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Mediterranean eating pattern among a Chinese population

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Abstract.
BACKGROUND: Subjects with a Mediterranean eating pattern would be a low risk for metabolic syndrome and cardiovascular disease.
MATERIAL AND METHODS: The eating pattern of two subsets of subjects was evaluated by an accurate alimentary interview, the first composed of Italian subjects living in Liguria, a region overlooking the Mediterranean sea, and the second composed of individuals from Si-Chuan, a continental region in north western China.
RESULTS: In the two groups the Mediterranean dieting score was very similar, while a detailed diet composition assessment showed that in the customary food intake reported by Chinese individuals the unsaturated to saturated fat acids ratio and the omega 6 to omega 3 fat acids ratio was sharply lower and higher, respectively, in comparison with the corresponding values referred to by the Mediterranean people.
DISCUSSION: These results suggest that the eating style of the population from the region of Si-Chuan seems to be similar to that found in Northern Europe and the US, and therefore subjects might be at increased risk of developing metabolic syndrome.

Keywords: Mediterranean diet, Chinese population, saturated and unsaturated fat, ω3 and ω6 fatty acid

The metabolic syndrome is a health condition characterized by abdominal obesity, dyslipidemia, elevated blood pressure and impaired glucose tolerance, with increasing prevalence of type 2 diabetes. Metabolic syndrome is associated with cardiovascular disease which is the most common cause of death in western developed countries [1]. The Seven Countries study in the 1960s showed that, among the western industrialized societies, the populations in the Mediterranean region experienced lower cardiovascular disease mortality probably as a result of different dietary pattern. The Mediterranean diet reflects the common dietary style of populations living in the Mediterranean region, sharing a set of widespread lifestyle, cultural attitudes and eating habits [2–4]. The Mediterranean diet includes the following characteristics: a high intake of plant foods comprising mainly fruits and vegetables, cereals and whole-grain breads, beans, nuts and seeds; the consumption of locally grown, fresh and seasonal, unprocessed foods; the daily assumption of large quantities of fresh fruit whereas concentrated sugars or honey are consumed a few times per week in smaller quantities; the use of olive oil as a main cooking ingredient and source of fat; the intake of low to moderate amounts of cheese, yogurt and dairy products and the eating of red meat only in small quantities, whereas fresh fish is consumed in abundance; finally a low to moderate amount of red wine often accompanies main meals [5–8]. Recent research and epidemiological studies have clearly demonstrated the protective effect of the Mediterranean diet as an important lifestyle

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strategy for reducing the incidence of cardiovascular disease and promoting longevity [9–11]. Moreover, in non-Mediterranean populations the adherence to the Mediterranean diet entails an improvement of insulin sensitivity and reduces the prevalence of metabolic syndrome, with related cardiovascular morbidity and mortality [10, 12, 13]. The metabolic benefits of a Mediterranean diet are substantially accounted for by an increased intake of monounsaturated and polyunsaturated fatty acids in comparison to the saturated fatty acids, and by an optimal omega 6 to omega 3 fatty acids ratio [14–16]. Furthermore, the consumption of great amounts of insoluble fibers and long chain carbohydrates with high glicemic index could improve insulin resistance and prevent the development of type 2 diabetes [17]. The pattern of the traditional Chinese alimentation has many similarities with the Mediterranean diet, the Mediterranean diet score when applied to traditional Chinese diet being fully comparable to the score from Mediterranean populations [18, 19]. Furthermore, it is increasingly considered that the Mediterranean-type diet is easily transposable to non-Mediterranean regions, with considerable metabolic benefits [20]. To gain insight on this topic, this study compares the eating habits and the dieting pattern of individuals from Su-Chuan, a region in the Nord-west of China, with those of a group of subjects living in Liguria, Italy, a region overlooking the Mediterranean sea with people customarily still adopting a traditional eating pattern.

1. Material and methods

1.1. Population

The study was carried out in two groups of healthy people, the first composed of 200 individuals from the province of Si-Chuan in the North-west of China, and the second composed of 200 subjects living in Liguria, a Mediterranean region of Italy. The study was carried out on free living Italian and Chinese population in September-November 2015. Demographic and anthropometric data of the entire set of persons of the study are shown in Table 1. After the stature and body weight measuring, subjects directly underwent an accurate alimentary interview carried out by the same investigator (FSB).

1.2. Alimentary interview

The alimentary interviews both in the Si-Chuan individuals and in the Ligurian subjects were carried out directly by the same investigator (FSB), a Chinese dietitian graduated at the University of Genova, Italy. In

Table 1
Chinese subjects from the region of Si-Chuan and Italian subjects from Liguria: Demographic and anthropometric data. BMI: body mass index

	Si-Chuan subjects	Ligurian subjects	*p*
Subjects n	200	200	
Males n (%)	96 (48)	92 (46)	
Females n (%)	104 (52)	108 (54)	
age (years, range)	36 (15–78)	42 (15–88)	ns
body weight (kg, mean ± sd)	61 ± 6	71 ± 14	<0.01
BMI (kg/m^2, mean ± sd)	23.2 ± 3.3	24.7 ± 5.0	<0.025
physical activity: sedentary n (%)	100 (50)	116 (58)	ns
physical activity: mild n (%)	76 (38)	65 (33)	ns
physical activity: moderate n (%)	24(12)	19 (9)	ns

the two groups the dietary intake was assessed using a clinical food frequency questionnaire. This consisted of items in the following categories: bread/pasta/rice, vegetables, fruits, meat, fish, eggs, dairy products, beverages, snacks, soups and oil/salt/sauces. The quantity and the frequency of consumption per day and per week for each item were recorded with the aid of photographs to illustrate portion sizes. Furthermore, data have been validated by a 24 hour dietary recall. The daily nutrient consumption as assessed by the mean weekly intake of each nutrient was then calculated using food tables from multiple sources: for the Mediterranean subjects the INRAN tables (Rome Italy) and the WindFood software (Medimatica, Colonnella, Italy) were employed, while for the Si-Chuan individuals specific tables for Chinese food were adopted [21].

1.3. Mediterranean Score

The Mediterranean score was then calculated according to the consumption of eight categories of food, and a score of 1 was given if the criteria for each category was fulfilled [18, 22, 23].

For each subject the following food consumption patterns were considered:

- Intake of food with monounsaturated/ saturated fat ratio higher than 1.6.
- Intake of ethanol lower than 10 g/day.
- Intake of pulses higher than 50 g/day
- Intake of cereal higher than 300 g/day
- Intake of fruits greater than 300 g/day
- Intake of vegetables greater than 300 g/day
- Intake of meat and meat products lower than 100 g/day
- Intake of milk and dairy products lower than 200 g/day

In the population of this study very few female subjects were are used to drink wine or spirits (containing ethanol), and therefore, in order to improve the reliability of the comparisons, the item regarding ethanol intake was not considered. Each subject was classified as having an eating pattern adherent to the Mediterranean style when the individual score value was higher than 4 for males and higher than 3 for females. Moreover, the individuals were asked about their usual physical activity, and they were semi-quantitatively rated as sedentary, mild or moderate physical exercisers; at the time of the study, no subject was practicing strenuously or agonistic exercise.

1.4. Statistics

Due to the sample size, statistics were performed by parametric methods and the significance was placed at 0.05 level. The mean differences in daily nutrient intake between Su-Chuan and Ligurian individuals were assessed by the Student t test for independent comparisons. The chi-square test was used to compare the number of subjects with high and low Mediterranean score between the Mediterranean and the Chinese subset. The relationship between body weight (dependent variable) and energy intake (independent variable) was assessed both by simple correlation and multiple regression analysis, taking also into account the subject's age and the physical exercise level (independent variables). Physical activity was dummy coded as 1: sedentary, 2: mild physical exercise, 3: moderate physical exercise.

2. Results

In the two subsets of subjects of this study the number of male/female individuals was nearly the same, and no difference in age was found. All individuals had a stable body weight for at least six months. In the Si-Chuan population the mean body weight and BMI values were higher than those found in the Ligurian group ($t = 2.59$,

Table 2
Chinese subjects from the region of Si-Chuan and Italian subjects from Liguria: number of persons reporting a Mediterranean eating pattern (Mediterranean eating score > 4 male and > 3 for female)

	Mediterranean eating pattern
Si Chuan total n (%)	122 (61)
Si Chuan male n (%)	116 (58)
Si Chuan female n (%)	132 (66)
Ligurian total n (%)	116 (58)
Ligurian male n (%)	94 (47)
Ligurian female n (%)	148 (74)

No significant differences (chi-square test) between Si-Chuan and Ligurian population considering all individuals and the male and female subset separately.

$p < 0{,}01$ and $t = 2.29$, $p < 0.02$, respectively). On the contrary, in the two subsets the number of subjects being sedentary or reporting mild or moderate activity was substantially similar (chi- square = 1.752) (Table 1). Considering all subjects, the overall energy intake as assessed by the alimentary interview was positively related to the body weight values ($r = 0.434$, $p < 0.012$). Furthermore, in the multiple regression model, body weight value was predicted ($r^2 = 0.32$) negatively by age ($t = -3.91$, $p < 0.0021$), and positively by energy intake ($t = 5.928$, $p < 0.001$) and physical exercise level ($t = 2.224$, $p < 0.025$). The number of subjects reporting Mediterranean eating pattern (score > 4 for male and > 3 for females) was substantially similar among the Si-Chuan individuals and the subjects from Liguria (Table 2), and in both subgroups no difference between male and female individuals was observed. Table 3 shows the usual daily food intake composition of the Chinese individuals and the Italian subjects: in the Si-Chuan individuals the mean values of daily alimentary consumption of energy, fat and carbohydrates were significantly ($p < 0.01$) greater than those observed in the Ligurian subjects, while the protein intake was essentially similar. On the contrary, when data are expressed as percent of total intake, in the two subsets the daily assumption of protein, fat and carbohydrates was quite similar (Table 3). In the Chinese individuals the daily intake of cholesterol ($p < 0.01$) and mono and polyunsaturated fatty acids ($p < 0.05$) was significantly greater than that found in the Ligurian subjects, while in the former the total fiber intake was smaller ($p < 0.02$) than in the latter (Table 3). Finally, in the Italian cohort the mean values of monounsaturated to saturated fatty acids ratio was higher ($p > 0.01$) and the omega 6 to omega 3 fatty acid ratio was lower ($p < 0.02$) in comparison to the values observed in the Si-Chuan individuals (Table 3).

3. Discussion

In this study, both the cohort investigated showed the body weight values closely correlated with the energy intake. Moreover the multiple regression model carried out in the whole population indicates that, keeping constant the daily energy intake, the persons with have higher energy expenditure and then needing more energy for maintaining a stable weight throughout the time, as the younger subjects and the moderate exercisers are, have a body weight lower than their older and sedentary counterpart, respectively. The presence in the multiple regression model of such significant relationships among the overall data strongly supports the reliability of the alimentary interview findings. The Si-Chuan and the Ligurian subsets were fully comparable for gender, age and physical activity level. Higher body weight and BMI values in the Chinese individuals are simply accounted for by a greater food intake in the Chinese individuals. Since mean BMI values were within normal range both in the Si-Chuan and in the Ligurian subset, and the study specifically regards only the eating pattern, severe bias due to slight differences in body weight between the two subsets can be ruled out.

Table 3
Chinese subjects from the region of Si-Chuan and Italian subjects from Liguria: Daily usual intake of some nutrients (mean ± sd)

	Si-Chuan subjects	Ligurian subjects	*p*
energy (kcal)	2348 ± 362	1961 ± 513	<0.01
protein (g and % of the intake g)	75.5 ± 16.2 (12.9 ± 2.5)	80.6 ± 17.8 (17.6 ± 6.5)	
total fat (g and % of the intake)	97 ± 16.8 (37.3 ± 3.3)	76.1 ± 29.1(37.6 ± 13.1)	<0.01
carbohydrates (g and % of the intake)	292.2 ± 56.4 (50.0 ± 4.2)	229.6 ± 77.6(47.3 ± 11.2)	<0.01
cholesterol (mg)	362 ± 199	269 ± 230	<0.01
fiber (g)	13.9 ± 4.7	19.1 ± 6.7	<0.02
saturated fatty acids (SA, g)	26.4 ± 6.0	21.5 ± 10.3	<0.05
monounsaturated fatty acids (MUFA, g)	48.7 ± 9.8	39.4 ± 18.5	<0.05
polyunsaturated fatty acids (PUFA, g)	17.2 ± 5.4	9.8 ± 4.6	<0.05
MUFA/SA ratio (g/g)	1.88 ± 0.32	2.2 ± 0.71	<0.01
ω 6 fat acids/ω 3 fat acid ratio (g/g)	8.17 ± 2.15	6.02 ± 3.8	<0.02

The pattern of the traditional Chinese alimentation has many similarities with the Mediterranean diet, the Mediterranean diet score when applied to traditional Chinese diet being fully comparable to the score from Mediterranean populations [18, 19]. Furthermore, it is increasingly considered that the Mediterranean-type diet is easily transposable to non-Mediterranean regions, with considerable metabolic benefits [20].

However, when the diet composition was evaluated in more detail, marked differences between Si-Chuan and Mediterranean diet do emerge. In comparison with the Mediterranean population, the Si-Chuan individuals assumed more carbohydrates and lipids per day, while the protein intake was essentially similar: since percentage values were very similar in the two subsets of subjects, this simply refers to a generally greater food and energy intake in the latter. Furthermore, among the Chinese individuals, an overall higher lipid assumption is also accounted for by a greater food intake. Richness of mono and polyunsaturated fatty acids represents one of the key features of the Mediterranean diet: despite this dietary pattern can be considered a "high fat" diet, the quality of the fats consumed may provide the biological rationale explaining the benefit following the adoption of such dietary pattern [24]. In the Si-Chuan population the monounsaturated to saturated fatty acids ratio was lower than in the Ligurian subjects, and the omega 6 to omega 3 fatty acids ratio was greater, thus reflecting in the former group an unhealthy alimentation that closely resembles that of the North-European and American population. In fact, a growing body of evidence suggests that a high intake and storage of saturated fatty acids influences the development of hepatic steatosis and promotes endoplasmic reticulum stress and proapoptotic environment [25, 26], cellular mechanisms leading to the clinical condition of metabolic syndrome [27]. Among the polyunsaturated fatty acids a high omega 3 intake may decrease the metabolic syndrome risk as a result of the beneficial effect on insulin resistance, blood pressure, and dyslipidemia [28, 29]. Conversely, the omega 6 polyunsaturated fatty acids, which competes with those of omega 3 for several physiologic processes, could increase inflammatory eicosanoids and likely increase the risk of chronic diseases [30, 31, 32]. Recent evidence has suggested that the assumption of a balanced ratio of omega 6 to omega 3 polyunsaturated fatty acids may be relevant for optimal health and the prevention of chronic disease [29, 30, 31]. The sharp difference in the omega 6 to omega 3 fatty acids ratio between the customary food intake of Chinese individuals and that of the Ligurian subjects suggests that the two subsets, in spite of a fully comparable Mediterranean diet score, do not follow a similar eating pattern.

The main limitation of this study is the exclusively subjective evaluation of the food intake, that could influence the overall results when two cohorts of individuals with substantially different eating habits are compared. However, the bias can be reduced when the interviewer is directly involved in both populations: in this sample, the simple and multiple regression results suggest a sufficient accuracy of the data.

This investigation indicates that the Mediterranean diet score as designed for evaluating the alimentary patterns of European and American populations gives unreliable results when used for assessing the Chinese eating habits. Moreover, it can be suggested that the eating style of the population from the region of Si-Chuan in the North of China does not resemble the Mediterranean diet, rather it seems to be similar to that observed in continental Europe and in the US; therefore subjects might be at increased risk of developing metabolic syndrome.

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