

## Mediterranean Adequacy Index of Italian diets

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### Abstract

*Objective:* To assess, particularly in longitudinal studies, how close or far the food intakes of population groups are from a reference dietary pattern.

*Design:* Computation of an index, called the Mediterranean Adequacy Index (MAI), by dividing the sum of the percentage of total energy from typical Mediterranean food groups by the sum of the percentage of total energy from non-typical Mediterranean food groups. The reference Italian–Mediterranean diet utilised was that of subjects from Nicotera in 1960.

*Setting:* Different areas in Italy.

*Subjects:* Men aged 45–65 years at the start of the study from rural areas of Italy in the Seven Countries Study followed for 26 years (Crevalcore and Montegiorgio), elderly men and women from Perugia followed for 11 years, men and women from Pollica (Salerno) followed for 32 years, and families from Rofrano (Salerno) followed for 41 years.

*Results:* The median value of MAI among 40–59-year-old men from Nicotera in 1960 was 7.2; in Crevalcore it was 2.9 in 1965 and 2.2 in 1991; and in Montegiorgio, 5.6 in 1965 and 3.9 in 1991. In Pollica, the values in men ranged from 5.6 to 6.3 in 1967 and from 2.4 to 4.5 in 1999; for women, the corresponding ranges were 4.2–7.2 and 2.7–4.1. In elderly men of Perugia, median MAI value was 4.9 in 1976 and 3.2 in 1987; for women, the corresponding values were 3.1 and 2.6.

*Conclusions:* The diet of these Italian population groups has changed over the last four decades, progressively abandoning the nutritional characteristics of the reference Italian–Mediterranean diet. The MAI proposed is simple to compute; it has satisfactory discriminating power particularly for longitudinal dietary data with only a few limitations.

### Keywords

Mediterranean diet  
Mediterranean Adequacy Index  
Seven Countries Study  
Dietary studies in Italy  
Reference Italian–Mediterranean  
dietary pattern

In the Seven Countries Study, 16 cohorts of men were examined in 1958–1961 with a standardised procedure that included questionnaires on family status and medical history, anthropometrics, physical examination, electrocardiogram, blood samples and dietary appraisal. In five of these cohorts – rural East and West Finland, rural Italy (Crevalcore and Montegiorgio) and a sample of inhabitants of a small commercial market town in The Netherlands (Zutphen) – food consumption was subsequently assessed longitudinally. The same method of dietary survey, the diet history method, was used.

First, the eating patterns of all men in the two rural Italian cohorts were assessed in 1965 to determine if dietary recommendations developed by a group of experts assembled by the World Health Organization (WHO) were met<sup>1</sup>. The population nutrient goals were expressed as percentage of total energy intake. Alcohol consumption and its contribution to energy intake were not taken into consideration.

Next, the relationship between conformity to dietary recommendations and subsequent mortality over 20 years was examined. Even though the mean values of food

consumption of the two rural cohorts were quite different, they were pooled together to obtain statistical significance in view of the similarities in the levels of participation and in mortality patterns. The 1536 subjects were divided into classes by total energy and macronutrient density. Approximately two-thirds of men who met dietary carbohydrate recommendations were within recommendations for fat and protein. Almost all of those who did not consume the recommended proportion of carbohydrate did not consume the recommended levels of fat; however, approximately two-thirds of the latter group were within the protein requirements.

Regarding the association of eating patterns with 20-year subsequent mortality, higher energy intake was associated with lower total mortality and coronary mortality, but not with cancer mortality. Recommendations for total and complex carbohydrates were associated with lower total mortality and cancer mortality, but not with coronary mortality; lower coronary mortality was observed when carbohydrate intake was lower than the recommended percentage. Similarly, for protein density, trends were not identical between cancer

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mortality and coronary mortality. The recommended levels for total fat, saturated fatty acids and polyunsaturated fatty acids seemed to be associated with lower total mortality, and in particular with lower coronary mortality<sup>1</sup>.

Subsequently, a collaborative study conducted by researchers from Finland, Italy and The Netherlands (FINE study) examined trends in food intake in two rural cohorts from Finland, two rural cohorts from Italy and one cohort from The Netherlands, all from the Seven Countries Study<sup>2</sup>. The same dietary history method was used for dietary appraisal so that food group classification would be comparable between the three countries. Consumption trends of food groups during follow-up were expressed graphically. Daily food group consumption was reported in grams for fish, vegetables and fruit. For saturated and unsaturated fatty acids and alcohol intake, the values were expressed as percentage of total energy in a graphical form. Dietary fibre was expressed in g/1000 kcal.

The FINE study concluded that: 'The northern European cohorts, e.g. East and West Finland and, to a lesser extent, Zutphen, still consume an atherogenic diet at old age, while the Italian diet is still Mediterranean. Compared in their dietary intake at middle age, however, the dietary pattern of the Finnish and Dutch cohorts has changed slightly in the direction of a healthy diet while the diet of the Italian men remained Mediterranean at old age'<sup>2</sup>.

However, the ways of expressing food group intakes reported above cannot be considered suitable to assess a positive or negative change in the dietary pattern in a population over the course of time. For the assessment of food habit trends in longitudinal studies, the population nutrient goals of WHO are too generic. They refer only to nutrients; there is no differentiation between animal and vegetable proteins; and important beneficial food components, such as those with antioxidant activity, are not adequately considered. Also, graphical expression of food group consumption in grams cannot be considered correct when, over the course of time, drastic decreases in energy intake occur. Furthermore, expressing the consumption of a single food group as a percentage of total energy intake

presents some limitations, because it is space-consuming in publications and does not provide any information on how the overall diet is changing with time.

The objective of the present study was to develop a method to assess, particularly for longitudinal studies, how the dietary intakes of various population groups compare with a reference dietary pattern.

## Design

Various attempts have been made to discover how close or far the dietary trend of a free-living population is to the diet considered as a reference for that population. We believe that two relevant points have to be considered. First, if energy intake is changing considerably over the course of time, food group consumption has to be expressed as percentage of total intake. Second, a national reference diet has to be defined to evaluate the change in diet over the course of time<sup>3</sup>.

As the reference Italian-Mediterranean diet, we proposed that of subjects from Nicotera in 1960<sup>4</sup>. Nicotera was a rather poor rural area in the South of Italy, perched on a spur in the mountains overlooking the Tyrrhenian Sea about 60 km north of Reggio Calabria, near the toe of Italy. In 1960, Nicotera was designated as the third Italian rural area of the Seven Countries Study, but due to a shortage of funds and then because of its similarity with the two Greek rural areas, the study was not continued longitudinally.

Table 1 lists the mean daily intakes of food groups among subjects in Nicotera for three age groups, shown as the mean of three seasons in 1960<sup>5</sup>. Cereals were well represented, as also were vegetables, legumes and fish. The only edible fat used was virgin olive oil. Meat, eggs, cheese and milk were present in rather low amounts. Wine, mostly red wine, was consumed moderately by men. Both men and women engaged in moderate physical activity and, in some cases, only men in rather heavy physical work.

The prevalence of heart disease was low and hypertension was uncommon, as was overweight.

**Table 1** Mean daily food intake (g or ml) of subjects in Nicotera, Italy (1960, mean of three seasons)

	Males			Females		
	13-19 years	20-59 years	>60 years	13-19 years	20-59 years	>60 years
<i>n</i>	37	107	14	45	115	10
Cereals	538	488	452	319	348	241
Vegetables	286	344	401	236	274	177
Legumes	55	49	62	32	36	13
Fruit	70	101	70	80	76	100
Fish	25	42	34	20	30	43
Edible fats	38	46	52	30	36	27
Meat	34	53	27	26	29	35
Eggs	11	20	11	12	11	7
Cheese	13	15	33	9	12	16
Milk (ml)	45	33	24	15	37	24
Sugar products	26	24	28	20	19	14
Wine (ml)	88	293	216	35	52	31

## Methods and subjects

As a first attempt we computed the Mediterranean Food Balance, which was obtained by subtracting from the sum of groups of typical Mediterranean foods (bread, cereals, legumes, potatoes, vegetables, fruit, fish, red wine, vegetable oils) the sum of groups of non-typical Mediterranean foods (milk, cheese, meat, eggs, animal fats and margarines, sweet beverages, cakes, pies and cookies, sugar), both as a percentage of total energy. After initial analysis, the discriminating power of the Mediterranean Food Balance score was found to be inadequate for longitudinal data. Thus, this approach was not considered suitable.

Accordingly, we computed an index that we called the Mediterranean Adequacy Index (MAI), which was obtained by dividing the sum of the percentage of total energy from typical Mediterranean food groups by the sum of the percentage of total energy from non-typical Mediterranean food groups.

The diets of 40–59-year-old men from Nicotera in 1960 – the reference Italian–Mediterranean diet – and the diets of men from Crevalcore and Montegiorgio of the Seven Countries Study in 1965, 1970 and 1991 were analysed using the MAI. The weighed record method in a subsample of 40–59-year-old men in Nicotera was used for dietary appraisal for three seasons<sup>5</sup>; in Crevalcore and Montegiorgio, the diet history method was used on all subjects<sup>6</sup>; in the tables, only the data of the longitudinal groups are reported.

Subsequently, we analysed the diets of population groups from Pollica, Perugia and Rofrano, which had been examined longitudinally. Pollica (Cilento – Salerno) is situated between the sea and the extensive mountains of Cilento. The coastal area became an active part of Magna Grecia 2500 years ago. In 1999 a follow-up food consumption survey using the dietary history method was conducted among 49 families initially examined in 1967. The survey in 1999 also included new relatives, sons and grandchildren.

In Perugia, elderly subjects (36 men and 36 women) aged more than 60 years in 1976 were examined in 1976, 1981 and 1987 by the dietary history method<sup>7</sup>.

Rofrano (Cilento – Salerno) is located in the hinterland. In 1954, the National Institute of Nutrition carried out a survey among 226 families to examine food intakes and other nutritional variables. At that time, the socio-economic conditions of inhabitants (about 3000) were at a low level and the main reason for high rates of emigration. The foodstuffs produced locally were the main food sources. One hundred and fifty-seven families were re-examined in 1980 and then again in 1995<sup>8</sup>. Lifestyles had changed considerably due to improved socio-economic conditions, and food habits had also changed.

## Results

Table 2 shows the percentile distribution of MAI among men from Crevalcore and Montegiorgio in the three follow-ups and of their young relatives (sons or nephews in the same age range as the elderly subjects when they were initially examined). Also shown is the percentile MAI distribution of 40–59-year-old men from Nicotera in 1960, whose dietary pattern served as the reference Italian–Mediterranean diet.

The median values of MAI differed considerably between Nicotera in 1960 and Crevalcore in 1965; for the latter, the situation had already worsened after 5 years and remained constant until 1991. The young relatives showed the same values as the elderly men in 1991. In 1965, only a minority of men followed the reference Italian–Mediterranean diet.

In Montegiorgio in 1965, the median MAI was higher than in Crevalcore, but a decreasing trend can be observed in the follow-up data. For young men in 1991 the median value of MAI was even lower than for elderly men. In 1965 only a quarter of the elderly men followed a reference Italian–Mediterranean diet. Therefore the diet of men from Crevalcore and Montegiorgio became worse over time, progressively abandoning the traditional reference Italian–Mediterranean pattern, particularly in Montegiorgio. Even in Nicotera, considered in 1960 as reference for its Mediterranean characteristics, the median MAI of the diet of a group of 43 men examined in 1996 had decreased to 2.8.

**Table 2** Percentile distribution of the Mediterranean Adequacy Index among Italian men in rural cohorts of the Seven Countries Study

	<i>n</i>	25th percentile	50th percentile	75th percentile
Nicotera, 1960*	64	5.4	7.5	10.8
Crevalcore, 1965	171	2.2	2.9	4.4
Crevalcore, 1970	171	1.5	2.0	2.6
Crevalcore, 1991	171	1.7	2.2	3.0
Crevalcore, 1991 (young)†	18	1.9	2.2	2.7
Montegiorgio, 1965	82	4.0	5.6	7.6
Montegiorgio, 1970	82	3.0	4.5	6.1
Montegiorgio, 1991	82	2.6	3.9	4.8
Montegiorgio, 1991 (young)†	23	1.9	2.4	2.9

\* Reference Italian–Mediterranean diet.

† Young male relatives of subjects examined longitudinally.

The mean and standard deviation of MAI, obtained from individual means of food group intakes as a percentage of total energy, were computed for the same subjects. The resulting mean values were moderately higher than the medians. Because of the general high standard deviation, the percentile expression was preferable.

Table 3 shows the MAI percentile distribution of subjects in Pollica. After 32 years the median value for men decreased, particularly in the 20–39 year age class. In 1967, a satisfactory MAI was observed only at the 75th percentile for men in all age categories. As for women, the MAI value in 1967 was at the 50th percentile, being satisfactory for the youngest and oldest subjects; however, in 1999 it decreased considerably in both age groups. Women aged 40–59 years showed low MAI values in both 1967 and 1999. From the above data it is clear that in 1999 young men and women did not follow a recommended Mediterranean diet. The situation of the elderly was slightly better only for men.

Table 4 shows the percentile distribution of the MAI of diets among elderly subjects from Perugia examined from 1976 to 1987. In 1976 at the 75th percentile the MAI reached a value that could be considered acceptable only for men, whereas at the 50th percentile it was rather low. The trend was for a progressive decrease and, in 1987, the MAI could be considered low or very low for the majority of men. The situation was even less favourable for women, whose MAI was always at very low levels.

MAI for the Rofrano diets was calculated only as a mean value, since the individual values of the percentage of energy from each food group were not available. The MAI decreased from 10.9 in 1954 to 3.7 in 1980 and to 3.4 in 1995.

## Discussion and conclusions

Various indices of overall diet quality have been proposed and have been associated with risk factors for disease. Some indices are based on single nutrients or a group of nutrients, others on food or food groups, and a few on nutrients and foods<sup>9</sup>. The indices used most commonly are the Dietary Diversity Score (DDS), which is based on variety among five major energy-dense food groups

(fruit, vegetables, grains, dairy and meat); the Overall Variety Score (OVS), based on the intake of individual food items and most popular in the USA; and the Nutrient Adequacy Score (NAS 100), which is based on assessment of nutrients consumed at least at the level of 100% of the Recommended Dietary Allowances<sup>10</sup>. We believe that the above indices are not suitable for populations with different nutritional patterns, such as Italian or other Mediterranean populations. They are based on national dietary recommendations which do not comply with a reference Mediterranean diet or that have been devised for other purposes.

The Mediterranean Adequacy Index that we propose is simple to compute. It has satisfactory discriminating power, particularly for longitudinal dietary data. It can be used with dietary data obtained in large-scale studies only if the dietary surveys are carried out with reliable and valid methods, e.g. dietary history or food diary.

The MAI has a few minor limitations:

- If the mean values of food groups are available only as  $\text{g day}^{-1}$ , they should be expressed per 1000 kcal or corresponding kJ. In this case the MAI will generally be higher than when expressed as a percentage of total energy. The different energy densities of foods could be a confounding factor.
- The percentage of energy for each food group and for each individual is required to compute the percentile distribution. This is needed particularly in longitudinal studies when consistent changes in energy intake occur.
- A national reference index must be based on the diet followed by a population with low risk factors of chronic diseases.

When the values of MAI are higher than a reference index for a population, the reason can be found in the influence of too high an intake of certain Mediterranean foods such as cereals or wine and/or too low an intake of certain non-Mediterranean foods such as animal foods. Therefore the interpretation of the ratio has to be based not only on typical Mediterranean and non-Mediterranean foods, but also on the distribution of the same typical Mediterranean foods.

**Table 3** Percentile distribution of the Mediterranean Adequacy Index among subjects from Pollica (Cilento, Italy)

	Men			Women		
	20–39 years	40–59 years	>60 years	20–39 years	40–59 years	>60 years
1967						
<i>n</i>	25	24	14	27	22	8
25th percentile	2.9	3.5	3.3	3.6	2.9	3.3
50th percentile	6.1	5.6	6.3	7.2	4.2	6.6
75th percentile	8.0	8.2	9.0	9.8	9.6	10.6
1999						
<i>n</i>	9	4	14	7	7	17
25th percentile	1.7	–	3.5	1.4	2.3	2.7
50th percentile	2.4	4.0	4.5	2.7	4.1	3.1
75th percentile	2.9	–	6.2	3.1	5.0	4.4

**Table 4** Percentile distribution of the Mediterranean Adequacy Index among non-institutionalised elderly people in Perugia, Italy (age >60 years in 1976)

	25th percentile	50th percentile	75th percentile
<b>Men (n = 36)</b>			
1976	3.1	4.9	6.6
1981	3.3	3.9	5.2
1987	2.3	3.2	5.4
<b>Women (n = 36)</b>			
1976	2.1	3.1	3.7
1981	2.0	2.5	3.0
1987	1.8	2.6	4.0

From the above results we can conclude that the diet of the population groups examined in Italy over the last four decades has changed, progressively abandoning the nutritional characteristics of the reference Italian-Mediterranean diet. This is particularly worrisome for the typical Mediterranean areas of Italy.

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