

Original article

Adherence to the Mediterranean diet and fresh fruit intake are associated with improved asthma control

Background: The traditional Mediterranean diet is claimed to possess antioxidant and immune-regulatory properties in several chronic diseases. Typical Mediterranean foods have recently been associated with improvement of symptoms of asthma and rhinitis in children. However the effect of adherence to Mediterranean diet on adult asthma outcomes is unknown. We aimed to investigate the association between adherence to Mediterranean diet and asthma control.

Methods: Cross sectional study of 174 asthmatics, mean (SD) age of 40 (15) years. The patients were defined as *controlled*, in contrast to *noncontrolled*, if they showed FEV1 $\geq$ 80% of predicted, exhaled nitric oxide (NO) $\leq$ 35 ppb, and Asthma Control Questionnaire score < 1 . Dietary intake was obtained by a food frequency questionnaire, and Mediterranean diet was assessed by alternate Mediterranean Diet (aMED) Score. Logistic regression models adjusting for confounders were performed to estimate the association between Mediterranean diet and asthma control.

Results: Controlled asthmatics (23%) had significantly higher aMED Score, intake of fresh fruit, and lower intake of ethanol compared to noncontrolled (77%). High adherence to Mediterranean diet reduced 78% the risk of non-controlled asthma after adjusting for gender, age, education, inhaled corticosteroids and energy intake (OR = 0.22; 95% CI = 0.05–0.85; *P*-trend = 0.028). The higher intake of fresh fruit decreased the probability of having noncontrolled asthma (OR = 0.29; 95% CI = 0.10–0.83; *P*-trend = 0.015), while the higher intake of ethanol had the opposite effect (OR = 3.16; 95% CI = 1.10–9.11; *P*-trend = 0.035).

Conclusion: High adherence to traditional Mediterranean diet increased the likelihood of asthma to be under control in adults. The study introduces a novel link between diet and asthma control, as measured by symptoms, lung function and exhaled NO.

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Asthma control still remains difficult to attain in all patients (1). The remarkable variation in asthma prevalence between countries or geographically adjacent areas suggests that environmental factors play a determinant role both in asthma prevalence and severity. The marked changes in dietary patterns in recent decades – e.g. decrease in intake of antioxidant micronutrients and fatty acids – may explain some of the variation (2). Interventions with supplementation of a single nutrient have been disappointing (3–5), and it may be important to consider the diet as a whole to understand the possible synergistic effects of various food components. Several studies have shown that asthma outcomes were negatively associated with citrus fruits (6), apples, pears (7–9), tomato, carrots, leafy vegetables (7), butter, whole milk (9) and nonpasteurized farm milk (10), and positively associated with fast foods (11). However, studies addressing the associ-

ations between different dietary patterns and asthma are still lacking.

Mediterranean diet, a cultural model for healthy eating, has been associated with low incidence of mortality and morbidity by chronic diseases in Mediterranean populations, compared to US or Northern Europe (12, 13). A similar north-south gradient has been observed for asthma (14), with some Southern Mediterranean countries such as Greece or Albania, presenting the lowest prevalence. Mediterranean diet is characterized by high intake of vegetables, pulses, fruit, nuts, whole grain cereals and unsaturated fatty acids, mainly from olive oil, as well as by low intake of meat and meat products. Furthermore, the diet contains lot of fish; moderately dairy products, mostly cheese or yogurt; and ethanol regularly but with moderate amounts (15). Mediterranean diet is a 'cocktail' of

many components reported as potentially protective for asthma (2).

Data on the relationship between a Mediterranean dietary pattern and the occurrence of asthma and atopy is scarce. In children, fruits, vegetables and nuts have been associated with improvement of symptoms of asthma and rhinitis (15, 16). The effect of adherence to a Mediterranean diet on asthma outcomes is unknown.

We aimed to test the whether good adherence to Mediterranean type diet is associated with asthma control in adults.

Methods

Participants and study design

Consecutive 219 patients, older than 16 years old, attending an outpatient Asthma and Allergy clinic at a University Central Hospital, with medical diagnosis of asthma, were invited to participate in a cross-sectional study occurring between July 2004 and June 2005. Exclusion criteria were: food allergy, changing of dietary patterns in the last 12 months; pregnancy; presence of diseases which involved specific nutritional therapy and dietary planning; acute illness in the last 4 weeks; or inability to comply with the measurement instruments. From the total patients invited, 45 were excluded (29 did not fill inclusion criteria, eight due to incomplete data record, four were considered energy intake outliers and three refused to participate). The study was approved by the institutional ethics committee and written informed consent was obtained from patients.

Anthropometry, physical activity, dietary intake and mediterranean diet assessment

Body mass index (BMI) was calculated as weight (kilograms) divided by the square of height (metres). Weight and height were measured to the nearest 0.1 kg and 0.5 cm, by a mechanical balance with stadiometer (Seca model 700®; Seca Headquarter, Hamburg, Germany).

Physical activity (PA) was measured using the International Physical Activity Questionnaire (IPAQ) (17). The short 7 days self-administered version is a seven-item questionnaire that provides information about four domains: sedentary activity, time spent walking, and moderate- and vigorous-intensity PA. Physical activity within domains was estimated by weighting the reported frequency (events per week) by duration (minutes per event) and by a standard metabolic equivalent (MET) level assigned to each activity (Walking = 3.3; Moderate-intensity PA = 4.0 and Vigorous-intensity PA = 8.0). A combined total PA was computed as the sum of the domains scores and reported as a continuous measure (Total PA score = total MET-min/week).

Dietary intake was obtained by a self-administered, semi-quantitative food frequency questionnaire (FFQ), validated for Portuguese adults (18). The FFQ is an 86-item questionnaire that assess usual dietary intake over the previous 12 months, including food groups and beverages. Food intake was calculated by weighting one of the nine possibilities of frequency of consumption (from 'never or less than one time per month', to 'six or more times a day'), by the weight of the standard portion size of the food-item. Energy and nutritional intake were estimated using an adapted Portuguese version of the nutritional analysis software Food Processor Plus® (ESHA Research Inc., Salem, OR, USA).

Mediterranean dietary pattern was assessed by alternate Mediterranean Diet (aMED) Score (19), an adapted version of the original Mediterranean-Diet Scale (20), recently developed to use with FFQ. This aMED was based on dietary intake of nine selected-items: vegetables; pulses; fresh fruits, nuts, whole grains; fish; red and processed meats; ethanol; and ratio of monounsaturated to saturated fat (MUFA : SFA). A value of one or zero points was assigned to each of the nine components, using the gender-specific median of study subjects as cut-off value; one point was given for intakes at or above the median and zero points for intakes below, for almost all items; only red and processed meats intake less than median was criteria for one point. One point was also assigned for men with ethanol intake between 5–25 g/day, and for women between 5–15 g/day. Intakes below or above those cut-off values were criteria for zero points. Adherence to the Mediterranean diet was measured by total aMED score, ranging from zero to nine points; scores were categorized into tertiles corresponding to low, medium and high adherence.

Asthma control and quality of life: definitions and assessment

Asthma Control was defined combining the results of lung function, exhaled NO, and the Asthma Control Questionnaire (ACQ) score. Subjects were classified as having 'controlled' asthma if simultaneously had FEV1 $\geq$ 80% predicted (21), exhaled NO $\leq$ 35 ppb (22), and ACQ score below 1.00 (23). If any of these features was not present, subject were classified as 'noncontrolled'.

Lung function was measured by determination of forced expiratory volume 1 s (FEV1) using the PIKO-1® (Ferraris Respiratory Europe Ltd, Hertford, UK) (24). Patients were asked to perform a set of three technically acceptable manoeuvres and the highest FEV1 measurement was registered and expressed as predicted percent.

Exhaled nitric oxide (NO) was measured with the NIOX® system (Aerocrine, Stockholm, Sweden), using the online technique recommended by the American Thoracic Society (ATS) (25), at a flow rate of 50 ml/s.

The seven-item ACQ was designed to assess the clinical asthma control during the previous week. A seven-point scale (0 = no impairment, 6 = maximum impairment) was used and score was calculated as the mean of the seven-items, ranging from zero (totally controlled) to six (severely uncontrolled) (26).

Asthma quality of life was measured by the Asthma Life Quality Test (ALQ), developed by the American College of Allergy, Asthma and Immunology and validated in Portuguese (27). The self-administered ALQ, includes 20 questions of dichotomous answer (yes/no) assessing six domains: activity and sleep; symptoms; triggers; unscheduled health care use; medication; and psychological. Total score was calculated as the sum of affirmative responses, ranging from zero to 20 (lower values indicate better asthma quality of life).

Statistical analyses

Energy intake outliers were previously excluded from the study and were defined as energy intake values above arithmetic mean + 2 standard deviations (SD), and implausible low intakes < 500 kilocalories (kcal) for women, and < 800 kcal for men. The characteristics of excluded patients, regarding to age, education, smoking status and asthma severity were similar to the 174 (81%) included in analysis. Atopic status defined by skin prick test, medical diagnosis of allergic rhinitis, current use of inhaled corticosteroid (ICS), education ($\leq$ 4, 5–9, and $\geq$ 10 years) and smoking status (non-smoker, past smoker and current smoker) were also recorded.

Exhaled NO was logarithmically transformed to attain normal distribution. Ratio MUFA : SFA and ethanol were adjusted for total energy intake by nutrient residual model, as proposed by Willett WC (28).

The associations between Mediterranean diet and asthma outcomes were performed using linear regression (LR), multiple linear regression (MLR) and logistic regression models. Linear regression was initially fitted to analyse the associations between aMED score and dietary items (independent variables) and the asthma outcomes (dependent variables). Multiple linear regression models adjusted for confounders were performed separately for exhaled NO, FEV1, ALQ and ACQ scores (categorical confounders were transformed into dummy variables).

Logistic regression models were performed to analyse the associations between Mediterranean diet and asthma control level. Alternate Mediterranean Diet score and dietary items were categorized into tertiles. Odds ratios (OR) were calculated by reference with the lowest tertile.

Considering that aMED score was obtained through all the dietary items, all the regression models were fitted separately. Gender, education, age, total energy intake, BMI, PA score, smoking, atopy, rhinitis and ICS were analysed as potential confounders. Only the variables significantly associated with each asthma outcome in univariate analysis were considered in the final *logistic and regression* models. Considering the biological plausibility related with dietary intake, gender, age and energy intake were considered in all models. A 0.05 level of significance and 95% confidence intervals (95% CI) were considered. The data analysis was performed using the statistical package SPSS®, 12.0 (SPSS Inc., Chicago, IL, USA).

Results

Based on the asthma control definition, 23% and 77% of the subjects were classified, respectively, as having controlled and noncontrolled asthma (Table 1).

Table 2 shows the unadjusted and adjusted association of dietary exposures with markers of asthma severity and control. Higher aMED score was significantly associated with ACQ score after adjusting for gender, age, education, ICS use and energy intake. Considering the dietary items, significant positive associations were observed between the ratio MUFA : SFA and exhaled NO, and nuts and FEV1, even after adjustment for confounders. Ethanol intake was associated with worst control measured by the ACQ; however, after adjusting for confounders this association was no longer significant.

High adherence to Mediterranean diet had a 78% reduction in the risk of having noncontrolled asthma after controlling for gender, age, education, ICS and energy intake (OR = 0.22; 95% CI = 0.05–0.85; *P*-trend = 0.028). The higher consumption of fresh fruit decreased the probability of having noncontrolled asthma (OR = 0.29; 95% CI = 0.10–0.83; *P*-trend = 0.015) while the higher intake of ethanol had the opposite effect (OR = 3.16; 95% CI = 1.10–9.11; *P*-trend = 0.035). The odds ratio for asthma control accordingly to the Mediterranean diet are shown in Table 3 and illustrated in Fig. 1.

Table 1. Characteristics of participants according to asthma control

	Controlled (<i>n</i> = 40)	Noncontrolled (<i>n</i> = 134)	<i>P</i> -value
Demographic			
Age (years)	42.9 (13.4)	39.7 (15.6)	0.206*
Gender (female/male)	31/9	111/23	0.445†
Education, <i>n</i> (%)			
≤ 4	14 (35)	55 (41)	0.723‡
5–9	10 (25)	34 (25)	
≥10	16 (40)	45 (34)	
BMI (kg/m ²)	26.8 (4.5)	27.3 (5.3)	0.620*
Current smoker	6 (15)	7 (5)	
Clinical			
Atopic, <i>n</i> (%)	24 (65)	97 (77)	0.138†
Allergic rhinitis, <i>n</i> (%)	26 (65)	90 (68)	0.753†
Current ICS, <i>n</i> (%)	22 (55)	103 (77)	0.007 †
Exhaled NO (ppb)	19.5 (16.8–22.6)	33.0 (28.8–37.9)	<0.001 ‡
FEV1 (% predicted)	103.8 (22.3)	82.7 (22.3)	<0.001 *
ALQ score	10.1 (3.8)	11.7 (4.2)	0.027 *
ACQ score	0.4 (0.3)	1.5 (1.0)	<0.001 *
Lifestyle			
Physical Activity (MET-min/week)	1405 (8739)	1844 (9492)	0.328‡
Energy intake (kcal/day)	3375 (978)	3217 (1227)	0.457*
aMED Dietary-items (g/day)			
Vegetables	295.5 (1292.9)	321.4 (1397.4)	0.634‡
Pulses	25.7 (112.5)	25.7 (185.5)	0.700‡
Fruit	302.9 (818.2)	234.8 (3226.6)	0.024 ‡
Nuts	0.0 (71.0)	0.0 (178.0)	0.856‡
Whole grains	33.5 (198.8)	19.3 (332.7)	0.118‡
Fish	58.7 (290.2)	52.7 (527.1)	0.282‡
Red and processed meats	59.1 (236.0)	63.8 (271.4)	0.219‡
Ethanol	5.2 (141.4)	16.8 (301.6)	0.015 ‡
Ratio MUFA : SFA	0.86 (1.0)	0.90 (1.0)	0.325‡
aMED score	5.0 (7.0)	4.0 (9.0)	0.043 ‡

Data presented as mean (SD), except for aMED score and dietary-items and PA expressed as median (range) and exhaled NO expressed as geometric mean < (95%CI). aMED score and dietary items presented as unadjusted variables, except for ratio MUFA : SFA and ethanol. Bold characters indicate a statistical significance at *P* < 0.05. ACQ, asthma control questionnaire; AQL, asthma quality of life; aMED, alternate Mediterranean diet; exhaled NO, fraction of exhaled nitric oxide; FEV1, forced expiratory volume in the first second; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids.

**t*-test.

†Chi-square test.

‡Mann–Whitney *U*-test.

Discussion

Adherence to Mediterranean diet and fresh fruit intake increased the likelihood of asthma being under control. Higher intakes of nuts and a lower ratio MUFA : SFA were associated with better lung function and lower level of exhaled NO. Higher intake of ethanol increased the risk of uncontrolled asthma.

The association analyses were extensively adjusted for confounders. We assessed established lifestyle factors that could have an important role in asthma, and factors that influence dietary intake, such as physical activity, body mass index and total energy intake. Nevertheless, our

Table 2. Associations between mediterranean diet and airway inflammation, lung function, asthma quality of life and asthma control questionnaire score

	Exhaled NO, ppb		FEV1, % predicted		AQL score		ACQ score	
	Unadjusted* β** (95% CI)	Adjusted† β** (95% CI)	Unadjusted* β (95% CI)	Adjusted‡ β (95% CI)	Unadjusted* β (95% CI)	Adjusted§ β (95% CI)	Unadjusted* β (95% CI)	Adjusted¶ β (95% CI)
aMED Dietary items								
Vegetables, g/day	0.000 (0.000–0.001)	0.000 (0.000–0.001)	–0.006 (–0.020–0.008)	–0.006 (–0.023–0.011)	0.001 (–0.001–0.003)	–0.001 (–0.003–0.002)	0.000 (0.000–0.001)	0.000 (0.000–0.001)
Pulses, g/day	–0.001 (–0.004–0.003)	–0.001 (–0.004–0.003)	0.036 (–0.071–0.143)	0.023 (–0.085–0.131)	0.003 (–0.015–0.021)	0.000 (–0.016–0.016)	–0.002 (–0.006–0.002)	–0.002 (–0.006–0.002)
Fruit, g/day	0.000 (–0.001–0.000)	0.000 (0.000–0.000)	0.009 (–0.004–0.021)	0.011 (–0.003–0.024)	0.002 (0.000–0.004)	0.000 (–0.002–0.002)	0.000 (0.000–0.001)	0.000 (–0.001–0.000)
Nuts, g/day	0.006 (0.000–0.011)	0.004 (–0.001–0.010)	0.239 (0.059 –0.419)*	0.239 (0.056 –0.421)*	–0.019 (–0.050–0.011)	–0.019 (–0.046–0.004)	–0.005 (–0.012–0.003)	–0.004 (–0.011–0.003)
Whole grains, g/day	–0.001 (–0.003–0.002)	0.000 (–0.002–0.002)	0.025 (–0.043–0.094)	0.023 (–0.051–0.097)	–0.001 (–0.012–0.011)	–0.007 (–0.018–0.008)	–0.001 (–0.004–0.001)	–0.003 (–0.005–0.000)
Fish, g/day	–0.001 (–0.003–0.000)	–0.001 (–0.003–0.001)	0.026 (–0.035–0.086)	0.031 (–0.031–0.092)	0.007 (–0.003–0.017)	0.001 (–0.008–0.010)	0.001 (–0.002–0.003)	0.000 (–0.000–0.000)
Red meats, g/day	–0.002 (–0.005–0.001)	–0.002 (–0.005–0.001)	–0.006 (–0.094–0.082)	–0.021 (–0.113–0.071)	0.012 (–0.003–0.026)	0.008 (–0.005–0.021)	0.002 (–0.002–0.005)	0.000 (–0.003–0.004)
Ethanol, g/day	0.002 (0.000–0.005)	0.000 (–0.002–0.003)	–0.013 (–0.090–0.064)	–0.038 (–0.113–0.037)	0.007 (–0.005–0.020)	0.007 (–0.004–0.018)	0.004 (0.001 –0.007)*	0.001 (–0.002–0.004)
Ratio MUFA : SFA	0.640 (0.104 – 1.176)*	0.637 (0.075 – 1.199)*	2.417 (–15.139–19.972)	3.417 (–14.765–21.600)	1.104 (–1.836–4.044)	1.902 (–0.724–4.529)	0.323 (–0.376–1.022)	0.355 (–0.321–1.030)
aMED score	0.011 (–0.054–0.075)	0.029 (–0.041–0.099)	1.670 (–0.389–3.728)	2.056 (–0.174–4.286)	0.163 (–0.184–0.510)	–0.008 (–0.337–0.321)	–0.052 (–0.134–0.031)	–0.085 (–0.169 to–0.002)*

ACQ, asthma control questionnaire; AQL, asthma quality of life; aMED, alternate mediterranean diet; NO, nitric oxide; FEV1, forced expiratory flow in the first second; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids.

*Linear regression; multiple linear regression adjusted for: †gender, age, energy intake, BMI, education, rhinitis and atopy; ‡gender, age, energy intake, rhinitis and education; §gender, age, energy intake, BMI, education and ICS; ¶gender, age, energy intake, education and ICS; **P-value < 0.05; ***Representing adjusted ratio of geometric means.

Table 3. Association between mediterranean diet and asthma control

	Unadjusted†		Adjusted‡	
	OR (95% CI)	P-trend	aOR (95% CI)	P-trend
aMED Dietary items				
Vegetables (g/day)				
<211.54	1.00 [reference]		1.00 [reference]	
211.54–426.63	0.61 (0.26–1.47)		0.60 (0.23–1.53)	
>426.63	0.81 (0.33–1.99)	0.802	0.93 (0.32–2.70)	0.918
Pulses (g/day)				
<17.51	1.00 [reference]		1.00 [reference]	
17.51–37.48	0.84 (0.32–2.23)		0.81 (0.29–2.24)	
>37.48	0.69 (0.31–1.53)	0.368	0.76 (0.32–1.78)	0.560
Fruit (g/day)				
<178.40	1.00 [reference]		1.00 [reference]	
178.40–304.97	0.61 (0.23–1.64)		0.61 (0.21–1.76)	
>304.97	0.30 (0.12–0.76)*	0.008*	0.29 (0.10–0.83)*	0.015*
Nuts (g/day)				
<0.00	1.00 [reference]		1.00 [reference]	
0.00–2.54	1.57 (0.42–5.87)		1.57 (0.40–6.18)	
>2.54	0.84 (0.39–1.81)	0.601	0.81 (0.36–1.84)	0.563
Whole grains (g/day)				
<13.05	1.00 [reference]		1.00 [reference]	
13.05–41.52	0.40 (0.16–1.03)		0.37 (0.13–1.02)	
>41.52	0.47 (0.18–1.21)	0.334	0.42 (0.14–1.21)	0.347
Fish (g/day)				
<38.15	1.00 [reference]		1.00 [reference]	
38.15–74.21	1.22 (0.51–2.93)		1.22 (0.49–3.07)	
>74.21	1.00 (0.43–2.34)	0.923	1.10 (0.43–2.83)	0.905
Red and processed meats (g/day)				
<51.88	1.00 [reference]		1.00 [reference]	
51.88–73.15	1.77 (0.75–4.21)		1.64 (0.64–4.17)	
>73.15	1.59 (0.68–3.72)	0.251	1.29 (0.51–3.28)	0.530
Ethanol (g/day)				
<3.14	1.00 [reference]		1.00 [reference]	
3.14–29.92	1.18 (0.53–2.63)		1.41 (0.58–3.39)	
>29.92	3.90 (1.42–10.73)*	0.041*	3.16 (1.10;9.11)*	0.035*
Ratio MUFA : SFA				
<0.81	1.00 [reference]		1.00 [reference]	
0.81–1.0	1.45 (0.62–2.39)		1.44 (0.59–3.52)	
>1.0	1.69 (0.71–4.01)	0.203	1.89 (0.75–4.78)	0.072
aMED adherence				
Low	1.00 [reference]		1.00 [reference]	
Moderate	0.28 (0.08–1.05)		0.32 (0.08–1.26)	
High	0.21 (0.06–0.75)*	0.016*	0.22 (0.05–0.85)*	0.028*

aMED, alternate mediterranean diet; SFA, saturated fatty acids; MUFA, monounsaturated fatty acids.

* $P < 0.05$.

†Logistic regression.

‡Logistic regression adjusted for gender, age, education, energy intake and ICS.

results are limited by the cross sectional design of the study which leaves open any possible cause-effect relationship. Other factors may play a role. For example, the traditional Mediterranean lifestyle is also linked with small-scale farming of fruits, vegetables and vine. Reduced exposure to soil microbiota in urban environment has been coined as a major facilitator of the 'allergy epidemic' (29) and the consumption of self-produced vegetables has given protection against atopic conditions (30). Adherence to Mediterranean diet may thus reflect

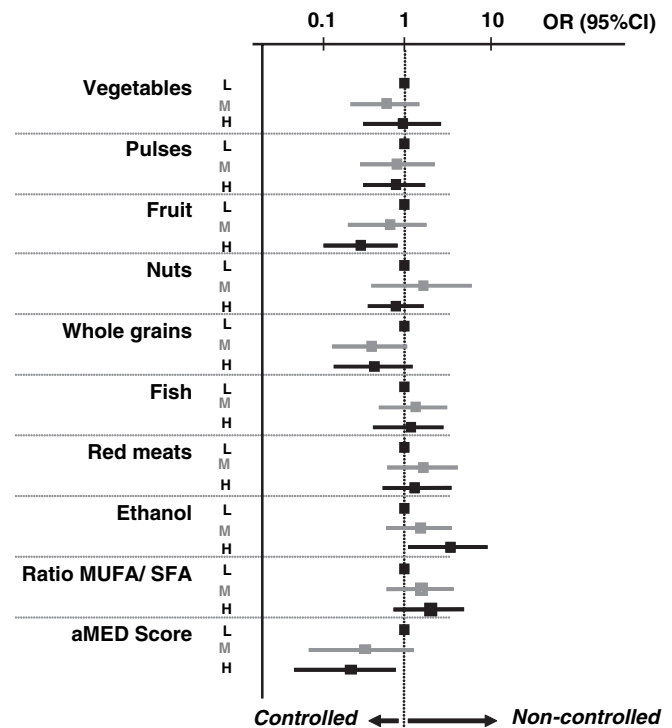


Figure 1. Odds ratios between mediterranean diet and asthma control. Logistic regression adjusted for gender, age, education, energy intake and ICS. Squares and lines represent OR and the 95% CI respectively. L, M and H represent, respectively, the lowest (reference), moderate, and higher tertile of intake.

greater exposure to immunomodulating soil saphrophytes giving protection against severe asthma.

Two recent population-based studies have addressed the relationship between mediterranean diet and asthma (15, 16). Chatzi et al. observed in rural areas of Crete, a protective effect of mediterranean diet on allergic rhinitis, and of fruits, vegetables and nuts on self reported wheezing in children and adolescents. In a Spanish multicentre study, mediterranean diet decreased the risk of severe asthma in school aged girls (16). Additionally, nuts, seafood and cereals were also protective, while fast-food was a risk factor. However these studies have several limitations including the fact that the potential confounding effects of education and energy intake were not considered in the analysis (28, 31, 32). Our population consisted of asthmatic subjects and we used a Mediterranean diet index, which summarizes the diet as an integral entity, by means of a single score that results from a combination of food groups and nutrients. Although it is difficult to quantify the adherence to a diet, grouping foods to obtain complex scores is a useful tool to evaluate associations at the population level (33). In our study daily ingestion of fresh fruit above 300 g decreased by 71% the risk for noncontrolled asthma. Consumption of fruit has been associated with reduced risk of wheezing (34), as well as with lower prevalence of

asthma and bronchial hyper-responsiveness (8, 9). Fruit may provide fibre and antioxidants, which may reduce oxidative stress-related inflammatory diseases (35). However, studies with antioxidant supplementation (3, 36) have been disappointing calling for exploration of the interactions that may occur between nutrients and bioactive compounds.

Intake of nuts, including almonds, hazelnuts, walnuts, peanuts, pine nuts, pistachios and cashews, was positively associated with lung function. In children, an inverse associations between nuts intake and wheezing (19, 37) and asthma (16) has been reported. However, the association between nuts and asthma were poorly addressed until now, probably because some nuts, namely peanuts and walnuts, are also involved in food allergy (38).

These foods contain a high proportion of MUFA and α -linolenic acid, fibre, vitamins, minerals and many bioactive compounds, including a variety of polyphenols (39) that may modulate redox status (40), inflammatory and immune response (41).

Intake of MUFA has been associated with increased risk for allergic sensitization (42, 43) and hay fever (42, 44), while SFA such as dairy products have been associated with reduced asthma risk (9). We did not find significant associations between dietary intake of vegeta-

bles, pulses, whole grains or red and processed meat, and asthma outcomes, suggesting the beneficial effects of mediterranean diet when considered as a global dietary pattern.

We observed that ethanol intake was associated with increased risk of noncontrolled asthma. In other studies, alcohol beverages consumption has been associated with increased risk for asthma and hay fever symptoms, allergic sensitization and serum IgE (45–47). The aMED score, used in the present study, considers total ethanol intake, irrespective of the different alcoholic beverages. The association between specific beverages, such as wine, beer, distilled and spirituous drinks and asthma needs further investigation.

In summary, the present study introduces a beneficial link between the adherence to a global mediterranean dietary pattern and adult asthma control and severity. Our results suggest that high adherence to mediterranean diet and of its typical foods, such as fresh fruits and nuts, may reduce asthma severity in adults. Furthermore, the results reinforce the adverse effects of high ethanol intake on asthma control. Prospective studies, both in children and adults, are needed to evaluate whether change of diet towards Mediterranean pattern will improve asthma control and disease outcomes.

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