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Effects of Greek orthodox christian church fasting on serum lipids and obesity

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Abstract

Background: No study to date has focused on the impact of Greek Orthodox Christian fasting on serum lipoproteins and obesity yet.

Methods: 120 Greek adults were followed longitudinally for one year. Sixty fasted regularly in all fasting periods (fasters) and 60 did not fast at all (controls). The three major fasting periods under study were: Christmas (40 days), Lent (48 days) and Assumption (August, 15 days). A total of 6 measurements were made during one year including pre- and end-fasting blood collection, serum lipoprotein analyses and anthropometric measurements.

Results: Statistically significant end-fasting total and LDL cholesterol differences were found in fasters. Fasters compared to controls presented 12.5% lower end-total cholesterol ($p < 0.001$), 15.9% lower end-LDL cholesterol ($p < 0.001$) and 1.5% lower end-BMI ($p < 0.001$). The end- LDL/HDL ratio was lower in fasters (6.5%, $p < 0.05$) while the change in end- HDL cholesterol in fasters (4.6% decline) was not significant. Similar results were found when the pre- and end-fasting values of fasters were compared. No change was found in control subjects.

Conclusions: Adherence to Greek Orthodox fasting periods contributes to a reduction in the blood lipid profile including a non-significant reduction in HDL cholesterol and possible impact on obesity.

Background

Fasting, the voluntary abstention from all restricted foods, is a feature of many religions, and the putative health benefits have attracted both scientific and popular interest. Commonly, religious doctrines proscribe foods from animal sources permanently or for particular periods.

There are several religions, such as Hinduism, Buddhism, Judaism, Islam, Seventh-Day-Adventism that have often been studied regarding their relation to health [1–14]. However, the studies on Orthodox Christianity are very limited.

Orthodox Christian holy books recommend a total of 180–200 days of fasting per year. The faithful are advised to avoid olive oil, meat, fish, milk and dairy products every Wednesday and Friday throughout the year. Additionally, there are three principal fasting periods per year: i) a total of 40 days preceding Christmas (meat, dairy products and eggs are not allowed, while fish and olive oil are allowed except on Wednesdays and Fridays), ii) a period of 48 days preceding Easter (Lent). During Lent fish is allowed only two days whereas meat, dairy products and eggs are not allowed. Olive oil consumption is allowed only at weekends, iii) a total of 15 days in August (the Assumption) when the same dietary rules apply as for Lent with the exception of fish consumption which is allowed only on August 6th. Seafood such as shrimps, squid, cuttlefish, octopus, lobsters, crabs as well as snails are allowed on all fasting days throughout the year. The Greek Orthodox fasting practices can therefore be characterized as requiring a periodic vegetarian diet including fish and seafood.

The variant of vegetarianism followed during fasting periods by Orthodox Christians, with a diet of vegetables, legumes, nuts, fruits, olives, bread, snails and seafood, is a type of the so-called Mediterranean diet [15,16]. To date little is known as to the effects of this 'hidden' element of the traditional Orthodox Christian diet on health and no data exist on the effect of Orthodox Christianity's dietary rules on blood lipid levels and obesity. The objective of this study was therefore to assess the effects of intermittent short-term religious fasting, according to the dietary rules of the Orthodox Christian Church, on blood lipoprotein profile and the prevalence of obesity.

Methods

Subjects

The subjects of this study were selected from an adult population in the region of Heraklion, Crete. One hundred-twenty Orthodox Christians were asked to participate in this study. Sixty individuals (31 males, 29 females), mean age (x ± SD) 41 ± 12 years, fasted regularly according to the dietary rules and the fasting periods of the Christian Orthodox Church. Fasters had been practicing the fasting rituals for a mean of 20 ± 14 years. Another group of sixty subjects (24 males, 36 females), mean age (x ± SD) 38 ± 9 years, were control subjects that did not fast. Among the fasting group, 20 were lay persons (fasted for 13 ± 10 years) and 40 were under religious order (fasted for 23 ± 15 years): 19 nuns living in a convent and 21 priests living with their families in community parishes. The family history of each subject was recorded with regard to diabetes, CHD, smoking, hormonal disturbances and drug intake.

Study design

Three pairs of measurements were made over a 1-year period (2000–2001), coinciding with the beginning and end of each of the three major fasting periods of the Christian Orthodox Church: Christmas, Lent and the Assumption. All measurements were made between 8.00–10.00 am and they included fasting blood collection, anthropometric measurements and the completion of questionnaires.

Questionnaires

All subjects signed informed consent forms and completed questionnaires on fasting, health habits (coffee and alcohol consumption, smoking), certain items of personal data (marital status, educational level), physical activity, dietary habits (24 h recall, 3-day dietary record). Fasters were defined as those who fasted regularly during all three principal fasting periods, while current smokers as those who smoked at least one cigarette per day.

Anthropometric variables

Body weight was measured all six times by a digital scale (Seca, Hamburg, Germany, Model 770) with an accuracy of ± 100 g. Subjects were weighed barefoot in very light clothing. Standing height was measured once without shoes to the nearest 0.5 cm with the use of a stadiometer with the shoulders in relaxed position and arms hanging freely. Body Mass Index (BMI) was calculated by dividing weight (kg) by height squared (m^2). Waist and hip circumferences were measured twice, at the first and sixth measurement of the study [17]. Blood pressure (BP) was measured all six times in the right arm with a traditional sphygmomanometer. Three seated BP measurements were taken for each subject spaced two minutes apart.

Biochemical assays

Serum lipoprotein concentrations were always determined after 12 h of fasting. Blood samples were transferred to the University hospital of Crete in tanks containing ice packs that maintained the temperature at 3–4°C. Total cholesterol was determined by Allain's method [18], HDL-C was measured by the heparin-manganese precipitation method [19] and triacylglycerols were determined using Fossati's method [20], while LDL-C was calculated as follows: LDL-C = TC - (HDL -C + TG/5) [21]. During the period October 2000 – September 2001 the coefficient of variation for the biochemical analysis of total cholesterol was 2,85%, for HDL was 5,40% and for triacylglycerols was 3,92%. DNA extraction was performed according to the method of Miller et al [22]. Apo E genotype was determined by PCR amplification and subsequent digestion with the restriction enzyme *Hha* I (*New England Biolabs*) as described by Reymer et al [23] in Harokopio University of Athens.

Table 1: Sociodemographic characteristics of the population.

	FASTERS N (%)	**CONTROLS** n (%)	p
Sex			
Males	31 (52%)	24 (40%)	NS[a]
Females	29 (48%)	36 (60%)	
Age (years)[c]	42 ± 12	38 ± 9	NS[b]
Tobacco use			
Smokers	4 (7%)	33 (55%)	<0.001[a]
Non-smokers	56 (93%)	27 (45%)	
Educational level			
Higher	26 (43%)	14 (23%)	NS[a]
Secondary	24 (40%)	34 (57%)	
Minimum school level / No education	10 (17%)	12 (20%)	

a. Chi-square test (χ^2) – Fisher exact test. b. ANOVA analysis. c. Values are means ± SD.

Statistical methods
Differences in gender, tobacco use, educational level and apolipoprotein E distribution were compared using χ^2 analysis, while differences in age were compared by ANOVA analysis. Regression analysis was used to compare end-fasting lipid concentrations and BMI with age, sex, smoking, educational level, BMI, WHR, fasting and the pre-fasting values. The influence of fasting on end-fasting values was examined using ANCOVA analysis. Paired samples T-test and Mann-Whitney test were used to compare pre and end-fasting values in fasters.

Pre-fasting values comprise the mean of the three measurements that were made before the beginning of the Christmas, Lent and Assumption fasting periods, while end-fasting values are the mean of the three measurements that were made at the end of each one of the fasting periods.

Results
Demographic data on a hundred and twenty subjects are presented in Table 1. Sixty of the subjects were fasters (26% male, 24% female) with a mean age of 42 ± 12; the other sixty were control subjects (20% male, 30% female) with a mean age of 38 ± 9. There was no statistically significant difference in the age of the two groups (ANOVA). The subjects in the fasters group had been observing the fasting rituals for a mean of 20 ± 14 years. The rate of compliance with the fasting rules was 100%. All subjects in both groups did not suffer from any disease like thyroid, diabetes, cancer, cardiovascular diseases, and did not take any medication.

The levels of serum lipids, blood pressure and body measurements of all three periods for fasters and controls are presented in table 2.

Effect of fasting on end-fasting values
Multiple Linear Stepwise Regression Analysis indicated that fasting is a significant determinant for end-total cholesterol, end-LDL cholesterol, end-LDL/HDL ratio and end-BMI (Table 3), showing that fasters have lower levels of these variables.

Females have higher levels of end-HDL cholesterol while men have higher levels of end-TC/HDL and end-LDL/HDL ratios. Waist-to-hip ratio was positively related to end-total cholesterol and end-LDL cholesterol.

Comparisons of end-fasting values between the two groups
Comparisons of mean end-fasting values between fasters and controls are shown in Table 4. Mean end-TC, end-LDL and end-BMI were statistically lower ($p < 0.001$) in fasters compared to controls. Fasters presented 12.5% lower end-TC, 15.9% lower end-LDL cholesterol and 1.5% lower end-BMI compared to controls. Moreover, fasters had significantly lower LDL/HDL ratios ($p < 0.05$). All results were adjusted for age, sex, BMI and smoking.

Comparisons of pre and end-fasting values in the fasters' group
The fasters who had 3 complete pairs of measurements were included in this analysis (Table 5). Paired samples T-test showed that fasters presented 9.1% decline in end- total cholesterol, 12.4% decline in end- LDL, 8.5% decline in end- HDL and 1.4% decline in end- BMI compared to their respective pre-values. All these differences were significant ($p < 0.001$). As for the ratios end- TC/HDL and end- LDL/HDL although they declined the changes were not significant. The same analysis was done in controls that presented no significant changes over the year. A further step was to categorize fasters in two subgroups: 1) nun-priests and 2) lay people and to compare their pre- and end- fasting values. Mann-Whitney test showed that

Table 2: Levels of serum lipids, blood pressure and body measurements.

		CHRISTMAS		EASTER		AUGUST	
		PRE-[a]	END-[a]	PRE-[a]	END-[a]	PRE-[a]	END-[a]
GLUCOSE (mmol/L)	F[b]	4.97 ± 1.24 (59)	4.97 ± 1.39 (56)	4.65 ± 0.88 (49)	4.85 ± 1.13 (52)	5.16 ± 1.15 (47)	4.91 ± 1.11 (48)
	C[b]	4.75 ± 0.73 (60)	5.00 ± 1.25 (52)	4.76 ± 1.00 (54)	4.48 ± 0.68 (50)	4.62 ± 0.69 (41)	4.73 ± 0.87 (43)
TCHOL (mmol/L)	F	5.90 ± 1.20 (59)	5.45 ± 1.13 (56)	5.63 ± 1.15 (49)	5.05 ± 1.15 (52)	5.51 ± 1.17 (47)	5.12 ± 1.18 (48)
	C	5.25 ± 1.02 (60)	5.24 ± 1.12 (52)	5.25 ± 1.09 (54)	5.08 ± 1.04 (50)	5.16 ± 1.02 (41)	5.48 ± 1.28 (43)
HDL (mmol/L)	F	1.22 ± 0.35 (59)	1.19 ± 0.27 (56)	1.17 ± 0.33 (49)	1.05 ± 0.29 (52)	1.23 ± 0.60 (47)	1.09 ± 0.28 (48)
	C	1.18 ± 0.28 (60)	1.21 ± 0.28 (52)	1.36 ± 0.78 (54)	1.19 ± 0.29 (50)	1.20 ± 0.28 (41)	1.20 ± 0.33 (43)
TRIGL (mmol/L)	F	1.48 ± 0.95 (59)	1.39 ± 0.81 (56)	1.38 ± 0.72 (48)	1.43 ± 0.92 (52)	1.31 ± 0.82 (47)	1.36 ± 0.90 (48)
	C	1.01 ± 0.42 (60)	1.02 ± 0.50 (52)	1.04 ± 0.42			
LDL (mmol/L)	F	4.00 ± 1.06 (59)	3.62 ± 1.00 (56)	3.80 ± 0.99 (48)	3.33 ± 0.97 (51)	3.75 ± 1.03 (47)	3.41 ± 1.05 (48)
	C	3.61 ± 0.91 (60)	3.56 ± 1.01 (52)	3.58 ± 0.99 (54)	3.37 ± 0.95 (50)	3.47 ± 0.94 (40)	3.77 ± 1.13 (43)
TC_HDL	F	5.21 ± 1.80 (59)	4.81 ± 1.48 (56)	5.10 ± 1.49 (49)	5.14 ± 1.71 (52)	5.04 ± 1.73 (47)	4.97 ± 1.54 (48)
	C	4.70 ± 1.44 (60)	4.58 ± 1.50 (52)	4.37 ± 1.52 (54)	4.48 ± 1.35 (50)	4.52 ± 1.37 (41)	4.79 ± 1.42 (43)
WEIGHT (kg)	F	78.4 ± 16.4 (60)	77.0 ± 16.0 (57)	77.6 ± 16.0 (51)	76.0 ± 15.5 (52)	76.4 ± 16.1 (47)	75.4 ± 15.7 (49)
	C	72.3 ± 15.8 (60)	74.1 ± 16.4 (52)	73.1 ± 16.2 (54)	72.7 ± 16.5 (50)	74.1 ± 17.0 (41)	74.7 ± 16.6 (43)
BMI (kg/m^2)	F	28.6 ± 5.1 (59)	28.3 ± 5.1 (57)	28.2 ± 4.7 (51)	27.7 ± 4.8 (52)	27.7 ± 4.9 (47)	27.5 ± 4.7 (49)
	C	25.8 ± 4.3 (60)	26.3 ± 4.5 (52)	25.9 ± 4.2 (54)	25.7 ± 4.4 (50)	26.1 ± 4.6 (41)	26.5 ± 4.8 (43)
SYST (mm Hg)	F	129 ± 18 (59)	128 ± 19 (57)	130 ± 21 (51)	129 ± 20 (52)	121 ± 16 (47)	117 ± 16 (49)
	C	117 ± 14 (60)	109 ± 12 (52)	109 ± 13 (53)	106 ± 13 (50)	106 ± 15 (41)	107 ± 12 (43)
DIAST (mm Hg)	F	79 ± 8 (59)	79 ± 13 (57)	79 ± 13 (51)	81 ± 13 (52)	77 ± 12 (47)	73 ± 10 (49)
	C	74 ± 11 (60)	69 ± 9 (52)	67 ± 10 (53)	67 ± 9 (50)	66 ± 11 (41)	66 ± 10 (43)

a. The values are presented as Mean ± SD (n) b. F = Fasters, C = Controls

Table 3: Effect of various variables including fasting on serum lipids and BMI.[a]

Dependent variables	Predictors	Beta	t	p
End Total Cholesterol	Pre-fasting TC	0.94	28.3	<0.001
	Fasting	-0.24	-7.7	<0.001
	WHR	0.19	3.2	0.002
	Sex	-0.12	-2.1	0.037
End LDL cholesterol	Pre-fasting LDL-C	0.93	32.7	<0.001
	Fasting	-0.23	-8.5	<0.001
	WHR	0.2	3.9	<0.001
	Sex	-0.12	-2.4	0.018
End HDL cholesterol	Pre-fasting HDL-C	0.74	10.9	<0.001
	Sex	-0.24	-3.54	<0.001
End TC/HDL cholesterol	Pre TC:HDL-C	0.85	19.1	<0.001
	Sex	0.17	3.9	<0.001
End LDL/HDL cholesterol	Pre LDL:HDL-C	0.88	21.0	<0.001
	Sex	0.14	3.4	<0.001
	Fasting	-0.1	-2.7	0.008
End fasting BMI	Pre-fasting BMI	1.0	115.9	<0.001
	Fasting	-0.35	-4.06	<0.001

Multiple Linear Stepwise Regression Analysis with mean end-TC, end-LDL cholesterol, end-HDL cholesterol, end-BMI and the end-ratios of TC/HDL-C and LDL-C/HDL-C as the dependent variables. Independent variables were age, mean pre-BMI, fasting, smoking, sex, educational level, WHR, pre-ratios of TC/HDL-C and LDL-C/HDL-C and the pre-values of the dependent variables. Sex, fasting and smoking are dummies (sex: 0 = females and 1 = males, fasting: 0 = control subjects and 1 = fasters, smoking: 0 = smokers and 1 = non-smokers). a. The subjects that had all six measurements were included (n = 71).

Table 4: ANCOVA analysis. Effect of fasting on end-fasting mean ratios with covariates the respective pre-fasting mean ratios between fasters and control subjects.

End-fasting variables	FASTERS (n = 40)		CONTROLS (n = 31)		
	Mean	SEMa	Mean	SEM[a]	p
Glucose (mmol/L)	4.95	0.07	4.86	0.08	NS
Total cholesterol (mmol/L)	4.9	0.05	5.6	0.06	<0.001
HDL cholesterol (mmol/L)	1.1	0.03	1.2	0.03	NS
LDL cholesterol (mmol/L)	3.3	0.04	3.8	0.05	<0.001
Triglycerides (mmol/L)	1.27	0.05	1.25	0.06	NS
TC/HDL-C[b]	4.7	0.08	5.0	0.1	NS
LDL-C/HDL-C[c]	3.1	0.06	3.3	0.07	0.041
BMI (kg/m^2)	27.0	0.06	27.4	0.07	<0.001

a. Standard Error of the Mean b. The ratio of total cholesterol: high-density lipoprotein c. The ratio of low-density lipoprotein: high-density lipoprotein The results are adjusted for age, BMI, sex, smoking

Table 5: Pared samples T-test. Mean pre-fasting values compared to mean end-fasting values in the group of fasters (n = 43).

Variables	Pre-Fasting		End-Fasting		
	Mean	SEMa	Mean	SEM[a]	p
Glucose (mmol/L)	4.93	0.16	4.95	0.19	NS
Total cholesterol (mmol/L)	5.6	0.15	5.1	0.14	<0.001
HDL cholesterol (mmol/L)	1.2	0.04	1.1	0.04	<0.001
LDL cholesterol (mmol/L)	3.8	1.14	3.3	0.13	<0.001
Triglycerides (mmol/L)	1.41	0.13	1.36	0.09	NS
TC/HDL-C[b]	5.0	0.2	4.9	0.2	NS
LDL-C/HDL-C[c]	3.3	0.1	3.2	0.1	NS
BMI (kg/m^2)	28	0.7	27.6	0.7	<0.001

a. Standard Error of the Mean b. The ratio of total cholesterol: high-density lipoprotein c. The ratio of low-density lipoprotein: high-density lipoprotein

the changes seen in fasters' group remained when each subgroup was analyzed separately though they were not significant. It was observed that between the major fasting periods studied (between the end of Christmas and the beginning of Lent; and between the end of Lent and the beginning of the Assumption fasting period) when fasters returned to their usual dietary habits (non-fasting periods) total cholesterol and LDL cholesterol were increased by 6% and 9% respectively.

Dietary data

Table 6 shows that at end-fasting periods fasters had 10% reduction in energy intake (EI), 17% reduction in total fat (%EI), 23% increase in carbohydrates (%EI) and 43.5% increase in fiber consumption, whereas the respective percentages for the controls are +7%, +1%, +1.7% and +3.3%. All the differences found between the two groups are significant.

Distribution of Apo E polymorphism

Subjects in this study were screened for the common apolipoprotein E (apoE) polymorphism, as genetic variation at the apoE locus has been shown to influence serum lipid responsiveness to dietary interventions and account for much of the interindividual variability in dietary response [24,25] Several studies, for example, support the concept that the ε4 allele is associated with an increased cholesterol response to dietary manipulation, and that subjects carrying the ε4 allele are the most responsive to diets restricted in saturated fat and cholesterol [24–27].

Fasters and control subjects were classified in three groups according to their apoE genotype: subjects homozygous for the common ε3 allele (apoE3/3 genotype, (38 fasters and 40 controls); subjects with the apoE2/3 genotype (nine fasters and four controls); carriers of the ε4 allele (apoE3/4 and apoE4/4 genotypes; four fasters and six

Table 6: Ancova analysis. Dietary differences between fasters and controls among pre and end-fasting periods based on the 24 h dietary record.

		Pre-fasting	End-fasting	Difference	p-value
		Mean ± SE			
Energy (kcal)	F[a]	1788 ± 74	1596 ± 64	-182 ± 67	0.002
	C[a]	1906 ± 75	2043 ± 65	137 ± 69	
Total fat (% of total energy intake)	F	38.3 ± 0.8	31.8 ± 1.1	-6.6 ± 1.1	<0.001
	C	38.7 ± 0.8	39.1 ± 1.1	0.4 ± 1.1	
Carbohydrates (% of total energy intake)	F	48.8 ± 1.1	59.8 ± 1.2	11.0 ± 1.3	<0.001
	C	45.5 ± 1.1	44.6 ± 1.3	-0.8 ± 1.3	
Protein (% of total energy intake)	F	13.8 ± 0.4	10.0 ± 0.4	-3.8 ± 0.6	<0.001
	C	14.3 ± 0.4	14.4 ± 0.4	0.1 ± 0.6	
Fiber (g per 1000 kcal)	F	11.5 ± 0.5	16.5 ± 0.5	5.0 ± 0.6	<0.001
	C	9.2 ± 0.5	9.5 ± 0.5	0.3 ± 0.6	

a. a. F = Fasters (n = 58), C = Controls (n = 56) The results were adjusted for sex, age and pre-BMI. In the analysis were included the subjects that had completed the 24 h dietary record in all 6 measurements.

controls, respectively). Chi-square analysis showed that apoE genotype distribution did not differ between fasters and controls (data not shown).

Discussion

The most important finding of this study is that most serum lipid variables decreased significantly over the fasting periods. Fasters, as compared to controls, had decreased levels of mean end- total cholesterol, LDL-C, LDL/HDL-C ratio and BMI. Several genetic factors account for the variation in cholesterol levels and obesity indices, however, we believe that the possibilities of genetic differences between the two groups are minimal since the population of Crete is stable with a long history over 4000 years. In addition to this, the ApoE genotype distribution found no differences between the two groups (fasters vs controls). In the fasters' group the mean decrease within all three fasting periods was 9% for total cholesterol and 12% for LDL-C. However, it was observed that during non-fasting periods when fasters returned to their usual dietary habits, total cholesterol and LDL-C increased by 6% and 9% respectively. This shows that the reduced end-total and LDL cholesterol concentrations that were observed within the fasting periods were not sustained when the subjects returned to their usual dietary habits even though the increase did not reach the initial pre- levels. The reduction in HDL that occurred in fasters is a common finding with low-fat and vegetarian diets [28–31]. The findings above are in agreement with the results reported by Barnard et al who conducted a strict vegetarian-diet intervention study for 5 weeks on 35 women [30]. The intervention diet consisted of grains, legumes, vegetables and fruit. After the intervention diet phase total cholesterol, LDL and HDL were decreased by 13.2%, 16.9% and 16.5% respectively [30]. BMI was also significantly reduced ($p < 0.001$) while, in agreement with our findings, the TC/HDL and LDL/HDL ratios remained unchanged (table 5)[30]. Similar were the findings in another 6-week vegetarian-diet intervention study by Masarei et al [28] and in a 12-week low-fat-vegan-diet intervention study by Nicholson et al [32]. Lee [33] and Hoffman [34], who compared omnivores with lacto-ovo-vegetarians, found no difference in LDL/HDL ratio between the two groups. The contrasting results on LDL/HDL ratio could be attributed to differences in the population samples studied.

Nieman et al [14] and Toohey et al [35] investigated Seventh-Day Adventists with similar demographic and lifestyle factors and with comparable diets and dietary habits to our cohort. They found that lacto-ovo-vegetarians and lifetime strict vegetarians had lower concentrations of total and LDL cholesterol when compared with non-vegetarians and lacto-ovo-vegetarians respectively ($p < 0.05$) [14]. Toohey et al found also found lower levels of BMI, triacylglycerols and TC/HDL ratio [35]. The present study showed that women had lower levels of LDL/HDL ratio and TC/HDL ratio, which is also a better predictor for CHD in women [36–38]. This is explained by the higher concentrations of HDL that women have compared to men [39].

The positive association of waist-to-hip ratio with total and LDL cholesterol is in agreement with other studies that correlate waist-to-hip ratio with coronary risk factors and CHD prevalence [40–42]. Waist-to-hip ratio measurement is a simple and cost-effective measure that contributes in predicting abnormal lipoprotein levels and increased risk of cardiovascular disease.

Both the fasting and control groups had mean BMI in the overweight category. Fasting had a small but statistically significant impact on fasters' BMI at the end of the fasting periods that was not sustained in non-fasting periods. In accordance to the results in this study, Haddad et al studying a group of vegans and nonvegetarians found significantly lower BMI levels in the vegan group [43]. Moreover, others found that vegetarians have lower BMI than meat eaters [44–46]. At the same time following a Mediterranean-style diet has also been proven to be beneficial to weight loss [47]. As regards religious fasting some studies associate it with weight loss and decline in BMI [2,3] while others do not [4,5,48].

Educational level was not found to influence any of the blood lipid variables in this study (Table 3). This was an unexpected result since higher education is associated with better health care and awareness whereas low educational level has been related to unfavorable lipid profile [49], all-cause and CAD mortality [50] and hypertension [51].

The beneficial changes seen in fasters diet during the fasting periods, especially regarding energy intake, total fat and fiber consumption, can also explain the reductions in the biochemical and obesity indices. A recent study of the University of Crete showed that the Christian Orthodox nuns' diet was very low in cholesterol and in saturated fat intake (6% of total energy intake), and high in fiber and antioxidant vitamins [16]. This could be attributed to nuns' high consumption of fruit, vegetables, cereals and legumes. In another study Haddad et al found that vegans consume more grains, vegetables, fruit, legumes and seeds and as a result their diet consists of more dietary fiber and less dietary cholesterol [43]. It is well known that reduced intakes of dietary SFA and cholesterol lower total and LDL cholesterol concentration and are associated with low risk of cardiovascular diseases [52,53]. The Orthodox Christians' diet, which is based on vegetables, legumes, fruit, cereals, bread and olive oil, is a Mediterranean-type of diet with periodic abstinence from meat and other animal products during the fasting periods. Numerous investigators [54–56] have recognized the beneficial role of the Mediterranean diet in cardiovascular diseases, and the protective effect in terms of cancer and longevity have also been noted [57,58]. In addition, supplementary studies have associated religiosity with good health [10]. This has been confirmed in a recent study by Chliaoutakis et al [59], which is the only published work to date which investigates the association between the Orthodox Christian lifestyle and health. Chliaoutakis et al found that devout Orthodox Christians adopt healthier life-styles and that religion has a substantial impact on mental and physical health-related behaviors [59]. In the present study, contrary to Chliaoutakis' findings, the physical activity of the two groups (fasters vs controls) did not differ in any of the testing periods.

Our study attempts to provide an understanding of the impact of Christian Orthodox fasting on serum blood lipids and obesity indices before and at the end of the three major fasting periods. Compared to controls, fasters presented decreased lipoproteins and BMI levels. These results support our hypothesis by highlighting the beneficial influence of Christian Orthodox fasting on lipoprotein profile and prevalence of obesity.

Competing interests
None declared.

Authors' contributions
Author K.S mainly organized and performed the study, and drafted the manuscript. Author N.T participated in the design of the study and supervised the manuscript. Author M.L performed the statistical analyses. Author G.M performed part of the statistical analysis. Author A.K conceived of the study, participated in its design, and supervised the study and the manuscript.

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