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Moderate Consumption of Olive Oil by Healthy European Men Reduces Systolic Blood Pressure in Non-Mediterranean Participants[1]

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Abstract

We evaluated the effects of a moderate consumption of olive oil on lipid profile, BMI, and blood pressure (BP) in a group of 160 healthy men from non-Mediterranean regions [Northern Europe ($n = 50$; Finland and Denmark) and Central Europe ($n = 60$; Germany)] and Mediterranean regions [Southern Europe ($n = 45$; Italy and Spain)]. The study was a randomized, cross-over trial with 3 intervention periods of 3 wk and 2 wash-out periods of 2 wk. At the intervention periods, 3 similar olive oils (25 mL/d), differing only in their phenolic concentration, were administered to the healthy volunteers. Plasma oleic acid levels increased 2–3% ($P < 0.05$) in men from populations with lower habitual olive oil intakes (Northern and Central Europe). General linear models showed that the administration of the sequence of the 3 olive oils was responsible for a 3% decrease in systolic BP (SBP) ($P < 0.05$), but not in diastolic BP, in the non-Mediterranean subjects. Multivariate analysis indicated that the lipid profile did not change in either Mediterranean or non-Mediterranean men due to the olive oil intervention. The results of this study suggest that a moderate consumption of olive oil may be used as an effective tool to reduce SBP of healthy men who do not typically consume a Mediterranean diet. However, additional longer trials are necessary for confirmation. J. Nutr. 137: 84–87, 2007.

Introduction

Since the Seven Countries Study was initiated in the 1950s by Ancel Keys (1,2), public interest in the Mediterranean diet, which is high in monounsaturated fatty acids (MUFA)[9] and natural antioxidants, has increased due to its wide range of health benefits and possible prevention of cardiovascular risk. This healthy eating pattern obtains the majority of energy from foods of vegetable origin and the intake of SFA and cholesterol remains low (3). When saturated or trans unsaturated fats are replaced with MUFA from vegetable oils, like olive oil, plasma LDL cholesterol (LDL-C) primarily decreases (4). This replacement is associated with a considerable reduction in coronary heart disease risk, without reduction of plasma HDL cholesterol (HDL-C) or an increase in triglycerides (TG) (3,4).

Furthermore, it has also been reported that the adherence to a Mediterranean diet increases the likelihood of controlling arterial blood pressure (BP) (5,6). Although genetic factors seem to be responsible for as much as 20–40% of BP variations in the general population (7), epidemiologic data suggest that lifestyle factors, such as dietary habits, are a major contributor to the high prevalence of hypertension (8,9). Olive oil intake, per se, has been inversely associated with both systolic BP (SBP) and diastolic BP (DBP) (5).

Because cardiovascular mortality is much lower in Mediterranean populations than in those from North European and Western countries (10), a shift in the dietary habits of the Northern European population to the traditional Mediterranean pattern likely would be desirable. However, changing well-established dietary patterns is not always easy. There are numerous factors that can markedly influence dietary intake, such as differences in culture, ethnicity, religion, availability of specific foods, and economic development among others (11). Therefore, it may be practical to gradually encourage healthier dietary patterns, beginning with the introduction of small changes.

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[9] Abbreviations used: BP, blood pressure; CVD, cardiovascular heart disease; DAFNE, Data Food Networking; DBP, diastolic blood pressure; fast-GC, fast gas chromatography; GLM, general linear models; HDL-C, HDL cholesterol; LDL-C, LDL cholesterol; MUFA, monounsaturated fatty acid; SBP, systolic blood pressure; TC, total cholesterol; TG, triglycerides.

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Our objective was to analyze the effects of a moderate consumption of olive oil in healthy men from non-Mediterranean regions [Northern Europe (Finland and Denmark) and Central Europe (Germany)] and Mediterranean regions [Southern Europe (Italy and Spain)].

Subjects and Methods

Subjects. A total of 160 healthy men aged 33.3 ± 11.1 y were recruited from 6 centers in 5 European countries (Finland, Denmark, Germany, Italy, and Spain). All subjects were considered healthy on the basis of a complete physical examination and routine biochemical and hematological laboratory determinations. Exclusion criteria were: smoking; use of antioxidant supplements, aspirin, or drugs with established antioxidant properties; hyperlipidemia; obesity; diabetes; hypertension; intestinal disease; or any other disease or condition that would impair adherence.

The subjects were divided into 3 groups according to the region they were from (North, Central, and South Europe). The protocol was fully explained to all participants. All subjects provided written informed consent. The local institutional Ethic Committees[10] approved the protocol.

Study design. The study was a randomized, cross-over trial with 3 intervention periods of 3 wk and 2 wash-out periods of 2 wk. During the intervention periods, 3 similar olive oils (25 mL/d), differing only in their phenolic concentration (low, 2.7 mg/kg olive oil; medium, 164 mg/kg; and high, 366 mg/kg), were consumed by the men. Daily doses of olive oil were prepared without knowledge of contents in containers delivered to the participants at the beginning of each intervention period. The α-tocopherol concentration for the 3 oils was 111.9 mg/kg. The fatty acid composition was the same for the 3 oils (**Table 1**). Subjects were examined at baseline and at the end of the study. They recorded their habitual diet for 3 consecutive days at baseline and the end of the study period. Food consumption was converted into corresponding nutrient intake with validated nutrition software from each country (Denmark: DanKost 3000 software, Dankost A/S; Finland: NUTRICA@ version 2.5. software; Germany: PRODI version 4.5. LE 2001; Italy: Dieta ragionata release 3.0. della ESI Stampa Medica SrL; Spain: MediSystem 2000, Conaycyte).

Blood sampling and biochemical determinations. Venous blood (2 mL) was collected in tubes containing 1 g/L EDTA at baseline and endpoint. Plasma was obtained by centrifugation of blood at 1500 × *g*; 20 min at 4°C. Aliquots (500 μL) of the plasma samples were mixed with 100 μmol/L 3,5-ditert-butyl-4-hydroxytoluene to avoid auto-oxidation and were stored at −80°C until analyzed. We performed all biochemical and analytical determinations in duplicate.

Plasma total cholesterol (TC), HDL-C, and TG concentrations were measured using enzymatic methods (Roche Diagnostics) (12–14). We calculated LDL-C using the Friedewald formula and measured plasma fatty acids by fast GC after transforming them into methyl esters (15).

BP and BMI measurements. BP was measured with a mercury sphygmomanometer after a minimum of 10 min rest in the seated position; the mean of 2 measurements was used for analysis. An easy-calibration precision scale was used to measure body wt (in underwear). Subjects weighed 75.8 ± 9.7 kg, their height was 1.78 ± 0.06 m, and their BMI was 23.8 ± 2.5 kg/m^2.

Statistical analysis. Data are presented as means ± SD. A Levene test was performed to check homogeneity of variance. Paired *t* tests were used for intra-group comparisons and 1-factor ANOVA for inter-group comparisons. Tukey's post hoc tests were performed for multiple comparisons between groups. For performing a more powerful multivariate analysis, general linear models were used to analyze the effect of a moderate consumption of olive oil in the lipid profile and BP values. For each model, the dependent variable was defined as the difference between the endpoint and the baseline values of each of the variables (SBP, DBP, TC, HDL-C, LDL-C, and TG) and the independent variable was the plasma oleic acid level at the end of the study, considered as a biomarker of the olive oil intake. Because age and BMI affect plasma lipid concentrations and BP, they were included in each model as covariates, as were the baseline plasma oleic acid level, the baseline value of each variable under study, the European region the participants were from, the phenolic concentration of the participants' plasma at baseline and at the end of the study, and the sequence in which the men received oil treatments. For all analyses, 2-sided significance was determined at the $P < 0.05$ level. Analyses were performed using the SPSS statistical software package (version 12.0).

TABLE 1 Fatty acid composition of the olive oils used for the study

Fatty acid	*g/100 g*
Myristic acid (14:0)	0.02
Palmitic acid (16:0)	11.78
16:1(n-7)	1.05
17:0	0.06
17:1	0.13
Stearic acid (18:0)	2.59
Oleic acid [18:1(n-9)]	75.65
Linoleic acid [18:2(n-6)]	7.17
20:0	0.39
α-Linolenic acid [18:3(n-3)]	0.70
20:1(n-9)	0.29
22:0	0.10

Results

The men's BMI and body weight did not change throughout the study.

Dietary records. At baseline, energy intake from fat was significantly lower in men from Northern Europe than in those from the other 2 regions (**Table 2**). While SFA provided the highest percentage of fat in the men from the northern and central regions, in men from the Mediterranean area, around one-half of the energy derived from fat was due to MUFA intake. The amount of cholesterol consumed was significantly higher for men from Central Europe, whereas those from Northern and Southern Europe had intakes that did not differ. Compared with the other 2 groups, baseline vitamin E intake was significantly lower in men from Northern Europe, vitamin A intake was significantly lower in men from Southern Europe, and vitamin B-12 intake was significantly lower in men from Central Europe.

As expected, the dietary percentage of MUFA increased due to the consumption of olive oil in participants from all 3 regions (the endpoint data in Table 2 include supplemental olive oil), although the increase was only of borderline significance ($P =$ 0.07) for the men from Southern Europe. In addition, a significant decrease in the SFA and PUFA intake occurred for men from both non-Mediterranean regions.

Plasma fatty acid composition. Baseline plasma oleic acid levels were significantly higher in the Mediterranean men than in the non-Mediterranean volunteers (**Table 3**). Subjects from Southern Europe had lower plasma palmitic and linoleic acid levels than those from Northern and Central Europe. Men from Northern Europe had lower plasma arachidonic acid levels than men from both other groups.

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TABLE 2 Daily energy and nutrient intakes of men from the 3 regions at baseline and after consuming olive oil for 9 wk[1]

	Northern Europe, $n = 50$		Central Europe, $n = 60$		Southern Europe, $n = 45$	
	Baseline	Endpoint	Baseline	Endpoint	Baseline	Endpoint
Energy, *kJ/d*	10.0 ± 0.1	10.2 ± 0.1	10.1 ± 0.1	10.3 ± 0.1	9.9 ± 0.1	10.0 ± 0.1
Protein, *% energy*	17.8 ± 2.8	16.3 ± 3.2	15.8 ± 3.8	14.9 ± 3.7	16.3 ± 3.2	16.1 ± 3.2
Carbohydrates, *% energy*	50.9 ± 8.0	50.9 ± 7.6	49.2 ± 7.2	49.3 ± 7.2	47.9 ± 7.5	47.0 ± 7.2
Fat, *% energy*	31.2 ± 6.3^{b}	32.8 ± 6.6^{y}	34.9 ± 5.4^{a}	35.9 ± 5.9^{x}	35.8 ± 6.2^{a}	36.9 ± 6.3^{x}
SFA, *% energy*	14.1 ± 2.4^{b}	11.6 ± 2.2^{*y}	15.9 ± 2.6^{a}	13.3 ± 2.2^{*x}	11.7 ± 2.2^{c}	11.6 ± 2.3^{y}
MUFA, *% energy*	11.5 ± 2.4^{b}	16.1 ± 2.4^{*y}	12.9 ± 2.5^{b}	17.3 ± 2.6^{*y}	18.7 ± 2.6^{a}	20.0 ± 2.7^{x}
PUFA, *% energy*	5.6 ± 0.1^{b}	5.0 ± 0.1*	6.1 ± 0.2^{a}	5.3 ± 0.1*	5.4 ± 0.1^{b}	5.4 ± 0.1
Cholesterol, *mg/d*	312.7 ± 62.3^{b}	301.4 ± 64.5	367.4 ± 66.2^{a}	320.5 ± 64.3*	298.3 ± 62.1^{b}	298.1 ± 63.0
Vitamin E, *mg/d*	8.5 ± 3.2^{b}	10.0 ± 3.6^{*y}	10.6 ± 3.4^{a}	12.8 ± 3.5^{*x}	10.6 ± 3.3^{a}	11.3 ± 3.5^{y}
Vitamin A, *mg/d*	1.3 ± 0.7^{a}	1.1 ± 0.6^{x}	1.3 ± 0.8^{a}	1.2 ± 0.8^{x}	0.3 ± 0.1^{b}	0.4 ± 0.1^{y}
Vitamin B-6, *mg/d*	1.9 ± 0.4	1.8 ± 0.3	1.8 ± 0.3	1.8 ± 0.2	1.7 ± 0.3	1.6 ± 0.3
Vitamin B-12, *mg/d*	6.5 ± 0.5^{a}	6.2 ± 0.4^{x}	4.7 ± 0.5^{b}	4.6 ± 0.5^{y}	7.3 ± 0.7^{a}	7.1 ± 0.4^{x}
Vitamin C, *mg/d*	108.4 ± 11.1	103.7 ± 10.9	115.5 ± 12.0	123.9 ± 12.5	99.2 ± 10.1	97.2 ± 10.2
β-Carotene, *mg/d*	2.8 ± 0.6	2.9 ± 0.7	3.3 ± 0.8	3.4 ± 0.6	3.1 ± 0.8	3.3 ± 0.7

[1] Values are means ± SD. Means at a time with superscripts without a common letter differ, $P < 0.05$. * Different from baseline, $P < 0.05$.

Plasma lipid concentrations. Baseline plasma HDL-C was significantly higher and LDL-C and TC concentrations significantly lower in men from Southern Europe than in those from Northern and Central Europe. Plasma TC and LDL-C concentrations decreased significantly in the non-Mediterranean participants after 9 wk of olive oil treatment (*t* test, **Table 4**). However, after adjusting for the covariates listed in statistical methods, plasma lipids were not affected by olive oil in any of the groups.

BP. SBP and DBP significantly decreased after the 9 wk of olive oil consumption for men from the non-Mediterranean regions (**Table 5**). After adjusting for all covariates, however, only SBP was significantly decreased in the non-Mediterranean men ($P = 0.002$).

TABLE 3 Relative composition of the 5 major fatty acids in plasma of men from the 3 regions at baseline and after consuming olive oil for 9 wk[1]

	n	Fatty acids	Baseline, *%*	Endpoint, *%*
Northern Europe	50	16:0	25.4 ± 0.7^{a}	23.9 ± 0.8^{x}
		18:0	7.8 ± 0.4	7.6 ± 0.3
		18:1(n-9)	24.8 ± 1.6^{b}	27.2 ± 1.7^{*x}
		18:2(n-6)	35.3 ± 1.8^{a}	34.6 ± 1.7^{x}
		20:4(n-6)	6.7 ± 0.6^{b}	6.7 ± 0.4^{y}
Central Europe	60	16:0	25.0 ± 0.6^{a}	23.5 ± 0.7^{x}
		18:0	8.1 ± 0.3	8.1 ± 0.4
		18:1(n-9)	23.0 ± 1.4^{b}	25.5 ± 1.3^{*y}
		18:2(n-6)	36.0 ± 1.7^{a}	35.0 ± 1.7^{x}
		20:4(n-6)	7.9 ± 0.4^{a}	8.0 ± 0.7^{x}
Southern Europe	45	16:0	21.8 ± 0.6^{b}	21.5 ± 0.6^{y}
		18:0	7.4 ± 0.4	7.6 ± 0.5
		18:1(n-9)	29.7 ± 1.5^{a}	30.4 ± 1.4^{x}
		18:2(n-6)	33.0 ± 1.6^{b}	32.6 ± 1.5^{y}
		20:4(n-6)	8.1 ± 0.6^{a}	7.9 ± 0.5^{x}

[1] Values are means ± SD. Means at a time with superscripts without a common letter differ, $P < 0.05$. * Different from baseline, $P < 0.05$.

Discussion

A moderate consumption of 25 mL of olive oil significantly reduced SBP in the study participants from Northern and Central Europe. In contrast, these effects did not occur in men from Southern European regions.

The daily baseline dietary records showed different dietary habits in Mediterranean and non-Mediterranean countries. A recent study describing the dietary patterns of 10 European countries and their social-demographic determinants, using the comparable inter-country DAFNE (Data Food Networking) data (16), showed that olive oil is the added fat of choice in the Mediterranean region, whereas the Central European and Scandinavian populations have higher intakes of other vegetable oils and animal fats.

It is interesting to note some outcomes of the moderate consumption of olive oil. We expected that plasma oleic acid levels would increase after daily supplementation in all subjects. This increase, however, was not significant in the Italian and Spanish subjects ($P = 0.071$) due to their habitually high intake of olive oil (10,11), which was clearly reflected in their baseline

TABLE 4 Plasma lipid concentrations in men from the 3 regions at baseline and after consuming olive oil for 9 wk[1]

	n		Baseline	Endpoint
			mmol/L	
Northern Europe	50	Triglycerides	1.0 ± 0.6	0.9 ± 0.7
		Total cholesterol	4.8 ± 0.7^{a}	4.6 ± 0.6*
		LDL cholesterol	3.1 ± 0.5^{a}	2.9 ± 0.6*
		HDL cholesterol	1.2 ± 0.7^{b}	1.3 ± 0.6*
Central Europe	60	Triglycerides	0.9 ± 0.5	0.9 ± 0.6
		Total cholesterol	4.8 ± 0.8^{a}	4.7 ± 0.7*
		LDL cholesterol	3.2 ± 0.5^{a}	2.9 ± 0.5*
		HDL cholesterol	1.2 ± 0.6^{b}	1.3 ± 0.6*
Southern Europe	45	Triglycerides	0.9 ± 0.6	0.9 ± 0.6
		Total cholesterol	4.7 ± 0.8^{b}	4.7 ± 0.7
		LDL cholesterol	2.8 ± 0.5^{b}	2.7 ± 0.6
		HDL cholesterol	1.3 ± 0.7^{a}	1.3 ± 0.7

[1] Values are means ± SD. Means at a time with superscripts without a common letter differ, $P < 0.05$. * Different from baseline, $P < 0.05$.

TABLE 5 SBP and DBP of men from the 3 regions at baseline and after consuming olive oil for 9 wk[1]

	n		Baseline	Endpoint
			mm Hg	
Northern Europe	50	SBP	126.7 ± 2.6[a]	122.5 ± 2.4*
		DBP	80.6 ± 3.3[a]	78.4 ± 3.1[x]
Central Europe	60	SBP	124.2 ± 2.4[a]	119.8 ± 2.5*
		DBP	78.6 ± 3.2[a]	75.7 ± 3.0[x]
Southern Europe	45	SBP	122.0 ± 2.4[b]	119.6 ± 2.3
		DBP	74.0 ± 3.1[b]	72.6 ± 2.9[y]

[1] Values are means ± SD. Means at a time with superscripts without a common letter differ, $P < 0.05$. *Different from baseline, $P < 0.05$.

oleic acid levels. The MUFA to SFA dietary lipid ratio also remained significantly higher in men from Southern Europe than in men from Northern and Central Europe.

Although the participants were allowed to continue their habitual diets, most of the non-Mediterranean volunteers reduced their SFA and PUFA intakes in an attempt to balance their total fat intake. This resulted in a healthier lipid profile at the end of the study. The health benefits of olive oil used to recruit volunteers for the study, together with its ease of use and pleasant incorporation into their habitual meals, could have encouraged the non-Mediterranean subjects to change the quality of their fat intakes.

It has recently been reported that changing the proportions of dietary fat by decreasing SFA and increasing MUFA decreases BP in healthy subjects (17). These results agree with SBP outcomes in the non-Mediterranean participants of this work. In addition, Rasmussen et al. (17) observed that the beneficial effect on BP induced by fat quality was negated by high total fat intake. In our study, the non-Mediterranean participants had high total fat intakes at the beginning of the study and after consuming supplemental olive oil for 9 wk (≥34.9% energy). However, despite the high total fat intake, they had lower SBP at the end of the study.

In conclusion, the outcomes of our study suggest that moderate administration of olive oil could be used as an effective tool to reduce SBP of healthy men in those European populations where the Mediterranean diet is not typically consumed. The introduction of olive oil into non-Mediterranean diets should be accompanied by a reduction in saturated fat to improve lipid profiles. Nevertheless, a longer study should be conducted to verify that small changes or modifications in the diet can be made, which would hopefully become habitual.

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Literature Cited

1. Keys AB. Seven Countries: a multivariate analysis of death and coronary heart disease. Cambridge (MA): Harvard University Press; 1980.
2. Kromhout D, Keys A, Aravanis C. Food consumption patterns in the 1960s in seven countries. Am J Clin Nutr. 1989;49:889–94.
3. Pérez-Jiménez F, López-Miranda J, Mata P. Protective effect of dietary monounsaturated fat on arteriosclerosis: beyond cholesterol. Atherosclerosis. 2002;163:385–98.
4. Sacks FM, Katan M. Randomized clinical trials on the effects of dietary fat and carbohydrate on plasma lipoproteins and cardiovascular disease. Am J Med. 2002;113 Suppl 9B:S13–24.
5. Psaltopoulou T, Naska A, Orfanos P, Trichopoulos D, Mountokalakis T, Trichopoulou A. Olive oil, the Mediterranean diet, and arterial blood pressure: the Greek European Prospective Investigation into Cancer and Nutrition (EPIC) study. Am J Clin Nutr. 2004;80:1012–8.
6. Panagiotakos DB, Pitsavos CH, Chrysohoou C. Status and management of hypertension in Greece: role of the adoption of a Mediterranean diet: the Attica study. J Hypertens. 2003;21:1483–9.
7. Ward R. Familial aggregation and genetic epidemiology of blood pressure. In: Laragh JH, Brenner BM, editors. Hypertension, pathophysiology, diagnosis and management. New York: Raven Press; 1990. p. 81–100.
8. Hermansen K. Diet, blood pressure and hypertension. Br J Nutr. 2000; 83 Suppl 1:S113–9.
9. Perona J, Cabello-Moruno R, Ruiz-Gutierrez V. The role of virgin olive oil components in the modulation of endothelial function. J Nutr Biochem. 2006;17:429–45.
10. Visioli F, Caruso D, Grande S, Bosisio R, Villa M, Galli G, Sirtori C, Galli C. Virgin Olive Oil Study (VOLOS): vasoprotective potential of extra virgin olive oil in mildly dyslipidemic patients. Eur J Nutr. 2005; 44:121–7.
11. Trichopoulou A. Traditional Mediterranean diet and longevity in the elderly: a review. Public Health Nutr. 2004;7:943–47.
12. Siedel J, Hägele EO, Ziegenhorn J, Wahlefeld AW. Reagent for the enzymatic determination of serum total cholesterol with improved lipolytic efficiency. Clin Chem. 1983;29:1075–80.
13. Sugiuchi H, Uji Y, Okabe H, Irie T, Uekama K, Kayahara N, et al. Direct measurement of high-density lipoprotein cholesterol in serum with polyethylene glycol-modified enzymes and sulphated alpha-cyclodextrin. Clin Chem. 1995;41:717–23.
14. Bucolo G, David H. Quantitative determination of serum triglycerides by the use of enzymes. Clin Chem. 1973;19:476–82.
15. Bondia-Pons I, Castellote AI, López-Sabater MC. Comparison of conventional and fast gas chromatography in human plasma fatty acid determination. J Chromatogr B. 2004;809:339–44.
16. Naska A, Fouskakis D, Oikonomou E, Almeida MDV, Berg MA, Gedrich K, Moreiras O, Nelson M, Trygg K, et al. Dietary patterns and their socio-demographic determinants in 10 European countries: data from the DAFNE databank. Eur J Clin Nutr. 2006;60:181–90.
17. Rasmussen BM, Vessby B, Uusitupa M, Berglund L, Pedersen E, Riccardi G, Rivellese AA, Tapsell L, Hermansen K. Effects of dietary saturated, monounsaturated, and n-3 fatty acids on blood pressure in healthy subjects. Am J Clin Nutr. 2006;83:221–6.