

**The Mediterranean diet in the Stroke Belt: a cross-sectional study on adherence and perceived knowledge, barriers, and benefits**

by

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## Abstract

The Mediterranean diet (MD) is recommended by the current Dietary Guidelines for Americans, yet little is known about the diet in the Stroke Belt. Thus, we investigated MD adherence and perceived benefits and barriers to consumption of the MD in the US Stroke Belt. A survey containing MD knowledge, barriers, and benefits (KBB) questions, a MD adherence screener (MEDAS), questions based on the Precaution Adoption Model, and demographic/anthropometric questions was distributed to US residents. Responses from the Stroke Belt (SB; n = 305), California (CA; n = 489), and all other US states (OtherUS; n = 435) were obtained. The CA group served as the reference group. A linear model was used to assess KBB question scores, adjust for sex and age, and all other demographic variables. Multivariable linear regression analysis was used to assess the differences in total MEDAS adjusted for all covariates. Barriers on MD convenience, sensory factors, and health were significantly greater in the SB group, but not the OtherUS group, in all models ( $p < 0.05$ ). Ethics & feasibility was found to be a significantly less of a benefit in the SB group in all models ( $p < 0.05$ ). For each point increase in MEDAS, a reduction in 0.43 and 0.51 points ( $p < 0.05$ ) was observed in the SB and otherUS groups, respectively. There were no significant differences in MEDAS by sex, age, or ethnicity. Our results identify key barriers and benefits of the MD in the SB which can inform targeted MD intervention studies.

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## List of Abbreviations

CA	California
KBB	Knowledge, Barriers, & Benefits
MD	Mediterranean Diet
MEDAS	Mediterranean Diet Adherence Screener
SB	Stroke Belt

## Chapter 1

The Mediterranean diet in the Stroke Belt: a cross-sectional study on adherence and perceived knowledge, barriers, and benefits



## **1. Introduction**

Traditionally, a Mediterranean-based diet contains high intakes of fruit, vegetables, nuts, and whole grain cereals (1). Red and processed meats, dairy products, and sweets are limited while fish and poultry are encouraged in moderation. Extra virgin olive oil is the primary dietary fat, and red wine is preferred in moderation with meals, respecting social beliefs. The Mediterranean diet (MD) was first identified as one of the healthiest patterns of eating by Ancel Keys in the Seven Countries Study in 1983 (2). Keys sought to determine which areas of the world had increased heart and vascular disease and which factors could be influencing it. Data was collected in the U.S., Finland, the Netherlands, Yugoslavia, Japan, Greece, and Italy over 25 years and measured serum cholesterol, dietary content, heart attack rates, mortality, and lifestyle and risk factors. It was found that those eating a Mediterranean diet had greater serum levels of monounsaturated fatty acids, less saturated fatty acids, and increased oleic acid. When extra virgin olive oil was the primary dietary fat, all-cause and coronary heart disease death rates were lowest.

Since the Seven Countries Study, following a MD is associated with reduced cardiovascular disease risk (3) and overall mortality (4), the prevention and control of type II diabetes (5), and a decreased risk of developing metabolic syndrome (6). The majority of the foods encouraged in the MD are high in vitamins, minerals, and antioxidants, which all play a role in disease prevention and overall health (7). The high intakes of extra virgin olive oil and nuts lead to greater consumption of antioxidants, omega-3 fatty acids, and monounsaturated fatty acids, which decrease risk of cardiovascular disease (3,4). More recently, it was named the Best Diet of 2019 by U.S. News & World Report (8) and has been promoted by the American Heart Association for reduction of stroke risk (9) and for its similar benefits to the DASH diet (10). The Mediterranean diet was also added to the 2015-

2020 Dietary Guidelines for Americans as a recommended healthy food pattern to increase overall health (11). The American Diabetes Association (5) recommends a MD due to the results of the PREDIMED study, which was a randomized clinical trial that evaluated the MD's impact on disease risk and found that increased MD adherence reduced cardiovascular disease risk and new-onset diabetes diagnoses (3).

The Stroke Belt (SB) is a band of 11 states (Alabama, Arkansas, Georgia, Indiana, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia) defined by the National Heart, Lung, and Blood Institute as areas where the stroke death rates are more than 10% greater than the U.S. average (12). These states also have increase rates of hypertension, diabetes, and coronary heart disease compared to non-Stroke Belt states (13). However, even with the scientific knowledge that adherence to a MD can reduce the risk for many of the diseases affecting the Stroke Belt, there is very little data on MD adherence in the SB, or in the overall United States.

It has been suggested that factors such as perceived benefits and barriers towards adopting a diet are strong predictors of food choice and how likely a person is to change his or her diet (14). Kristal et al. found that perceived benefits and beliefs were positively associated with not only current diet, but also future intention to adopt healthier behaviors and perceived self-efficacy. It was also concluded that intrinsic motivations, like beliefs, had stronger associations with behavior change than exterior motivations like social norms (14). An increase in perceived barriers to eating a healthful diet, like ease and taste, have been strongly associated with decreased intakes of healthy foods (15). Specifically, ease was a significant predictor for lower consumption of fruit, vegetables, and fiber. Perceived social support and taste were also predictive of fruit and vegetable intake (15). There is currently

very little knowledge of what U.S. citizens perceive to be benefits or barriers towards adopting the MD. Benefits and barriers towards adopting a healthy diet have been assessed in Spain, but no data has been collected on perceived benefits or barriers towards the MD (16).

Theories and models of behavior change have been proposed as ways to increase nutrition education efficacy and encourage the adoption of healthy behaviors and diets. The Transtheoretical Model of behavior change (17) is a psychological theory of motivation and behavior change that identifies five stages of change: pre-contemplation (unaware, unengaged), contemplation (considering behavior change), preparation (active planning for behavior change), action (changing behavior), and maintenance (consistently continuing goal behavior). Behavior change is considered flexible, nonlinear movement and people can jump from one stage to another at any given time. In health education, it is common for people to “relapse” back to lower stages, but nutritional education tailored to a person’s stage of change can increase behavior change outcomes (18). The Precaution Adoption Process Model (PAPM) is derived from the Transtheoretical Model and proposes that there are seven states that a person can be in when deciding to adopt a health behavior (“unaware”, “unengaged”, “deciding”, “decided no”, “decided yes”, “action”, and “maintenance”), and that these are influenced by beliefs, experiences, prior knowledge, and perceived benefits and barriers towards this behavior (19,20). Nutrition education that is specified for a participant’s stage of change towards a behavior has been shown to be more effective than general nutrition advice (20).

The MD is recommended as a healthy dietary approach because adherence to the MD is associated with reduced risk of chronic diseases such as cardiovascular disease, type II diabetes, and stroke. Yet, in the Stroke Belt where chronic disease is highly prevalent

(3,5,12), little is known about factors associated with MD adherence. In particular, there is currently no knowledge of perceived benefits or barriers towards the MD or the stage of change towards adopting a MD in the Stroke Belt: this knowledge could identify key targets for nutrition education and further research. In the present study, the purpose was to assess in the Stroke Belt: 1) MD adherence; 2) perceived benefits and barriers towards a MD; and 3) participants' stage of change towards adopting a MD.

## **2. Methods**

### *2.1 Survey Instrument Development*

A survey was developed to assess Mediterranean diet adherence, participants' stage of change towards adopting the MD, perceived benefits and barriers of the MD, and demographic variables. MD adherence was evaluated using the 14 question Mediterranean Diet Adherence Screener (MEDAS) that was previously validated in the PREDIMED study (3) and has been used to assess MD adherence in Alabama (21) (Supplemental Table 1). Three questions were asked to assess participants' readiness to adopt a MD using the Precaution Adoption Process Model (stages of change) (19) (Supplemental Table 2). A pool of 100 questions measuring perceived benefits and barriers of the MD was created by adapting questions from previously-validated studies (15,22–28) assessing perceived benefits and barriers towards adopting a healthy diet (Supplemental Table 3). The questions were then screened by five registered dietitians who had experience studying the MD in Italy. The perceived benefits and barriers questions were narrowed down by removing redundant and unclear questions to a final 18 questions assessing perceived barriers to the MD (knowledge, convenience, sensory appeal, and health) and 26 questions assessing perceived benefits (knowledge, weight loss, ethnical, natural content, familiarity, price, sensory appeal, and mood) measured using a five point Likert scale (Supplemental Tables 4 & 5). Seven demographic and anthropometric questions determining age, sex, ethnicity, height, weight, level of education, and previous nutrition education or knowledge were included as well (Supplemental Table 6). The Black-African and Black-Other categories were combined into the Black category due to only 12 participants being in the Black-Other category. Indian, Pakistani, and Asian-Other categories were also combined in the Asian-Other category due to

low numbers of participants in order to create categories with enough participants to run statistical analyses. The Middle School education category was added to the High School Diploma category in our final analysis as well to create the High School or less category.

## *2.2 Survey Distribution*

This survey was distributed using Amazon Mechanical Turk (MTurk) from September 9th-November 14th, 2018. MTurk is an online platform that connects “requesters” with “workers” who perform an online task for the requester and receive compensation for it. Tasks are then either accepted or rejected if directions dictated by the requester are not followed. For this survey, workers were instructed that they must be located within the U.S. to participate. This survey was completed by 1,443 workers, and they were compensated \$0.60 if the survey was accepted. Participants were eligible to complete the study if they were currently located within the United States and had an approval rating greater than 90% for all previous MTurk survey responses. Workers were redirected to Qualtrics XM to complete the survey. Once the survey was completed, data was exported to Microsoft Excel. The participants’ locations were recorded by Qualtrics and used to ensure participants were located in the U.S. before approving their response.

## *2.3 Study Population*

This study was approved by the Auburn University institutional review board prior to distributing the surveys. Responses were excluded if the survey was completed in less than 90 seconds ( $n = 31$ ), the participant failed to pass two of the three attention check questions in the survey ( $n = 41$ ), or if they were located outside of the United States ( $n = 142$ ) (Figure 1). The 1,229 participants were sorted into three groups based on geographic location: California (CA) ( $n = 489$ ), Stroke Belt (SB) ( $n = 305$ ), and OtherUS ( $n = 435$ ) and the CA

respondents served as the reference group. California was selected as the reference group due to its Mediterranean climate (29,30) and recent data showing it is as a hotspot for adherence to the Mediterranean diet in the U.S (31).

#### *2.4 Factor Analysis*

A principal component factor analysis was performed using IBM SPSS Statistics 23 to determine if the original factors for benefits and barriers towards the MD could be better described by distinct underlying factors. Varimax rotation method with Kaiser Normalization was used.

#### *2.5 Statistical Analysis*

IBM SPSS Statistics 23 was used to determine frequency distributions in the demographic data and perform Pearson's chi-squared tests to analyze differences in demographic categories between groups and participants by stage of change. A multivariable linear regression analysis was used to assess the differences in total MD adherence scores between the groups adjusted for all covariates. A multivariate linear model was used to assess barrier and benefit question scores in the groups and was adjusted using three models: Model 1 was unadjusted, Model 2 was adjusted for sex and age, and Model 3 was adjusted for all demographic variables. A multivariate linear model was then used to assess benefits using reformulated benefit factors. A backward stepwise logistic regression was performed to identify the predictors of the stage of change with the demographic variables. Inclusion and retention criteria in the logistic regression model were set at 0.25 and 0.10, respectively. Akaike's Information Criteria (AIC) was used to select the most parsimonious model. Multivariable linear regression, multivariate linear model, and logistic regression statistical analyses were conducted in R v3.52.

### **3. Results**

#### *3.1 Demographics*

We first determined whether there were demographic differences between participants in the CA, SB, and OtherUS groups. As shown in Table 1, we observed significant differences ( $P < .001$ ) in Sex. The SB group had a greater proportion of females compared to the other groups. Significant differences ( $P = .009$ ) in Age were also observed. The CA group had the greatest proportion of the youngest (18-24 years old) participants while the SB group has the greatest proportion of the oldest (55-64 and >65 years old) participants. We also observed significant differences ( $P < .001$ ) in Ethnicity. The CA group had a greater proportion of non-white participants. Finally, we observed significant differences ( $P < .001$ ) in BMI. The SB group had the greatest proportion of obese participants. There were no significant differences between groups in education or nutrition knowledge.

#### *3.2 Mediterranean Diet Adherence*

Total MD adherence score was assessed using multivariable linear regression adjusting for demographic variables and was found to be significantly lower in the SB and OtherUS groups in comparison to the CA group (Table 2). For each point increase in MD adherence in the CA group, a reduction in  $0.35 \pm 0.15$  points ( $P = 0.019$ ) and  $0.46 \pm 0.13$  points ( $P < 0.001$ ) was observed in the SB and OtherUS groups, respectively. MD adherence was increased  $0.358 \pm 0.169$  in those with a bachelor's degree ( $P = .035$ ) and increased  $0.559 \pm 0.211$  in those with a master's degree ( $P = .008$ ). Obese participants had lower MD adherence scores by  $0.376 \pm 0.155$  ( $P = .015$ ). There were no other significant differences in sex, age, or ethnicity.

#### *3.3 Barriers to consuming a MD*



We first performed a Factor Analysis to determine whether factors could be derived from the 18 questions related to knowledge, convenience, sensory appeal, and health barriers (Supplemental Table 4). Principle component analysis resulted in models that failed to explain greater than 50% of the total variance. Therefore, we assessed perceived barriers constructed a priori. We next examined internal validity of the questions in the four barrier factors (Table 3). The knowledge barrier had a Cronbach's  $\alpha = 0.429$ , indicating poor internal validity for the questions in this factor. Convenience, sensory appeal, and health had Cronbach's Alphas of  $>0.6$ , indicating the questions within these factors were assessing the intended barriers. We used a linear regression model that was unadjusted (Model 1), adjusted for sex and age (Model 2), and adjusted for sex, age, ethnicity, education, and BMI (Model 3) to assess knowledge, convenience, sensory appeal, and health barriers in the SB and OtherUS groups using the CA group as a reference.

All four of the barriers, knowledge ( $\beta = 0.569$ ,  $SE = 0.212$ ,  $P = .007$ ) convenience ( $\beta = 0.955$ ,  $SE = 0.251$ ,  $P = <.001$ ), sensory appeal ( $\beta = 0.650$ ,  $SE = 0.202$ ,  $P = .001$ ), and health ( $\beta = 0.981$ ,  $SE = 0.217$ ,  $P = <.001$ ) were observed to be significant barriers to the MD in the SB group in Model 3 compared to the CA group (Table 3). This significance was maintained in Models 1 & 2. In the OtherUS group, knowledge was also a significant barrier in Model 3 ( $\beta = 0.387$ ,  $SE = 0.190$ ,  $P = .042$ ), as was convenience ( $\beta = 0.466$ ,  $SE = 0.225$ ,  $P = .038$ ). These factors were also significant in Models 1 & 2.

### *3.4 Benefits to consuming a MD*

Perceived benefits from adopting a MD were measured using 26 questions that were sorted a priori into 8 factors: health, weight loss, ethical concerns, natural content, familiarity, price, sensory appeal, and mood (Supplemental Table 5). A Factor Analysis was

performed to determine if these questions would be better suited with other factors. Principle component analysis resulted in a model that identified four new factors for MD benefits that were categorized as: quality of life, healthy diet, ethics & feasibility, and improved taste (Supplemental Table 7). Internal validity was calculated for the new factors, and all of the benefit factors were found to be adequate (Cronbach's  $\alpha > 0.6$ ) (Table 4). We then used a linear regression model that was unadjusted (Model 1), adjusted for sex and age (Model 2), and adjusted for sex, age, ethnicity, education, and BMI (Model 3) to assess knowledge, convenience, sensory appeal, and health barriers in the SB and OtherUS groups using the CA group as a reference (Table 4). Only ethics & feasibility was significant in the SB group compared to the CA group in Model 1 ( $\beta = -0.867$ ,  $SE = 0.183$ ,  $P = .003$ ), Model 2 ( $\beta = -0.841$ ,  $SE = 0.298$ ,  $P = .005$ ), and Model 3 ( $\beta = -0.912$ ,  $SE = 0.311$ ,  $P = .003$ ). For every one point increase in perceived ethical & feasibility benefit in the CA group, there was a 0.912 ( $SE = 0.311$ ) decrease in the SB group when adjusting for all demographic factors.

When broken down by questions within the ethics & feasibility factor, the items "Eat foods that are like the foods I ate when I was a child" and "Save money" were perceived to be significantly less of a benefit in the SB group than in the CA group in Model 3 ( $\beta = -0.335$ ,  $SE = 0.101$ ,  $P < .001$ ) and ( $\beta = -0.257$ ,  $SE = 0.089$ ,  $P = .005$ ), respectively (Supplemental Table 8). Similar results were also observed in Models 1 & 2. There was no significant differences in the ethics & feasibility factor question responses between the CA and OtherUS groups.

### *3.5 Stages of Change & Demographic Influences*

The CA group had a significantly greater number of participants in the decided yes category while the OtherUS group had significantly fewer ( $P < 0.05$ ) (Table 5). The OtherUS

group also had a significantly greater number of participants in the action/maintenance stage ( $P < 0.05$ ). There was no significant difference between groups in percentage of participants in the unaware/unengaged, deciding, or decided no stages of change. There was also no difference between groups in having heard of the MD before.

Logistic regression was performed to determine the effect of demographic variables on likelihood to be in each stage of change towards adopting the MD (Tables 6-8). Participants were significantly less likely to be in the Unengaged/Unaware stage in the CA group if they held any education greater than a high school education ( $P < 0.05$ ). Chinese participants in the CA and OtherUS groups were more likely to be in the Unaware/Unengaged stage, as well as Asian-other and Other respondents in the CA group ( $P < 0.05$ ).

Those with higher education in the CA group were at least 2 times more likely to be in the Action/Maintenance stage ( $P < 0.05$ ), and Black participants in the CA and OtherUS groups had greater odds of being in this stage as well ( $P < 0.05$ ). There was significantly reduced odds (OR = 0.31, 95% CI: 0.14-0.61) for obese participants to be in the Action/Maintenance phase in the CA group. In OtherUS participants who were between the ages of 35-44, there was a significantly reduced likelihood of being in the Action/Maintenance stage (OR = 0.54, 95% CI: 0.30-0.94).

OtherUS was the only group with significant factors in the Decided No stage. Those who were Chinese or Other ethnicities were 5.04 (95% CI: 0.73-21.73) and 3.95 (95% CI = 0.86-13.40) times more likely to have decided not to eat a MD ( $P < 0.05$ ), and were 6.48 (95% CI = 0.92-29.58) times more likely to be in the Decided No stage if they had a GED ( $P < 0.05$ ). Participants in the CA group had significantly greater odds of being in the Deciding stage if they were overweight ( $P < .01$ ), and were less likely if they were female or Chinese. Black

participants were also less likely to be in the Deciding stage in the OtherUS group (OR = 0.38, 95% CI: 0.17-0.75). In the SB group, obese participants were 5.46 (95% CI = 2.08-16.23) times more likely to be in the Decided Yes stage ( $P < .01$ ). The CA group participants had greater odds of being in the Decided Yes stage if they were 35-44 years old, 55-64 years old, or obese ( $P < 0.05$ ) while participants in OtherUS group had significantly increased odds (OR = 2.77, 95% CI = 1.41-5.68) for being female.

Table 1: Demographics of geographic groups

	CA (n= 489)		Stroke Belt (n= 305)		OtherUS (n=435)		P-value
	n	%	n	%	n	%	
<i>Sex*</i>							
Male	214	43.8	107	35.1	228	52.4	<.001
Female	275	56.2	198	64.9	207	47.6	
<i>Age*</i>							
18-24	74	15.1	30	9.8	36	8.3	.009
25-34	203	41.5	121	39.7	190	43.7	
35-44	110	22.5	69	22.6	103	23.7	
45-54	59	12.1	33	10.8	58	13.3	
55-64	30	6.1	37	12.1	34	7.8	
>65	13	2.7	15	4.9	14	3.2	
<i>Ethnicity*</i>							
White	285	58.3	236	77.4	333	76.6	<.001
Black	31	6.3	47	15.4	53	12.2	
Chinese	52	10.6	3	1.0	11	2.5	
Asian-other	79	16.2	12	3.9	19	4.4	
Other ethnic group	42	8.6	7	2.3	19	4.3	
<i>Education</i>							
High School or lower	83	17.0	59	19.3	56	12.8	.178
GED	11	2.2	9	3.0	9	2.1	
Technical or trade certificate	31	6.3	23	7.5	20	4.6	
Associate degree	65	13.3	47	15.4	60	13.8	
Bachelor's degree	229	46.8	127	41.6	215	49.4	
Master's or professional degree	70	14.3	40	13.1	75	17.2	
<i>BMI*</i>							
Underweight	22	4.5	3	1.0	12	2.8	<.001
Normal weight	241	49.3	112	36.7	204	46.9	
Overweight	129	26.4	105	34.4	133	30.6	
Obese	96	19.6	82	26.9	80	18.4	
Unknown	1	0.2	3	1.0	6	1.4	
<i>Qualification</i>							
Health or nutrition related qualifications	24	4.9	13	4.3	18	4.1	.834
No health or nutrition related qualifications	465	95.1	292	95.7	417	95.9	

\* Significance across score categories by Pearson's chi-squared test

Table 2: Multivariate linear model assessing Mediterranean diet adherence between groups adjusted for demographic categories

	$\beta$	SE	p-Value
<i>Group</i>			
CA	Ref		
SB	-0.431	0.156	<b>.006*</b>
OtherUS	-0.508	0.139	<b>&lt;.001</b>
<i>Sex</i>			
Male	Ref		
Female	0.004	0.119	.970
<i>Age</i>			
18-24	Ref		
25-34	0.087	0.195	.657
35-44	0.132	0.214	.538
45-54	0.205	0.242	.395
55-64	0.285	0.271	.295
>65	0.205	0.357	.566
<i>Ethnicity</i>			
White	Ref		
Black All	0.092	0.192	.632
Chinese	-0.345	0.267	.197
Asian - Other	0.008	0.211	.970
Other	0.051	0.256	.841
<i>Education</i>			
High School or lower	Ref		
GED	0.219	0.398	.582
Technical Degree	0.090	0.274	.742
Associate's Degree	0.268	0.211	.204
Bachelor's Degree	0.358	0.169	<b>.035</b>
Master's Degree	0.559	0.211	<b>.008</b>
<i>BMI</i>			
Under	0.443	0.341	.194
Healthy	Ref		
Overweight	-0.052	0.139	.707
Obese	-0.376	0.155	<b>.015</b>
Unknown	0.476	0.643	.459

\*p values < 0.05 are indicated in bold font

Table 3: Multivariate linear model analysis of MD barriers across geographic groups

	CA	SB			Other US		
		$\beta$	SE	P-value	$\beta$	SE	P-value
<i>Knowledge (n = 4)<sup>‡</sup></i> <i>(Cronbach's Alpha = 0.429)</i>							
Model 1 <sup>†</sup>	Ref	0.590	0.201	<b>.003*</b>	0.434	0.181	<b>.017</b>
Model 2 <sup>††</sup>	Ref	0.556	0.202	<b>.006</b>	0.400	0.182	<b>.028</b>
Model 3 <sup>†††</sup>	Ref	0.569	0.212	<b>.007</b>	0.387	0.190	<b>.042</b>
<i>Convenience (n = 4)</i> <i>(Cronbach's Alpha = 0.771)</i>							
Model 1	Ref	0.984	0.240	<b>&lt;.001</b>	0.445	0.217	<b>.040</b>
Model 2	Ref	0.903	0.240	<b>&lt;.001</b>	0.460	0.217	<b>.034</b>
Model 3	Ref	0.955	0.251	<b>&lt;.001</b>	0.466	0.225	<b>.038</b>
<i>Sensory Appeal (n = 3)</i> <i>(Cronbach's Alpha = 0.786)</i>							
Model 1	Ref	0.702	0.193	<b>&lt;.001</b>	0.083	0.175	.636
Model 2	Ref	0.628	0.193	<b>.001</b>	0.099	0.174	.571
Model 3	Ref	0.650	0.202	<b>.001</b>	0.070	0.181	.700
<i>Health (n = 4)</i> <i>(Cronbach's Alpha = 0.663)</i>							
Model 1	Ref	1.043	0.208	<b>&lt;.001</b>	-0.228	0.187	.224
Model 2	Ref	0.953	0.207	<b>&lt;.001</b>	-0.234	0.187	.208
Model 3	Ref	0.981	0.217	<b>&lt;.001</b>	-0.251	0.194	.197

<sup>‡</sup> Number of questions in each factor

\* p values < 0.05 are indicated in bold font

<sup>†</sup> Model 1 (unadjusted)

<sup>††</sup> Model 2 (adjusted for sex and age)

<sup>†††</sup> Model 3 (adjusted for sex, age, ethnicity, education, and BMI)

Table 4: Multivariate linear model analysis of MD benefits across geographic groups

	CA	SB			Other US		
		$\beta$	SE	P-value	$\beta$	SE	P-value
<i>Quality of Life (n = 6)<sup>‡</sup></i> (Cronbach's Alpha= 0.825)							
Model 1 <sup>†</sup>	Ref	-0.053	0.326	.872	0.208	0.295	.481
Model 2 <sup>††</sup>	Ref	-0.069	0.330	.835	0.218	0.297	.464
Model 3 <sup>†††</sup>	Ref	0.083	0.345	.810	0.266	0.309	.390
<i>Healthy Diet (n = 5)</i> (Cronbach's Alpha = 0.766)							
Model 1	Ref	0.234	0.243	.336	-0.259	0.220	.239
Model 2	Ref	0.147	0.244	.548	-0.225	0.220	.307
Model 3	Ref	0.177	0.256	.490	-0.231	0.230	.313
<i>Ethics and Feasibility (n = 5)</i> (Cronbach's Alpha = 0.762)							
Model 1	Ref	-0.867	0.183	<b>.003</b>	-0.113	0.267	.673
Model 2	Ref	-0.841	0.298	<b>.005</b>	-0.090	0.269	.738
Model 3	Ref	-0.912	0.311	<b>.003</b>	-0.223	0.279	.425
<i>Improved Taste (n = 3)</i> (Cronbach's Alpha = 0.667)							
Model 1	Ref	-0.010	0.165	.950	-0.155	0.149	.300
Model 2	Ref	-0.063	0.166	.704	-0.159	0.149	.289
Model 3	Ref	-0.108	0.173	.536	-0.220	0.155	.157

<sup>‡</sup> Number of questions in each factor

\* p values < 0.05 are indicated in bold font

<sup>†</sup> Model 1 (unadjusted)

<sup>††</sup> Model 2 (adjusted for gender & age)

<sup>†††</sup> Model 3 (adjusted for gender, age, ethnicity, education, & BMI)



Table 5. Percent of participants in the CA, SB, and OtherUS groups by stage of change

Stages of Change	CA	SB	OtherUS
Unaware/Unengaged	22.1	21.0	20.5
Deciding	35.4	40.0	36.6
Decided No	5.3	8.5	6.0
Decided Yes*	16.6	11.5	9.7
Action/Maintenance*	20.7	19.0	27.4

\* Significance across score categories by Pearson's chi-squared test ( $p < 0.05$ )

Table 6. Backward stepwise logistic regression of stage of change by demographic factors in the CA group

CA	Stages of Change				
	Unaware/ Unengaged OR (95% CI)	Deciding OR (95% CI)	Decided Yes OR (95% CI)	Decided No OR (95% CI)	Action/ Maintenance OR (95% CI)
<b>Sex</b>					
Female	-	0.67 (0.45-0.99)*	1.62 (0.98-2.75)	-	-
<b>Age</b>					
25-34	-	-	1.83 (0.95-3.70)	-	-
35-44	-	-	2.94 (1.44-6.22)**	0.28 (0.05-0.98)	-
45-54	-	1.73 (0.97-3.07)	-	-	-
55-64	-	-	5.65 (2.22-14.47)***	-	-
<b>Ethnicity</b>					
Black	-	-	-	-	2.58 (1.03-6.15)*
Chinese	2.57 (1.28-5.06)**	0.35 (0.16-0.70)**	-	-	-
Asian-other	1.92 (1.05-3.41)*	-	-	-	-
Other	2.10 (0.99-4.28)*	-	-	-	-
<b>Education</b>					
Certificate	0.20 (0.04-0.63)*	-	-	-	3.01 (1.03-8.63)*
Associate's	0.32 (0.14-0.69)**	-	-	-	3.44 (1.49-8.32)**
Bachelor's	0.43 (0.25-0.74)**	-	-	2.18 (0.97-5.21)	2.08 (1.04-4.52)*
Master's or professional	0.29 (0.13-0.63)**	-	-	-	2.75 (1.18-6.65)*
<b>BMI</b>					
Underweight	2.20 (0.81-5.58)	-	-	-	-
Overweight	-	1.89 (0.33-0.83)**	-	-	-
Obese	-	-	1.98 (1.12-3.43)*	-	0.31 (0.14-0.61)*

\* p-value <.05

\*\* p-value <.01

\*\*\* p-value <.001

- Not applicable

Table 7. Backward stepwise logistic regression of stage of change by demographic factors in the SB group

SB	Stages of Change				
	Unaware/ Unengaged OR (95% CI)	Deciding OR (95% CI)	Decided Yes OR (95% CI)	Decided No OR (95% CI)	Action/ Maintenance OR (95% CI)
<b>Age</b>					
35-44	-	-	-	0.33 (0.08-1.01)	-
45-54	-	-	-	0.23 (0.01-1.16)	-
55-64	-	-	1.85 (0.67-4.69)	0.42 (0.06-1.52)	-
<b>Ethnicity</b>					
Black	-	-	0.45 (0.10-1.40)	-	-
Chinese	11.05 (1.01-244.93)	-	-	-	-
<b>Education</b>					
Bachelor's	0.57 (0.31-1.02)	-	-	-	1.52 (0.85-2.71)
<b>BMI</b>					
Overweight	-	-	2.31 (0.84-6.97)	-	-
Obese	-	0.68 (0.40-1.14)	5.46 (2.08-16.23)**	-	-
<b>Health Qualifications</b>					
Yes	-	-	-	-	2.70 (0.78-8.47)

\* p-value <.05

\*\* p-value <.01

\*\*\* p-value <.001

- Not applicable

Table 8. Backward stepwise logistic regression of stage of change by demographic factors in the OtherUS group

OtherUS	Stages of Change				
	Unaware/ Unengaged OR (95% CI)	Deciding OR (95% CI)	Decided Yes OR (95% CI)	Decided No OR (95% CI)	Action/ Maintenance OR (95% CI)
<b>Sex</b>					
Female	-	-	2.77 (1.41-5.68)**	-	-
<b>Age</b>					
35-44	-	-	-	-	0.54 (0.30-0.94)*
45-54	-	-	0.14 (.01-0.66)	-	-
55-64	-	-	2.12 (0.77-5.21)	2.84 (0.78-8.32)	-
>65	-	2.93 (0.99-9.70)	-	-	0.20 (0.01-1.06)
<b>Ethnicity</b>					
Black	-	0.38 (0.17-0.75)**	-	-	4.18 (2.29-7.75)***
Chinese	3.72 (1.03-12.87)*	-	-	5.04 (0.73-21.73)*	-
Other	-	-	-	3.95 (0.86-13.40)*	-
<b>Education</b>					
GED	-	-	-	6.48 (0.92-29.58)*	-
Associate's	-	-	-	-	2.20 (1.00-4.91)
Bachelor's	0.71 (0.44-1.14)	-	-	-	1.58 (0.85-3.08)
Master's or professional	-	-	-	-	2.03 (0.96-4.41)
<b>BMI</b>					
Underweight	-	-	-	-	2.07 (0.67-6.24)
Overweight	-	-	1.72 (0.84-3.43)	-	-
Obese	0.52 (0.25-1.00)	-	-	-	-

\* p-value <.05

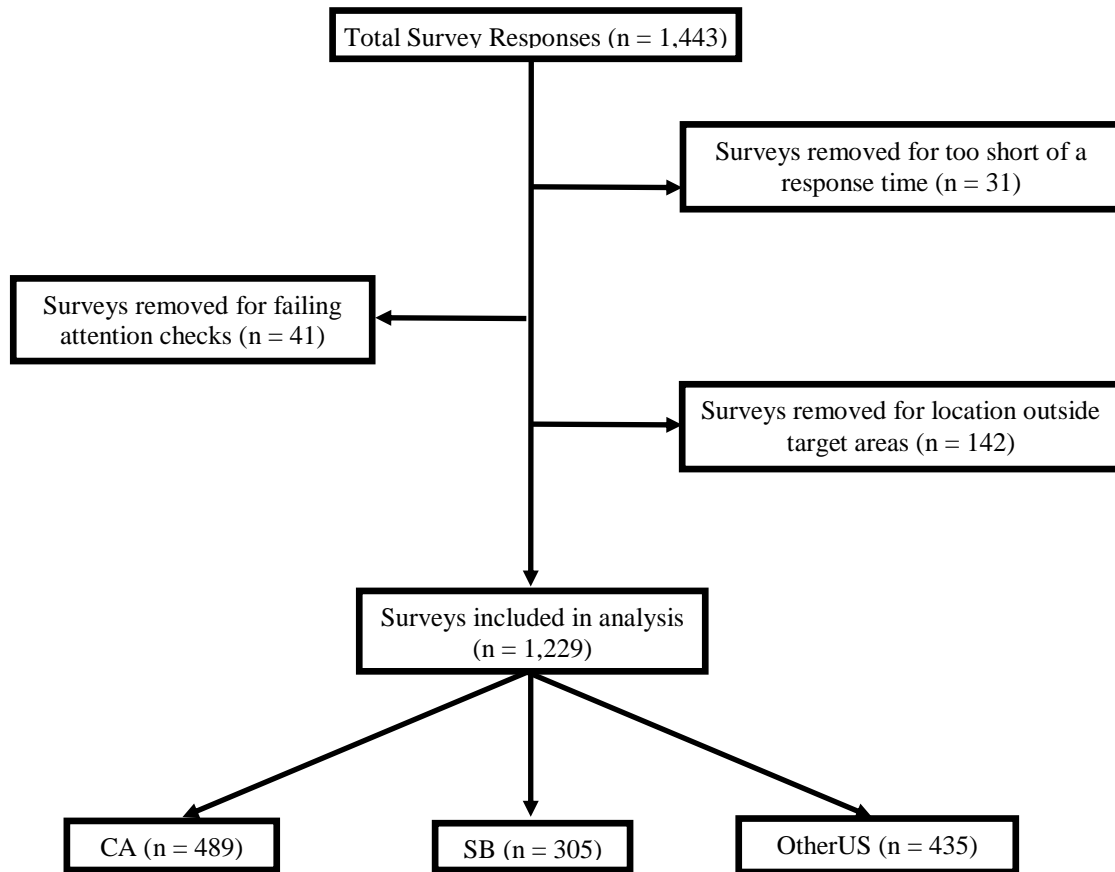
\*\* p-value <.01

\*\*\* p-value <.001

- Not applicable

**Figure Legend:** Survey responses were collected through Amazon Mechanical Turk. A total of 1,443 responses were collected, and 31 were removed for completing the survey in less than 90 seconds, 41 were removed for failing to pass attention check questions located within the survey, and 142 surveys were rejected for not being located within the US. A total of 1,229 surveys were used for analysis, with 489 from California, 305 from the Stroke Belt, and 435 from other locations within the United States.

Figure 1: Data collection and exclusion flow chart



#### **4. Discussion**

Mediterranean diet adherence and factors influencing adherence has not previously been measured across the geographical regions of the United States, so we developed a survey to assess MD adherence, perceived benefits & barriers of the MD, and participants' stage of change towards adopting the MD and distributed it using Amazon MTurk to participants in CA, the SB, and the rest of the United States. In the present study, the majority of respondents had at least an associate's degree, and there were no significant differences between groups in relation to education, which has been associated with nutrition knowledge and adherence (16). However, 64.8% of participants were within the typical MTurk worker population age range of 25-44 years old. MTurk worker populations have been shown to be more diverse than typical student or internet samples without any significant differences in the quality of the data (32,33). The survey utilized multiple practices suggested by Kees et al. for high quality MTurk data (33) including utilizing location to check respondents' locations, specifying a required previous acceptance rate of at least 90%, offering greater compensation than other surveys, including three attention checks throughout the survey, and implementing a minimum time requirement. MTurk worker demographics are typically male, younger, have higher education, and make less money than a true representative sample of the United States; yet, the population in the present study had a greater percentage of female respondents than previously reported in MTurk populations (32–34).

MD adherence scores were significantly lower in both the SB and OtherUS groups compared to the CA group. Our findings are consistent with the observation that California has recently been identified as a hot spot for MD adherence while the southeast US was identified as a cold spot (31). This is also consistent with the impact of diet in the SB on

stroke risk. The CARDIA study found over a 7 year period that participants in Oakland, California had significantly lower BP than those in Birmingham, Alabama and concluded that elevated blood pressure in Alabama is a contributing factor to its position in the SB (35). The MD is recommended as a way to lower or control blood pressure, and lower adherence in the SB could be contributing to the elevated blood pressure (9)

The lower MD adherence scores in the SB are also consistent with the observation that the MD is effective for maintaining a healthy weight (5), and that the rate of obesity in California is the 4th lowest in the U.S. (36), while the prevalence of obesity in the SB is significantly greater than the rest of the U.S. (13). Our results demonstrating significantly greater percentage of obesity in the SB group compared to the CA and OtherUS groups is consistent with US regional obesity prevalence (36). We found that participants with bachelor's or master's degrees were more likely to follow a MD compared to those with lower education, which confirms previous results correlating greater education with more willingness to adopt a MD in Spain (16) and with MD adherence in Alabama (21). Obese participants had lower MD adherence, confirming that those who are obese are less likely to follow the MD (37).

All four perceived barriers (knowledge, convenience, sensory appeal, and health) were considered significant barriers to the MD in the SB group compared to the CA group when controlled for all demographic factors. Our results demonstrate that regional differences in barriers to the MD exist in the US. Previous examinations of barriers towards adopting the MD in Spain and Europe found that sensory appeal, knowledge, and convenience were also significant reasons people were reluctant to adopt the MD (37); and Pitts et al. identified access and convenience as the primary roadblock towards adopting healthier diets in the SB (38). The perceived health barrier had the greatest decrease in the SB group compared to CA



group, specifying that the participants in this SB group considered the MD to be unhealthy due to a lack of protein, iron, energy, or general lack of health benefits. These results suggest that participants in the SB are misinformed on the health benefits of the MD. Knowledge of the MD is a unique barrier to the MD in the United States; as we observed in the SB and OtherUS groups a lack of understanding about the diet itself that European countries do not share. Convenience was also a significant barrier towards the MD in the OtherUS group, indicating that outside of California, the MD is considered inconvenient to follow. Indeed, commodity organizations in California are actively promoting the MD by marketing it as an easy, healthful way to eat (30) which could be influencing the perceived barrier inconvenience for participants living in California compared to the SB.

In the perceived benefits, the feasibility & ethics factor was the only benefit that was significantly different between the SB and CA groups. Within this factor, the only two questions that were significant across all three models in the SB were “Eat foods that are like the foods I ate when I was a child” and “Save money”, indicating that participants in the SB were significantly more likely to consider the MD to be unfamiliar and expensive. “Eat foods that are easy to plan, buy, and prepare” was also significant in Model 3 in the SB, so convenience is an issue as well. There was no significant difference in perception of benefit factors between CA and OtherUS, suggesting that these beliefs are unique to the SB.

When evaluating differences in the number of participants in each stage of change between groups, only Decided Yes and Action/Maintenance had significant differences. The largest proportion of Decided Yes participants were in the CA group, while the lowest was in the OtherUS group. However, the greatest number of people in the Action/Maintenance stage was in the OtherUS group, and the lowest number was in the SB group. This is consistent

with current data on MD hotspots in the U.S. (10). CA is a significant hotspot for the MD, while other regions of the U.S. like New England are also hotspots while the majority of the southeast is a coldspot. Logistic regression analysis of stage of change suggested that in the CA group, those with any level of education greater than a GED were at least two times more likely to be in the Action/Maintenance stage and had a significantly lower OR of being in the Unaware/Unengaged stage. Previous studies have shown a correlation between education and nutrition knowledge, and these results confirm with previous findings (4). Obese individuals in this group were also less likely to be in the Action/Maintenance stage, indicating that education and weight status are indicators of stage of change towards adopting a MD diet. Those who are obese and have lower levels of education are more likely to be in Unaware/Unengaged stage.

In the SB group, the only demographic variable that played a significant role in participant's stage of change was obesity. Obese participants were 5.46 times more likely to be in the Decided Yes stage. This is consistent with our findings from the MD adherence scores that demographic factors have less influence than region in the SB.

OtherUS participants were 6.48 times more likely to be in the Decided No category if the participant had a GED, confirming previous findings that those with lower education were less likely to follow a MD. Chinese and Other ethnicity respondents were also 5.04 and 3.95 times more likely to be in the Decided No category. In both the CA and OtherUS groups, female and Black participants were significantly more likely to be in the Action/Maintenance stage.

This survey was most notably limited by the MTurk population. While there were no significant differences between groups that are believed to have influenced results, the

MTurk population is not representative of the United States. Participants' locations for grouping were determined by locations recorded by Qualtrics, however it is possible that respondents were traveling or not native to the location where they took the survey which could lead to them being incorrectly sorted into one group. The present survey also did not directly assess MD knowledge, which could play a role in perceptions of the MD and perceived benefits or barriers. Stage of change and MD adherence data were self-reported and could be influenced by self-selection into the study or personal bias.

## **5. Conclusion**

Overall, the SB and OtherUS groups were determined to have less MD adherence than CA. The significant barriers to the MD in the SB group were knowledge of the diet, convenience, sensory appeal, and health beliefs. In the OtherUS group, only knowledge and convenience were significant barriers compared to the CA group. Participants in the SB group were significantly less likely to report ethics & feasibility to be benefits of the MD. When assessing participants' stage of change towards adopting a MD, the greatest number of Decided Yes participants were in the CA group and the lowest number of Action/Maintenance participants were in the SB group. Demographic factors including BMI, sex, and education significantly influenced participants' stage of change towards adopting the MD as well. Our data suggests that future nutrition education interventions should be aimed at improving knowledge about the MD and its health benefits and ways to make it more convenient, as well as target those who are older and have less formal education in the Stroke Belt. In conclusion, this study identifies key barriers and benefits of the MD in the SB which can inform future targeted MD intervention studies.

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Supplemental Table 1: Mediterranean Diet Adherence Screener

Check the box that applies

We would like to ask you a few questions about your diet:

1. Do you use olive oil as main culinary fat?	Yes	No	
	<input type="checkbox"/>	<input type="checkbox"/>	
2. How many tablespoons of olive oil do you consume in a given day (including oil used for frying, salads, out-of-house meals, etc.)?	<1	1-4	>4
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. How many vegetable servings do you consume per day? (1 serving: ½ cup cooked, 1 cup raw [consider side dishes as half a serving])	<1	1-2	>2
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. How many fruit units (including natural fruit juices) do you consume per day? (1 serving: 1 cup)	<1	1-3	>3
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. How many servings of red meat, hamburger, or meat products (ham, sausage, etc.) do you consume per day? (1 serving: 2-3 ounces)	<1	1-3	>3
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. How many servings of butter, margarine, or cream do you consume per day? (1 serving: 1 tablespoon)	<1	1-3	>3
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. How many sweet or carbonated beverages do you drink per day?	<1	1-3	>3
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. How many glasses of wine do you drink per week?			
<input type="checkbox"/> Red <input type="checkbox"/> White <input type="checkbox"/> Both	<2	2-7	>7
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. How many servings of legumes (beans, black eyed peas) do you consume per week? (1 serving: 1 cup)	<1	1-3	>3
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. How many servings of fish or shellfish do you consume per week? (1 serving: 2-3 ounces of fish or 3 ounces of shellfish)	<1	1-3	>3
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. How many times per week do you consume commercial sweets or pastries (not homemade), such as cakes, cookies, biscuits, or custard?	<3	3-5	>5
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. How many servings of nuts (including peanuts) do you consume per week? (1 serving: ¼ cup)	<1	1-3	>3
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Do you preferentially consume chicken, turkey, or rabbit meat instead of veal, pork, hamburger, or sausage?	Yes	No	
Are you a vegetarian or vegan? <input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/>	<input type="checkbox"/>	
14. How many times per week do you consume boiled vegetables, pasta, rice, or other dishes with a sauce of tomato, garlic, onion, or leeks without meat sautéed in olive oil?	<1	1-2	>2
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Supplemental Table 2: Stage of changes questions and benefits and barriers section

The next set of questions and responses are based on your knowledge, attitudes, and beliefs about a Mediterranean-based diet.

In this survey a Mediterranean-based diet is characterized by a high intake of fruit, vegetables, olive oil, nuts, and cereals; a moderate intake of fish and poultry; a low intake of dairy products, red meat, processed meats, and sweets; and wine in moderation, consumed with meals.

Check the box that applies.

1. Have you ever heard of about a Mediterranean-based diet?
<input type="checkbox"/> Yes [if you checked Yes, go to Question 2]
<input type="checkbox"/> No
2. Are you currently eating a Mediterranean-based diet?
<input type="checkbox"/> Yes
<input type="checkbox"/> No [if you checked No, go to Question 3]
3. Which best describes your thoughts about eating a Mediterranean-based diet?
<input type="checkbox"/> I've never thought about it.
<input type="checkbox"/> I'm undecided about it.
<input type="checkbox"/> I've decided I don't want to eat it.
<input type="checkbox"/> I've decided I do want to eat it.

For next set of questions check the box to indicate whether you agree or disagree with the statements below.

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
4. I need more information about a Mediterranean-based diet.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. I do not think about the nutritional aspects of the types of foods I eat.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. I find there are a lot of conflicting messages concerning healthy eating.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. It would be too expensive to eat Mediterranean-based diet foods.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. My family/partner won't eat a Mediterranean-based diet.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Mediterranean-based diet meals or snacks are not available when I eat out.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Someone else decides on most of the foods I eat.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. It takes too long to prepare Mediterranean-based diet meals.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. I don't want to change my eating habit or routine.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. I don't have enough willpower to eat a Mediterranean-based diet.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. I don't know how to prepare Mediterranean-based diet meals.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. A Mediterranean-based diet would not be tasty enough.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. There is not enough protein in a Mediterranean-based diet.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. If I eat a Mediterranean-based diet, it would not be filling enough.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

18.	If I eat a Mediterranean-based diet, I would miss eating lots of junk.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19.	There is not enough iron in a Mediterranean-based diet.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20.	If I eat a Mediterranean-based diet, I would be worried about my health.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21.	If I eat a Mediterranean-based diet, I wouldn't get enough energy or strength.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**For next set of responses, check the box to indicate whether you agree or disagree with the completion of the following sentence:**

**By eating a Mediterranean-based diet, I will ...**

		Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
22.	Decrease my saturated fat intake	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23.	Improve my digestion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24.	Be fit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25.	Have a better quality of life	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26.	Live longer	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27.	Be healthier by decreasing my intake of chemicals, steroids, and antibiotics that are found in meat	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28.	Eat more fruits and vegetables	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29.	Reduce my chances of developing major diseases	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30.	Eat high protein foods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31.	Eat foods high in fiber and roughage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32.	Eat foods to help me control my weight	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33.	Use olive oil which is more healthy for me and/or my family	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34.	Help the environment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
35.	Help animal welfare / rights	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
36.	Eat foods that contains natural ingredients	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
37.	Eat foods that are easy to plan, buy, and prepare	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
38.	Eat foods that are familiar	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
39.	Eat foods that are like the foods I ate when I was a child	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
40.	Save money	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
41.	Eat foods that are good value for money	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
42.	foods that tastes better than processed foods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
43.	Use olive oil to improve the taste of cooked meals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
44.	Eat a greater variety of foods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
45.	Be more content with myself	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
46.	Eat foods to help me cope with stress	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
47.	Eat foods to make me feel good	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Supplemental Table 3: Original 100 barrier and benefits questions with factors and sources

Type	Factor	Question	Source
<i>Barrier</i>			
Price		[Mediterranean diets] are expensive	Lee & Yun, 2015 (22)
Price		The price of [the Mediterranean diet] is high	Lee & Yun, 2015
Knowledge		I need more information about [Mediterranean] diets	Lea, Crawford, Worsley, 2006 (23)
Accessibility		I don't want to change my eating habit or routine	Lea, Crawford, Worsley, 2006
Accessibility		My family/partner won't eat a [Mediterranean] diet	Lea, Crawford, Worsley, 2006
Accessibility		[Mediterranean] meals or snack are not available when I eat out	Lea, Crawford, Worsley, 2006
Accessibility		There is not enough choice when I eat out	Lea, Crawford, Worsley, 2006
Accessibility		I don't have enough willpower	Lea, Crawford, Worsley, 2006
Accessibility		Someone else decides on most of the food I eat	Lea, Crawford, Worsley, 2006
Price		It would be too expensive	Lea, Crawford, Worsley, 2006
Knowledge		I don't want to eat strange or unusual foods	Lea, Crawford, Worsley, 2006
Accessibility		I would have to go food shopping too often	Lea, Crawford, Worsley, 2006
Health		There is not enough protein in them	Lea, Crawford, Worsley, 2006
Health		I would get indigestion, bloating, gas, or flatulence	Lea, Crawford, Worsley, 2006
Health		It would not be filling enough	Lea, Crawford, Worsley, 2006
Health		I would miss eating lots of junk	Lea, Crawford, Worsley, 2006
Health		There is not enough iron in them	Lea, Crawford, Worsley, 2006
Health		I would be worried about my health	Lea, Crawford, Worsley, 2006
Accessibility		It is inconvenient	Lea, Crawford, Worsley, 2006
Accessibility		I don't know how to prepare [Mediterranean diet] meals	Lea, Crawford, Worsley, 2006
Health		I wouldn't get enough energy or strength	Lea, Crawford, Worsley, 2006
Taste		It would not be tasty enough	Lea, Crawford, Worsley, 2006
Accessibility		I would need to eat such a large quantity of plant foods	Lea, Crawford, Worsley, 2006
Health		I think humans are meant to eat lots of meat	Lea, Crawford, Worsley, 2006
Accessibility		The foods I would need aren't available where I shop	Lea, Crawford, Worsley, 2006
Knowledge		I don't know what to eat instead of lots of meat	Lea, Crawford, Worsley, 2006
Accessibility		It takes too long to prepare [Mediterranean diet] meals	Lea, Crawford, Worsley, 2006
Worry		I don't want people to think I'm strange or a hippy	Lea, Crawford, Worsley, 2006
Worry		I do not worry about food, I just eat what I like.	Pettinger, Holdsworth, Gerber, 2004 (24)
Knowledge		I do not think about the nutritional aspects of the types of food I eat	Pettinger, Holdsworth, Gerber, 2004
Accessibility		It would be difficult for me to change my eating habits	Pettinger, Holdsworth, Gerber, 2004
Accessibility		My lifestyle prevents me from eating a healthy and balanced diet	Pettinger, Holdsworth, Gerber, 2004
Accessibility		My choice of food is generally influenced by habit	Pettinger, Holdsworth, Gerber, 2004
Knowledge		I find there are a lot of conflicting messages concerning healthy eating	Pettinger, Holdsworth, Gerber, 2004
Enjoyment		[Mediterranean] diets are boring	Lea & Worsley, 2002 (25)

<i>Benefit</i>	The Med Diet will...	
Health	Decrease my saturated fat intake	Lea, Crawford, Worsley, 2006 (23)
Health	Eat more fiber	Lea, Crawford, Worsley, 2006
Health	Prevent disease in general (e.g. heart disease, cancer)	Lea, Crawford, Worsley, 2006
Natural Content	Eat a more 'natural' diet	Lea, Crawford, Worsley, 2006
Health	Have lots of vitamins and minerals	Lea, Crawford, Worsley, 2006
Health	Stay healthy	Lea, Crawford, Worsley, 2006
Health	Control my weight	Lea, Crawford, Worsley, 2006
Health	Improve my digestion	Lea, Crawford, Worsley, 2006
Variety	Eat a greater variety of foods	Lea, Crawford, Worsley, 2006
Health	Be fit	Lea, Crawford, Worsley, 2006
Health	Have a better quality of life	Lea, Crawford, Worsley, 2006
Health	Have plenty of energy	Lea, Crawford, Worsley, 2006
Sensory Appeal	Have a tasty diet	Lea, Crawford, Worsley, 2006
Mood	Be more content with myself	Lea, Crawford, Worsley, 2006
Health	Lower my chances of getting food poisoning	Lea, Crawford, Worsley, 2006
Ethical Concern	Help the environment	Lea, Crawford, Worsley, 2006
Ethical Concern	Help animal welfare / rights	Lea, Crawford, Worsley, 2006
Ethical Concern	Increase efficiency of food production	Lea, Crawford, Worsley, 2006
Ethical Concern	Decrease hunger in the Third World	Lea, Crawford, Worsley, 2006
Price	Save money	Lea, Crawford, Worsley, 2006
Convenience	Save time	Lea, Crawford, Worsley, 2006
Convenience	Have fewer food storage problems	Lea, Crawford, Worsley, 2006
Social	Appear more 'trendy' to my friends	Lea, Crawford, Worsley, 2006
Health	I think [Mediterranean] foods are healthier than regular foods	Pettinger, Holdsworth, Gerber, 2004 (24)
Sensory Appeal	I think [Mediterranean] foods taste better than processed foods	Pettinger, Holdsworth, Gerber, 2004
Sensory Appeal	Using Olive oil improves the taste of salads	Thompson, Haziris, Alekos, 1994 (26)
Sensory Appeal	Using olive oil improves the taste of cooked meals	Thompson, Haziris, Alekos, 1994
Health	Using olive oil is more healthy for me and/or my family	Thompson, Haziris, Alekos, 1994

<i>Benefit</i>	<i>By following the Med diet, I will:</i>	
Health	Increase my control over my own health	Lea & Worsley, 2002 (25)
Health	Live longer	Lea & Worsley, 2002
Health	Be healthier by decreasing my intake of chemicals, steroids, and antibiotics that are found in meat	Lea & Worsley, 2002
Health	Eat more fruits and vegetables	Lea & Worsley, 2002
Health	By eating the right kinds of foods, people can reduce their chances of developing major diseases	Harnack, Block, Subar, Lane, Brand, 1997 (15)

Sensory Appeal Plenty of [Mediterranean based] foods taste good

Harnack, Block, Subar, Lane, Brand, 1997

*Benefit*

*The Med Diet:*

---

Health	Keeps me healthy	Steptoe, Pollard, Wardle, 1995 (27)
Health	Is nutritious	Steptoe, Pollard, Wardle, 1995
Health	Is high in protein	Steptoe, Pollard, Wardle, 1995
Health	Is good for my skin/ teeth/ hair/ nails etc.	Steptoe, Pollard, Wardle, 1995
Health	Is high in fiber and roughage	Steptoe, Pollard, Wardle, 1995
Mood	Helps me cope with stress	Steptoe, Pollard, Wardle, 1995
Mood	Helps me cope with life	Steptoe, Pollard, Wardle, 1995
Mood	Helps me relax	Steptoe, Pollard, Wardle, 1995
Mood	Keeps me awake / alert	Steptoe, Pollard, Wardle, 1995
Mood	Cheers me up	Steptoe, Pollard, Wardle, 1995
Mood/ Health	Makes me feel good	Steptoe, Pollard, Wardle, 1995
Convenience	Is easy to prepare	Steptoe, Pollard, Wardle, 1995
Convenience	Can be cooked very simply	Steptoe, Pollard, Wardle, 1995
Convenience	Can be bought in shops close to where I live or work	Steptoe, Pollard, Wardle, 1995
Convenience	Is easily available in shops and supermarkets	Steptoe, Pollard, Wardle, 1995
Sensory Appeal	Smells nice	Steptoe, Pollard, Wardle, 1995
Sensory Appeal	Looks nice	Steptoe, Pollard, Wardle, 1995
Sensory Appeal	Has a pleasant texture	Steptoe, Pollard, Wardle, 1995
Sensory Appeal	Tastes good	Steptoe, Pollard, Wardle, 1995
Natural Content	Contains natural ingredients	Steptoe, Pollard, Wardle, 1995
Natural Content	Contains no artificial ingredients	Steptoe, Pollard, Wardle, 1995
Price	Is not expensive	Steptoe, Pollard, Wardle, 1995
Price	Is good value for money	Steptoe, Pollard, Wardle, 1995
Health	Helps me control my weight	Steptoe, Pollard, Wardle, 1995
Familiarity	Is what I usually eat	Steptoe, Pollard, Wardle, 1995
Familiarity	Is familiar	Steptoe, Pollard, Wardle, 1995
Familiarity	Is like the food I ate when I was a child	Steptoe, Pollard, Wardle, 1995
Convenience	Is easy to plan, buy, and prepare	Pieniack, Verbeke, Vanhonacker Guerrerno, Hersleth, 2009 (28)

## Supplemental Table 4: Barrier Questions with Factors

### *Knowledge*

---

- I need more information about a Mediterranean-based diet.
- I do not think about the nutritional aspects of the types of foods I eat.
- I find there are a lot of conflicting messages concerning healthy eating.
- I don't know how to prepare Mediterranean-based diet meals.

### *Convenience*

---

- My family/partner won't eat a Mediterranean-based diet.
- Mediterranean-based diet meals or snacks are not available when I eat out.
- Someone else decides on most of the foods I eat.
- It takes too long to prepare Mediterranean-based diet meals.

### *Sensory Appeal*

---

- A Mediterranean-based diet would not be tasty enough.
- If I eat a Mediterranean-based diet, it would not be filling enough.
- If I eat a Mediterranean-based diet, I would miss eating lots of junk.

### *Health*

---

- There is not enough protein in a Mediterranean-based diet.
- There is not enough iron in a Mediterranean-based diet.
- If I eat a Mediterranean-based diet, I would be worried about my health.
- If I eat a Mediterranean-based diet, I wouldn't get enough energy or strength.

### *Price*

---

- It would be too expensive to eat Mediterranean-based diet foods.

### *Familiarity*

---

- I don't want to change my eating habit or routine.

### *Mood*

---

- I don't have enough willpower to eat a Mediterranean-based diet.

## Supplemental Table 5: Benefit Questions with Original Factors

---

### *Health*

---

Decrease my saturated fat intake  
Improve my digestion  
Have a better quality of life  
Live longer  
Eat more fruits and vegetables  
Reduce my chances of developing major diseases  
Eat high protein foods  
Eat foods high in fiber and roughage  
Use olive oil which is more healthy for me and/or my family  
Eat a greater variety of foods

---

### *Weight Loss*

---

Be fit  
Eat foods to help me control my weight

---

### *Natural Content*

---

Be healthier by decreasing my intake of chemicals, steroids, and antibiotics that are found in meat  
Eat foods that contains natural ingredients

---

### *Ethical Concerns*

---

Help the environment  
Help animal welfare / rights

---

### *Convenience*

---

Eat foods that are easy to plan, buy, and prepare

---

### *Familiarity*

---

Eat foods that are familiar  
Eat foods that are like the foods I ate when I was a child

---

### *Price*

---

Save money  
Eat foods that are good value for money

---

### *Sensory Appeal*

---

Eat foods that tastes better than processed foods  
Use olive oil to improve the taste of cooked meals

---

### *Mood*

---

Be more content with myself  
Eat foods to help me cope with stress  
Eat foods to make me feel good



Supplemental Table 6: Demographic and anthropomorphic questions

Finally, we would like to ask you a few questions about yourself

1. Are you male or female?
  - a) Male
  - b) Female
  
2. How old are you?
  - a) less than 18
  - b) 18-24
  - c) 25-34
  - d) 35-44
  - e) 45-54
  - f) 55-64
  - g) 65-74
  - h) more than 75
  
3. What is your ethnic origin?
  - a) White
  - b) Black African
  - c) Black other
  - d) Indian
  - e) Pakistani
  - f) Chinese
  - g) Asian- other
  - Please specify:.....*
  - h) Any other ethnic group
  - Please specify:.....*
  
4. What is the highest level of education you have completed?
  - a) Elementary school
  - b) Middle school
  - c) High school diploma
  - d) GED
  - e) Technical or trade certificate
  - f) Associate degree
  - g) Bachelor's degree
  - h) Master's or professional degree
  
5. Do you have any health or nutrition related qualifications?
  - a) Yes
  - Please specify: .....*
  - b) No
  
6. What is your body weight?  
*Please specify: .....*
  
7. What is your height?  
*Please specify: .....*

Supplemental Table 7: Benefit questions after factor analysis

<b>Factors and Questions</b>	<b>Loadings<sup>‡</sup></b>
<i>Factor 1: Quality of Life</i>	
Have a better quality of life	.731
Live longer	.699
Eat high protein foods	.447
Be fit	.717
Be more content with myself	.601
Eat foods to help me cope with stress	.638
<i>Factor 2: Healthy Diet</i>	
Decrease my saturated fat intake	.650
Eat more fruits and vegetables	.679
Eat foods high in fiber and roughage	.586
Be healthier by decreasing my intake of chemicals, steroids, and antibiotics that are found in meat	.603
Eat foods that contains natural ingredients	.638
<i>Factor 3: Ethics &amp; Feasibility</i>	
Help animal welfare / rights	.532
Eat foods that are easy to plan, buy, and prepare	.633
Eat foods that are like the foods I ate when I was a child	.650
Save money	.803
Eat foods that are good value for the money	.730
<i>Factor 4: Improved Taste</i>	
Eat a greater variety of foods	.570
Eat foods that tastes better than processed foods	.730
Use olive oil to improve the taste of cooked meals	.715

<sup>‡</sup>Factor analysis loadings for each question using Varimax rotation method with Kaiser Normalization

Supplemental Table 8: Multivariate analysis of questions within the Ethics & Feasibility factor between geographic groups

	CA	SB			Other US		
		$\beta$	SE	P-value	B	SE	P-value
<i>Help animal welfare/rights</i>							
Model 1 <sup>†</sup>	Ref	-0.055	0.085	.521	0.114	0.077	.139
Model 2 <sup>††</sup>	Ref	-0.062	0.086	.471	0.133	0.078	.086
Model 3 <sup>†††</sup>	Ref	-0.032	0.090	.724	0.141	0.080	.074
<i>Eat foods that are easy to plan, buy, and prepare</i>							
Model 1	Ref	-0.154	0.080	.053	0.045	0.072	.528
Model 2	Ref	-0.152	0.080	.060	0.048	0.073	.512
Model 3	Ref	-0.178	0.084	<b>.035</b>	-0.002	0.075	.978
<i>Eat foods that are like the foods I ate when I was a child</i>							
Model 1	Ref	-0.325	0.096	<b>&lt;.001</b>	0.031	0.087	.720
Model 2	Ref	-0.301	0.096	<b>.002</b>	0.039	0.087	.653
Model 3	Ref	-0.335	0.101	<b>&lt;.001</b>	-0.006	0.090	.948
<i>Save money</i>							
Model 1	Ref	-0.254	0.084	<b>.003</b>	-0.021	0.076	.785
Model 2	Ref	-0.247	0.085	<b>.004</b>	-0.020	0.077	.796
Model 3	Ref	-0.257	0.089	<b>.004</b>	-0.041	0.080	.608
<i>Eat foods that are good value for the money</i>							
Model 1	Ref	-0.098	0.079	.214	-0.117	0.079	.214
Model 2	Ref	-0.099	0.079	.211	-0.115	0.072	.107
Model 3	Ref	-0.095	0.083	.252	-0.130	0.075	.081

\* p values < 0.05 are indicated in bold font

<sup>†</sup> Model 1 (unadjusted)

<sup>††</sup> Model 2 (adjusted for sex and age)

<sup>†††</sup> Model 3 (adjusted for sex, age, ethnicity, education, and BMI)