




# Virtual teaching kitchen classes and cardiovascular disease prevention counselling among medical trainees

Alexander C Razavi <sup>1</sup>, Anna Latoff,<sup>2</sup> Amber Dyer,<sup>2</sup> Jaclyn Lewis Albin <sup>3</sup>, Kristi Artz,<sup>4</sup> Alexandra Babcock,<sup>5</sup> Francesca Cimino,<sup>6</sup> Farzaneh Daghigh,<sup>7</sup> Beth Dollinger,<sup>8</sup> Maya Fiellin,<sup>9</sup> Emily A Johnston <sup>10</sup>, Grace Marie Jones,<sup>11</sup> Robert D Karch,<sup>12</sup> Emily T Keller,<sup>13</sup> Heather Nace,<sup>2</sup> Nimisha K Parekh,<sup>14</sup> Stephanie Nelson Petrosky,<sup>15</sup> Amy Robinson,<sup>16</sup> Jessica Rosen,<sup>17</sup> Eva M Sheridan,<sup>18</sup> Susan W Warner,<sup>19</sup> Jada L Willis,<sup>20</sup> Timothy S Harlan<sup>9</sup>

**To cite:** Razavi AC, Latoff A, Dyer A, *et al*. Virtual teaching kitchen classes and cardiovascular disease prevention counselling among medical trainees. *BMJ Nutrition, Prevention & Health* 2023;6:e000477. doi:10.1136/bmjnph-2022-000477

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/bmjnph-2022-000477>).

For numbered affiliations see end of article.

## Correspondence to

Dr Timothy S Harlan;  
drdrmrmd@mac.com

Received 18 April 2022  
Accepted 15 December 2022  
Published Online First  
2 February 2023



© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

## ABSTRACT

**Background** Hands-on culinary medicine education for medical trainees has emerged as a promising tool for cardiovascular health promotion.

**Purpose** To determine whether virtual culinary medicine programming associates with Mediterranean diet (MedDiet) adherence and lifestyle medicine competencies among medical trainees across the USA.

**Method** A total of 1433 medical trainees across 19 sites over a 12-month period were included. The Cooking for Health Optimisation with Patients-Medical Trainees survey composed of 61 questions regarding demographics, nutritional attitudes, dietary habits including MedDiet score and lifestyle medicine counselling competencies. Multivariable logistic regression assessed the association of virtual culinary medicine education with MedDiet intake and nutritional attitudes.

**Results** There were 519 medical trainees who participated in virtual culinary medicine education and 914 medical trainees who participated in their standard nutrition curricula. More than one-half of participants were women (n=759) and the mean age was 27 years old. Compared with students enrolled in traditional nutrition curricula, participants in virtual culinary medicine education were 37% more likely to adhere to MedDiet guidelines for fruit intake (OR 1.37, 95% CI 1.03 to 1.83, p=0.03). Virtual culinary medicine education was associated with higher proficiency in lifestyle medicine counselling categories, notably recommendations involving fibre (OR 4.03; 95% CI 3.05 to 5.34), type 2 diabetes prevention (OR 4.69; 95% CI 3.51 to 6.27) and omega fatty acids (OR 5.21; 95% CI 3.87 to 7.02). Virtual culinary medicine education had a similar, although higher magnitude association with MedDiet counselling competency (OR 5.73, 95% CI 4.26 to 7.70) when compared with historical data previously reported using hands-on, in-person culinary medicine courseware (OR 4.97, 95% CI 3.89 to 6.36).

**Conclusions** Compared with traditional nutritional educational curricula, virtual culinary medicine education is associated with higher MedDiet adherence and lifestyle medicine counselling competencies among medical trainees. Both virtual and hands-on culinary medicine

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ In-person culinary medicine education associates with higher Mediterranean diet adherence.

## WHAT THIS STUDY ADDS

⇒ Virtual kitchen-based nutrition is associated with a greater knowledge of diet-related cardiovascular disease prevention.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Integration of nutrition didactics with hands-on cooking modules, in-person and virtual, can help promote cardiovascular health for medical trainees and their future patients.

education may be useful for cardiovascular health promotion.

## INTRODUCTION

Adherence to poor dietary patterns contributes to approximately one in five deaths globally,<sup>1</sup> and insufficient diet quality has been identified as the primary contributor to death and disability in the USA.<sup>1</sup> There is a well-established association between diet and atherosclerotic cardiovascular disease (ASCVD) and associated metabolic disorders, including type 2 diabetes and metabolic syndrome.<sup>2-5</sup> In particular, food preferences, nutritional competencies and eating behaviours are key contributing factors to the suboptimal control of ASCVD and related upstream risk factors, including hypercholesterolaemia, hypertension and type 2 diabetes.<sup>6,7</sup> Given that ASCVD remains the leading cause of morbidity and mortality worldwide and affects nearly half of all US adults,<sup>8</sup> the implementation of novel primary

prevention strategies is necessary to help reduce disease burden and improve quality of life.

Nutrition is a central component of ASCVD guidelines involving risk reduction; however, approximately 9 in 10 cardiovascular specialists report receiving none to minimal nutritional education during fellowship training.<sup>9</sup> While there are several approaches to help address such gaps in training, culinary medicine has emerged as among the most promising. Culinary medicine is a discipline and training modality within clinical and public health education that provides medical trainees (eg, medical students, nursing students, dietetic interns), healthcare professionals and community members with experiential, food-based nutrition knowledge and the culinary skills needed for implementation.<sup>10 11</sup> While several previous studies have demonstrated that culinary medicine interventions centred on Mediterranean diet (MedDiet) principles lead to higher fruit and vegetable consumption among community members and also associate with improved dietary-counselling competencies among medical students, residents, physicians and nurses,<sup>12-15</sup> it is unknown as to whether these same benefits are obtained when culinary medicine education is delivered in the virtual setting. In particular, we have previously found that medical trainees participating in hands-on culinary medicine education were 82% more likely to adhere to a MedDiet pattern compared with those participating in traditional nutrition curricula,<sup>13</sup> though whether this benefit also applies to culinary medicine delivered online and remotely for medical trainees cooking in their homes is unclear.

The arrival of the SARS-CoV-2 pandemic in late 2019–2021, with its social distancing mandates and indefinite timeline, forced medical education to look for innovative approaches to train students and to reach communities.<sup>16 17</sup> During the height of the pandemic, face-to-face education was suspended and many academic/medical institutions shifted towards multimedia education and remote learning. Recently, multimedia education, by means of the combined use of picture, video and text to impart knowledge to learners, has shown preliminary success as a means of delivering nutrition education.<sup>18 19</sup> These studies have suggested that virtual medical education may still be effective for teaching knowledge-based skills and improving medical competencies. However, little evidence exists regarding the impact of virtual culinary medicine education on trainees and whether this platform can lead to similarly improved nutrition knowledge when compared with in-person teaching kitchen classes. Therefore, the novelty of the current study compared with our previously published results in 2019 is whether virtually delivered culinary medicine courseware may also be observed to have a positive association with MedDiet adherence and nutritional attitudes that are associated with optimal cardiovascular health.

The purposes of this study were to examine: (1) the association between virtual culinary medicine programming with MedDiet adherence and lifestyle competencies

when compared with traditional nutritional curricula and (2) a comparison of the utility/efficacy of virtual culinary medicine classes with pre-pandemic, in-person experiential education for improving MedDiet adherence and lifestyle medicine competencies centred on ASCVD prevention. We report on the question of whether virtual culinary medicine programming may impart the same beneficial effects, or if a hybrid model which combines both in-person and virtual curricula may be most optimal for primary prevention ASCVD counselling.

## METHODS

### Curriculum

The Health meets Food curriculum was originally designed as an elective 32-hour nutrition-based and culinary-based in-person course via a sequence of eight, 4-hour modules (one 4-hour module taught one time per week for 8 weeks).<sup>13</sup> Educators (eg, physicians, dietitians, chefs) instruct medical students on evidence-based principles of the MedDiet, employing validated patient nutrition counselling, case-based learning and experiential cooking. The curriculum implements the MedDiet principles with an Americanised adaptation to the recipes to make the meals and counselling points more palatable for course participants, their patients and community members. The eight core module topics are as follows: (1) introduction to culinary medicine; (2) weight management, portion control and breakfast; (3) dietary fats; (4) food allergy and intolerance; (5) dietary protein and vegetarian diets; (6) renal function, dietary sodium, hypertension and flavour building; (7) dietary carbohydrates, snacks and desserts and (8) dietary patient interventions.<sup>13</sup> Modules include a virtual 60 min competency-based didactic programme introducing students to the main principles of the MedDiet. Participants in the course take part in an in-kitchen component involving 90 min of team-based case studies and nutrition discussion along with 90 min of hands-on cooking. Modules conclude with students engaging in discussion of clinical case studies while sharing the dishes they have prepared. While programming varies based on institution of enrollment, most host sites offer the programming as an elective module, while some have the curricula built into their course requirements. Participation in culinary medicine modules at all but two sites (Tulane University in New Orleans, Los Angeles and Touro University in Vallejo, California, USA) was offered in a voluntary manner to medical trainees.

### Virtual curriculum

To adapt to the need of virtual programming for an indefinite time during the SARS-CoV-2 pandemic, the original curricula was modified. Instead of the in-person sections of class, participants worked on teams for case studies and cooked along in their home kitchens via conferencing platforms (eg, Zoom, WebEx). The original menus, consisting of four separate recipe groups, were modified

for servings to be more applicable to home-sized batches, restricted kitchen equipment (eg, removal of blenders, need for more than two stovetop burners, consideration for equipment typical for trainees' kitchens and the time needed for one individual to cook alone) and offered participants the opportunity to choose the most suitable recipe(s) for taste preferences, dietary restrictions, shopping and equipment needs during the enrolments of the course. Each partner site made varied accommodations for the acquisition of recipe needs, with some sites additionally providing ingredient bags containing the needs for the class that were picked up by students before each class session.

During virtual synchronous sessions, preliminary questions, overarching themes and knife skills demonstrations were hosted as a whole group. Then the participants were broken up by recipe groups to work on case studies as a team, followed by guided cooking by an instructor cooking along in their own home or teaching kitchen. When recipes were completed, all participants and instructors rejoined as a whole group to share dishes and preparation steps, a discussion of the recipes and role of nutrition related to the topic of the module, and review of case study questions.

### Traditional nutrition education

Nutrition education in traditional medical education curricula was assumed to be non-homogeneous in the control group as there is no standard of evidence-based nutrition education within the current curriculum, and the minimum 25 hours in nutrition education recommended by the National Academy of Sciences is not satisfied in the majority of trainee programs.<sup>20</sup> A random sample of trainees not participating in culinary medicine curriculum (n=914) was also surveyed. These participants were recruited from the student body via the same communication methods and represented all participating institutions (n=19) in the current analysis.

### Study design

Cooking for Health Optimisation with Patients-Medical Trainees (CHOP-MT) is the CHOP substudy assessing medical trainees.<sup>13 15</sup> This study used a cross-sectional design, which involved completing one electronic survey requiring approximately 10 min to complete. From July 2012 to June 2021, the CHOP-MT survey has been completed across over 50 partner-sites throughout the USA, including medical schools and residency programmes. During the 2020–2021 academic year, 19 sites offered culinary medicine curriculum virtually (online supplemental table 1).

### Study population

The current sample included 519 medical trainees who participated in virtual culinary medicine courses (exposure) and 914 medical trainees participating in their standard nutrition curricula (control) at the 19 institutions participating in culinary medicine programming.

For trainees participating in culinary medicine curricula during the study duration, this electronic survey was offered on completion via email solicitation. Additionally, in order to compare virtual classes (n=519) with in-person programming, we included historical data from 4125 medical trainees who completed the in-person programming and CHOP-MT survey prior to the pandemic.

### Data collection

The survey was distributed via email and Web links to student bodies at partner sites offering culinary medicine courses to both students enrolled in culinary medicine programming as well as students not enrolled in virtual or hybrid culinary medicine classes during the course of the study.

The CHOP-MT survey was composed of a total of 61 questions regarding nutritional attitudes, dietary habits (MedDiet score), self-perceived lifestyle medicine counselling competencies and demographics. The MedDiet score has been previously validated by Trichopoulou *et al.*<sup>21</sup>

The CHOP-MT survey also contains three questions assessing attitudes about nutrition. The prompt for these questions was, 'In general, I believe that...'. The range of possible mean scores was from one to five (1=strongly disagree; 2=disagree; 3=neither agree nor disagree; 4=agree and 5=strongly agree), with higher scores indicating more positive attitudes. There were 13 questions on dietary habits. The prompt for dietary habits was, 'On average over the last 6 months, how often did you consume...'. Next, participants answered 27 questions associated with lifestyle medicine counselling competencies. There were 13 questions that were prompted by, 'For me educating patients independently of support from other medical professionals on the following topics, I feel...'. Additionally, there were 12 questions that were prompted by, 'For me educating patients on the following topics independently of support from other medical professionals, I feel...'. The last two questions in this section were prompted by, 'In the majority of my patient visits, I...'. Finally, participants answered 18 demographic questions, including the institution they attend and training track, timing, frequency and type of their curricula exposures, age, sex, race, special dietary practices (eg, gluten-free, vegetarian, weight watchers and/or kosher) and prior nutrition education (undergraduate or graduate coursework), intended specialty, satisfaction with their quality and quantity of nutrition education, influences in participation in the culinary medicine curricula, and the frequency with which they participate in patient nutrition counselling.<sup>13</sup>

### MedDiet score

MedDiet intake was assessed through a standard, validated nine-point questionnaire developed by Trichopoulou *et al.*<sup>21</sup> and used in previous publications by CHOP-MT investigators.<sup>11 15</sup> A composite score was derived by totaling the respective component scores for each participant, with a

higher score corresponding to a higher intake of MedDiet components (online supplemental table 2).

### Nutritional attitudes, lifestyle medicine counselling competencies and dietary habits

Self-reported lifestyle medicine competencies were evaluated by a 25-item survey also used in previous culinary medicine analyses by CHOP-MT investigators.<sup>11 15</sup> Surveys are reported in online supplemental tables 3 and 4. This provides evidence for areas of interest to track for medical trainee behaviours for both the study samples.

### Statistical analysis

Continuous variables were presented as means and SD, while percentages were used for categorical variables. The Student's t-test and Wilcoxon signed-rank test were used to assess differences in normally and non-normally distributed continuous variables, respectively. Differences between categorical variables were evaluated through Pearson's  $\chi^2$  test. Nutritional attitudes, lifestyle medicine counselling competencies and dietary habits were dichotomised in statistical analyses previously reported by CHOP-MT investigators<sup>11 15</sup> as follows: nutritional attitudes: strong agreement versus not; lifestyle medicine counselling competencies: complete proficiency vs not; dietary habits: satisfying average intake requirement versus not. Strong agreement and complete proficiency for nutritional attitudes and lifestyle medicine counselling competencies, respectively, were defined through selection of 'mostly confident to totally confident' on the three-point Likert-based surveys.

The three-point Likert scale was used to generate individual response values, with satisfying average intake of vegetables, fruits, whole grains, saturated and monounsaturated fats, legumes cheese or fermented dairy, seafood, alcohol, red and processed meat, baked products and calorie-containing beverages other than alcohol.

Multivariable logistic regression was used to calculate ORs for the association of virtual culinary medicine education with MedDiet intake and nutritional attitudes. Consistent with previous studies,<sup>13 14</sup> covariables adjusted for included gender, ethnicity, special diet, prior nutrition training and intended specialty.

Statistical analyses were performed by using SAS V.9.3 (SAS Institute). All hypothesis tests were two sided and used an alpha threshold of <0.05 for the detection of clinical significance.

## RESULTS

A total of 1433 medical trainees completed the CHOP-MT survey in its entirety. More than half of respondents were women (n=759; ~53%), and individuals were on average 27 years of age ( $\pm$  5.4). Nearly one-third of the study sample participated in the culinary medicine curriculum (table 1).

Virtual culinary medicine education had a significant positive association with all MedDiet categories except

**Table 1** Characteristics of 1433 students attending medical schools offering virtual culinary medicine courseware

	No virtual class participation (n=914)	Virtual class participation (n=519)	P value
Age, mean, years	26.2 $\pm$ 4.4	27.2 $\pm$ 5.4	<0.001
Female, %	58.5	56.7	0.69
Ethnicity, %			0.68
White	53.3	55.5	
Black	3.6	4.1	
Asian	30.1	26.4	
Hispanic	6.5	7.1	
Other	6.5	6.9	
Special dietary practices*	28.1	28.1	0.99
Prior nutrition education†	17.4	15.6	0.38

\*Special dietary practices defined, by not limited to, gluten free, vegetarian, Weight Watchers and/or kosher.  
†Prior nutrition education defined as formal nutrition training in undergraduate or graduate coursework.

alcohol (table 2). Compared with nutrition education in traditional medical education curricula, medical trainees participating in virtual education were 37% more likely to adhere to MedDiet guidelines involving fruit (p=0.03), but 26% less likely to adhere to MedDiet guidelines involving fermented dairy (p=0.02). There was no difference between virtual teaching kitchen education and traditional nutritional curricula for satisfying nutritional requirements for several dietary habits, including saturated fats, whole grains or red meat.

Table 3 presents the relationship between the CHOP-MT curriculum and 27 lifestyle medicine counselling competency questions. Trainees were approximately five times as likely to master total competency of MedDiet principles compared with students who did not participate in culinary medicine education (p<0.001). As with previous reports by CHOP-MT investigators,<sup>11 15</sup> the virtual hands-on culinary medicine education students were more likely to achieve proficiency in 23 additional lifestyle medicine counselling categories, such as recommendations involving fibre (OR 3.83; 95% CI 3.05 to 5.34), dietary patterns to prevent and treat type 2 diabetes (OR 3.76; 95% CI 3.51 to 6.27), role of dietary omega-3 and omega-6 fatty acids in cardiovascular disease (OR 4.22; 95% CI 3.87 to 7.02), as well as vegetarian diet (OR 3.39, 95% CI 2.55 to 4.52) and DASH (Dietary Approaches to Stop Hypertension) diet principles (OR 7.02; 95% CI 6.42 to 11.95).

With respect to sites offering virtual-only programming during the 2020–2021 academic year, there was superiority

**Table 2** Cross-sectional relationship between virtual culinary medicine and dietary habits

	OR (95% CI)*†	P value
Satisfying nutritional requirement for vegetables	1.02 (0.70 to 1.50)	0.91
Satisfying nutritional requirement for legumes	1.20 (0.96 to 1.51)	0.11
Satisfying nutritional requirement for fruits	1.37 (1.03 to 1.83)	0.03
Satisfying nutritional requirement for nuts or nut butters	0.95 (0.76 to 1.20)	0.68
Satisfying nutritional requirement for cheese for fermented dairy	0.74 (0.58 to 0.94)	0.02
Satisfying nutritional requirement for red and processed meat	0.89 (0.70 to 1.14)	0.37
Satisfying nutritional requirement for non-fried fish or seafood	1.18 (0.91 to 1.52)	0.22
Satisfying nutritional requirement for whole grains	0.97 (0.77 to 1.23)	0.82
Satisfying nutritional requirement for monounsaturated fats	0.97 (0.76 to 1.22)	0.77
Satisfying nutritional requirement for alcohol	2.19 (0.66 to 7.33)	0.20
Satisfying nutritional requirement for baked products	1.47 (0.95 to 2.28)	0.08
Satisfying nutritional requirement for calorie-containing beverages	1.01 (0.79 to 1.29)	0.93
Satisfying nutritional requirement for saturated fats	0.98 (0.72 to 1.34)	0.91

\*Comparing those who received virtual teaching kitchen classes versus those who were not enrolled in virtual teaching classes and received traditional nutrition education (reference).  
 †Adjusted for gender, ethnicity, special diet, prior nutrition training, intended specialty.

across 24 of 25 lifestyle medicine counselling categories with improved ORs when compared with prepandemic results,<sup>11</sup> including recommendations involving MedDiet principles (1.15-fold improvement), DASH diet (1.25-fold improvement), role of dietary omega-3 fatty acid and omega-6 fatty acids in cardiovascular disease, (1.23-fold improvement) and dietary patterns to prevent and treat type two diabetes (1.25-fold improvement).

## DISCUSSION

Overall, our results revealed that trainees exposed to virtual hands-on cooking nutrition education course were more likely to demonstrate competency across 25 lifestyle medicine counselling categories compared with in-person classes as documented in prepandemic research.<sup>11</sup> Health professions students completing culinary medicine programming were 37% more likely to satisfy MedDiet intake recommendations for fruits compared with those not participating. In contrast, students completing in-person hands-on cooking classes were 82% more likely to satisfy intake of fruits, vegetables and legumes compared with medical trainees taking part in traditional medical education curricula. These results, in combination with significant positive associations of the programming with 25 competencies in lifestyle medicine counselling, suggest that virtual teaching of kitchen-based nutrition and culinary education are associated with a greater knowledge of diet-related ASCVD prevention among medical trainees. However, significant progress is still required as virtual teaching kitchen education was not significantly associated with several important nutritional competencies related to ASCVD risk reduction, including limiting saturated fat intake, limiting red meat intake and increasing consumption of whole grains.

Historically, medical trainee exposure to online nutrition lectures has shown improved knowledge and case-based management of diet for patients. The virtual, kitchen-based nutrition education in medical training shows similar results as those previously reported using in-person hands-on cooking classes.<sup>13</sup> Programming in the virtual environment appears to enhance that effect, possibly due to the self-efficacy that emerges from participating in one's home kitchen as well as the opportunity to use class time as meal preparation for the week. There are likely lessons in culinary flexibility and improvisation that translate well to future cooking choices for participants. In the setting of a changing educational and healthcare delivery environment, our virtual teaching kitchen education software may serve as a platform and model to help reach communities that have limited access to in-person primary care resources. As previously described, there is an exceedingly large need to improve nutrition education within medical training; however, current models may not be well suited to incorporate given that teaching-kitchen-based education is not a standardised component within preclinical and clinical years. Through our series of studies in the last decade<sup>13-15</sup> and the current results, we have now shown consistent evidence that culinary education, both in-person and delivered virtually in the home environment, associates with higher adherence to health habits that can lower ASCVD risk.

Limitations to discuss in our study are highly similar to those previously described,<sup>13</sup> and include operator bias, limited prospective data, selection bias and an evolving landscape of dietary approaches for ASCVD risk reduction. In particular, the instructors that teach culinary medicine classes both virtually and in-person are all different, therefore, there may be slight incongruencies

**Table 3** Cross-sectional relationship between culinary medicine education and diet competencies

Competency	OR historic (95% CI)*†	P value	OR virtual (95% CI)†	P value
Mediterranean diet	4.97 (3.89 to 6.36)	<0.0001	5.73 (4.26 to 7.70)	<0.001
Dash diet	7.02 (5.42 to 9.10)	<0.0001	8.76 (6.42 to 11.95)	<0.001
Vegetarian diet	2.86 (2.25 to 3.64)	<0.0001	3.39 (2.55 to 4.52)	<0.001
Low fat diet	3.41 (2.66 to 4.36)	<0.0001	4.43 (3.28 to 5.98)	<0.001
High protein/low fat diet	2.87 (2.23 to 3.71)	<0.0001	3.41 (2.51 to 4.64)	<0.001
Serving size	3.94 (3.08 to 5.04)	<0.0001	4.50 (3.36 to 6.03)	<0.001
Moderate alcohol consumption	2.74 (2.17 to 3.46)	<0.0001	3.03 (2.29 to 4.02)	<0.001
Eating disorder recognition	3.00 (2.38 to 3.78)	<0.0001	3.11 (2.36 to 4.09)	<0.001
Role of dietary saturated fat and cholesterol in blood lipids	3.46 (2.73 to 4.38)	<0.0001	3.72 (2.81 to 4.93)	<0.001
Dietary patterns to prevent and treat type II diabetes	3.76 (2.96 to 4.79)	<0.0001	4.69 (3.51 to 6.27)	<0.001
Weight loss strategies for type II diabetes	3.70 (2.92 to 4.70)	<0.0001	4.01 (3.01 to 5.33)	<0.001
Weight loss strategies for overweight or obese patients	3.83 (3.02 to 4.86)	<0.0001	4.86 (3.65 to 6.47)	<0.001
Role of dietary omega-3 and omega-6 fatty acids in cardiovascular disease	4.22 (3.30 to 5.38)	<0.0001	5.21 (3.87 to 7.02)	<0.001
Role of dietary fats in cardiovascular disease	4.29 (3.36 to 5.47)	<0.0001	5.17 (3.86 to 6.93)	<0.001
Identifying antioxidant-rich grocery produce	3.82 (2.99 to 4.87)	<0.0001	4.42 (3.31 to 5.91)	<0.001
Calories per each macronutrient and their basic metabolic roles	2.58 (2.04 to 3.27)	<0.0001	2.59 (1.96 to 3.41)	<0.001
Role of hydration in health and fluid needs based on activity and age	2.60 (2.06 to 3.29)	<0.0001	2.67 (2.02 to 3.53)	<0.001
Dietary strategies for Coeliac disease	3.26 (2.54 to 4.19)	<0.0001	3.05 (2.28 to 4.08)	<0.001
Dietary strategies for patients with food allergies	3.20 (2.52 to 4.08)	<0.0001	3.01 (2.27 to 3.98)	<0.001
The role of glycaemic index and load in dietary management	4.63 (3.59 to 5.97)	<0.0001	5.82 (4.28 to 7.92)	<0.001
Fibre in disease prevention and example ingredients	3.83 (3.02 to 4.86)	<0.0001	4.03 (3.05 to 5.34)	<0.001
Food label competency	2.75 (2.16 to 3.49)	<0.0001	3.09 (2.32 to 4.13)	<0.001
Dietary strategies to prevent and treat osteoporosis	3.41 (2.66 to 4.36)	<0.0001	3.40 (2.55 to 4.54)	<0.001
Calculation of body mass index	3.20 (2.53 to 4.05)	<0.0001	3.55 (2.67 to 4.70)	<0.001
Overall benefits of aerobic exercise on health and well-being	2.18 (1.70 to 2.81)	<0.0001	2.08 (1.54 to 2.82)	<0.001

\*Comparing those who received hands-on teaching kitchen classes versus those who were not enrolled in teaching classes and received traditional nutrition education (reference).

†Adjusted for gender, ethnicity, special diet, prior nutrition training, intended specialty.

in the style that each class is taught. However, standardisation in the teaching curriculum manual has helped to alleviate and lessen this potential bias. Likewise, our cross-sectional design limits our ability to conclude on the maintenance of ideal dietary habits for ASCVD risk reduction that are associated with virtual teaching kitchen programming. In future studies, it is our goal to assess surveys and measurements both prior to and after culinary medicine programming to speak towards

the potential long-term benefits of culinary medicine. Lastly, the elective nature of programming may increase the risk of selection bias as individuals who participate may be more likely to follow healthy dietary patterns compared with those who do not elect to participate. Nonetheless, our previous work has demonstrated benefits of teaching kitchen education among non-healthcare professional community members and children in a randomised controlled design.<sup>15</sup>

Moving forward, studies that assess the key differences among various dietary patterns of interest with respect to cardiometabolic health and lifestyle medicine are paramount. Our ongoing study shows that kitchen-based nutrition education delivered in the virtual environment, when compared with in-person programming as well as culinary medicine programming itself, is associated with a higher likelihood of MedDiet adherence and lifestyle medicine counselling competence in medical trainees enrolled at partner sites across the USA. However, significant progress is still required as virtual teaching kitchen education was not significantly associated with several important nutritional competencies related to ASCVD risk reduction, including limiting saturated fat intake, limiting red meat intake and increasing consumption of whole grains. Furthermore, practical challenges relating to widespread implementation of culinary medicine programmes, such as limited kitchen space at medical schools and the inclusion of additional curricula in an already rigorous schedule, must be addressed.

The authors will continue to advocate for teaching kitchen implementation as required medical training, but the virtual programming can clearly be a component of the delivery of culinary medicine programming. In future, the addition of nutrition-specific topics to board exams may also incentivise nutrition education and standards across medical institutions and hospitals.

Our findings reinforce the need for nutrition education reform in American medical schools and suggest that integrating nutrition didactics with hands-on cooking modules in both the in-person and virtual settings provides an optimised design to improve medical trainees' own diets as well as their clinical dietary counselling skills.

#### Author affiliations

<sup>1</sup>Division of Cardiology, Emory University School of Medicine, Atlanta, Georgia, USA

<sup>2</sup>Tulane University School of Medicine, New Orleans, Louisiana, USA

<sup>3</sup>The University of Texas Southwestern Medical Center, Dallas, Texas, USA

<sup>4</sup>Spectrum Health, Grand Rapids, Michigan, USA

<sup>5</sup>Mercy Health, St Louis, Missouri, USA

<sup>6</sup>Fort Belvoir Community Hospital, Fort Belvoir, Virginia, USA

<sup>7</sup>Philadelphia College of Osteopathic Medicine, Philadelphia, Pennsylvania, USA

<sup>8</sup>Lake Erie College of Osteopathic Medicine, Erie, Pennsylvania, USA

<sup>9</sup>The George Washington University School of Medicine and Health Sciences, Washington, District of Columbia, USA

<sup>10</sup>Nutritional Sciences, Pennsylvania State University, University Park, Pennsylvania, USA

<sup>11</sup>Touro University California College of Osteopathic Medicine, Vallejo, California, USA

<sup>12</sup>University of Central Florida College of Medicine, Orlando, Florida, USA

<sup>13</sup>Maine Medical Center, Portland, Maine, USA

<sup>14</sup>University of California Irvine, Irvine, California, USA

<sup>15</sup>Dr. Kiran C. Patel College of Osteopathic Medicine, Fort Lauderdale, Florida, USA

<sup>16</sup>University of New Mexico School of Medicine, Albuquerque, New Mexico, USA

<sup>17</sup>New York Medical College School of Medicine, Valhalla, New York, USA

<sup>18</sup>Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, Hempstead, New York, USA

<sup>19</sup>The University of Tennessee Health Science Center, Memphis, Tennessee, USA

<sup>20</sup>Texas Christian University, Fort Worth, Texas, USA

**Correction notice** The article has been corrected since it was published online. The co-author Stephanie Petrosky's affiliation has been amended to Dr. Kiran C. Patel College of Osteopathic Medicine, Fort Lauderdale, Florida, USA.

**Twitter** Alexander C Razavi @alexrazavi, Jaclyn Lewis Albin @JaclynAlbin and Francesca Cimino @FMCiminoMD

**Contributors** ACR: inception, data curation, investigation, methodology, validation, writing original draft, critical reviewing and editing final draft; JLA: investigation, critical reviewing and editing final draft; KA: investigation, critical reviewing and editing final draft; AB: investigation, critical reviewing and editing final draft; FC: investigation, critical reviewing and editing final draft; FD: investigation, critical reviewing and editing final draft; BD: investigation, critical reviewing and editing final draft; AD: investigation, critical reviewing and editing final draft; MF: investigation, critical reviewing and editing final draft; EJ: investigation, critical reviewing and editing final draft; GMJ: investigation, critical reviewing and editing final draft; RDK: investigation, critical reviewing and editing final draft; AL: investigation, critical reviewing and editing final draft; HN: investigation, critical reviewing and editing final draft; NKP: investigation, critical reviewing and editing final draft; SNP: investigation, critical reviewing and editing final draft; AR: investigation, critical reviewing and editing final draft; JR: investigation, critical reviewing and editing final draft; EMS: investigation, critical reviewing and editing final draft; SWW: investigation, critical reviewing and editing final draft; JLW: investigation, critical reviewing and editing final draft; TSH: inception, data curation, investigation, methodology, validation, writing original draft, critical reviewing and editing final draft. Both ACR and TSH are authors responsible for the overall content as guarantors.

**Funding** This research was supported by several grants. Culinary Medicine programming was supported in part by the Goldring Family Foundation, The Woldenberg Family Foundation, the Humana Foundation and the Robert Wood Johnson Foundation.

**Competing interests** None declared.

**Patient consent for publication** Not applicable.

**Ethics approval** Ethics approval was obtained through the local and site-specific institutional review boards for this research. Name of Institution Providing Institutional Review Board Review: The Administrators of the Tulane Educational Fund. IRB Registration #: 00000324. FWA#: 0000205. IRB Reference #:729959. Participants gave informed consent to participate in the study before taking part.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** No data are available.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

#### ORCID iDs

Alexander C Razavi <http://orcid.org/0000-0002-3213-0876>

Jaclyn Lewis Albin <http://orcid.org/0000-0001-9942-4353>

Emily A Johnston <http://orcid.org/0000-0003-0389-6626>

#### REFERENCES

- Mokdad AH, Ballesteros K, Echko M, *et al*. The state of US health, 1990–2016: burden of diseases, injuries, and risk factors among US states. *JAMA* 2018;319:1444–72.
- Estruch R, Ros E, Salas-Salvadó J, *et al*. Primary prevention of cardiovascular disease with a mediterranean diet supplemented with extra-virgin olive oil or nuts. *N Engl J Med* 2018;378:e34.

- 3 Sotos-Prieto M, Bhupathiraju SN, Mattei J, *et al.* Association of changes in diet quality with total and cause-specific mortality. *N Engl J Med* 2017;377:143–53.
- 4 Yu E, Malik VS, Hu FB. Cardiovascular disease prevention by diet modification: JACC health promotion series. *J Am Coll Cardiol* 2018;72:914–26.
- 5 Hu FB, Manson JE, Stampfer MJ, *et al.* Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. *N Engl J Med* 2001;345:790–7.
- 6 Sacks FM, Katan M. Randomized clinical trials on the effects of dietary fat and carbohydrate on plasma lipoproteins and cardiovascular disease. *Am J Med* 2002;113 Suppl 9B:13S–24S.
- 7 Sacks FM, Svetkey LP, Vollmer WM, *et al.* Effects on blood pressure of reduced dietary sodium and the dietary approaches to stop hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med* 2001;344:3–10.
- 8 Virani SS, Alonso A, Benjamin EJ, *et al.* Heart disease and stroke statistics-2020 update: a report from the American heart association. *Circulation* 2020;141:e139–596.
- 9 Devries S, Agatston A, Aggarwal M, *et al.* A deficiency of nutrition education and practice in cardiology. *Am J Med* 2017;130:1298–305.
- 10 Polak R, Phillips EM, Nordgren J, *et al.* Health-Related culinary education: a summary of representative emerging programs for health professionals and patients. *Glob Adv Health Med* 2016;5:61–8.
- 11 Van Horn L, Lenders CM, Pratt CA, *et al.* Advancing nutrition education, training, and research for medical students, residents, fellows, attending physicians, and other clinicians: building competencies and interdisciplinary coordination. *Adv Nutr* 2019;10:1181–200.
- 12 Stauber Z, Razavi AC, Sarris L, *et al.* Multisite medical student-led community culinary medicine classes improve patients' diets: machine learning-augmented propensity score-adjusted fixed effects cohort analysis of 1381 subjects. *Am J Lifestyle Med* 2022;16:214–20.
- 13 Razavi AC, Monlezun DJ, Sapin A, *et al.* Multisite culinary medicine curriculum is associated with cardioprotective dietary patterns and lifestyle medicine competencies among medical trainees. *Am J Lifestyle Med* 2020;14:225–33.
- 14 Monlezun DJ, Dart L, Vanbeber A, *et al.* Machine learning-augmented propensity score-adjusted multilevel mixed effects panel analysis of hands-on cooking and nutrition education versus traditional curriculum for medical students as preventive cardiology: multisite cohort study of 3,248 trainees over 5 years. *Biomed Res Int* 2018;2018:5051289.
- 15 Razavi AC, Sapin A, Monlezun DJ, *et al.* Effect of culinary education curriculum on Mediterranean diet adherence and food cost savings in families: a randomised controlled trial. *Public Health Nutr* 2021;24:2297–303.
- 16 Lucey CR, Johnston SC. The transformational effects of COVID-19 on medical education. *JAMA* 2020;324:1033–4.
- 17 Rose S. Medical student education in the time of COVID-19. *JAMA* 2020;323:2131–2.
- 18 Kolasa K, Poehlman G, Jobe A. Virtual seminars for disseminating medical nutrition education curriculum ideas. *Am J Clin Nutr* 2000;71:1403–4.
- 19 Isgin-Atici K, Ozkan A, Celikkan U, *et al.* Usability study of a novel tool: the virtual cafeteria in nutrition education. *J Nutr Educ Behav* 2020;52:1058–65.
- 20 Adams KM, Kohlmeier M, Zeisel SH. Nutrition education in U.S. medical schools: latest update of a national survey. *Acad Med* 2010;85:1537–42.
- 21 Trichopoulou A, Costacou T, Bamia C, *et al.* Adherence to a Mediterranean diet and survival in a Greek population. *N Engl J Med* 2003;348:2599–608.



Supplemental Table 1. Partner Sites
California Health Sciences University, Clovis, CA
George Washington University, Washington, D.C.
Lake Erie College of Osteopathic Medicine, Elvira NY, Erie, PA, Bradenton, FL
Maine Medical Center, Portland, ME
NOVA Southeastern University, Ft. Lauderdale, FL
New York Medical College, Valhalla, NY
Philadelphia College of Osteopathic Medicine, Philadelphia, PA
Spectrum Health, Grand Rapids Michigan
St. Joseph Mercy Health System, Ann Arbor, MI
Touro University California, Vallejo, CA
Tulane University, New Orleans, LA
Uniformed Services University, Washington, D.C
University of California-Irvine GI Department, Irvine, CA
University of Central Florida, Orlando, FL
University of New Mexico, Albuquerque, NM
University of North Texas, Denton, TX
University of Tennessee, Memphis, TN
University of Texas-Southwestern Medical School + Moncrief Cancer Institute, Dallas, TX
Zucker School of Medicine, Hempstead, N.Y.

**Supplementary Table 2.** Assessment of Mediterranean diet adherence

<b>Mediterranean Diet Category</b>	<b>Serving Requirement</b>	<b>0</b>	<b>+1</b>
Vegetables (e.g. carrots, spinach, tomatoes).	4 or more servings per-day		
Legumes (e.g. beans, split peas, or lentils)	1 or more servings per week		
Fruits (e.g. oranges, apples, bananas)	3 or more servings per week		
Nuts, seeds, or nut butters (e.g. peanuts, almonds, cashews)	1 or more servings per week		
Red and processed meat (e.g. hamburgers, steak, hotdogs)	Less than 2 servings per week for women, less than 3 servings per week for men		
Non-fried fish or seafood (e.g. canned, baked, grilled)	2 or more servings per week		
Whole grains (e.g. whole wheat bread or pasta, oats, brown rice, corn tortilla)	1 or more servings per day		
Monounsaturated fats (e.g. avocado, olive or canola oils)	Higher reported intake of unsaturated fats versus saturated fats		
Alcohol	(1/2 to 1 drink per day for women, 1-2 drinks per day for men)		

**Supplementary Table 3.** Assessment of nutritional attitudes and core lifestyle medicine counseling competencies

<b>Attitudes</b>	Not at all confident or Somewhat confident	Neither not at all confident, or totally confident	Mostly confident to totally confident
Nutritional counseling should be included in any routine appointment, just like diagnosis and treatment.			
Specific advice about how to make dietary changes could help patients improve their eating habits.			
Physicians can have an effect on a patient's dietary behavior if they take the time to discuss the problem. (5)			
<b>Lifestyle Medicine Counseling</b>			
Mediterranean Diet and its health effects.			
DASH diet and its health effects.			
Vegetarian diet and its health effects			
Very low-fat diet and its health effects.			
High protein/high fat diet (e.g. Atkins) and its health effects.			
Examples of a serving size from the 2011 "My Plate" guidelines.			
Definition of moderate alcohol consumption and its health effects.			
Recognizing warning signs and symptoms of patients with eating disorders.			
Role of dietary cholesterol and saturated fat in blood lipids.			
Recommended dietary patterns for type 2 diabetes.			

Significance of modest weight loss for type 2 diabetes.	
Weight loss strategies in overweight or obese patients.	
Role of Omega-3 and -6 fatty acids in heart health and their food examples.	
Role of dietary fat types (e.g. saturated vs. other) and their food examples.	
Identifying antioxidant-rich grocery produce.	
Calories per gram of protein, carbohydrate and fat, and their basic metabolic roles.	
Role of hydration in health, and fluid needs based on activity and age.	
Celiac disease and management strategies for patient's diet and lifestyle.	
Food allergies and management strategies for patient's diet and lifestyle.	
The role of glycemic index and load in dietary management.	
Fiber in disease prevention, and example ingredients.	
Assessing the total calories, saturated fat, and sodium using the food label.	
Osteoporosis and prevention and treatment strategies for patient's diet and lifestyle.	
Calculation of body mass index (BMI) and waist-to-hip ratio based on gender.	
Overall benefits of aerobic exercise on health and well-being.	

**Supplemental Table 4. Dietary habits over the last 6 months**

	Once per month / Never	1-2 times per week	3-5 times per week	7 times per week (daily)	2 or more times daily
Vegetables (e.g. carrots, spinach, tomatoes)					
Legumes (e.g. beans, split peas, or lentils)					
Fruits (e.g. oranges, apples, bananas)					
Nuts or nut butters (e.g. peanuts, almonds, cashews)					
Cheese or fermented dairy (e.g. yogurt)					
Red and processed meat (e.g. hamburgers, steak, hotdogs)					
Non-fried fish or seafood (e.g. canned, baked, grilled)					
Whole grains (e.g. whole wheat bread or pasta, oats, brown rice, corn tortilla)					
Monounsaturated fats (e.g. olive oil, avocado, canola oil).					
1 alcohol serving (1 can of 12 oz. beer = 1 glass of wine = 1 shot of spirits)					
Baked products (e.g. muffins, doughnuts, pastries)					
Calorie-containing beverages (e.g. coke/soda, non-black coffee drinks, energy drinks)					
Saturated fats (e.g. butter, 2% or whole milk, margarine)					

Supplemental Table 1. Partner Sites
California Health Sciences University, Clovis, CA
George Washington University, Washington, D.C.
Lake Erie College of Osteopathic Medicine, Elvira NY, Erie, PA, Bradenton, FL
Maine Medical Center, Portland, ME
NOVA Southeastern University, Ft. Lauderdale, FL
New York Medical College, Valhalla, NY
Philadelphia College of Osteopathic Medicine, Philadelphia, PA
Spectrum Health, Grand Rapids Michigan
St. Joseph Mercy Health System, Ann Arbor, MI
Touro University California, Vallejo, CA
Tulane University, New Orleans, LA
Uniformed Services University, Washington, D.C
University of California-Irvine GI Department, Irvine, CA
University of Central Florida, Orlando, FL
University of New Mexico, Albuquerque, NM
University of North Texas, Denton, TX
University of Tennessee, Memphis, TN
University of Texas-Southwestern Medical School + Moncrief Cancer Institute, Dallas, TX
Zucker School of Medicine, Hempstead, N.Y.

**Supplementary Table 2.** Assessment of Mediterranean diet adherence

<b>Mediterranean Diet Category</b>	<b>Serving Requirement</b>	<b>0</b>	<b>+1</b>
Vegetables (e.g. carrots, spinach, tomatoes).	4 or more servings per-day		
Legumes (e.g. beans, split peas, or lentils)	1 or more servings per week		
Fruits (e.g. oranges, apples, bananas)	3 or more servings per week		
Nuts, seeds, or nut butters (e.g. peanuts, almonds, cashews)	1 or more servings per week		
Red and processed meat (e.g. hamburgers, steak, hotdogs)	Less than 2 servings per week for women, less than 3 servings per week for men		
Non-fried fish or seafood (e.g. canned, baked, grilled)	2 or more servings per week		
Whole grains (e.g. whole wheat bread or pasta, oats, brown rice, corn tortilla)	1 or more servings per day		
Monounsaturated fats (e.g. avocado, olive or canola oils)	Higher reported intake of unsaturated fats versus saturated fats		
Alcohol	(1/2 to 1 drink per day for women, 1-2 drinks per day for men)		

**Supplementary Table 3.** Assessment of nutritional attitudes and core lifestyle medicine counseling competencies

<b>Attitudes</b>	Not at all confident or Somewhat confident	Neither not at all confident, or totally confident	Mostly confident to totally confident
Nutritional counseling should be included in any routine appointment, just like diagnosis and treatment.			
Specific advice about how to make dietary changes could help patients improve their eating habits.			
Physicians can have an effect on a patient's dietary behavior if they take the time to discuss the problem. (5)			
<b>Lifestyle Medicine Counseling</b>			
Mediterranean Diet and its health effects.			
DASH diet and its health effects.			
Vegetarian diet and its health effects			
Very low-fat diet and its health effects.			
High protein/high fat diet (e.g. Atkins) and its health effects.			
Examples of a serving size from the 2011 "My Plate" guidelines.			
Definition of moderate alcohol consumption and its health effects.			
Recognizing warning signs and symptoms of patients with eating disorders.			
Role of dietary cholesterol and saturated fat in blood lipids.			
Recommended dietary patterns for type 2 diabetes.			



Significance of modest weight loss for type 2 diabetes.	
Weight loss strategies in overweight or obese patients.	
Role of Omega-3 and -6 fatty acids in heart health and their food examples.	
Role of dietary fat types (e.g. saturated vs. other) and their food examples.	
Identifying antioxidant-rich grocery produce.	
Calories per gram of protein, carbohydrate and fat, and their basic metabolic roles.	
Role of hydration in health, and fluid needs based on activity and age.	
Celiac disease and management strategies for patient's diet and lifestyle.	
Food allergies and management strategies for patient's diet and lifestyle.	
The role of glycemic index and load in dietary management.	
Fiber in disease prevention, and example ingredients.	
Assessing the total calories, saturated fat, and sodium using the food label.	
Osteoporosis and prevention and treatment strategies for patient's diet and lifestyle.	
Calculation of body mass index (BMI) and waist-to-hip ratio based on gender.	
Overall benefits of aerobic exercise on health and well-being.	

**Supplemental Table 4. Dietary habits over the last 6 months**

	Once per month / Never	1-2 times per week	3-5 times per week	7 times per week (daily)	2 or more times daily
Vegetables (e.g. carrots, spinach, tomatoes)					
Legumes (e.g. beans, split peas, or lentils)					
Fruits (e.g. oranges, apples, bananas)					
Nuts or nut butters (e.g. peanuts, almonds, cashews)					
Cheese or fermented dairy (e.g. yogurt)					
Red and processed meat (e.g. hamburgers, steak, hotdogs)					
Non-fried fish or seafood (e.g. canned, baked, grilled)					
Whole grains (e.g. whole wheat bread or pasta, oats, brown rice, corn tortilla)					
Monounsaturated fats (e.g. olive oil, avocado, canola oil).					
1 alcohol serving (1 can of 12 oz. beer = 1 glass of wine = 1 shot of spirits)					
Baked products (e.g. muffins, doughnuts, pastries)					
Calorie-containing beverages (e.g. coke/soda, non-black coffee drinks, energy drinks)					
Saturated fats (e.g. butter, 2% or whole milk, margarine)					