Concept Paper

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Integrating Nutrition, Culinary Medicine, and Agriculture in a Longitudinal, Case-Based Medical Education Curriculum

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Abstract: The United States is plagued with the highest rates of preventable metabolic diseases it has ever seen, and while poor nutrition is increasingly recognized as a critical contributing factor, good nutrition has been shown to be a potent factor in prevention and management of these illnesses. Notably, nutrition is inextricably intertwined with farming practices and the stewardship of our environment – particularly its soil. In this proposal, we propose a method to expose medical students to basic agricultural and environmental knowledge regarding the production of food, as well as educate them in practical nutrition education within the interactive, case-based, and longitudinal preclinical curriculum at Case Western Reserve University School of Medicine (CWRU SOM). We propose a two-part approach; first: integrating relevant topics in nutrition, culinary medicine, and farming practices into the preclinical blocks through Official Learning Objectives, and second: an optional 8-week, zero credit elective for students interested in pursuing a deeper understanding of these topics. Through these interventions, we believe courses like this will support a generation of physicians able to understand health from soil to plate with a consideration for the environment in addition to exemplifying healthful lifestyles themselves. We believe these kinds of future physicians will be the most effective in treating (and ideally reversing) the chronic disease epidemic.

Keywords: food as medicine; culinary medicine; farming as medicine; medical education; regenerative agriculture; farming; soil health; nutrition

1. Introduction

It is widely recognized that nutrition is foundational to disease prevention and disease management [1]. Today, 78% of chronic diseases like cardiovascular disease, diabetes, stroke, dementia, and cancer can be prevented with lifestyle factors including: abstaining from smoking, having a body mass index < 30, exercising >3.5 hr./wk, and adhering to healthy dietary patterns (high intake of fruits and vegetables) [2]. Healthy dietary patterns generally prioritize consumption of whole, unprocessed, or minimally processed foods. In the United States, Americans often do not know where or how their food is produced. Consumers are largely unaware of the impact foods have on their health, the environment, and the people who are involved in food production, including farmers, transporters, processing plant workers, grocers, and more. Additionally, Americans have shifted away from cooking at home: consumption of foods prepared outside of the home has increased from 18% to 32% between 1977 and 1996 according to the USDA [3], [4]. Foods prepared outside of the home are generally higher in saturated fat, added sugar, and refined carbohydrates, while being lower in dietary fiber and minerals [4] which negatively impacts overall health.

While nutrition education is at least present in name in most medical curricula, the curricula frequently miss key points in the use of food as medicine and as a powerful tool to treat illness in conjunction with pharmaceutical intervention [5]. Besides this, medical schools generally do not teach about other determinants of health that are related to food and nutrition, such as the ability to cook

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healthy meals, what to eat, how to navigate our current food system, and how to generally promote health to patients.

Without a meaningful mix of farming, cooking, and nutrition education, medical curricula forego a significant opportunity to build competencies in future physicians that allow them to help patients understand the role of food and diet in prevention of disease. Our proposed curricular interventions incorporate practical methods to instill culinary and nutritional knowledge within medical students to share with their future patients. Additionally, we want to promote thoughtful consideration of macro-level impact on nutrition and wellness, including soil health, and the effect of different farming practices on the environment: from carbon emissions to nutrient density of food products. The quality of soil directly affects the nutritional value of the foods grown within it, and by extension, determines the quality of our food system, which has direct implications on human health [6]. Modern agriculture methods that use large-scale tilling and an increasing number of chemical inputs destroy the soil microbiome, leading to a depletion of the nutrients available for uptake by the plant and has lasting effects for future growing sessions [7], [8]. Since the inception of intensive tillage paired with the utilization of synthetic chemical herbicides, insecticides, and fungicides, the plants we consume have become less nutrient dense [8]. This has caused a decrease in the amount of nutrition received by the consumer and subsequent consequences to health [9]. This has direct implications for the chronic disease epidemic. For example, a theory of obesity states that as the amount of food needed to meet micronutrient requirements increase, so will our appetites [10]. This is one of many ways in which human health may be affected by the way we produce and consume food. In addition, there are many potential negative consequences to our health and the environment with the use of herbicides, pesticides, and fungicides; the increase in global CO2 outputs caused by intensive tilling; and the destruction of topsoil, resulting in a reduction of fertile land. One possible answer is changing the way in which we farm by applying the principles of regenerative agriculture, which focuses on building soil quality by utilizing cover crops, reducing tillage, and reducing the use of synthetic chemicals. Aware and educated physicians represent one potential source of powerful advocacy when it comes to supporting such practices in the United States, such as with the 2023 Farm Bill [11].

Research has shown that globally, medical education fails to sufficiently incorporate nutrition and its role in disease prevention and disease management into curriculum, leading to a lack of medical student knowledge, confidence, and skills that would allow them to support their patients as practicing physicians [12]. With 11 million deaths and 255 million DALYs across the globe in one year attributable to dietary risk factors [13], the importance of adequately educating medical professionals in nutrition, culinary medicine, and agriculture cannot be overstated. We firmly believe that it is essential that medical students be aware of the root causes of chronic disease, and further, see food as a universal determinant of overall wellness or illness. Having the ability to select, prepare, and consume nutrient dense food is one of the best tools to promote health.

There is precedent and success in expanding medical student nutrition education to include culinary medicine principles, and the evidence is compelling. For example, a study conducted in the Netherlands demonstrated that a targeted educational program could significantly enhance medical students' understanding of nutrition and their willingness to engage in nutritional counseling. This suggests that such interventions have the potential to not only improve the knowledge base of future physicians but also have the potential to influence their practice patterns over their future careers and, by extension, positively affect patient outcomes [14]. In a similar vein, a Portuguese study found that a voluntary curricular intervention had multiple beneficial effects on student participants, including improving attitudes towards addressing nutrition in a clinical setting, positively influencing personal eating behaviors, and enhancing perceived competencies in providing dietary counseling to patients. This multi-dimensional impact underscores the importance of a holistic approach to nutrition education in medical training, prioritizing changing student/self-behaviors in order to model and provide hands-on experiential learning that bolster discussions about dietary interventions when these students then speak to their patients [15].[2]Another study focusing on pre-clerkship medical students in the United States affirmed that the introduction of clinical nutrition

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workshops into the curriculum was effective in boosting students' self-assessed knowledge levels, which led to increased student confidence and comfort levels in advising patients on nutritional matters [16]. [3] Collectively, these studies serve as strong precedents affirming that educational interventions aimed at enhancing nutrition knowledge can be successfully incorporated into medical education. They also suggest that such interventions can have a lasting impact, equipping future physicians with the skills and confidence they need to incorporate nutrition-based approaches into their patient care strategies. All of these results suggest that incorporating nutrition into medical education could really be as simple as adding a course to the preclinical curriculum and exposing students to the studies that reveal the importance of nutrition in preventing disease and enhancing the efficacy of conventional, western treatment methods for diseases across the spectrum.

In line with these precedents, but through the lens of a place-based, curriculum-specific approach, we propose the following to teach practical nutrition education to medical students at Case Western Reserve University School of Medicine (CWRU SOM), within its current, unique curricular structure that emphasizes multisystem, interactive, hands-on learning experiences throughout the preclinical years. Our approach is two-fold: the first portion incorporates a longitudinal, interdisciplinary approach to nutrition education by embedding nutrition topics in each subject taught in the preclinical medical education by including Official Learning Objectives about culinary medicine interventions for disease, farming practices and their influence on local and regional food supply and quality, and place-based sociocultural factors affecting food access for our patient population in Cleveland, Ohio. Hands-on experiences in a Teaching Kitchen will complement these learning objectives. The second part of our proposal provides an optional, focused elective for students interested in pursuing a deeper understanding of these topics.

2. Materials and Methods

At CWRU SOM, significant portions of the preclinical curriculum have interactive educational experiences through facilitated, case-based learning in small groups termed Case Inquiry Groups (IQ) [17]. Each week on Monday, groups of eight students and one faculty facilitator are introduced to up to two cases that include medical topics split into blocks which have a theme based upon biological systems and their related organs [17]. Students develop their own learning objectives based on the content of each case and return on Wednesdays and Fridays for discussion and group teaching of the key concepts they learned from their research of the student-generated learning objectives. [17] In preparation for the Wednesday and Friday sessions, examples of student's research include diagnosis, treatment, and management of the diseases described in each case, biological pathways associated with the disease pathophysiology, mechanisms of action of drugs used in treatment, and societal and cultural factors that may intersect between the patient and their disease. Unique to this structure, each student is responsible for doing research for all of the generated learning objectives, unlike other more traditional Problem-Based Learning formats that have students divide the objectives amongst each other to answer separately and teach back to each other to learn how to work in collaboration with peers [17]. This approach mirrors the reality that the onus is on physicians to continuously educate themselves on current scientific literature for the entirety of their careers.

This responsibility enables the curriculum to be enriched by current research and emerging understandings of medicine in the student-led discussions that take place later in the week in each IQ group. Examples of emerging understandings that have been brought into group discussion include mind-body medicine with consideration of trauma-informed care, and the importance of social determinants of health like water sources, access to healthy and fresh foods, and the impact of the built environment on fitness and mental health.

We believe that this structure of the curriculum functions as an ideal, flexible setting to adapt our medical education to the emerging understanding of the critical importance of farming, nutrition, and food in individual and community health. Although there is some focus on nutrition, these concepts are only briefly discussed in a biochemical context, with a focus on gastrointestinal pathologies and the consequences of surgical intervention or inflammation on the absorption of nutrients. Though these teachings are critical, there remains a need for the teaching of practical

nutrition knowledge, which would help future physicians provide more comprehensive, effective preventive care to their patients. The current curriculum has minimal instruction to show students how to support and counsel patients on nutritional interventions that simultaneously consider social and cultural contexts while also helping to prevent, or even reverse, chronic disease. There is ample research showing that this is possible and effective, as seen in the case of T2D, hypertension, chronic autoimmune disease, and others [18], [19]. Additionally, we believe that even the inclusion of more nutritional concepts during solely one block is insufficient, as we know nutrition to be important for the prevention and management of diseases that are discussed across the entirety of the curriculum. Our nutrition education should, therefore, be incorporated longitudinally with the pharmaceutical curriculum, which CWRU SOM curricular department suggested and is open to including.

To this end, we aspire to incorporate learning objectives (LOs) throughout the curriculum that include nutritional interventions to treat disease while understanding their mechanism of action, as is done for pharmacology. We also strive to incorporate learning objectives about environmental factors that affect disease processes, to expose students to the impact that these factors have on the presentation, treatment, and prognosis of diseases in each presented case. An example of how we may begin to accomplish this is to choose one or two IQ cases from each block to incorporate a new learning objective focused on food and farming. After confirming that the case and disease process has evidence-based, applicable nutrition recommendations regarding disease prevention and management, we will tailor the case to incorporate these learning objectives and provide resources in the recommended resource portion of the cases for students to use to research and discuss this concept. We see an opportunity to add learning objectives to cases that ask students to examine how the content and context of someone's diet (e.g., highly processed foods vs. whole-foods and meals mostly prepared at home, etc.) affects the development of disease, as well as the underlying biochemistry of how food improves disease states. We believe there are many opportunities to introduce students to concepts regarding food, cooking, and farming as it relates to medical disease and patient care. Even seemingly fewer practical topics such as the history of agriculture in the United States, or the quality of soil health, are relevant to the education of medical students, as these topics support their patient education and counseling sessions in the future when teaching patients about the importance of sourcing quality food ingredients for their home-cooked meals.

Some examples of changes we see possible are as follows: Block 1 [17] focuses on Population Health, Epidemiology, Biostatistics, Bioethics, and Health Disparities. These introductory cases include typical patients with common chronic diseases (hypertension, dyslipidemia, obesity, insulin resistance, etc.) living in urban settings. Any of these cases would be ideal for incorporation of LO's regarding food inequities in Northeast Ohio. Examples urban farming initiatives and the relationship between soil quality and nutrient content of food [20]. Additionally, we would want to set the stage for future focused nutrition objectives regarding dietary guidelines, through asking students to research the origins of current federal dietary recommendations, and how these guidelines were and are influenced by policy. Discussion of these topics in small group settings enables students to practice the counseling skills they will need in future clinical encounters and offers dedicated time to consider the place- and specific obstacles their patients may face when trying to follow nutrition prescription recommendations. Block 4 [17] focuses on Cardiovascular, Pulmonary, Renal, Cell Physiology, and Pharmacology subjects. Within the IQ case about myocardial infarction, we see an opportunity to consider nutrition recommendations for primary and secondary prevention, including exploration of the mechanisms of action and pathways by which lifestyle interventions reduce the risk of, or decrease the burden of atherosclerosis on heart disease [21]. Comparison of efficacy of these interventions with and without pharmacological treatment would enable students to speak confidently and knowledgeably to their medicine teams in the third year, and when counseling patients. A final example is within Block 6 [17] titled which highlights Neurology and Psychiatry. Opportunities within this block are analogous to what was described in Block 4, examining the preventative role of dietary interventions to reduce inflammation that is increasingly being studied as a precipitating factor for the development of neurodegenerative disease [22]. The gut-brain axis, and the influence of the gut microbiome in the function of the brain and body which

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is an exciting emerging field of study that current medical students should be exposed to. This is especially true since there are few extremely effective pharmacological treatments for severe Alzheimer's, progressive MS, mental illness, and neurodegenerative disease[23],[24],[25],[26],[27].

The second part of our intervention is for students who have already identified an interest in food and farming as medicine (which encompasses culinary medicine). It is also appropriate for future students who may experience culinary medicine and nutrition principles in the longitudinal curriculum and recognize that they would like to learn more. The authors of this manuscript have developed a zero-credit, elective course, consisting of thirty hours of content delivered over eight weeks. The course highlights practical nutrition information, speakers, farmers, and chefs along with hands-on experiences including sessions teaching and practicing culinary skills. Its overarching goal is to "enable medical students to provide their patients with quick and effective information that can be easily shared in patient encounters and implemented into daily living."

The elective aims to provide a standardized lecture component, which will evolve over the first few offerings as we make connections with speakers and record lecture content. This content will serve to convey a baseline of understanding around the impact of soil and food quality on health as well as demonstrate the use of these concepts clinically by physicians who have had success in treating patients with these tenets. The approach to this didactic portion is multidisciplinary, as we plan to bring physicians, dietitians/nutritionists, pharmacists, farmers, chefs, and more together involved in the same conversation around health. Students will hear from our expert speakers, have discussions, and complete reflections. These reflections will serve as the assessment component in addition to the final "project" of creating a one-day meal plan targeted at a pathology of choice. Culinary demonstrations will be weaved into the lecture series as well. Though we will be unable to access the new Teaching Kitchen facility at Case, we hope to partner with it in the future to have more hands-on culinary experiences for the elective.

The remainder of the elective curriculum will be experiential. For the first cohort, this will include local foraging, urban farming, and physically traveling across Cleveland to gain a tangible appreciation for current food inequities. We intend for this experiential component to grow into partnerships with local community members and organizations invested in food security to provide high quality nutrition to Northeast Ohio communities. Not only will we be providing education about how food and farming are critical to health, but we will be bringing awareness to the security and sustainability of local food systems. Creating mutual benefit through these partnerships is key, as we wish to learn from the people in the field doing work around food sovereignty and quality while investing in them as well through student time and energy, as well as any institutional connections we can facilitate. The experiential component is significant because of this student investment piece, which differentiates our proposed approach from other MedEd efforts to include culinary medicine and nutrition education. We believe that experience creates a deeper understanding of the challenges and consequences of food sovereignty and the destruction of foodways and nutrition in communities. The awareness of these issues is not enough - seeing firsthand the impact this has on patients we will care for in the hospital during our third and fourth years sets the stage for future physicians mindful of the power of community, state, and federal advocacy and engagement to change these systems.

In summary, our zero-credit elective will cover a wide range of educational topics through lecture and experiential learning. Content topics include, but are not limited to: treatment and prevention of diet-related chronic and metabolic disease; obtaining a nutrition-focused history of present illness with cultural awareness and humility regarding food choices and cooking methods; making appropriate dietary recommendations based on a patient's unique social circumstances and identity; how to cook, shop, and eat on a budget (including the use of the supplemental nutrition assistance program (SNAP, or food stamps)); an introduction to the concept of food pharmacies; lectures about agricultural history, soil health and its relationship to human health; hands-on culinary medicine experiences; and experiential sessions with local urban farmers. The elective will begin in the fall of 2023 with a possible second offering in the spring of 2024. At present, we have over 50 students interested in the elective and have chosen twenty-five students to be part of the elective, all

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of whom will be encouraged to participate in the co-occurring qualitative and quantitative research study that seeks to understand medical student perspectives on food and farming as medicine before and after participating in the elective. Data from this survey will be utilized to support our goals of administrative curricular faculty to support alterations to the overall medical school curriculum - part one of our proposed approach. Thus, each of the aims of our proposed curricular interventions support the other.

4. Discussion

Education around food, soil, and cooking is severely lacking in medical education. To "do no harm," physicians must have an awareness of these critical factors in determining a patient's health status. Expanding the educational focus and awareness of medical students to include agricultural practices, food availability (and food deserts), and other individual and structural factors that affect the diets of patients will help work towards a future in which physicians approach patient care with an appreciation for evidence-based lifestyle interventions. This awareness may also allow physicians to expand their treatments and prevention methods to include diet and nutrition, and work towards healing the root cause of the patient's disease. It is important that physicians understand the upstream factors that impact our food system and food culture to be able to effectively treat modern illnesses, mostly chronic. Our proposal highlights two approaches to alter our medical school curriculum: longitudinal curricular incorporation of nutrition and farming content, and a short-term, focused optional elective. This tiered approach seeks to reach and benefit as many students as possible while bringing new paradigms and partnerships to MedEd.

There are many challenges that come with making changes to medical curriculum. Economic, political, social, and logistical barriers pose obstacles that may impede timely implementation of these proposed changes. For a medical school curriculum to make such significant strides in this realm will require the willingness of administration and faculty to push beyond the status quo and actively choose to adopt these changes, therefore becoming a pioneer, which Case SOM is willing to be. It is always difficult to challenge the status quo with medical, symptom-based treatments, but the long-term outcomes of equipping future physicians with tools to administer the highest-quality, well rounded approach to care possible should substantially outweigh this difficulty.

One critique often leveled against integrating this type of training is that physicians do not have time nor energy in the current patient scheduling structure to address sweeping lifestyle changes, which is largely true in many current medical care settings. However, the healthcare landscape is undergoing a transformative shift, moving away from a traditional, reactive, fee-for-service model to one that emphasizes preventive care and value-based outcomes. Historically, the healthcare system has been structured around treating illnesses and conditions after they manifest, leading to prolonged treatments and higher costs. However, with the rising burden of chronic diseases and the associated economic implications, there's a growing recognition of the importance of preventive measures. Preventive care focuses on early detection, risk assessment, and interventions to prevent or mitigate the onset of diseases. Parallel to this, value-based care models are gaining traction, in which providers are compensated based on patient outcomes rather than the volume of services rendered. This model incentivizes healthcare professionals to prioritize long-term health and well-being over episodic treatments. The proposed changes in medical education, emphasizing nutrition, culinary medicine, and agricultural knowledge, align perfectly with these broader shifts. By equipping future physicians with a holistic understanding of nutrition and its role in health, we are not only promoting preventive care but also ensuring that healthcare delivery is more value-driven, focusing on genuine health outcomes rather than mere symptomatic relief. This alignment underscores the timeliness and relevance of integrating comprehensive nutrition education into the medical curriculum, preparing future doctors for a healthcare environment that prizes prevention, holistic well-being, and tangible health outcomes. With this emergence of various incentive structures such as Value Based Care, preventive Care, and DPC gaining popularity, we believe imparting medical students with an awareness of these important health determinants will create a more mindful generation of physicians able to implement parts of this curriculum into practice, regardless of their chosen

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specialty and with a greater appreciation of the need for collaboration across professions to provide whole person care.

Awareness is the first step to critical thought and change, and that is the major goal of our proposed changes. We strongly believe the seeds of this awareness must be planted during formative medical education to create physicians who are thinking about *all* the components involved in being well rounded physicians. Physicians who understand the environmental impacts on health from farm to plate and physicians who are examples of healthful lifestyles themselves will be the most effective in treating the chronic disease epidemic that currently plagues the United States and its healthcare infrastructure.

5. Conclusions

Moving forward, we hope to continue to make headway in the integration of culinary and nutritional education at Case and beyond. There are many amazing organizations doing this work in Cleveland and Northeast Ohio, and as stated we hope to create mutually beneficial relationships that empower students to take better care of communities and give back to the places they reside in for their schooling. We hope these partnerships become broader with time: Forming partnerships with other programs, schools, and institutions offers a multi-faceted approach to enriching medical education in the realm of nutrition and lifestyle medicine. Collaborative efforts can provide a platform for sharing best practices, research findings, and educational resources, thereby elevating the quality and impact of the curriculum. For example, a partnership with a school of public health could bring in expertise on community nutrition and food policy, while collaboration with culinary schools could offer hands-on training in preparing nutritious meals. Agricultural colleges could provide invaluable insights into sustainable farming practices and their impact on food quality. These partnerships could also facilitate interdisciplinary research projects, enabling a more comprehensive understanding of how nutrition intersects with various medical conditions and social determinants of health. Furthermore, collaborations could extend to international institutions, offering a global perspective on nutrition and healthcare. Such partnerships not only enrich the educational experience for medical students but also foster a more holistic, patient-centered approach to healthcare that is grounded in evidence-based practice and interdisciplinary collaboration.

Expanding traditional medical education to include culinary medicine and basic agricultural knowledge equips physicians with practical skills and knowledge to effectively communicate as part of the healthcare team with patients about the importance of nutrition and lifestyle. We propose a culturally humble approach that enables physicians to provide patients with practical information including cultural humility and culturally appropriate dietary recommendations, so that patients feel valued, seen, and heard by their physician while improving their overall health through fostering positive changes in daily living. By doing so, this integrated approach promotes health, prevents disease, and advances sustainable and resilient communities which are the bedrock of healthy individuals.

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