The Kitchen as a Lab

Translating Food into Clinical Science through Culinary Medicine

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This is to acknowledge that Jaclyn Albin, MD has not disclosed any financial interests or other relationships with commercial concerns related directly or indirectly to this program. Dr. Albin will not be discussing off-label uses in her presentation.

Biosketch

Jaclyn Albin, MD is an Assistant Professor of Internal Medicine and Pediatrics at UT Southwestern Medical Center (UTSW) in the Division of Combined Internal Medicine and Pediatrics (Med/Peds). Dr. Albin graduated from The George Washington University School of Medicine in 2009 and then completed her residency in combined Med/Peds at Baylor College of Medicine in 2013. She then served as a categorical Chief Resident in Pediatrics prior to joining the faculty at UT Southwestern in the fall of 2014. As a dual-trained pediatrician and internist, she treats patients of all ages, practicing primary care in the Combined Internal Medicine/Pediatrics Clinic at UTSW. Dr. Albin serves as the Associate Program Director for the Med/Peds Residency Program and loves teaching health promotion across the lifespan. She is passionate about nutrition, lifestyle, and other environmental influences on health. In 2017, Dr. Albin partnered with Tulane's Goldring Center for Culinary Medicine and Moncrief Cancer Institute and launched UTSW's Culinary Medicine Program. She serves as the Director, working to teach nutrition through hands-on cooking classes to medical students, residents, healthcare professionals, and the community. Dr. Albin loves blending her passion for nutrition and wellness with growing a garden, cooking, practicing yoga, and spending time with her husband and young children (all of whom eat their vegetables).

Purpose and Overview

A suboptimal diet is the leading risk factor for death and among the top three risk factors for disability in the United States [1]. It is estimated that about 75% of US healthcare spending goes to chronic, lifestyle-related disease including cardiovascular disease, diabetes, cancer, and obesity management [2]. In spite of the preventable nature of this public health crisis and clear research revealing the link between diet and health, physicians receive inadequate nutrition education to equip them for addressing their patients' needs. Most medical schools in the US fail to meet national recommendations for nutrition education [3], and these gaps persist in graduate medical education [4]. An emerging solution to enhance the practical knowledge of food science and the research behind health and diet is known as Culinary Medicine. Programs developing across the country have the potential to close widespread educational gaps for healthcare professionals while also serving as a model to engage the community in health promotion. Innovative solutions are vital to reverse the lifestyle-related disease burden and unsustainable healthcare costs in the United States, and Culinary Medicine uniquely brings a practical, inter-professional approach with great potential for turning the tide toward better health.

Educational Objectives

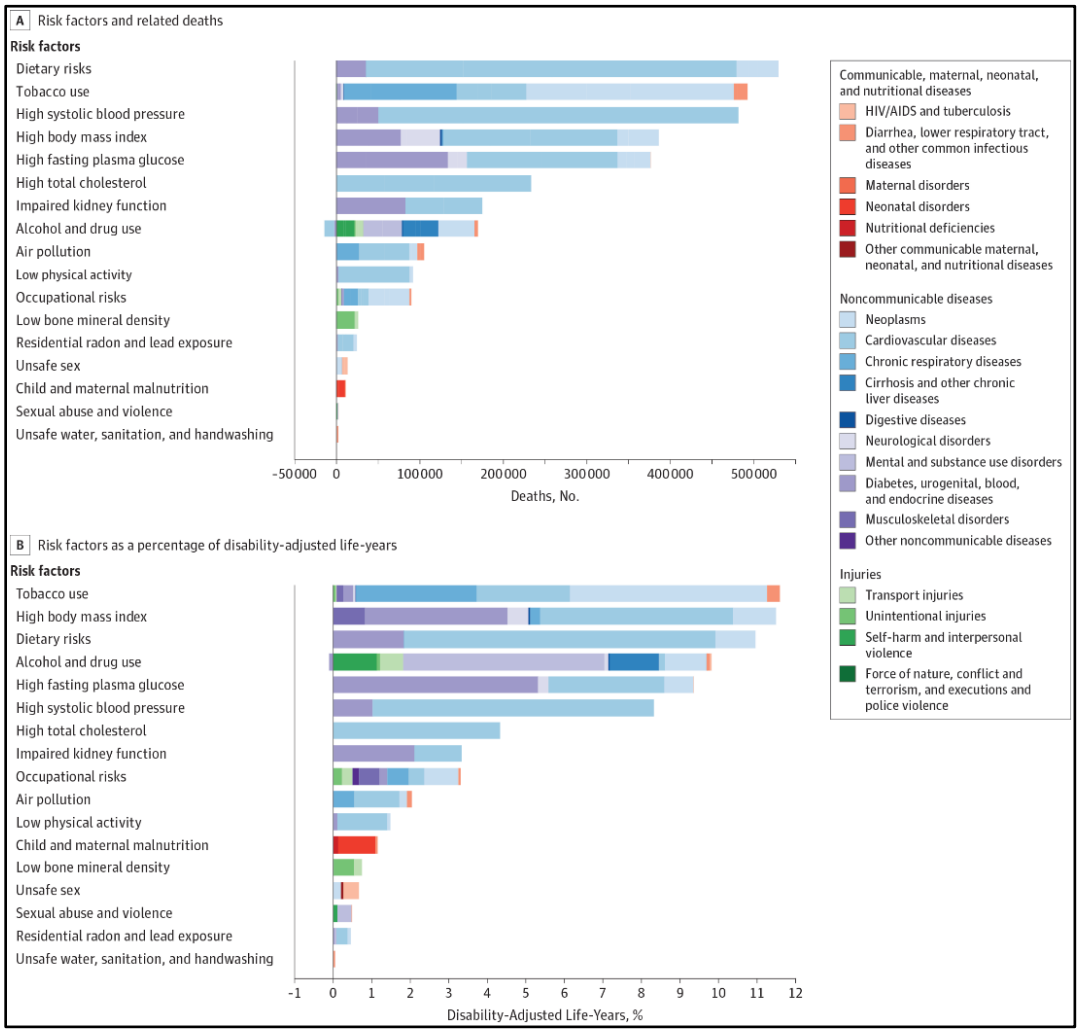
At the conclusion of this lecture, attendees should be able to:

1) Summarize the clinical implications of food-related disease
2) Discuss gaps in nutrition education in undergraduate and graduate medical education
3) Describe a unique solution found in the kitchen and share UTSW's story in building a Culinary Medicine Program
4) Review the dietary research driving the Culinary Medicine model

Food and Disease

In 2018, the US Burden of Disease Collaborators published an updated list of risk factors influencing disease burden in the US population from 1990-2016. They identified the key risk factors contributing to premature death and increased disability-adjusted life years using a comparative risk assessment framework. Dietary factors were identified as the #1 risk factor for premature death and #3 for disability, separately from many other independent risk factors including elevated body mass index (BMI). Breaking down each risk factor by state, the authors found that dietary factors are the #2 risk factor for disability in Texas, 2nd only to BMI, which was evaluated as an independent risk factor though clearly influenced by diet. They analyzed 14 distinct dietary habits to calculate this impact (including diets *low* in fruits, vegetables, legumes, whole grains, nuts/seeds, fiber, calcium, seafood, and polyunsaturated fatty acids and *high* in trans fats, sodium, sugar-sweetened beverages, processed meat, and red meat). The authors conclude that "US residents are not consuming a healthy diet" both in terms of caloric excess and poor quality and composition and that we need "a comprehensive program to improve dietary intake at national and local levels" [1].

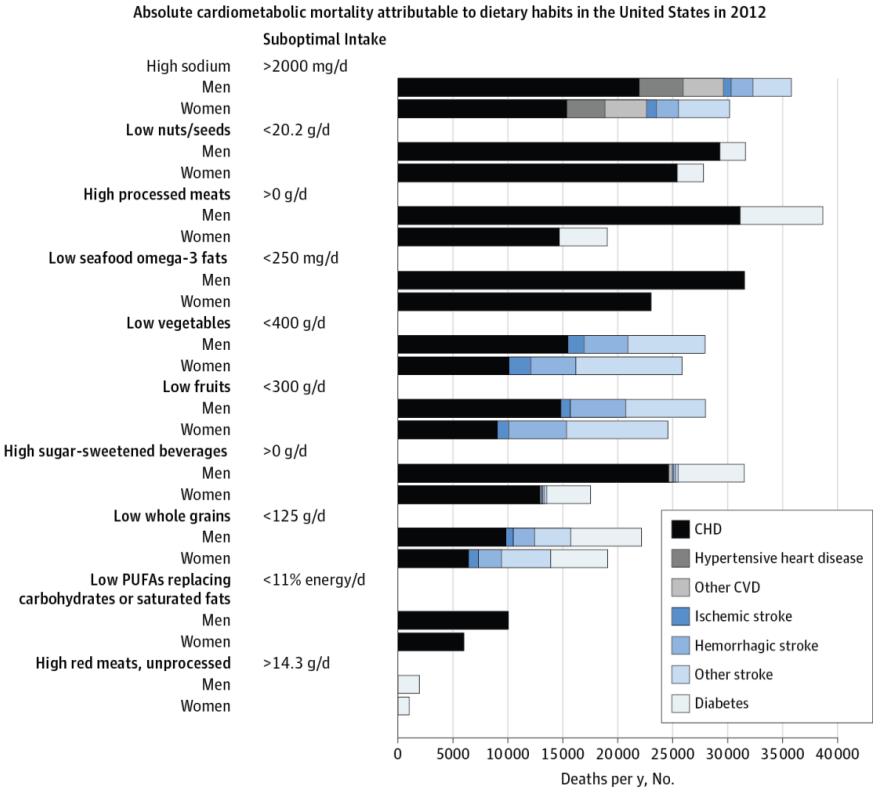
Number of Deaths and Percentage of Disability-Adjusted Life Years Related to the 17 Leading Risk Factors in the United States, 2016 [1]



The driving forces for our lifestyle-related disease epidemic are many, but the complex relationship between food and health is increasingly understood. Diet quality impacts a variety of complex risk factors for disease. Evidence now supports that dietary habits directly influence adiposity – visceral, hepatic, and subcutaneous – through a variety of modalities that leads to metabolic dysfunction and insulin resistance. Specific foods influence metabolic expenditure, inflammation, endothelial function, hepatic function, and many other cardiometabolic risk factors. Our growing understanding of the epigenetic effect of food sheds light on how genetic risk for certain disease processes can be directly influenced by specific dietary choices, particularly through their modulation of the microbiome. For weight management and health, we now know that "all calories are not created equal because of the divergent long-term effects of different foods on these pathways of weight homeostasis" [5]

In 2017, a group of researchers sought to estimate associations of 10 specific dietary factors with mortality due to heart disease, stroke, and type 2 diabetes in US adults.

Absolute Cardiometabolic Disease Mortality Associated with Suboptimal Dietary Habits among US Men and Women in 2012 [5]



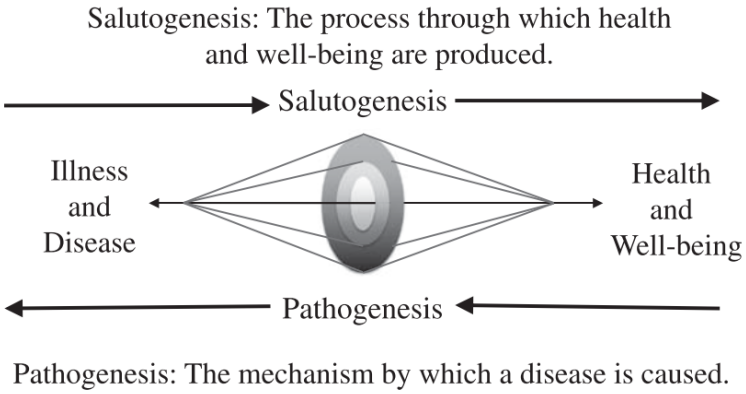
They estimated the absolute and percentage mortality between 2002 and 2012 for men and women. Suboptimal intake of 10 dietary factors (which includes inadequate intake of some foods, such as nuts/seeds, vegetables, and omega-3 rich seafood and excessive intake of others, such as sugar-sweetened beverages and processed meats). Based on a comparative risk assessment model, they estimated that over 45% of all cardiometabolic deaths were attributable to suboptimal intake of 10 dietary factors.

Nutrition in Medical Education

To address the profound disease and economic burden caused by suboptimal dietary patterns, we must turn to the role of healthcare education in addressing the crisis. To reduce costs and empower patients

and healthcare teams to find greater wellness, the educational approach to nutrition that equips future physicians to support practical lifestyle change must be adjusted.

The Relationship between Pathogenesis and Salutogenesis [2]



In his paper that proposes new models of education for an era of lifestyle-related disease, David Eisenberg discusses the concept of "salutogenesis" as an essential partner to the study of pathogenesis [2]. Current medical education models largely focus on teaching the pathogenesis, evaluation, and treatment of disease but fall short in equipping physicians to understand the key factors in maintenance of health and wellbeing. This limits their ability to serve as resources for meaningful lifestyle pursuits of health.

History and Status of Nutrition Education in Undergraduate Medical Education

Medical schools face an enormous challenge to incorporate increasing amounts of information into the curriculum, which inevitably limits non-essential topics. Nutrition science has unfortunately fallen into the background when it should be a foundational science. In 1985, the National Research Council recommended at least 25 hours of required nutrition education in medical school. In early the 2000s, the National Heart, Lung, and Blood Institute (NHLBI) granted Nutrition Academic Awards to 21 schools with a goal to formally integrate nutrition education into medical school curricula. Kelly Adams and colleagues have been monitoring this over the past two decades and found that the majority of allopathic medical schools (121/133 survey respondents) fail to achieve this recommendation, and the average number of hours reported by the schools is overall declining (as is the number of schools with a required nutrition course). For the minority that do meet the recommendation, it is unclear what is included in these hours. Most schools report a qualitative focus on biochemistry and not practical food science [3].

Notably, the National Research Council made the minimum recommendation in 1985, and the role of nutritional etiologies in chronic disease has increased substantially, as has nutrition research. A recent review in *Academic Medicine* looked at the health professions literature including peer-reviewed education material in MedEdPORTAL to provide an overview of nutrition education in undergraduate medical education. They found significant heterogeneity and a lack of adopted curricular standards. Given the diversity in quantity and type of exposure to nutrition curriculum, student knowledge about nutrition remains highly variable. Their findings led to several recommendations, including a focus on inter-professional education, increased use of online learning, attention to personal health behaviors, and practice in the skill of counseling patients using both standardized and real patients [6]. These concepts align with many national trends in medical education.

There are a variety of barriers educators face in implementing useful nutrition education, and experts propose shifting our approach to overcome challenges. Possible barriers include a lack of funding for nutrition education as well as unclear payment structure for nutrition in clinical practice environments. This likely contributes to a shortage of physician champions, as does a lack of department-based administrative homes for physician nutrition educators. Though less of an issue as the accumulated literature expands, historical concerns about the science base for nutrition has also been cited as a barrier. Finally, the focus of medical training on treatment of disease rather than prevention and well-being drive resources toward different priorities. [7] As national trends shift GME increasingly towards a competency-based model, we need a similar movement in nutrition education. Instead of focusing on hours of nutrition training, we need to define key competencies for learners and measure the impact of specific curricular innovations. The healthcare payment model shift toward a population health focus will actually benefit an emphasis on lifestyle change, and physicians skilled in such should be able to reduce costs for their patients and payer systems.

Status of Nutrition Education in Graduate Medical Education

The trend of inadequate nutrition education in undergraduate medical education continues in graduate medical education, and we cannot expect diverse residency and fellowship training programs to completely recover and fill the gaps. If anything, it appears that nutrition education access decreases with higher levels of training. A recent cross-sectional survey of interns at academic programs in internal medicine, general surgery, and obstetrics and gynecology found that 71% of mid-year interns felt unprepared to address nutritional needs when presented with brief, specific patient cases. Each case presented would be significantly impacted by definitive nutrition therapy, making their discomfort even more poignant. The authors found that the number of weeks of medical school training was statistically significant ($p=0.03$) with perceived preparation to address nutrition issues. Specifically, at least 4 weeks of medical school training led to higher perceived preparation. The interns' perceptions of inadequate preparation were confirmed with knowledge questions in the same survey [8].

Internal Medicine is notably the largest specialty training physicians in chronic disease management. In spite of this, the American College of Graduate Medical Education (ACGME) program requirements for Internal Medicine (IM) do not explicitly mention nutrition education. In a recently published study, a group of IM Program Directors and residents completed a survey assessing several aspects of nutrition education at their program. Program Directors were asked about modalities of nutrition instruction and barriers they faced in providing it. Residents were asked about modalities they experienced as well as their nutrition counseling patterns with patients, their program's support for healthy eating, and their personal fruit and vegetable intake. Both nutrition education in residency and resident fruit and vegetable intake were predictors of the frequency of residents' dietary counseling practices. Only 22% of residents reported counseling patients on dietary change often or always. Interestingly, residents were more likely to report higher amounts of nutrition training if they were in a Northeast or Western program, a community program, or from a medical school abroad. Residents also reported counseling patients more frequently in Northeast and Western programs and if their program had a primary care track [9].

Not surprisingly, we can continue to track the trend of educational deficit throughout higher levels of training. There are particular specialties where the lack of nutrition competence is extremely impactful. Similarly to internal medicine training requirements, the 38-page ACGME Program Requirements document for Cardiology fellowships does not mention nutrition or diet. While practice guidelines for prevention and management of ischemic heart disease include promotion of lifestyle changes and healthy diet as foundational, physicians rarely have the training to actually do this. Ideally, fellowship-level nutrition training would build on a foundation of prior general principles and enable focus on particular concepts relevant to each discipline. This necessitates nutrition education throughout various levels of training, beginning early and often.

In a recent survey of practicing Cardiologists and current fellows (n = 930), most practicing Cardiologists (90%) reported receiving no nutrition training in fellowship. They reported a little more nutrition training in residency and medical school, but 24% stated that they couldn't even recall if they had any nutrition training in medical school. Only 8% of Cardiologists felt they had cumulative nutrition training that was adequate, but 95% felt it was their role to provide basic nutrition information to patients. The same study also evaluated personal nutrition habits (which are linked to counseling practices), and only 20% of cardiologists meet fruit and vegetable minimum serving recommendations [10].

Lastly, we will highlight Gastroenterology (GI) fellowship, another specialty where nutrition impacts everyday practice. On one survey of GI fellows, researchers found that 90% of fellows wanted more nutrition education. This is not surprising, especially since only 25% of fellows in the same study felt comfortable addressing enteral and parental support for patients and understood basic macro- and micronutrient requirements [11]. The American College of Gastroenterology and several other societies designed GI fellowship Core Curriculum which outlines six domains for fellowship training goals in nutrition. Despite these recommendations, it is evident that fellows still feel their education to be inadequate. The authors of a recently published overview of current education in nutrition in GI fellowship advise fellows to seek out nutrition training outside their program, through additional training or certification with American Board of Obesity Medicine (ABOM,) American Society of Nutrition (ASN), American Society for Parenteral and Enteral Nutrition (ASPEN), and National Board of Physician Nutrition Specialists (NBPNS) [12].

Competency-Based Nutrition Education

The future of addressing the high burden of diet-related disease must adopt a team-based approach, inclusive of our dietetic colleagues, nurses, and many other healthcare partners. We need to operate on the premise that all healthcare professionals who engage in patient care can potentially impact nutrition-based outcomes. While most physicians will not have either the time or expertise to provide their patients with detailed dietary recommendations, a unified message about the importance of food in health must begin with physicians and nurses who have the broadest access to patients within the healthcare system. Partnering with our dietetic colleagues, we should explore opportunities for inter-professional education and collaboration.

To move forward, we need to define a foundation of guideline-based, required nutrition education that is linked to the demonstration of competencies. This will need to be an inter-professional effort, likely with a combination of hands-on and online components. Assessing competency will require creativity at

various levels of training and will need to include standardized and real patients. Furthermore, we know that emphasis on personal health behaviors not only increases learner engagement but has been shown to improve counseling abilities. One study done at Tulane University's Goldring Center for Culinary Medicine pooled over 600 medical student surveys evaluating perceived counseling competency on specific nutritional topics and identified predictive factors in multivariate analyses for nutrition attitudes and competencies. They found that the two largest predictors in perceived counseling competency were a student's personal dietary habits and prior nutrition education [13].

Moving away from assessment of knowledge, competencies enable a learner to demonstrate the translation of knowledge into skill or action. We now have several sets of competencies to guide our goal-setting in nutrition education. In the early 2000s, the previously mentioned Nutrition Academic Awards through the NHLBI described competencies to be used as guides in developing nutrition education. The American Heart Association's Advisory in Medical Nutrition Education was published earlier this year and includes a list of cardiovascular disease-related nutrition competencies categorized by ACGME domains as well as Association of American Medical Colleges (AAMC) EPAs (entrustable professional activities), which outline competencies for medical students. They include items ranging from taking a diet history to considering the impact of social determinants of health on diet behavior and knowing when to refer to dieticians, diabetic educators, obesity specialists, and others. The competencies also include cultural sensitivity, empathy, and communication skills as it relates to discussion of food and lifestyle change, and they also address recognition of controversy or of non-evidence-based dietary recommendations [4]. Similarly, the American Society of Nutrition has also defined competencies [14]. Medical educators can utilize these defined competencies to identify the greatest alignment with population health goals as a starting point for curricular integration.

Sample of EPAs Relevant to Nutrition Competencies [4]

EPA	Entrustable Behaviors
1. Gather a history and perform a physical examination	Gathers all information related to diet and CVD risk from Personal and family history, diet/lifestyle history, and basic laboratory data Formal diet assessment, when appropriate Evaluation of social, cultural, and economic factors that influence diet habits Physical examination findings, including BMI, waist circumference, and other physical findings of CVD risk Does all of the above in a complete manner and with sensitivity and cultural awareness
2. Prioritize a differential diagnosis after a clinical encounter	Synthesizes all diet-related information and draws on knowledge and experience to recognize Relationships between dietary history and CVD risk or risk factors, including acute CVD events Social, cultural, and economic factors that impact diet habits Openly discusses conclusions with supervisors and patients
3. Recommend and interpret common diagnostic screening tests	Performs diet-related screening and testing based on Standards of care National guidelines Cost awareness Patient preferences Performs test interpretation that Is accurate Recognizes urgency when present Discusses test results with supervisors and patients

Sample of CVD-Related Nutrition Competencies Categorized by ACGME Domain [4]

Practice-based learning and improvement: Demonstrate the ability to evaluate one's care and to continually improve it	Demonstrates the ability to Improve nutrition care delivery by incorporating new nutrition science, guidelines, assessment tools, patient education tools, and diet counseling techniques Monitor and improve patient diet behaviors and outcomes Monitor and improve one's progress in achieving nutrition competencies
Interpersonal and communication skills: Demonstrate skills that lead to effective exchange of information and collaboration to improve patient care	Demonstrates the ability to Communicate diet and nutrition information to patients based on education and health literacy levels Communicate effectively with dietitians, behaviorists, lipid specialists, and other team members in a manner that supports a team approach to health promotion and treatment of disease
Professionalism: Demonstrate the ability to carry out professional activities and to adhere to ethical principles	Demonstrates Empathy when counseling patients with alcoholism, obesity, eating disorders, dietary nonadherence, and culturally based dietary habits Professionalism in communications with all care team members and the ability to serve as a role model to those with less nutrition and medical knowledge Integrity in the delivery of evidence-based diet information (and avoids financial or other conflicts related to industry or business entities) Recognition of personal deficiencies in nutrition competency and the ability to work to rectify these

ACGME indicates Accreditation Council for Graduate Medical Education; ASCVD, atherosclerotic cardiovascular disease; BMI, body mass index; CVD, cardiovascular disease; and RDNs, registered dietitian nutritionists.

The History of Culinary Medicine

Culinary Medicine is a movement marked by rapid growth in the past 5 years and is defined by Dr. John La Puma, MD, as "a new evidence-based field in medicine that blends the art of food and cooking with the science of medicine." Dr. La Puma goes on to describe culinary medicine as "aimed at helping people reach good personal medical decisions about accessing and eating high quality meals that help prevent and treat disease and restore well-being" [15]. As you can imagine, success of this model necessitates medical professionals, chef instructors, dieticians, behavioral experts, and open-minded learners. It is important to note here that culinary medicine is not about defining a perfect diet but about teaching people the life skills necessary to sustain dedication to nutritious food; for many patients, food is medicine. Without specific training, most clinicians do not understand the way food impacts metabolism, the immune system, and general well-being, and they struggle to offer advice to patients that is personalized and inclusive of an individual patient's unique culture and cognizant of barriers to dietary improvement.

In 2003, SUNY-Upstate taught the first documented cooking and nutrition elective in a US medical school. In 2007, a Harvard University partnership with the Culinary Institute of America taught the first continuing education course to clinicians known as Healthy Kitchens, Healthy Lives. This course has been very successful and continues and to offer continuing education (CME) to clinicians. In 2013, Tulane University became the first medical school with a dedicated teaching kitchen and developed curriculum in Culinary Medicine through a partnership with Johnson & Wales College of Culinary Arts [15]. Thanks to the negotiations of one of our own faculty, Dr. Keith Argenbright, Tulane licenses curriculum to other medical schools, residency programs, and hospital systems. As of 2018, there are over 40 medical school and residency programs licensing the curriculum to teach students, residents, faculty, and community members.

Thus, teaching kitchens are emerging as a common approach to instill practical skills for coaching patients built on a foundation of personal health promotion. A 2016 review identified 10 culinary medicine programs worldwide (with nine in the US) that have launched culinary classes for trainees at various levels, practicing clinicians, community participants, or all of the above. Of these, Tulane's Goldring Center licenses to additional programs. Through these classes, the kitchen becomes a lab, combining cooking, dietary research, and educational innovation [16].

Evidence for Dietary Recommendations in Nutrition Education and Culinary Medicine

Because dietary factors have a profound influence on both premature death and chronic disability, it is important to summarize the current evidence for dietary factors that improve health outcomes since that drives our nutrition and culinary curriculum. This is a rapidly evolving field. Studying the impact of diet on health is highly complex, influenced by numerous variables, and is rarely done to the agreement of all nutrition scientists. Based on currently available evidence, one of the best-studied and most broadly applicable approaches is the Mediterranean-style diet. More of a lifestyle eating plan than a prescriptive diet, it is currently meant to encompass numerous cultures and dietary patterns. Courtney Davis and colleagues recently did a literature review of all the major Mediterranean diet studies across the world to create a streamlined definition. They found that actual food quantities seemed to vary by the studies reviewed, but when they analyzed for nutrient content, there was less variation between the studies [17]. In other words, similar dietary nutrient goals can be achieved with a variety of different food components. Thus, nutritious diets that have the potential to prevent and treat chronic disease do not all look the same. It is vitally important that we work with patients to identify what works for their cultural preferences and lifestyle.

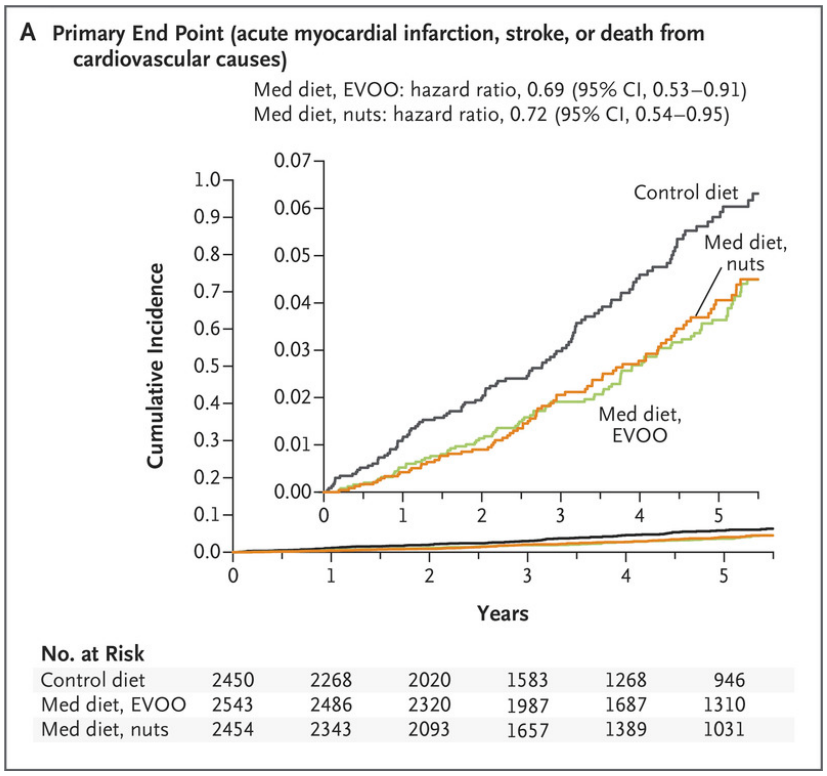
Key themes include olive oil as a major source of dietary fat, with purported benefit stemming from low saturated fat and a high omega 3:6 ratio. Vegetables and fruits, nuts and seeds, and whole grains should make up the majority of the diet (plant-based). Legumes are advised to be eaten at least twice weekly, and this is also true of fish and seafood that are high in omega-3s, such as salmon and certain white fish. Dairy should be overall reduced with a focus on fermented dairy (such as yogurt and cheese), and meat should also be reduced to a few times a week due to a less favorable omega 3:6 ratio. The main beverage is water with allowable moderate intake of wine with meals. In Mediterranean culture, meals are consumed with others.

- **Olive oil** as a major source of dietary fat
- Large intake of **vegetables and fruits**
- Daily **nuts and seeds, whole grains, herbs/spices**
- **Legumes** and **fish** several times a week
- Less frequent *poultry* and *dairy*
- Infrequent *red meat*

We will now briefly review some key Mediterranean dietary research. In 2003, researchers studied the survival benefit association of a Mediterranean-style diet. In this study of a Greek population, participants completed an extensive, validated food questionnaire (performed in person) that quantified adherence to Mediterranean diet with a score of 0-9, with higher scores denoting greater adherence. To simplify, they assigned one point for higher than median intake of beneficial foods and one point for less

than median intake of foods advised to be consumed in moderation. They scored fats based on a ratio of monounsaturated to saturated fats (with a point assigned for a higher ratio). The researchers found a significant association with decreased all-cause mortality for higher Mediterranean diet score. Specifically looking at participants with a score of five compared to participants with a score of seven, there was a 25% reduction in all-cause mortality at the higher score of seven [18]. This begins to make the case that a dietary change doesn't have to be profound or perfect to provide significant health benefit.

The PREDIMED study has been considered one the more important studies revealing the benefits of a Mediterranean-style diet, but this trial is actually illustrative of the challenges of dietary research as evidenced by a recent retraction and republication [19]. In order to understand the issues with the original publication in 2013, it is helpful to review the original study design. Taking place at 11 centers with 169 clinics in Spain, the study included men and women between the ages of 55-80 at high risk for cardiovascular disease but without evidence of cardiovascular disease at enrollment. The participants were randomized to three different groups. In the first intervention arm, participants were coached on the principles of a Mediterranean diet and were given olive oil with instructions to use at least four tablespoons daily. The second intervention arm was similarly coached on Mediterranean diet and given mixed nuts (almonds, walnuts, and hazelnuts) with guidance to eat at least 30g (1/4 cup) daily. The control group was given information about a low fat diet and a small, non-food gift. In the original study as well as the re-analysis, the results were basically the same, with the intervention arms both leading to significant reduction in the composite endpoint of major cardiovascular events by about 30% [19].



Next, we will briefly review what led to the retraction of the 2013 paper and republication in 2018. In 2017, there was an analysis that the baseline variable distribution in this study appeared different from what would be expected for appropriate randomization. The authors reviewed each site's assignment to intervention groups and uncovered irregularities in randomization. First, there were 425 participants that were not individually randomized. Instead, they were assigned to the same diet as a household member that had been previously randomized. One can imagine the challenge in randomizing household members to different diets, but it would have been necessary for pure

randomization per the protocol. Another site assigned entire clinics (11 clinics) to a diet rather than individually randomizing, and this impacted 467 participants. Finally, a 3rd site was found to have some inconsistent use of the randomization tables, making it unclear if 593 participants there were appropriately randomized. The authors analyzed the data excluding those not appropriately randomized and also re-analyzed the original data controlling for reliance on randomization. Ultimately, after re-analysis and adjustments were made, their conclusions were not significantly changed, and the adjusted Kaplan Meier curve above [19] shows the benefit of both Mediterranean diet arms through 30% reduction in the primary composite endpoint of myocardial infarction, stroke, and cardiovascular death.

In addition to having a significant impact on general mortality and cardiovascular outcomes, there are other aspects of health impacted by a Mediterranean diet. Purportedly due to the anti-inflammatory and antioxidant components, a couple of recent reviews found that the Mediterranean diet is significantly associated with improved global cognition and appears to play a protective role against cognitive decline and development of Alzheimer's disease [20, 21]. Another area of great interest is the impact of diet on cancer risk. A systematic review in 2014 showed that a high adherence to a Mediterranean diet reduces overall risk for malignancy and seems to have a particular impact on associated risk reduction of aero-digestive cancers [22]. Finally, the European Prospective Cohort, known as EPIC, made an important discovery. Participants in their study with a one-unit increase in Mediterranean diet score saw an associated risk reduction in heart disease of 6%. There was cumulative benefit for each point increase in diet score, and this emphasizes the value of small change.

Health Benefit or Disease Prevented	Study Type	Results	Reference
Cognition	Systematic Review & Meta-analysis Systematic Review	Improved global cognition Decreased cognitive decline	[20] [21]
Cancer	Systematic Review	Associated risk reduction in overall, colorectal, prostate, and aero-digestive cancers	[22]
CHD	EPIC (European Prospective Investigation into Cancer and Nutrition) Cohort	A 1-unit increase in Medi diet score was associated with 6% reduced risk of CHD	[23]

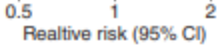
There are numerous studies not specifically on the Mediterranean diet but on related components that further build on the evidence for the some of the diet's key recommendations. We will briefly review four such studies. First, researchers examined the critical question of the role certain macronutrients play in health outcomes. In the Women's Health Initiative Dietary Modification Trial, women in the

intervention group reduced dietary fat to less than 20% of total calories consumed and also reduced saturated fat (<10% of calories) and cholesterol (<300 mg daily). The low fat dietary efforts had no significant impact on reducing risk for cardiovascular disease [24]. The specific Mediterranean diet feature of daily nut intake was evaluated with an analysis of diet and health outcomes for participants in both the Nurse's Health study and the Health Professional's Follow-Up Study, two large, prospective cohorts with 30 years of follow-up. They found that daily consumption of nuts compared to no consumption of nuts was associated with a 20% lower death rate [25]. Recently, researchers wanted to evaluate the role of fat in health outcomes after breaking it down into the different types of fat. They evaluated the association of specific dietary fat categories and relationship with mortality, specifically looking at the impact of substitution of dietary carbohydrates with specific types of fat. Not surprisingly, trans fats are the most detrimental, increasing mortality significantly. When replacing carbohydrates in the diet with saturated fats, there appears to be a modest increase in mortality. This area remains somewhat controversial and needs to be further studied to distinguish between animal-based sources of saturated fat, such as processed meat, and plant-based sources, such as coconut. What is clear, however, is that substitution of dietary carbohydrates with mono- and polyunsaturated fats has an association with decreased mortality [26]. Lastly, Aune's meta-analysis, known as the fruit and vegetable study, included 95 studies and found that fruit and vegetable consumption is inversely associated with all-cause mortality. This occurs in a dose-dependent fashion, placing optimal intake of fruits and vegetables at about six to eight servings per day [27]. In this case, more seems to be better.

Study Theme	Type and Participants	Results	Reference
Women's Health Initiative Dietary Modification Trial	RCT of 48,835 women to low fat diet (<20% fat) or control	After 8.1 years of mean f/u, a low fat diet did not significantly reduce risk of CV disease	[24]
Nuts & Mortality	Nurses' Health Study & Health Professionals' Follow-Up Study prospective cohorts	Daily serving of nuts vs. no consumption of nuts → associated 20% decreased risk of death	[25]
Dietary Fats and Mortality	Nurses' Health Study & Health Professionals' Follow-Up Study prospective cohorts	Less carbs and more: *Trans fat* → large increase mortality *Saturated fat* → mod increase mortality *Unsaturated fat* → decreased mortality	[26]
Fruit & Vegetable Study	Meta-analysis of 95 cohort prospective studies; included >2 million participants	Fruit and vegetable intake is associated with decreased mortality in a dose-dependent fashion (optimal: 6-8 servings per day)	[27]

In summary, Mozaffarian's recent comprehensive review of disease and dietary patterns presents a detailed meta-analysis of several hundred studies looking at the effects of specific foods on cardiovascular disease (including heart disease and stroke), diabetes, and obesity, as per below [28].

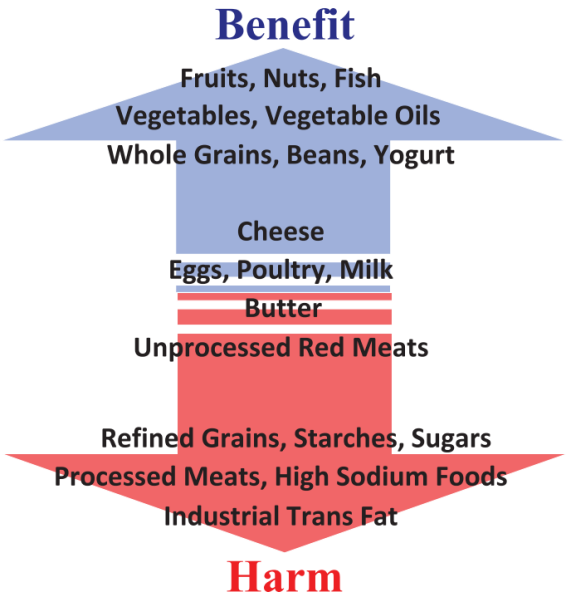
	Endpoint	No. of studies	No. of subjects	No. of events	Unit	RR	Reference
Fruits	CHD	16 PCs	817,155	13,786	Each 1 serving/day (100 g)	0.94 (0.91, 0.98)	Gan Y 2015
	Stroke	8 PCs	377,159	9,706	Each 1 serving/day (100 g)	0.82 (0.75, 0.91)	Hu D 2014
	Diabetes	7 PCs	368,232	21,063	Each 1 serving/day (100 g)	0.94 (0.89, 1.00)	Li M 2014
Vegetables	CHD	14 PCs	705,316	13,135	Each 1 serving/day (100 g)	0.95 (0.92, 0.98)	Gan Y 2015
	Stroke	6 PCs	342,118	8,854	Each 1 serving/day (100 g)	0.94 (0.90, 0.99)	Hu D 2014
	Diabetes	5 PCs	173,995	18,758	Each 1 serving/day (100 g)	0.98 (0.89, 1.08)	Li M 2014
Green leafy vegetables	Diabetes	3 PCs	127,148	13,331	Each 1 serving/day (100 g)	0.76 (0.62, 0.94)	Li M 2014
Legumes	Stroke	6 PCs	254,628	6,690	Each 4 servings/wk (400 g)	0.98 (0.84, 1.14)	Afshin A 2014
	CHD	4 PCs	198,904	6,514	Each 4 servings/wk (400 g)	0.86 (0.78, 0.94)	Afshin A 2014
	Diabetes	2 PCs	100,179	2,746	Each 4 servings/wk (400 g)	0.78 (0.50, 1.14)	Afshin A 2014
Whole grains	CHD	6 PCs	--	5,383	high vs low	0.78 (0.71, 0.86)	Tang G 2015
	Stroke	4 PCs	207,984	877	2.5 vs. 0.2 servings/day	0.83 (0.68, 1.14)	Mellen P 2008
	Diabetes	10 PCs	385, 868	19,829	Each 1 serving/day (50 g)	0.81 (0.74, 0.89)	Aune D 2013
Nuts and seeds	CHD death	5 PCs, 1 RCT	206,114	6,749	Each 4 servings/week (4 oz [113 g])	0.76 (0.69, 0.84)	Afshin A 2014
	Nonfatal CHD	3 PCs, 1 RCT	141, 390	4,280	Each 4 servings/week (4 oz [113 g])	0.78 (0.67, 0.92)	Afshin A 2014
	Diabetes	5 PC, 1 RCT	230,216	13,308	Each 4 servings/week (4 oz [113 g])	0.87 (0.81, 0.94)	Afshin A 2014
Fish	CHD Death	12 PCs	282,075	4,195	2-4 servings/week vs. ≤3 servings/month	0.79 (0.67, 0.92)	Zheng J 2012
	Stroke	8 PCs	394,958	16,890	≥ 5 vs. 1 serving/week	0.88 (0.81, 0.96)	Chowdhury R 2012
	Diabetes	13 PCs	481,489	20,830	Each 1 serving/day (100 g)	1.12 (0.94, 1.34)	Wu J 2012
Unprocessed red meats	CVD death	13 PCs	1,070,215	24,241	high vs low	1.12 (0.95, 1.33)	Abete I 2014
	Stroke	5 PCs	239,251	9,593	Each 1 serving/day (100 g)	1.13 (1.03, 1.23)	Chen G 2013
	Diabetes	9 PCs	447,333	28,206	Each 1 serving/day (100 g)	1.19 (1.04, 1.37)	Pan A 2011
Processed red meats	CVD death	6 PCs	1,186,761	35,537	Each 1 serving/day (50 g)	1.24 (1.09, 1.40)	Abete I 2014
	Stroke	5 PCs	239,251	9,593	Each 1 serving/day (50 g)	1.11 (1.02, 1.20)	Chen G 2013
	Diabetes	8 PCs	372,391	26,234	Each 1 serving/day (50 g)	1.51 (1.25, 1.83)	Pan A 2011
White meat (poultry, rabbit)	CVD death	5 PCs	1,197,805	31,535	Each 1 serving/day (100 g)	1.00 (0.87, 1.15)	Abete I 2014
Total dairy	CHD	10 PCs	253,260	8,792	high vs low	0.94 (0.82, 1.07)	Qin L 2015
	Stroke	16 PCs	764,635	28,138	high vs low	0.88 (0.82, 0.94)	Hu D 2014
	Diabetes	14 PCs	459,790	35,863	Each 1 serving/day	0.98 (0.96, 1.01)	Chen M 2014
Milk	CHD	6 PCs	259,162	4,391	Each 1 serving/day (200 ml)	1.00 (0.96, 1.04)	Soedamah-Muthu S 2011
	Stroke	9 PCs	525,609	22,382	high vs low	0.91 (0.82, 1.01	Hu D 2014
	Diabetes	7 PCs	167,982	15,149	Each 1 serving/day (200 g)	0.87 (0.72, 1.04)	Aune D 2013
Cheese	CHD	7 PCs	--	--	high vs low	0.84 (0.71, 1.00)	Qin L 2015
	Stroke	5 PCs	282,439	9,919	high vs low	0.94 (0.89, 0.995)	Hu D 2014
	Diabetes	8 PCs	242,960	17,620	Each 1 serving/day (50 g)	0.92 (0.86, 0.99)	Aune D 2013
Butter	CHD	5 PCs	--	--	high vs low	1.02 (0.88, 1.20)	Qin L 2015
	Stroke	3 PCs	173,853	5,299	high vs low	0.95 (0.85, 1.07)	Hu D 2014
Yogurt	CHD	5 PCs	--	--	high vs low	1.06 (0.90, 1.34)	Qin L 2015
	Diabetes	9 PCs	408,096	32,995	Each 1 serving/day (½ cup)	0.82 (0.70, 0.96)	Chen M 2014
Eggs	CHD	7 PCs	263,938	5,847	Each 1 serving/day (1 egg)	0.99 (0.85, 1.15)	Rong Y 2013
	Stroke	6 PCs	210,404	7,579	Each 1 serving/day (1 egg)	0.91 (0.81, 1.02)	Rong Y 2013
	Diabetes	5 PCs	69,297	4,889	≥1 egg/day vs. never or <1 egg/week	1.42 (1.09, 1.86)	Shin J 2013
100% fruit juice	Diabetes	11 PCs	407,288	34,549	Each 1 serving/day (8 oz.)	1.06 (0.98, 1.14)	Imamura F 2015
Sugar-sweetend beverages	Diabetes, non-BMI adjusted	13 PCs	421,973	36,492	Each 1 serving/day (8 oz.)	1.42 (1.19, 1.69)	Imamura F 2015
	Diabetes, BMI adjusted	17 PCs	464,937	38,253	Each 1 serving/day (8 oz.)	1.27 (1.10, 1.46)	Imamura F 2015
	CHD	4 PCs	194,664	7,396	Each 1 serving/day (8 oz.)	1.17 (1.10, 1.24)	Xi B 2015
Coffee—	CVD	29 PCs	--	--	3 vs. 0 cups/day, nonlinear	0.89 (0.85, 0.93)	Ding M 2014
Caffeneited	Diabetes	11 PCs	--	--	Each 1 serving/day (1 cup)	0.91 (0.89, 0.94)	Ding M 2014
Decaffeneited	Diabetes	11 PCs	--	--	Each 1 serving/day (1 cup)	0.94 (0.91, 0.98)	Ding M 2014
Tea	CHD	7 PCs	235,368	8,328	Each 1 serving/day (1 cup)	0.90 (0.81, 0.996)	Zhang C 2015
	Diabetes	14 PCs	503,165	35,574	Each 1 serving/day (1 cup)	0.98 (0.96, 0.995)	Yang W 2014
	Stroke	8 PCs	307,968	11,329	Each 1 serving/day (1 cup)	0.94 (0.90, 0.973)	Zhang C 2015



The data can be further simplified with the graph encouraging increased consumption of fruits and vegetables as well as nuts, seeds, legumes, whole/unprocessed grains (which retain the fiber and

nutrients), fish, fermented dairy, and oils with a lower proportion of saturated fats and higher omega 3:6 ratio. From a patient care standpoint, emphasis on what a patient *should* be eating is often more effective than spending most nutrition counseling time on what they should be avoiding.

Evidence-Based Dietary Priorities for Cardiometabolic Health (with placement position on figure reflecting net effects) [28]



The UT Southwestern Culinary Medicine Launch

The UTSW story of enhanced nutrition education through culinary classes began with the recent evolution of the medical school's curriculum. In addition to the transition to an 18 month pre-clinical period, the outpatient Pediatric and Internal Medicine clerkship experiences were combined into a single Ambulatory Clerkship. The clerkship co-directors designed weekly themes focusing on important wellness initiatives relevant to both personal health and professional practice. During the week focusing on nutrition, physician educators launched a Cooking and Nutrition module which became our first experience to deliver a hands-on culinary class as nutrition education. Classes take place in the School of Health Professions' teaching kitchen where the Department of Clinical Nutrition offers food science courses for the dietetics program. All clerkship students at UTSW take this class as a required clerkship activity.

There has been recent attention to the educational preferences of millennial learners, and this, at least in part, includes a need for more experiential and collaborative learning. In the development of the nutrition and cooking module, we focused on these themes. Prior to class, students are asked to read an article about the deficiency of education in nutrition [3] and take a brief quiz. They also screen a popular documentary looking at food policy (Michael Pollan's *In Defense of Food*). During the class session, we begin with a didactic discussion that reviews the importance of nutrition education to personal wellness and professional practice. Students then divide into teams to prepare a meal (with recipes and ingredients provided) in the teaching kitchen, and the evening concludes with eating together during an additional learning session about specific strategies for advising patients on food-related lifestyle change. The most common theme of their feedback centers on wanting more exposure earlier in their medical education, which prompted the desire to grow the program.

As the first licensee of the curriculum originally designed at the Goldring Center for Culinary Medicine at Tulane University (www.culinarymedicine.org), UTSW's Moncrief Cancer Institute (MCI) launched the curriculum to teach cancer survivors the role of food in secondary prevention of cancer. Quickly gaining popularity, the classes expanded to include a partnership with the University of North Texas Health Science Center's medical students and Texas Christian University's dietetic students. Desiring ongoing opportunities for health education and community growth in Culinary Medicine, MCI sponsored their lead culinary-trained Registered Dietician Nutritionist (RDN) to support the physician-led launch at the UTSW School of Medicine. Just over a year after the first Ambulatory Clerkship Cooking and Nutrition

module, we launched an eight-module culinary medicine elective for two cohorts of first year medical students. Through partnership with the School of Health Professions' Department of Nutrition, we were graciously allowed use of the teaching kitchen on campus, and we designed opportunities for inter-professional education that includes integrating dietetic students into medical student classes.

Employing a co-teaching model with the expertise of an RDN and a physician, we were also fortunate to have participation from a volunteer community chef our first year. Absolutely critical to our program's success are the student volunteers, both from the dietetics program and the medical school. Student leaders organize the volunteers that ensure our classes run smoothly and efficiently. Establishing the elective included recruitment of first-year medical students through an announcement at their orientation. The students were so enthusiastic that the response level crashed the enrollment site, and it had to be reset. We filled the elective with 34 students in seconds and maintained a waiting list of over 30 additional students who were unfortunately not able to take the course. We continue working on creative strategies to identify funding and faculty time that will allow for sustainability and growth. Our current resources include use of the Department of Clinical Nutrition's teaching kitchen, MCI's support of RDN time and miscellaneous kitchen needs, and a Southwestern Academy of Teachers (SWAT) Small Education Grant. In addition, we recently began a collaboration with the Family Medicine Department to deliver culinary medicine training to their new intern class. Additional undergraduate, graduate, and continuing education possibilities are under consideration.

Culinary Medicine Curriculum

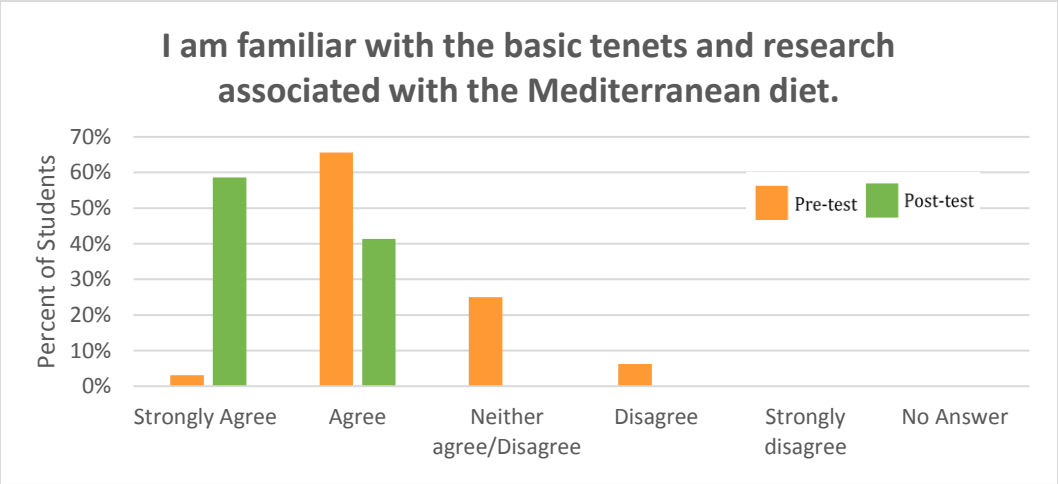
Originally developed at Tulane University's Goldring Center for Culinary Medicine, the curriculum we utilize includes numerous resources for leading nutrition education in a kitchen. There are currently about 25 modules with additional topics in development. Modules range from a focus on basic concepts such as macromolecule impact on health and disease (including a Fats module and a Carbohydrates module), diet related to specific conditions (including modules devoted to CHF, IBS and IBD, and Celiac Disease), and diets relevant to specific groups of patients (including modules addressing the Pediatric Diet, Nutrition in HIV and AIDs, Nutrition in Pregnancy, and Geriatric Diet). Each module represents a 3-hour class which begins with case studies in small groups. Student groups each have a different case and set of questions to discuss. A patient history and dietary habits are typically provided, and group determines answers through discussion and use of electronic devices to look up unfamiliar terms or concepts. Our volunteer students with more clinical experience (typically third and fourth year medical students) support the first year students with what may be their first exposure to cases, and cases are later discussed in a large group.

Each module has one to two required readings and often numerous supplemental readings, and we review the relevant literature during the didactic session near the end of class. Each module also includes between six and ten recipes (all available to the public on the aforementioned website), and the ingredients, recipes, and nutrition facts are provided at each station during the cooking portion of class. The RDN educator has culinary training and circulates the room to assist with practical and culinary questions. Dietetic student volunteers and peer educators answer questions about food science and recipes. Many modules include handouts designed to be used as a resource and given to patients. There is a national committee of faculty at different institutions who were early adopters of

the curriculum, and we conference monthly to update modules with the latest literature informing the topic.

Culinary Medicine Elective Feedback

We collected survey data from our first elective cohort of first year medical students at the beginning of the course in the fall of 2017 and again after their last session in April of 2018. There was a large increase in the number of students who understood that a physician's personal health habits influences the care they provide. Similarly, 82% reported making changes to their own eating habits. Given that the Mediterranean diet is the most heavily researched diet and its principles influence the culinary medicine curriculum, we found that all elective students increased their confidence with the research and basic principles of the Mediterranean diet.



Additional findings included a significant increase in comfort having a discussion with patients about eating habits and health as well as 100% confidence in understanding the role of a dietician on a healthcare team. Students described the course as having "shaped the trajectory of my first year of medical school" and leaving a "lifelong impression," particularly due to its unique inter-professional approach to teaching practical knowledge about food.

Research and Educational Growth

While this field is young and the research is emerging, there is one study comparing perceived competency in nutrition concepts for those in traditional education versus those with culinary medicine training. Cooking for Health Optimization with Patients (CHOP)-Medical Students included all traditional education students (n = 627) as well as students taking the Culinary Medicine elective (n = 84) over two years at Tulane University. The researchers used comparative effectiveness techniques to analyze the results of a 59-question survey (which assessed personal dietary habits, nutrition counseling attitudes, and self-perceived confidence in key nutrition competencies) administered twice a year for the two year study. In the elective group, they found a 72% increase in proficiency in the overall competencies (OR 1.72, CI 1.54-1.92) [29]. A key limitation, however, is that the survey design of this work measures perceived or self-assessed competency. A Phase II version of this study includes a national sample but still relies on self-perception of competency, raising the question of reliability of one's self-assessment of competency. Thus, a more objective analysis of demonstrated competency becomes vital.

A 2014 meta-analysis of clinical nutrition curricula found that most studies relied on convenience surveys for curriculum impact, as did our own data. They could not identify any studies that provided longitudinal tracking of nutrition curricular impact on medical practice or on the effect on patients [30]. Admittedly, evaluation of medical student impact on patient outcomes is a challenge given their transient engagement with any particular patient population. However, in the context of the growing use of simulation in education, we are working to assess the impact of our Culinary Medicine curriculum on student competencies through use of standardized patient (SP) encounters. Prior to the first Culinary Medicine class of the 2018-19 academic year, each participating student will complete three SP interviews, each presenting a different patient case necessitating specific dietary counseling skills. The SPs will complete evaluations that are mapped to specific LCME counseling competencies as well as the American Heart Association Nutrition competencies [4]. At the end of the elective year, the intervention/elective group and the control group will return for three additional, unique patient case interviews with SPs. They will similarly be evaluated by SPs with assessments mapped to specific competencies. We hope to measure the impact of the Culinary Medicine Elective on both general counseling skills and nutrition-specific competencies in order to determine the potential role for expanding this curriculum to a larger cohort of medical students.

A critical objective of our work in culinary medicine is to make it accessible to those most impacted by food-related disease, which is the poor and food-insecure patient population. There is a critical need for more research on the impact of accessible and culturally-relevant cooking classes in a community setting. There is one randomized controlled trial demonstrating improved biometrics in low income patients using hands-on community cooking classes versus traditional medical nutrition therapy and diabetes education classes [31]. We hope to add to the literature in this area by identifying the most effective approaches for helping patients achieve health outcomes while also having an opportunity to provide scholarly work for students interested in having a community impact. The Food as Medicine (FAME) research team at UTSW recently received Patient Centered Outcomes Research funding to build on existing food insecurity research partnerships with Crossroads and the North Texas Food Bank (NTFB), and we launched the pilot phase of the study earlier this year with culinary medicine classes for adults and their children at a nearby NTFB distribution site.

Additional health education growth remains a key priority as most trainees desire greater competency in discussing nutrition and lifestyle-related change with their patients. After experiencing the Cooking and Nutrition Module on the Ambulatory Clerkship and serving as a peer mentor for the Culinary Medicine Elective, one of our recent graduates developed a self-guided elective designed for 4th year medical students. Through primarily online-learning and self-study, the four-week elective has weekly electronic assignments to keep students on track. Throughout the month, students learn about the impact of policy on nutrition recommendations, study nutrition epidemiology, and gain a foundation for evaluating nutrition research. They explore introductory research behind the Mediterranean and DASH diets and practice dietary history skills, including participation in a culinary medicine class on campus or through our community projects. This elective has officially been approved for credit beginning this fall and has completely full enrollment. On the GME scene, UTSW's Family Medicine residency program worked with our team to launch an education pilot for their new intern class who begin exposure to Culinary Medicine during their orientation.

In Summary

The estimated impact of lifestyle-related disease on health outcomes and economic cost is substantial and alarming. Physicians are not currently well-equipped to support patients in guided lifestyle change, and changing the culture must begin with education. Culinary Medicine has emerged as a solution for inter-professional education in nutrition and food science, and its success in delivering practical knowledge also makes it a promising resource for patient care.

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