, 2013). Other US organizations, such as Slow Food (Slow Food USA,

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2000) and the National Farm to School Network (National Farm to School Network, n.d.) advocate for school gardening programs that incorporate cooking education elements.

In nutrition research, cooking components are often part of nutritional interventions and have been shown to potentially be more effective than nutrition education (knowledge-, attitude-, and awareness-centered approaches) alone in changing diet (Curtis et al., 2012). Two recent systematic reviews examined the impact of some of these interventions. Although the scope of these reviews differs from the work presented here, the noted limitations highlight the variability in this emerging field of research on cooking and health. One review, focusing on children, found cooking interventions that included hands-on food preparation showed promise as a strategy for improving psychosocial factors including food related preferences and attitudes, as well as food behaviors (Hersch et al., 2014). A review of adult intervention studies that consisted of cooking or food preparation as the primary aim found similarly promising results on a range of outcomes including improved diet, positive food choices and other health outcomes (Reicks et al., 2014). However, both reviews noted that significant variability in study curricula, non-rigorous study designs and the lack of standardized assessment tools hindered the replicability of the research (Hersch et al., 2014; Reicks et al., 2014). This may, in part, be explained by the complexity of defining cooking and lack of clear definitions in the literature (Engler-Stringer, 2010). The absence of a standardized definition of healthy cooking has led many authors to define healthy cooking individually and imprecisely (Engler-Stringer, 2010). Therefore, interventions are building cooking skill education into their curriculum, but failing to identify if the behaviors they teach are impacting dietary habits or health outcomes (Engler-Stringer, 2010).

The purpose of this study was to develop an evidence-based conceptual model outlining healthy cooking behaviors in relation to chronic disease prevention. This is the first conceptual framework of cooking behavior to our knowledge. A validated model is a significant step toward improved understanding of the relationship between cooking, disease and disease prevention and may serve to inform future assessment tools. A unified understanding of key cooking behaviors and ability to measure these behaviors in a reproducible way is critical for the development of quality interventions targeting healthy eating environments.

2. Developing the conceptual framework of healthy cooking.

A conceptual framework of healthy cooking behaviors (Fig. 1) was developed based on the results of a comprehensive literature search (Supplemental Fig. S1). Fifty-nine peer-reviewed, English language quantitative studies evaluating the relationships between cooking behaviors and health were examined. Both observational studies focusing on the associations between certain cooking practices and health, as well as experimental studies examining cooking interventions were included. Outcomes of interest included behavioral (diet quality including specific nutrient intake, cooking frequency/methodology, oil usage) and physiological (chronic disease risk including cancer, diabetes, obesity, and cardiovascular disease, as well as metabolic measures and mortality) factors. Studies focusing exclusively on psychosocial and attitudinal variables were not included as the primary focus of this paper was to build an evidence-based model of cooking behaviors. Key characteristics of 34 observational and 25 experimental studies were reviewed and used to inform the final model (Supplemental Tables S2-S3).

The proposed model represents the key cooking behaviors shown to impact health outcomes extracted from the literature. These cooking behaviors, gleaned from the included observational and experimental studies (Supplemental Tables S4-S5), were further organized into overarching themes, forming the broad constructs of the model. The initiating construct is the action of cooking, titled 'Cooking Frequency', followed by four constructs that occur during food preparation including 'Techniques/Methods', 'Minimal Usage, 'Additions/Replacements' and 'Flavoring'. These broad constructs are further defined by individual behaviors (Table 1) and a detailed description of each construct is provided below. The directional relationship between these constructs and their potential impact on chronic disease including obesity, cardiovascular disease (CVD), diabetes and cancer is put forward.

2.1. Cooking frequency

'Cooking Frequency' is defined as the decision to cook at home, as opposed to going to a restaurant or ordering take-out. A sub-construct to cooking frequency is cooking from basic ingredients, sometimes referred to as "cooking from scratch". The definition of the terms "basic ingredients" and "scratch" vary widely in the literature but

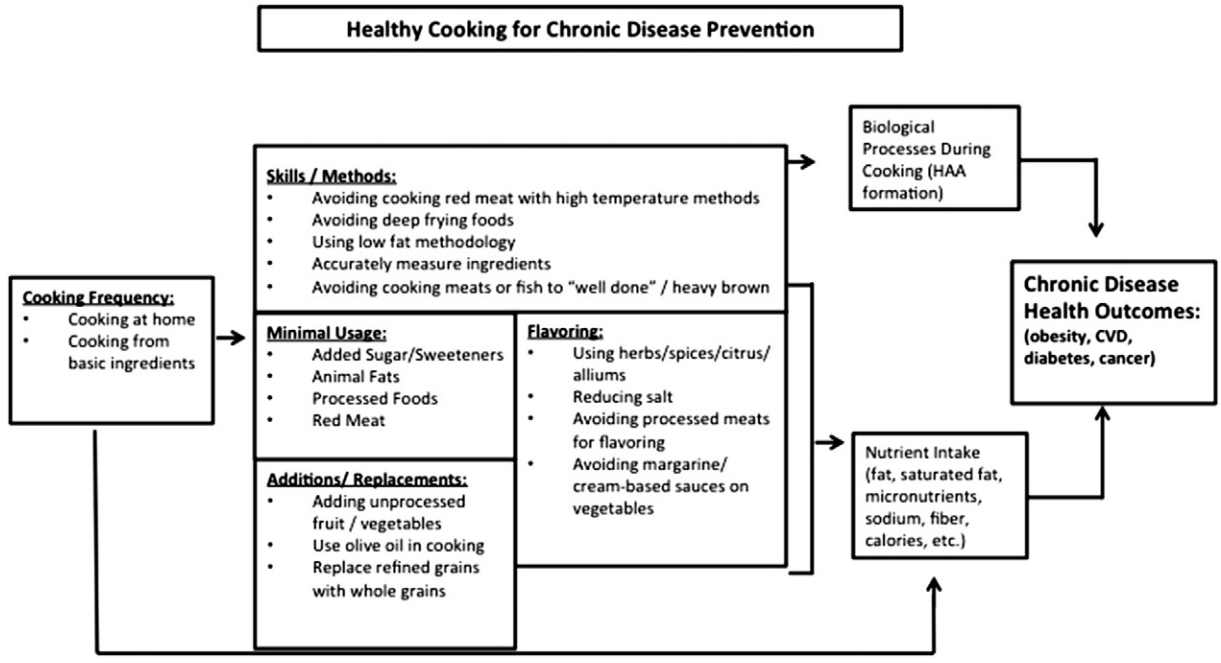

Fig. 1. Conceptual Model of Healthy Cooking: Scheme depicting the conceptual framework and the constructs that define healthy cooking in relation to chronic disease. This figure outlines the directionality of these constructs and how they inter-relate to influence dietary behaviors and health Abbreviations: CVD: Cardiovascular disease; HAA: Heterocyclic aromatic amines.

Table 1
Constructs and defining behaviors.

Construct	Defining behaviors (+ positive/− negative)[a]	Example "Did you…
Frequency		
Cooking Frequency	Frequency of preparing meals in the home (+)	Cook dinner at home
	Preparing meals from "basic" ingredients (+)	Make a stew from fresh meat and vegetables, not using canned stock or bouillon
Techniques/methods		
Avoid cooking red meat with high temperature methods	Boiling, grilling, BBQ, broiling, frying red meat (−)	Fry pork chops
Avoid deep frying foods	Foods fully submerged in high temperature liquid fat (−)	Deep fry chicken
Use low fat cooking methodology	Baking, boiling, steaming, grilling (+)	Steam spinach
Accurately measure ingredients	Assign appropriate portions (+)	Make a four cup yield soup recipe for four people
	Smaller portions of high fat foods (+)	Serve a smaller portion of macaroni and cheese
	Measure salt/oil (+)	Measure oil with teaspoons
Avoid cooking meats to well done/well browned	Cook meat and fish to well done (−)	Cook your steak to well-done
	Fully browned surface of fried foods (−)	Fry pork chops so the crust is completely browned
Minimal usage		
Limit red meat	Limit pork, lamb, beef, vary with plant based foods, eggs, fish or poultry (+)	Make chicken burgers
Limit/avoid processed foods	Limit or avoid all packaged/processed foods (+)	Make chicken stock or use water instead of prepared stock
Limit animal fats	Limit lard/bacon grease/chicken fat/butter/shortening, vary with liquid vegetable based oils (+)	Use liquid vegetable oil instead of shortening while making tortillas
Limit sugar	Use less sugar baking or general cooking (+)	Make a cake with reduced sugar
Additions/replacements		
Add unprocessed fruit/vegetables to main dishes	Incorporate fruit and vegetables into all dishes (not just veg side dishes) (+)	Add fresh carrots or tomatoes to rice
Use olive oil	Use of olive oil for cooking (+)	Specifically use olive oil when cooking
Replace refined grains with whole grains	Use of whole grains (+)	Use brown rice instead of white rice
Flavoring		
Using herbs/spices/citrus/alliums	Add herbs/spices/orange/lemon/lime/onion/garlic/shallots while cooking (+)	Use spices, herbs, onions or other low calorie flavorings when cooking
Reducing salt	Use low/no salt while cooking (+)	Did you add a small amount or no salt when cooking
Avoid processed meats when cooking	Bacon/ham hocks/jerky/sausage, hotdogs (−)	Use bacon to flavor a soup
Avoid margarine/cream-based sauces on vegetables	On all vegetable preparations (−)	Serve broccoli with cheese sauce

A table of the key constructs of healthy cooking identified in the literature and their sub-constructs, further defined by examples of individual behaviors.
[a] +/− signs refer to behaviors resulting in positive impacts on health vs negative impacts on health outcomes.

generally suggest cooking without the use of ultra-processed foods and using whole foods. Ultra-processed foods have been defined in the literature as those foods which are made with substances extracted from whole foods but little or no actual whole foods included such as frozen heat and serve meals, salad dressings, chips, confections and other products (Moodie et al., 2013). Cooking frequency has been positively associated with diet quality (Larson et al., 2006; Laska et al., 2012; Chen et al., 2012; Crawford et al., 2007; Gustafsson et al., 2002; Sweetman et al., 2011), as well as lower mortality (Chen et al., 2012).

2.2. Techniques and methods

'Techniques/Methods' refers to cooking approaches that positively impact nutrient content such as avoiding cooking red meat with high temperature cooking methods, avoiding deep frying foods, using low fat cooking methods, accurately measuring ingredients, and avoiding cooking meats until well-done or heavily browned. Techniques refer to actions taken by individuals while in the process of cooking (avoiding browning) and methods refer to procedures applied to ingredients during preparation (deep frying or steaming). 'Techniques/Methods' have been shown to positively impact nutrient content through reduced fat intake (Archuleta et al., 2012; Newman et al., 2005) and reduced sodium intake (Kitaoka et al., 2013). 'Techniques/Methods' also impacts biological processes that may occur during cooking. This includes deep frying, high temperature cooking of red meat or heavy browning of fried surfaces which has been shown to increase the development of carcinogenic compounds on foods including heterocyclic amines and polycyclic aromatic hydrocarbons (WCRF / AICR, 2007).

2.3. Minimal usage

'Minimal Usage' is defined as the restriction of products when cooking that should be minimized or moderated. Foods to use minimally (or moderately) while preparing meals include added sugars and sweeteners, animal fats, processed foods, and red meat. Reducing these types of foods while cooking is a skill taught in many nutrition-based intervention studies that include cooking components (Archuleta et al., 2012; Newman et al., 2005; Kitaoka et al., 2013; Bielamowicz et al., 2013; Kisioglu et al., 2004; Millett et al., 2012; Wrieden et al., 2007). Excessive use of sugar has been linked to increased body weight, high blood pressure and poor lipid profiles (Te Morenga et al., 2013; Te Morenga et al., 2014), animal fat consumption has been associated with increased obesity risk (Milanovic et al., 2009) and processed or red meats have been associated with increased risk of cancer, cardiovascular disease and all-cause mortality (Sinha et al., 2009; Larsson & Orsini, 2014). Processed foods impact nutrient intake as they are typically low in fiber, micronutrients and phytochemicals, yet high in fat, sugar and sodium (Moodie et al., 2013).

2.4. Additions/replacements

Addition foods are defined as healthy foods added during the cooking process and include unprocessed fruit and vegetables (e.g. fresh or frozen as opposed to canned) to meals as well as olive oil to improve the nutritional content of recipes. Increased fruit and vegetable intake has been associated with reduced risk of hypertension, coronary heart disease (CHD) and stroke (Boeing et al., 2012), reduced risk of

certain cancers (WCRF / AICR, 2007), and to some extent reduced risk of type II diabetes (Li et al., 2014). The use of olive oil for cooking has been associated with reduced incidence of obesity (Soriguer et al., 2009) and cardiovascular events, as well as cardiovascular and all-cause mortality (Schwingshackl & Hoffmann, 2014).

Replacements are defined as ingredients that are actively removed from recipes and replaced with healthier ingredients, such as refined grains replaced with whole grain alternatives. Whole grain consumption has been associated with reduced risk of type II diabetes (Aune et al., 2013) colorectal cancer (Aune et al., 2011), and cardiovascular disease (Ye et al., 2012).

2.5. Flavoring

'Flavoring' refers to the way the taste of food can be enhanced during cooking in a healthful way. 'Flavoring' includes increasing the use of spices, citrus, alliums and herbs, avoiding using cream-based sauces or margarine to flavor vegetables, and reducing salt while cooking; behaviors that have been taught in nutrition intervention classes to successfully reduce sodium (Archuleta et al., 2012; Millett et al., 2012) and fat intake (Archuleta et al., 2012) and improve health and behavior outcomes (Bielamowicz et al., 2013; Kisioglu et al., 2004; Chapman-Novakofski & Karduck, 2005; Sorensen et al., 2011). Avoiding the use of processed meats as flavoring is also included, as processed meat intake has been associated with increased all-cause mortality (Larsson & Orsini, 2014) as well as certain cancers (WCRF / AICR, 2007) and stroke (Chen et al., 2013).

In summary, cooking at home (frequency) has been shown to correlate with improved dietary intake (Larson et al., 2006; Laska et al., 2012; Chen et al., 2012; Crawford et al., 2007; Gustafsson et al., 2002; Sweetman et al., 2011). However, myriad behaviors involved in meal preparation can also impact the nutritional quality of food and in turn, health outcomes. This paper proposes using certain methodologies or techniques when preparing food, strategically reducing, replacing or adding ingredients to dishes and using unprocessed flavoring agents as cooking behaviors that may impact health.

3. Validation of the conceptual framework

To assess the face validity of this conceptual framework, a focus group was conducted of experts in the fields of nutrition, culinary arts, epidemiology, and health promotion (faculty at public health school in department of health promotion) to gauge consensus on the identified key healthy cooking constructs and sub-constructs. This portion of the project was reviewed and approved by the Institutional Review Board of the University of Texas Health Science Center HSC-SPH-14-0795.

The objective of this focus group discussion was to review the overarching constructs and defining sub-constructs identified in the literature. Two researchers ran the focus group using a semi-structured interview guide. Focus group discussions were recorded and transcribed. The transcribed interviews were then coded and analyzed using a framework analysis approach. Analysis of the resulting data included both inductive and deductive coding. Inductive coding was used to identify key cooking behaviors not included in the original model. Deductive coding was used to assess the degree of agreement on constructs in the presented model. This qualitative approach has been outlined in other studies (Bird et al., 2014; Leamy et al., 2011). The transcripts and field notes were analyzed by the first author with NVivo Version 10 (QSR International).

Consensus was established as over 90% of participants reached agreement for each of the overarching constructs. However, a few defining behaviors of certain sub-constructs were clarified or removed, based on feedback from focus group participants. If a particular behavior was consistent in the literature but lacked consensus from the group, it was removed. New behaviors suggested by the group were added to the model if they were also supported by the available literature. One behavior used to define healthy cooking 'Techniques/Methods' included modifying meats to be lower in fat (trimming/removing skin of poultry/draining ground beef). This behavior was consistent in the literature but not agreed upon by focus group participants and was, therefore, removed from the model. Regarding ingredient additions, using canola oil and adding extra whole grains to dishes were also removed from the original model due to lack of consensus. Other behaviors including avoiding butter, using low sodium/low fat alternatives and replacing sugar with artificial sweeteners were also removed.

Given the changes in defining behaviors noted above, several of the sub-constructs were re-defined and re-organized under different headings based on feedback from the expert panel. Panel participants also mentioned promoting the use of grass fed beef/butter and limiting/avoiding processed foods. While limiting/avoiding processed foods is in line with published research (Moodie et al., 2013), the literature on use of butter for cooking and grass fed beef is not present to warrant inclusion in the current model. Participants also mentioned several upstream cooking behaviors including food sourcing, grocery shopping, knife skills and ability to read a recipe. While potentially important, these factors were outside the scope of this project, which focused on meal optimization as opposed to basic abilities. Further, specific upstream behaviors such as recipe literacy or grocery shopping vary across cultures.

4. Discussion

This paper proposes a conceptual framework of healthy cooking behavior based on the current literature. Overall, there appears to be sizable variability with regards to the definition and measurement of healthy cooking behaviors in interventions, and thus there are no standard guidelines for the development of healthy cooking programming or evaluation. More specifically, the variability of definitions regarding key terminology such as 'made from scratch' and the wide use of non-validated assessment tools negatively impacts the quality and comparability of available literature on healthy cooking, an issue cited by other reviews (Hersch et al., 2014; Reicks et al., 2014; Engler-Stringer, 2010). The proposed framework of healthy cooking addresses this issue by offering a comprehensive definition of healthy cooking and could potentially guide the development of standardized tools for measurement in this field.

Dietary research tends to focus on selected outcomes, such as heart health, cancer incidence, obesity, or diabetes. It is important to note that these diets (e.g. cardiac diet, diet for management of diabetes etc.) are not necessarily synonymous. Thus, nutrition education is generally specialized for individual populations depending on their risk of certain diseases. The proposed conceptual framework is dynamic, such that the constructs are defined broadly enough to be applicable to a wide range of cooking behaviors across multiple health outcomes. A model based on existing literature cannot be static as scientific inquiry is by nature progressive. As a dynamic model, the current proposed framework is flexible enough to absorb new nutritional recommendations as research on diet and health outcomes continues to develop.

This framework introduces a comprehensive approach to understanding the impact of cooking in relation to nutrition and health, as the focus is on practical cooking behaviors as opposed to specific foods or nutrients. Because of its skill-based nature, a level of flexibility is inherent in the proposed model. This model could be applicable to culturally diverse populations and continuously and easily improved for generalizability. This project also offers a structure for developing assessment tools in the form of a coding system or survey that could be used to better understand the cooking practices of populations and gauge how those practices are impacted by interventions. During validation, all focus group participants indicated that the proposed constructs of healthy cooking could be used in their professional settings in diverse ways including intervention design, curriculum development, program evaluation and direct nutritional counseling assessments.

This further indicates the flexibility of this model and its potential for future applications to research studies as well as in the field (curriculum development, nutrition assessment).

The healthy cooking behaviors outlined here are only one part of a larger social ecological structure that impacts nutrition and health, and includes individual, interpersonal, organizational, environmental (community) and policy level influences (Richards et al., 2008). The proposed framework identifies individual-level behaviors that occur during the cooking process. However, these individual behaviors occur in the context of other environmental or upstream factors such as grocery store access and functional equipment. The framework focuses on individual cooking behaviors, and not environmental predictors of those behaviors, as cooking is an important contribution to diet quality that is poorly understood and under-researched.

This paper has several limitations. The studies on which we based the conceptual model mainly use self-reported dietary data, which have a high level of variability and are subject to misreporting (Burrows et al., 2010; Poslusna et al., 2009). With regard to experimental studies, cooking classes were offered in conjunction with nutrition education classes in many interventions (Newman et al., 2005; Kitaoka et al., 2013; Chapman-Novakofski & Karduck, 2005; Davis et al., 2011; Fulkerson et al., 2010; McKellar et al., 2007; McMurry et al., 1991; Shankar et al., 2007) making it difficult to determine the specific program components associated with changes in health and behavioral outcomes. Only two studies directly compared nutrition interventions with and without cooking elements (Sorensen et al., 2011; Curtis et al., 2012). Hence, the existing literature is limited with regards to cooking and its impact on health. The constructs themselves were challenging to outline and define, and will require further validation. However, the conceptual model is grounded in the extant literature and pulls from several disciplines of chronic disease prevention and control including cancer (Newman et al., 2005; Berjia et al., 2014; Dai et al., 2002; De Stefani et al., 2012; Di Maso et al., 2013; Gerhardsson de Verdier et al., 1991; Hakami et al., 2014; Icli et al., 2011; Joshi et al., 2012a; Joshi et al., 2012b; John et al., 2011; Kotsopoulos et al., 2006; Parr et al., 2013; Polesel et al., 2010; Sinha et al., 2005; Tasevska et al., 2009; Ward et al., 1997; Xu et al., 2006), overweight/obesity (Milanovic et al., 2009; Soriguer et al., 2009; Kisioglu et al., 2004; Sorensen et al., 2011; Davis et al., 2011; Fulkerson et al., 2010; McKellar et al., 2007; Kramer et al., 2012; Nigam et al., 2014), cardiovascular disease (Mozaffarian et al., 2007; Ramazauskiene et al., 2011) and diabetes (Archuleta et al., 2012; Bielamowicz et al., 2013; Chapman-Novakofski & Karduck, 2005; Nigam et al., 2014).

Several notable points came up during the focus group assessment including the potential benefits of using animal fats, grass fed beef/butter, and other unprocessed fats as well as the need to focus on whole/unprocessed foods as opposed to low sodium or low fat alternatives. These constructs were not included in the model due to lack of evidence. However, these are factors that should be considered in future studies. While attitudes about animal products including red meat and animal fat seem to be changing with continued research, the longer-term effects of these products on cancer and other disease risks need to be considered when making recommendations for chronic disease prevention in the general population. Participants also mentioned several upstream cooking behaviors that are important factors in cooking programming, and future iterations of this model should consider adding these factors.

This project sets the stage for several future steps. Additional validation of the framework validity including construct validity and predictive validity will be done in future studies. More focus groups with diverse participants should be conducted to gauge opinions on the constructs of healthy cooking presented. This is a key step as the field of nutrition develops quickly as new research emerges. Once further validation is complete, the conceptual model can be used to develop curricula for healthy cooking programs and serve as the base for an assessment tool to gauge the cooking behaviors of samples, giving researchers and clinicians deeper insight into the dietary habits of participants and patients.

Transparency document

The Transparency document associated with this article can be found, in online version.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.pmedr.2016.05.004.

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