

## Original Article

# Long-term adoption of a Mediterranean diet is associated with a better health status in elderly people; a cross-sectional survey in Cyprus

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**Background:** There is increasing evidence that there are protective health effects from diets which are high in fruits, vegetables, legumes, and whole grains, and which include fish, nuts, and low-fat dairy products. We sought to investigate the association of Mediterranean diet on clinical status of 150 elderly men and women.

**Methods:** During 2004 - 2005, we studied 53 men and 97 women, aged 65 to 100 years, from various areas of Cyprus. A diet score that assesses the inherent characteristics of the Mediterranean diet was developed for each individual (range 0-55). Adoption of the Mediterranean diet was evaluated against the presence of cardiovascular risk factors like hypertension, diabetes, hypercholesterolemia and obesity.

**Results:** 26% of men and 18% of women had diabetes, 60% of men and 58% of women had hypertension, 60% of men and 68% of women had hypercholesterolemia, and 34% of men and 52% of women were obese. More than 90% of the participants reported consistency in their dietary habits for at least the past 3-4 decades. A significant inverse correlation was observed between diet score and the number of the investigated risk factors ( $\rho = -0.26, p < 0.001$ ). When we took into account age, sex, smoking habits, and physical activity status, we observed that a 10-unit increase in the diet score was associated with 21% lower odds of having one additional risk factor in women ( $p < 0.001$ ) and with 14% lower odds in men ( $p = 0.05$ ).

**Conclusion:** Adherence to a Mediterranean diet is associated with reduced odds of having hypercholesterolemia, hypertension, diabetes and obesity among elderly people.

**Key Words:** hypertension, hypercholesterolemia, diabetes, obesity, Mediterranean diet, elderly

## Introduction

There is increasing scientific evidence that there are protective health effects from diets that are high in fruits, vegetables, legumes and whole grains, and which include fish, nuts, and low-fat dairy products. The traditional Mediterranean diet, whose principal source of fat is olive oil, encompasses all these dietary characteristics.<sup>1-4</sup> During the past decades a large body of evidence favorably related Mediterranean diet and all cause mortality, as well as incidence of coronary heart disease and various types of cancer.<sup>3-5</sup> The term traditional "Mediterranean diet" has a specific meaning. It reflects food patterns typical of some Mediterranean regions in the early 1960's, such as Crete, parts of the rest of Greece, Spain and southern Italy.<sup>1</sup> In general, the traditional Mediterranean diet is characterized by a pattern that is high in fruits, vegetables, cereals, potatoes, poultry, beans, nuts, lean fish, little red meat, dairy products, moderate alcohol consumption and olive oil as an important fat source. It is, also, characterized by moderate consumption of red or white wine (i.e. no more than 100 - 200 ml per day) and almost always during meals.<sup>6</sup> In addition, although intake of milk is moderate, the consumption of cheese and yogurt is high. "Feta" cheese is regularly added to salads and accompanies vegetable stews. As much as can be determined this diet is low in saturated fat (less than or

equal to 7-8% of energy), with total fat ranging from less than 25% to more than 35% of energy from one area to another. The high monounsaturated - to - saturated fat ratio is greater than two.<sup>6</sup> However, it is hard to define Mediterranean diet as a common characteristic of the Mediterranean countries, since differences exist as regards the dietary patterns. For example, the Italian variant of the Mediterranean diet is characterized by higher consumption of pasta, whereas in Spain, fish consumption is particularly high. In Greece, foods include large quantities of whole grain bread, cooked foods as well as salads rich in olive oil, in which vegetables and legumes are consumed in large amounts.<sup>6-8</sup>

Nevertheless, in all instances the ratio of monounsaturated to saturated lipids is much higher than in northern Europe and North America.

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Although there is evidence that a Mediterranean diet benefits human health, and particularly reduces the risk of cardiovascular disease and cancer, the data for elderly people are sparse. Given the lack of current data regarding the association between the Mediterranean diet and various health outcomes, we investigated the effect of this dietary pattern in Cyprus on the likelihood of having hypertension, hypercholesterolemia, diabetes and obesity, in a random sample of 65 years and older adults without any clinical evidence of cardiovascular disease.

## Materials and methods

### *Population of the study*

This study is a health and nutrition survey, which is being carried out in various areas of Cyprus (Arsos, Lemessos, Pachna, Pafos, Empa, Kallepia, Yeroskipou). From November 2004 to May 2005, 188 men and women, 65 years and older, and without any clinical history of cardiovascular disease were selected. Of them, 53 men and 97 women agreed, with informed consent, to participate (80% participation rate). People living in institutions were excluded from the study. The sampling was random and multistage according to the population of each city. All participants were interviewed by specialists who used a standard questionnaire. The number of enrolled participants is adequate to evaluate standardised differences between the investigated parameters greater than 0.5, achieving statistical power  $> 0.80$  at  $< 0.05$  probability level ( $p$ -value).

### *Clinical characteristics*

In this work special attention was given to people with hypercholesterolemia, hypertension, diabetes and obesity. In particular, hypercholesterolemia was defined as total serum cholesterol levels greater than 200 mg / dl or the use of lipid-lowering agents. High and low density lipoprotein (HDL, LDL) cholesterol and triglycerides levels were obtained. Hypertension was defined as the use of anti-hypertensive medication or systolic / diastolic blood pressure measurements  $> 140/90$  mmHg (average of three measurements in the sitting position and calm). Diabetes mellitus (type 2) was defined according to the American Diabetes Association diagnostic criteria. In particular, all participants had a fasting plasma glucose test. Blood glucose levels greater than 125 mg/dl classified participants as having diabetes. Weight and height were measured and body mass index was calculated as weight (in kilograms) divided by standing height (in meters squared). Obesity was defined as body mass index  $> 29.9$  Kg / m<sup>2</sup>.

### *Dietary assessment*

Consumption from 15 food groups was assessed as an average per week during the past year through a semi-quantitative food - frequency questionnaire. The frequency of consumption was then quantified in terms of the number of times a month a food was consumed. Alcohol consumption was measured by daily ethanol intake, in wineglasses (100 ml and 12% ethanol concentration). Then we developed a dietary score according to the Mediterranean dietary pattern which consists of: (a) daily consumption: of non refined cereals and products (whole grain bread, pasta, brown rice, etc), vegetables (2 - 3 serv-

ings/day), fruits (6 servings/day), olive oil (as the main added lipid) and dairy products (1 - 2 servings/day), (b) weekly consumption: of fish (4 -5 servings/week), poultry (3 - 4 servings/week), olives, pulses, and nuts (3 servings/week), potatoes, eggs and sweets (3 - 4 servings/week) and monthly consumption: of red meat and meat products (4 - 5 servings/month). In particular, for the consumption of food items that are close to this dietary pattern we assigned score 0 for rare or no consumption, 1 for 1 to 4 times / month, 2 for 5 to 8 times, 3 for 9 to 12 times / month, 4 for 13 to 18 times / month and 5 for almost daily consumption. On the other hand, for the consumption of foods that are away from this traditional diet, like meat and meat products, we assigned the opposite scores (i.e. 0 for almost daily consumption to 5 for rare or no consumption). Higher values of the suggested dietary score (range 0 - 55) indicates adherence to the traditional Mediterranean diet (i.e. which is also characterized by moderate consumption of fat and high mono-unsaturated: saturated fat ratio).

### *Lifestyle habits*

To evaluate physical activity status of the patients during the past year, we used a modified short version of a self-reported questionnaire, the International physical activity questionnaire (IPAQ) for the elderly.<sup>9</sup> Based on this questionnaire we assessed the frequency (times per week), duration (in minutes per time) and intensity of sports or occupation related physical activity. Participants who did not report any physical activities were defined as sedentary. For the rest of the participants we calculated a combined score by multiplying the weekly frequency, duration and intensity of physical activity. The upper tertile of the score classified participants as "highly" physical active, the medium tertile as "moderately" active and the lowest tertile as "low" physical active. Finally, current smokers were defined as those who smoked at least one cigarette per day or have stopped cigarette smoking during the past 12 months. Former smokers were defined as those who had stopped smoking more than one year previously. The rest of them were defined as never smokers or rare smokers.

The study was approved by our Institution, and conducted in accordance with the internationally agreed ethical principles for medical research.

### *Statistical analysis*

Continuous variables are presented as mean values  $\pm$  standard deviation. The categorical variables are presented as absolute and relative (%) frequencies. Associations between continuous variables and group of participants were evaluated through the analysis of variance (ANOVA), after controlling for equality of variances. Due to multiple comparisons we applied the Bonferroni correction to correct for the inflation of Type - I error. Associations between categorical variables were tested by the use of the chi-squared test, without the correction of continuity. Correlations between continuous variables were tested by the use of Spearman's correlation coefficient. Ordinal multiple logistic regression analysis, with the calculation of the corresponding odds ratios, evaluated the association of the Mediterranean diet score on the

likelihood of having one or more of the investigated clinical characteristics. Proportionality of the odds ratios was tested using the chi-square test.  $p < 0.05$  for two-sided hypotheses was considered as significant. All statistical calculations were performed on the SPSS version 12.0 software (SPSS Inc, Chicago, IL, U.S.A.).

### Results

The mean age of men and women was  $79 \pm 8$  years and  $75 \pm 7$  years, respectively. The reported years of schooling were  $5.7 \pm 2$  in men and  $4.0 \pm 2$  in women. Regarding the lifestyle habits, 45% of men and 50% of women reported none or low physical activity, while only 11% of men and 1% of women reported current smoking habits (47% of men and 1% of women reported former smoking). Concerning the investigated clinical characteristics data analysis showed that 26% of men and 18% of women had diabetes, 60% of men and 58% of women had hypertension, 60% of men and 68% of women had hypercholesterolemia, and 34% of men and 52% of women were obese (Table 1). Moreover, 77% of men and 83% of

women had at least one of the aforementioned characteristics, while 25% of men and women had 3 or more of these factors. All diabetic men and women were on special diet, 86% of men and 88% of women were also taken medication (like sulfonylureas, biguanides, alpha-glucosidase inhibitors etc.) and 1% of men and 11% of women were on insulin treatment; 37% of men and 53% of women with hypercholesterolemia were on special diet, 81% of men and 63% of women on pharmaceutical treatment, i.e. statin and / or diet and 8% of men and 7% of women were untreated; 16% of men and 30% of women consumed a special diet to manage their high blood pressure levels, while 60% of men and 58% of women were under antihypertensive medication.

Mean diet score was  $35 \pm 6$  in men and  $36 \pm 6$  women (no differences were observed between genders), which means that the level of adherence to the Mediterranean dietary pattern was 64% (i.e. diet score / 55 x 100 %). More than 9 out of 10 of the participants (i.e. 93% men and 95% women) reported that they followed the reported dietary habits for at least 30-40 years of their life.

**Table 1.** Clinical and anthropometric characteristics of the participants (% by gender)

	Men (n = 53)	Women (n = 97)	<i>p</i>
Diabetes mellitus (%)	26	18	0.20
Fasting blood glucose (mg/dl)	$130 \pm 60$	$127 \pm 57$	
Hypertension (%)	60	58	0.85
Systolic blood pressure (mmHg)	$141 \pm 15$	$136 \pm 15$	0.07
Diastolic blood pressure (mmHg)	$80 \pm 9$	$81 \pm 8$	0.53
Hypercholesterolemia (%)	60	68	0.34
Total serum cholesterol (mg/dl)	$217 \pm 38$	$234 \pm 42$	0.04
LDL cholesterol (mg/dl)	$134 \pm 19$	$146 \pm 32$	0.20
HDL cholesterol (mg/dl)	$47 \pm 9$	$57 \pm 14$	0.02
Triglycerides (mg/dl)	$167 \pm 75$	$141 \pm 62$	0.09
History of coronary heart disease (%)	11	5	0.20
Obesity (%)	34	52	0.03
Body mass index (kg/m <sup>2</sup> )	$29 \pm 4$	$30 \pm 6$	0.17
Waist circumference (cm)	$107 \pm 8$	$104 \pm 8$	0.11
Hip circumference (cm)	$107 \pm 7$	$113 \pm 11$	0.001
Waist to hip ratio	$1.00 \pm 0.06$	$0.92 \pm 0.05$	0.001

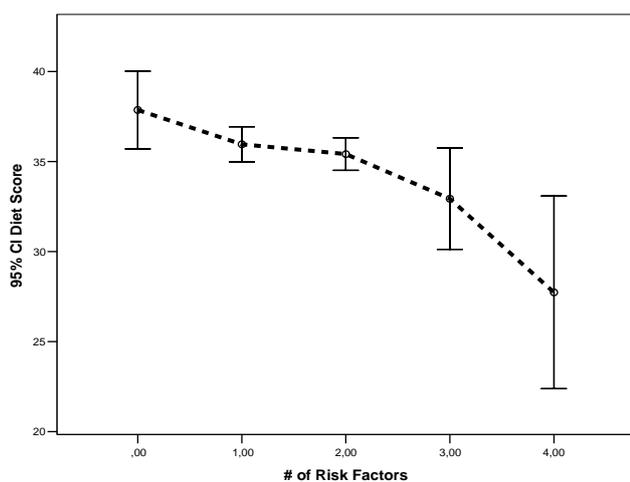
Data are presented as mean  $\pm$  standard deviation and relative frequencies (%).

**Table 2.** Results from ordinal logistic regression analysis that evaluated the association between adherence to the Mediterranean diet and presence of hypertension, hypercholesterolemia, diabetes and obesity

	b-coefficient	95% confidence interval	Odds ratio	<i>p</i>
Mediterranean diet score (per 10 units)	-0.186	-0.25 to -0.12	0.83	< 0.001
Age (years)	-0.071	-0.11 to -0.03	0.93	< 0.001
Male sex	0.488	-0.23 to 1.19	1.62	0.18
Smoking (y/n)	0.984	-0.07 to 2.04	2.66	0.06
Physical activity				
Low (reference category)	-	-	-	
Moderate	-0.053	-0.17 to 0.07	0.95	0.20
Vigorous	-0.042	-0.02 to 0.11	0.96	0.45

Mediterranean diet score was inversely correlated with body mass index ( $\rho = -0.18$ ,  $p = 0.02$ ), total cholesterol ( $\rho = -0.176$ ,  $p = 0.05$ ), triglycerides ( $\rho = -0.27$ ,  $p = 0.01$ ), glucose ( $\rho = -0.46$ ,  $p < 0.001$ ), and systolic blood pressure levels ( $\rho = -0.15$ ,  $p = 0.02$ ). An inverse correlation was also observed between diet score and the number of the investigated risk factors ( $\rho = -0.26$ ,  $p < 0.001$ ). When we took into account age, sex, smoking habits and physical activity status we observed that 10-unit increase in the diet score was associated with 17% lower odds of having one additional risk factor (Table 2). When we stratified our analysis by gender, the reduction in the odds was 21% in women ( $p < 0.001$ ) and 14% in men ( $p = 0.05$ ). Education status of the participants did not influence the previous relationships.

Finally we evaluated the association of the long term adherence to this dietary pattern on the likelihood of having hypertension, hypercholesterolemia, diabetes and obesity, separately. We observed that a 10-unit increase in the diet score was associated with a 6% lower odds of having hypertension ( $p = 0.06$ ), 9% lower odds of having hypercholesterolemia ( $p = 0.02$ ), 6% lower odds of having diabetes ( $p = 0.06$ ) and 12% lower odds of being obese ( $p = 0.001$ ), after adjusting for the aforementioned confounders.



**Figure 1.** Mean levels (and 95% CI) of the Mediterranean Diet score in relation to the number of the risk factors (hypertension, hypercholesterolemia, diabetes and obesity).

## Discussion

We evaluated the likelihood of having hypertension, hypercholesterolemia, diabetes and obesity in relation to the adoption of the Mediterranean dietary pattern, in elderly people. We observed that greater adherence to this pattern was associated with 21% lower odds of having one additional risk factor in women and with 14% lower odds in men. Moreover, adoption of the Mediterranean diet was associated with lower likelihood of having hypertension, hypercholesterolemia, diabetes and obesity, separately, and after adjusting for various potential confounders. Our findings carry an important public health message since long-term adoption of this dietary pattern seems to benefit people at increased age, and consequently reduce their cardiovascular risk and may prolong their life span.

According to the World Health Organization the standardised mortality rates from heart disease varies consid-

erably between northern and southern European populations.<sup>7</sup> Moreover, results from the 25-year follow up of the Seven Countries Study revealed that the prevalence of cardiovascular disease varied between 2 and 10% in southern European countries and between 10 and 18% in northern European countries. The Study's investigators attributed the differences in mortality rates between the 16 cohorts of the study in the nutritional habits of the participants and, especially, in the intake of saturated fatty acids and flavonoids.<sup>8</sup> The investigators of the Lyon Heart study have expanded the benefits of the Mediterranean diet on secondary prevention of cardiovascular disease.<sup>10</sup> In particular, the Lyon Heart study investigators studying 605 patients with myocardial infarction concluded that those who followed the Mediterranean diet had 50-70 % lower risk to recurrent heart disease, than the others who followed a diet similar to AHA Step-I diet. The CARDIO2000 investigators studying a sample of 848 middle aged and elderly patients with myocardial infarction and unstable angina and 1078 matched, by age and sex, controls from all Greek regions, reported that the adoption of Mediterranean diet was related with an adjusted 23% reduction of the risk of developing a first event of acute coronary syndromes.<sup>11</sup> In another work from the same study, the investigators reported that the adoption of Mediterranean diet was associated with a 7% to 10% reduction on the coronary risk in treated, untreated or uncontrolled hypertensive subjects.<sup>12</sup> The combination of Mediterranean diet and statin treatment was also associated with a 43% reduction of the coronary risk, independently from cholesterol levels and the other cardiovascular factors.<sup>13</sup> In a population-based study (the ATTICA study) that enrolled 3042 adult men and women from the Athens greater area the investigators observed that compared to normotensives, participants who had high blood pressure levels were less frequent to consume the traditional Mediterranean diet (35% vs. 64%,  $p = 0.02$ ).<sup>14</sup> Data analysis revealed that the consumption of Mediterranean diet was associated with 26% lower relative risk of being hypertensive, after adjusting for demographic, clinical and lifestyle variables. Additionally, well-controlled hypertensives consumed more frequently the Mediterranean diet than treated but uncontrolled hypertensives. Thus, the consumption of the Mediterranean diet was related to a 27% lower relative risk of being uncontrolled. Recently, in a prospective study involving 22043 middle age and older Greek adults the investigators reported that an inverse association with greater adherence to the Mediterranean diet was observed for coronary heart disease deaths.<sup>15</sup> In particular, approximately a 20% increment in the Mediterranean diet-score was associated with a 33% reduction in coronary heart disease mortality. These associations were evidences irrespective of sex, smoking status, level of education, body mass index, and level of physical activity. It is notable that the relation between the applied Mediterranean diet score and mortality was significant among participants 55 years of age or older, but not among younger participants. This association might reflect increasing cumulative exposure to a more healthy diet, i.e. the Mediterranean diet. Moreover, Trichopoulou *et al.* suggests that the Mediterranean dietary pattern when translated into other cultures

can use other food options (beyond olive oil) for increasing the intake of mono-unsaturated and poly-unsaturated fats, and as a consequence lead to similar effects in the health status of people.<sup>15</sup> In a review paper Trichopoulou concluded that the Mediterranean diet is positively associated with longevity among the elderly, and therefore the traditional Mediterranean diet represents a healthy nutritional pattern.<sup>16</sup> Kouris-Blazos *et al.*, studying 141 Anglo-Celts and 189 Greek-Australians of both sexes aged 70 years or more, concluded that a diet that adheres to the principles of the traditional Mediterranean diet was associated with longer survival irrespective of their origin.<sup>17</sup> Furthermore, Trichopoulou and colleagues in one of the few studies that assessed Mediterranean diet and longevity among elderly people from Greece, observed that one unit increase in diet score, devised a priori on the basis of eight component characteristics of the traditional common diet in the Mediterranean region, was associated with a significant 17% reduction in overall mortality.<sup>3</sup> The investigators of the Healthy Ageing: a Longitudinal study in Europe (HALE) observed that adhering to a Mediterranean diet was associated with 23% lower risk of death, while moderate alcohol use was associated with 22% reduction of the previous risk.<sup>18</sup> The “Food Habits in Later Life (FHILL)” study showed that, other than the whole diet, only legumes intake was a food stuff in its own right that was associated with a reduction in mortality hazard ratio, after adjustment for location/ethnicity of the 785 elderly people from Japan, Sweden, Australia, and Greece.<sup>19</sup> In accordance with previous studies, we found that greater adherence to the Mediterranean diet was associated with 21% lower odds of having one additional risk factor (i.e. hypertension, hypercholesterolemia, diabetes obesity) in women and with 14% lower odds in men, irrespective of various potential confounders. This finding may directly link to the reduction of cardiovascular risk and consequently prolong life span.

The Mediterranean diet is low in saturated fat, high in monounsaturated fat, mainly from olive oil, high in complex carbohydrates, from legumes, and high in fibre, mostly from vegetables and fruits. Total fat may be high ( $\approx 40\%$  of total energy intake), but the monounsaturated-to-saturated fat ratio is around 2. The high content of vegetables, fresh fruits, cereals and olive oil, guarantee a high intake of  $\beta$ -carotene, vitamins C and E, polyphenols and various important minerals. These key elements have been suggested to be responsible for the beneficial effect of diet on human health, and especially cardiovascular disease.<sup>5,14,16,20-23</sup> The Seven Countries Study investigators reported that the protective role of Mediterranean diet against atherosclerosis was partially explained due to the reduction of blood pressure levels.<sup>2</sup> Moreover, during the last years, many researchers related Mediterranean diet with improvements in the blood lipid profile (especially LDL cholesterol and triglycerides), decreased oxidation of lipids, decreased risk of thrombosis (i.e. fibrinogen levels) and inflammation, improvement in endothelial function, and insulin resistance, decrease in ventricular irritability and reduction in plasma homocysteine concentrations.<sup>1,21-24</sup> At this point it should be underlined that several other prudent or healthy diets that promote the consumption of less fat, and salt, eating more complex

carbohydrates like fibre, and drink less alcohol, have also been associated with longevity and other health complications.<sup>25-27</sup>

### Limitations

The extrapolation of our findings, in isolation from other studies, to the general population needs to be cautious.. We had a small sample and a moderate participation rate (80%), acceptable for population – based studies, like the present one. However, we cannot be sure whether the lifestyles of those who agreed to participate and of those who did not are different. Another limitation is the cross-sectional design of the study, which is adequate for hypothesis generation, but not for the assessment of cause and effect relationships.

### Conclusion

This work reveals the beneficial effects of the Mediterranean dietary pattern on cardiovascular risk factors, like hypertension, hypercholesterolemia, diabetes and obesity, in elderly people. The findings reinforce the case made in various longitudinal studies, for this dietary pattern to be a basis for public health programs with further investigation through intervention studies highly desirable.

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## Original Article

## Long-term adoption of a Mediterranean diet is associated with a better health status in elderly people; a cross-sectional survey in Cyprus

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### 老年人長期採用地中海型飲食與較佳的健康狀況有關：一個賽浦路斯橫斷性調查

背景：越來越多的研究證實攝取含有高量的水果、蔬菜、豆類及全穀類，包含魚類、堅果類及低脂乳製品的飲食，對健康具有保護的效應。本研究計畫探討地中海型飲食對 150 名男女性老人的臨床狀況之相關。

方法：在 2004-2005 年期間，我們研究來自賽浦路斯不同地區的 53 名男性及 97 名女性，年齡在 65-100 歲。每個人回答一個評估地中海型飲食的固有特性的問卷，並計算飲食分數(範圍 0-55)。評估採用地中海型飲食對抗心血管疾病的危險因子的能力，如高血壓、糖尿病、高膽固醇血症及肥胖。

結果：26%的男性與 18%的女性有糖尿病，60%的男性與 58%的女性有高血壓，60%的男性與 68%的女性罹患高膽固醇血症，64%的男性與 52%的女性為肥胖者。超過 90%的參與者自陳，至少過去三四十年間的飲食習慣是一致。飲食分數與研究的危險因子數呈現顯著負相關( $\rho=-0.26$ ,  $p<0.001$ )。當我們考量年齡、性別、抽菸習慣及體能活動狀況，發現飲食分數每增加 10 單位，可降低女性( $p<0.001$ ) 21%多一個額外危險因子的機率，男性則降低 14% ( $p=0.05$ )。

結論：採用地中海型飲食，與老年人降低罹患高膽固醇血症、高血壓、糖尿病和肥胖的機率有關。

關鍵字：高血壓、高膽固醇血症、糖尿病、肥胖、地中海型飲食、老人。