Health benefits and consequences of the Eastern Orthodox fasting in monks of Mount Athos: a cross-sectional study

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Short Title: Health benefits of Orthodox fasting in Athos monks

Key words: Orthodox fasting; Mediterranean diet; Nutrient intake; Cardiometabolic markers; Vitamin D

Abstract

Greek Orthodox fasting (OF), which involves 180-200 days of fasting per year, is dictated by the Christian Orthodox religion. For the first time, this prospective observational study examines the characteristics and the effects of OF on anthropometry, cardio-metabolic markers and calcium homeostasis in Athonian monks (AM). Daily intakes of energy, macro- and micronutrients of a day during a weekend of Nativity Fast, defined as non-restrictive day (NRD), and a weekday during Great Lent, labelled as restrictive day (RD) were recorded. The daily energy intake of 70 AM (age = 38.8±9.7 years) was low during both RD and NRD (1265.9±84.5 vs. 1660±81 kcal, respectively, $p<.001$). Paired-samples t-test showed statistically significant difference between daily intakes in RD and NRD: carbohydrates (159.6±21.8 vs. 294.3±23.4g, $p<.0001$) and saturated fat (12.7±0.0 vs. 16.4±0.0g, $p<.0001$) were lower, whereas protein (89.2±1.3 vs. 72.35±1.3g, $p<.0001$) was higher during RD.

A subsample of monks formed a study cohort for cardiometabolic and calcium homeostasis assessment (n = 50, age = 38.7±10.6 years). Body weight (74.3±12.9 kg) and BMI (23.8±4.1 kg/m^2) were independent of level of physical activity. Optimal profile for lipid and glucose parameters (total cholesterol: 183.4±41.7 mg/dl, LDL: 120.6±37.6 mg/dl, triglycerides: 72.2±31.3 mg/dl, HDL: 48.5±14.2 mg/dl and HOMA-IR 1.02±0.40) was

found. Profound hypovitaminosis D (8.8±6.2 ng/ml), high PTH: 115.5±48.0 pg/ml with normal serum calcium levels (8.9±3.2 mg/dl) was observed. Unaffected by variation in lifestyle factors, the results of this unique study offers clear evidence for the health benefits of the strict Athonian OF through optimal lipid and glucose homeostasis.

Introduction

A plethora of previous research highlighted the Mediterranean diet as an ideal paradigm of a health promoting diet (1,2) that can play an important role in the prevention of cardiometabolic diseases (3, 4). Since the pioneering work of Keys *et al* (5), in Crete, Greece, the cradle of the Mediterranean diet, several studies showed that the benefits of the Mediterranean diet are primarily due to the high intake of vegetables, fruits, cereals (preferably whole grain),the moderate intake of fish, dairy products and red wine, and to the limited intake of meat (6, 7). Whilst this diet is becoming less popular as Western-style eating habits become more widespread, Orthodox fasting (OF), a type of diet dictated by the Christian Orthodox religion, which involves periodic abstaining from certain foods, has been suggested to contribute significantly to the beneficial effects of the Mediterranean diet through a host of potentially cardio-protective mechanisms (8, 9),including the restriction of consumption of animal products and the increased consumption of plant-based foods during OF (10-12). Previous studies (13, 14), reported a more favourable lipid profile and a lower body mass index (BMI) in subjects following OF compared with non-fasting controls.

OF, mandated as a means for spiritual prosperity by the Greek Orthodox Church, also comprises the main nutritional model in monasterial communities in Greece (15) .There are some differences between the dietary pattern followed by monks from the typical OF followed by the general

Orthodox population, which include the restriction of meat and poultry consumption throughout the year and the consumption of local food products (12, 13). However, data on the effects of OF as practised by Orthodox monks are limited to previous studies in Orthodox monks in Crete (14-17), where nutrient profiles, including energy and fat intake were more favourable during the fasting week. The monasterial state of Mount Athos in Halkidiki, Northern Greece, comprises the largest Greek monasterial community. Previous efforts to assess the dietary habits of the Athonian monks (AM) as the most representative sample of a traditional OF pattern were unsuccessful due to administrative and ethical restrictions regulating this autonomous state. This study aimed at examining the characteristics and effects of OF, as it is practiced by the Orthodox monks living in Mount Athos, on anthropometric, cardio-metabolic and calcium homeostasis markers. This is the first prospective observational study of such a cohort of Athonian monks. Practical implications of the study are underpinned by the fact that - owing to the controlled environment and the homogeneous lifestyle of AM - this study offers a detailed evaluation of the health benefits of the highly restrictive variant, Athonian OF, of the Mediterranean diet relatively free of the influence of variation in lifestyle factors inevitable among the general population.

Materials and methods

Study population

Seventy monks residing in two Mount Athos monasteries (Vatopaidi and Stavronikita) were recruited to the study. The inclusion criteria were: i) adherence to OF for at least 6 months and ii) complete data on diet and lifestyle variables. Exclusion criteria were: i) presence of chronic kidney disease, diabetes mellitus or uncontrolled hypothyroidism (not adequately controlled or firstly diagnosed and receiving no treatment), ii) recent surgical operations or infections, iii) treatment with agents influencing body weight including glucose metabolism and lipid profile (corticosteroids, antipsyhotics, androgen deprivation therapy), iv) consumption of vitamin or mineral supplements, and vi) physical disabilities and/or neurodegenerative diseases that could affect physical activity.

Age, time in monastic life and time in Mount Athos, deaconship type and time spent on deaconship duties were recorded according to data files of the Monasteries, to which the research group was granted access.

Dietary analysis

In Athonian OF, red meat and poultry are not allowed throughout the year; legumes, cereals and vegetables are allowed throughout the year, whereas fish, dairy products and olive oil are not allowed on Monday, Wednesday and

Friday during non-fasting periods and on weekdays during fasting periods (Nativity Fast, Great Lent, Apostles' Fast and Dormition Fast) (16-19). To facilitate the nutritional analysis of the Athonian OF during a fasting period, we performed dietary and anthropometric evaluations during the middle (22nd-25th day of fasting) of the two principal fasting periods of Athonian OF (Nativity Fast and Great Lent), (December 2013 and March 2014, respectively). More specifically, we analyzed two days of Athonian fasting: a day during a weekend of Nativity Fast, where fish, olive oil, cereals, legumes, nuts, vegetables, fruits and alcohol (two meals per day) are allowed, defined as 'non-restrictive day' (NRD), and a weekday during Great Lent where only legumes, cereals, vegetables and fruits (one meal per day) are allowed, labelled as restrictive day (RD). Every monastery has a central feeding system for all monks. All foods and beverages consumed were recorded by the participants and were checked and verified by a dietician the following day. Furthermore, a photo album was used to improve the accuracy of estimation of portion sizes (20-23). The food intake was analyzed for energy, macro- and micronutrients using the Food Processor Nutrition Analysis Reports adhering to US dietary guidelines (24) and the Hellenic Health Foundation (25) for comparison with the Mediterranean diet model. Dietary data were compared with the established US Recommended Dietary Allowance (RDA) / Recommended Daily Intake (DRI) values (26).

Physical activity

Physical activity was categorized as light, moderate or intense (27) (see **Table 1** for examples). Because this classification was based on the duties (deaconship) each monk had within the monastery, it reflects occupational physical activity at the time of data collection. The time spent on these duties and the time spent on helping out elsewhere were both taken into consideration . For example, doing laundry was classified as intense or moderate physical activity, depending on the exact amount of work of the individual. Each participant's physical activity was classified individually by the researcher on site. Physical activity categorisation is temporal and reflective of the time when dietary data were recorded and blood samples were taken. As monks undertake certain tasks throughout the year ,for a minimum of a one year period, we assumed that this pattern is fairly stable because it is based on occupational activity.

Anthropometric measurements

Anthropometric measurements were performed in a subsample of 50 monks residing in one monastery using standardised procedures (28). Height was measured to the nearest 0.1 cm with a Holtain wall stadiometer. Body weight was recorded to the nearest 0.01 kg using a calibrated computerized digital balance (K-Tron P1-SR, USA Onrion IIc); each participant was barefoot and lightly dressed during measurement. The body mass index (BMI) was calculated as the ratio of weight in kilograms divided by the height in metres squared (kg/m^2) (29). Body fat (BF) mass and percentage, visceral fat (VF), muscle mass (MM), fat-free mass (FFM) and total body water (TBW) were measured using bioelectrical impedance analysis (BIA) (SC-330 S, Tanita Corporation, Tokyo) (30). Anthropometric evaluation was performed by two physicians (SK and AT). Optimal values for anthropometric parameters were categorized according to international standards and reference values of the BIA method as follows: BMI: 18.5-25 kg/m^2 (29) and BF percentage 10-22% (30).

Biochemical analysis

Biochemical analyses were performed in the same subsample of 50 AM in which anthropometry was evaluated. Blood samples were drawn in the morning, after a 12-hour overnight fast, one day following the end of each examination period, by ante-cubital venipuncture and samples were stored at -20°C prior to analysis. Lipid profile (total cholesterol, high density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), triglycerides), liver function tests [alanine transaminase (ALT), aspartate transaminase (AST)], ferritin, uric acid, calcium and glucose and fasting insulin measurements were performed using the Cobas INTEGRA clinical chemistry system (D-68298; Roche Diagnostics, Mannheim, Germany). Reference ranges are as follows: total cholesterol (140-200 mg/dl), HDL-C

(>40 mg/dl), LDL-C (<130 mg/dl: optimal, 130-159 mg/dl: borderline high, 160-189 mg/dl: high, >190 mg/dl: very high), triglycerides (<150 mg/dl: normal, 150-199 mg/dl: moderately high, 200-499 mg/dl: high, >500 mg/dl: very high), ALT (7-48 U/L), AST(10-40 U/L), ferritin (10-180 ng/ml), uric acid (2.8-5.8 mg/dl), calcium (8.5-10.2 mg/dl), glucose (70-110 mg/dl) and insulin (<25 mIU/L).

The inter- and intra-assay coefficients of variation (CVs) were 0.99 and 3.5% for total cholesterol, HDL-C, LDL-C, triglycerides, ferritin, serum calcium, uric acid, glucose and 1.3% and 2.5% for fasting serum insulin, respectively. Insulin resistance was estimated with the homeostasis model assessment of insulin resistance (HOMA-IR): [fasting insulin concentration (mU/mL) x FPG (mmol/L)] / 22.5] (31). Parathyroid hormone (PTH) determinations were performed using the electro-chemiluminescence immunoassay ECLIA (Roche Diagnostics GmbA, Mannheim, Germany). The reference range for PTH was 15 - 65 pg/mL, functional sensitivity 6.0 pg/ml, within-run precision 0.6 - 2.8% and total precision 1.6 - 3.4%. Vitamin D status was assessed with measurement of serum 25(OH)D by competitive electro-chemiluminescent immunoassay on the Roche Modular E170 (cat. no. 05894913190; Roche Diagnostics, Laval, Canada). This assay has a lower reporting limit of 3.8 ng/ml, and at concentrations of 24, 38, and 62 ng/mL the within-run CVs are 5.1, 3.1, and 7.1% and total CVs 12.1, 7.4, and 10.6%, respectively, as previously reported (32). Vitamin D status [25(OH) D] was classified as sufficient or insufficient according to recent Institute of Medicine criteria [sufficiency: serum 25(OH)D concentration 20 to 40 ng/ml (50 to 100 nmol/l), insufficiency < 20 ng/ml (50 nmol/l] (33).

Ethical considerations

All monks gave written informed consent for inclusion in the study. Official written approval for the evaluation of the monks was given by the "Holy Supervision Council" composed of representatives from all 20 monasteries of Mount Athos after submission of the study protocol a year before study initiation (Constitutive Chart of Mount Athos–Greek Constitution 1975/86 art. 105 & 1-5).

Statistical analysis

Continuous variables are reported as means and standard deviations. Dietary and nutrient intake on fasting days and non-fasting days were compared using paired samples t-test. Age differences between the groups with light, moderate and intense physical activity were tested using one-way analysis of variance with Tukey post hoc test. The effect of level of physical activity on overall health markers was tested with analysis of covariance to control for age. Normality of distribution was tested with one sample Kolmogorov-Smirnov test (exact statistics). Following the reporting guidelines for statistical tests in medical and behavioural research (34), respective effect sizes (*d* and *partial* *eta squared*) were reported for all statistical tests and means and standard deviations were provided for all comparisons. Effect sizes were discussed in both theoretical and practical implications according to the recommended reference values (35, 36). Assumptions were checked for each statistical analysis. Level of significance was set at $p < .05$ (non-directional). Data were analysed using SPSS v22. Effect sizes were obtained from the SPSS output where available or calculated using the online meta-analysis effect size calculators (37,38). Effect size calculation for paired sample comparison used the Morris and De Shon's correction (Eq 8) (39).

Results

The population characteristics are shown in **Table 1**. 70 monks were initially evaluated for physical activity and nutritional analysis, of which 50 additionally had anthropometric evaluation and blood analysis for cardiometabolic and calcium homeostasis markers.

Comparison of dietary and nutrient intake in fasting- and non-fasting days

Dietary analysis was performed for 70 monks (age 38.4±9.7 years, time in monastic life 12.5±8.2 years). **Table 2** presents macronutrient and micronutrient intake on RD and NRD. A key finding was that daily energy intake was considerably low on NRD and was even lower on RD

(1265.9±84.5 and 1660±81.0 kcal, respectively; $p<.001$). Fat intake was lower during NRD compared with RD (21.4±0.6 and 30.0±0.1g, respectively; $p<.001$). Total fat intake [% total energy intake (TEI)] was low during both RD and NRD (21.5 and 11.6%, respectively; $p<.001$). Protein intake was higher on RD, compared to NRD (89.2±1.3 and 72.3±1.3 g, respectively; $p<.001$). Overall, macronutrient consumption during RD comprised 50.2% carbohydrates, 21.5% fat and 28.3% protein and 70.9, 11.6 and 17.5% on NRD, respectively.

The levels of intake of many vitamins A, B_2, D and minerals (Ca, Mg, Na) were below the recommended % of DRI during both RD and NRD (26). Of major interest, vitamin D intake was very low during both RD and NRD (20.0 and 19.8% DRI, respectively). In contrast, although meat consumption is not allowed in Athonian OF, intake of vitamin B_{12} was adequate during both RD and NRD (229.2 and 233.3 % DRI, respectively) as was the intake of vitamin C (429.2 and 622.9 % DRI, respectively) and Fe (137.0 and 181.3 % DRI, respectively).

Anthropometry and physical activity

Table 3 presents anthropometric measurements performed in a subset of 50 monks. BMI and % BF were within the normal range in the vast majority of study participants. There was no effect of levels of physical activity on any of the anthropometric parameters. Age had no significant influence on the anthropometric measures ($p > 0.05$). Age, duration of monasticism and duration of stay in Mount Athos did not differ across the three physical activity levels **(Table 1)**.

Cardiometabolic parameters

Table 4 shows the cardiometabolic markers of the subsample of 50 monks. All markers fell within normal ranges with the exception of the existence of eucalcemic (secondary) hyperparathyroidism, with a marked PTH increase, resulting from profound hypovitaminosis D in the majority of the participants. In detail, monks demonstrated an optimal profile for all lipid parameters (total cholesterol 183.4±41.7 mg/dl, LDL-C 120.6±37.6 mg/dl, triglycerides 72.2±31.3 mg/dl, and HDL-C levels 48.5±14.2 mg/dl). Regarding glucose homeostasis, monks demonstrated a favourable profile (mean glucose levels 84.4±10.1 mg/dl, HOMA-IR 1.02±0.40). However, regarding calcium homeostasis, PTH was markedly above the upper limit of normal range (115.0±48.0 pg/dl), in conjunction with normal values of serum calcium (8.9±3.2 mg/dl). Of major interest, all monks were vitamin D deficient [25(OH) D levels 8.8 ± 6.2 ng/ml]. Neither age nor the levels of physical activity had a significant influence on any of the biochemical measures ($p > 0.05$ for all measures). **Figure 1** shows the proportions of monks with cardiometabolic parameters within the optimal, near optimal, borderline and outside the optimal range.

Discussion

This prospective observational study is the first report of anthropometry, cardio-metabolic markers and calcium homeostasis in Orthodox monks living in the largest monasterial community in Mount Athos . Significant differences in nutritional patterns between RD and NRD were evident, in conjunction with a favourable profile of anthropometric and cardiometabolic markers (40-44), with the exception of a profound hypovitaminosis D.

OF as practiced by Athonian monks is integrally interrelated to religious principles that are reflected in their daily dietary and physical habits from thousands of years. On this basis, among other spiritual concepts, temperance is a vital parameter of the Athonian OF, which is reflected as a restricted caloric dietary intake in combination with daily scheduled physical tasks (10, 11). This model of caloric restriction (CR), during OF and not throughout the year, according to the results of the present study resulted in restricted caloric intake during both RD (1266 kcal) and NRD (1660 kcal). Macronutrient consumption synthesis met the global diet recommendations (41) during both RD and NRD and represents an ideal paradigm of a Mediterranean diet pattern (7, 8). However, an interesting pattern of decreased carbohydrate intake and an increase in protein and fat intakes on RD compared to NRD was evident.

Our results also indicated that Athonian fasting includes a considerable restriction of total fat intake (RD: 21.47% and NRD: 11.64%) compared to the traditional Mediterranean diet, which is characterized by a 37-40% consumption of fat (of total energy intake) mainly from fish and plant sources (5-7, 42, 43). Dietary protein and fat intake during OF in Athos is mainly derived from fish, olive oil, dairy products and seeds, since meat consumption is excluded and legumes, fruits, beans and nuts are the main food choices. This nutritional model also met the goals of American Heart Association (AHA) guidelines for preventing cardiovascular disease (CVD) (consumption of fat intake less than 30% of total energy intake) (44).

Comparison of AM diet with previously reported data on Cretan monks (14-16) revealed significant differences in total energy and macronutrient intakes. Cretan monks demonstrated considerably higher total energy intake for both days (14), a phenomenon which could not be attributed to meat consumption *per se*. A potential explanation of these differences within a similar pattern of religious fasting might be specific regional food choices of AM.

In agreement with previous reports (13-17), inadequacy of calcium and magnesium intakes was evident for AM, probably resulting from the abstinence from animal product consumption in the Athonian diet. On the other hand, a potentially beneficial micronutrient profile for CVD prevention, in terms of sodium and potassium intake, characterizes this pattern of religious fasting as a low sodium diet (45). An additional beneficial characteristic of both Athonian and Cretan monks' diet was the high intake of dietary fiber in both groups; almost twofold higher during RD and three fold higher during NRD compared with the recommended intake (41).

Of major interest, although AM do not consume meat throughout the year, intakes of Fe and vitamin B_{12} were above the upper limit of recommended daily intake during both FD and NFD. These findings do not support previous observations (16, 17). In AM, this could be a result of a high intake of seafood and green legumes allowed during fasting. In addition, vitamin C intakes during RD and NRD for AM were recorded as 429.24% and 622.9% of DRI, respectively. Since high levels of vitamin C enhance the absorption of Fe, a synergistic effect of vitamin C on the adequacy of iron stores could be hypothesized (46,47). Intakes of vitamins A, D and B_2 were substantially below recommendations (41).

Regarding body weight and body fat, although not all monks were in the desirable range (**Figure 1)**, visceral fat (29, 42) was reported also at the optimal range for the total cohort. Interestingly, there were no significant effects of levels of physical activity on the anthropometric measures, highlighting dietary-induced health status as a unique parameter *per se*. Lipid and glucose homeostasis profile were found to be in the normal range for the majority of participants according to recommendations (41, 44). It should be noted that these values result from dietary habits and physical tasks, since AM in this study did not receive any treatment that could affect lipid parameters (48, 49).

The results of this study also demonstrated for the first time to our knowledge, that Orthodox monks are at high risk for developing profound hypovitaminosis D. AM according to the Athonian rules, are required to wear black cassocks during their outdoor physical and social activities, a phenomenon that was found to severely affect their vitamin D status. Similar findings have been also reported in other Mediterranean populations, in whom, for religious reasons, outdoor clothing hinders cutaneous vitamin D production (50,51).

This study is not free of limitations. First, a comparison group from the general orthodox population, residing outside the monasterial community of Athos, was not included. The comparison between orthodox fasting as practiced by AM and lay people, could provide useful results, regarding the potential differences in macro- and micronutrient profile and physical activity. Second, our study included a relatively small, however representative study sample, since food choices and physical tasks are equally shared and followed by a large part of the monk's community in Athos. Third, we did not include data from summer months on vitamin D status of Athonian monks therefore seasonal vitamin D variation is not adequately reported, throughout the year.

In conclusion: this study, for the first time, offered detailed assessment of Orthodox fasting practised in Mount Athos. This highly restictive variant of the Mediterranean diet results in significantly lower caloric intake on fasting days. Unaffected by variation in lifestyle factors, the results of this unique study offers clear evidence for the health benefits of the strict Athonian OF through optimal lipid and glucose homeostasis. Profound hypovitaminosis D observed in Athonian monks is a health concern that needs to be addressed. In the context of a health-promoting diet among the general population, further evaluation of the advantages and disadvantages of this highly restrictive variant of the Mediterranean diet is warranted.

Acknowledgement

The authors thank the “Holy Supervision Council” and the community of monks at Mount Athos for their participation.

Author's contribution

SK and AgP conceptualised and designed the study. SK, and AT collected all data. SK, AgP, AP, TT, EB, KT and HM analysed and interpreted the dietary data, SK, TT and DPN interpreted biochemical results. MK conducted biochemical analysis of the samples. EB and KT performed the literature review and performed the statistical analysis under the supervision of AP, HM and DPN. SK, AP and CP drafted the first version of the manuscript. All authors have read and critically revised the manuscript and approved the final version.

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Table 1. Sample characteristics: Differences in sample sizes are due to missing information.

	Light	Moderate	Intense	Test statistics
Full sample (n = 70)	N = 17	N = 25	N = 26	
Deaconship	Accountant (4); Administrator (1); Baker (1); Book publisher (1); Botanist (1); Caretaker (1); Computer assistant (2); Cook (5); Cooking assistant (3); Dining assistant (7); Ecclesiastical chanter (1); Electrician (1); Gardener (6); Gold polisher (1); Herb gardener (1); Hospitality greeter (3); Housekeeper (1); Iconographer (4); Incense maker (3); Laundry assistant (3); Librarian (2); Office worker (1); Pharmacist (2); Physiotherapist (1); Programmer (1); Representative (1); Secretary (2); Showroom assistant (2); Snail gardener (1); Tailor (2); Teacher (2); Unrecorded (3)			
Age (y)	33.9 ± 10.1	41.1 ± 9.2	38.6 ± 9.6	$F(2,65) = 2.955$, $p = 0.059$; $\eta^2 = 0.083$
Monasticism(y)	10.5 ± 9.8	15.4 ± 7.2	10.9 ± 7.2	$F(2,64) = 2.655$, $p = 0.078$; $\eta^2 = 0.077$
Subsample (n = 50)	N = 16	N = 18	N = 16	
Deaconship	Accountant (2); Baker (1); Book publisher (1); Botanist (1); Caretaker (1); Computer assistant (2); Cook (2); Cooking assistant (2); Dining assistant (4); Ecclesiastical chanter (1); Gardener (3); Herb gardener (1); Hospitality greeter (2); Iconographer (4); Incense maker (3); Laundry assistant (3); Librarian (2); Office worker (1); Pharmacist (2); Physiotherapist (1); Programmer (1); Representative (1); Secretary (2); Showroom assistant (2); Snail gardener (1); Tailor (1); Teacher (2); Unrecorded (1)			
Age (y)	34.3± 10.3	41.8± 10.3	39.5 ± 10.1	$F(2,47) = 2.332$, $p = 0.108$; $\eta^2 = 0.090$

Monasticism(y)	11.1 ± 9.9	15.3 ± 7.6	11.9 ± 6.6	$F(2,46) = 1.274$, $p = 0.289$; $\eta^2 = 0.052$

Table 2. Dietary and nutrient intakes during restrictive and non-restrictive days (n = 70)

Dietary/ nutrient intake	Restricted day	Non-restricted day	Test statistics for differences between R and NR day (df= 69)
Energy (kcal)	1265.9 ±84.5	1660.0±81.0	t = -24.146; p < .001, d = -3.01 r = 0.648, p < .001
Carbohydrates (gr)	159.6±21.8	294.3±23.4	t = -54.777; p < .001, d = -6.56 r = 0.588, p < .001
%TEI	50.2±3.2	70.9±2.5	Z = -7.300; p < .001
Fat (gr)	30.0±0.1	21.4±0.6	t = 37.412; p < .001, d = 7.21 r = 0.396, p = 0.001
%TEI	21.5±1.0	11.6±0.6	Z = -7.300; p < .001
Protein (gr)	89.2±1.3	72.3±1.3	t = 119.800; p < .001, d = 14.34 r = 0.618, p < .001
%TEI	28.3±1.1	17.5±0.5	Z = -7.300; p < .001
Saturated fat (gr) [a, b]	12.7±0.0	16.4±0.0	-
%TFI	42.4±0.2	76.8±0.0	Z = -7.300; p < .001
Cholesterol (gr) [a, b]	181.0±0.0	178.0±0.0	-
Fibre (gr)	23.4±0.9	36.2±0.8	t = -499.592; p < .001, d = -60.53 r = 0.973; p < .001
Ca (mg)	579.5±2.3	665.6±2.2	t = -2260.844; p < .001, d = -266.69 r = 0.990; p < .001
%DRI	57.9±0.2	66.5±0.2	Z = -7.649; p < .001
Fe (mg)	13.7±0.0	18.1±0.0	t = -619.482; p < .001, d = -1650.96 r = 0.999; p < 0.001
%DRI	137.0±0.0	181.3±0.6	Z = -7.772; p < .001
Mg (mg)	167.43±3.2	152.2±0.7	t = 621.927; p < .001, d = r = 0.999; p <.001
%DRI	39.86±0.7	36.26±0.9	Z = -7.451; p < .001
Na (mg) [a,b]	1733.0±0.0	1549.0±0.0	-
%DRI	72.2±0.0	64.5±0.0	Z = -8.367; p < .001
K(mg)[b]	2539.0±88.5	3755.5±88.6	t = -20515.135; p < .001, r = 1.000; p < .001

%DRI	67.7±2.36	100.1±2.3	Z = -7.526; p < .001
Vitamin A (mcg)[b]	805.6±24.2	708.2±24.4	t = 1936.152; p < .001, r = 1.000 ; p < .001
%DRI	80.5±2.4	70.8±2.4	Z = -7.414; p < .001
Vitamin B12 (mcg) [a,b]	5.5±0.0	5.6±0.0	-
%DRI	229.1±0.0	233.3±0.0	Z = -8.367; p < .001
Vitamin B2(mg) [b]	1.01±0.0	1.1±0.0	t = -99.723; p < .001, r = 0.971; p < .001
%DRI	77.5±1.8	85.4±1.2	Z = -7.457; p < .001
Vitamin C (mg)	257.5±2.9	373.7±2.9	t = -3868.426; p < .001, d = -508.70 r = 0.997; p < .001
%DRI	429.2±4.9	622.9±4.8	Z = -7.507; p < .001
Vitamin D (mcg)	1.0±0.0	0.9±0.3	-
%DRI	20.0±0.0	19.8±0.0	Z = -8.367; p < .001
Vitamin E mg [(a,b)]	5.7±0.3	13.8±3.0	-
%DRI	57.0±0.3	138.0±3.0	Z = -7.367; p < .001

%DRI =percentage of the Dietary Reference Intake; %TEI = percentage of the Daily Total Energy Intake; %TFI = percentage of the Daily Total Fat Intake, F: Fasting day, NF: Non-fasting day

[a] The correlation coefficient (*r*) and t-test statistics (*t*) cannot be computed because the standard error of the difference is 0. Z denotes Wilcoxon Signed Rank Test statistics with p-value for exact significance (two-tailed).

[b] Effect size cannot be calculated because of the uniform SD and/or perfect correlation.

Table 3. Anthropometric parameters.

	All (n = 50)	**Physical activity**			**Test statistics (F) for activity group comparison**
		Light (n = 16)	**Moderate**(n=18)	**Intense** (n = 16)	
Body weight (kg)	74.3±12.9	76.4±10.6	72.7±15.9	74.08±12.9	F = 0.359; p = .700; $\eta^2 = 0.015$
Body mass index (kg/m^2)	23.8±4.1	24.3±3.0	23.6±5.2	23.5±3.6	F = 0.188; p = .830; $\eta^2 < 0.01$
Body fat (kg)	14.5±9.4	16.0±6.3	14.4±13.3	13.2±6.7	F = 0.333; p = .719; $\eta^2 < 0.01$
Body fat (%)	18.1±8.7	19.6±5.5	17.7±11.0	17.1±8.7	F = 0.354; p = .704; $\eta^2 = 0.015$
Visceral fat (kg)	7.0±4.6	7.8±3.4	6.6±6.1	6.7±4.1	F = 0.320; p = .728; $\eta^2 = 0.013$
Fat free mass (kg)	59.9±6.3	61.0±6.2	58.2±5.9	60.7±6.8	F = 1.006; p = .373; $\eta^2 = 0.041$
Muscle mass (kg)	33.3±4.8	33.1±6.3	32.6±3.6	34.3±4.2	F = 0.545; p = .583; $\eta^2 = 0.023$
Total body water (%)	60.1±6.5	59.0±4.1	60.4±8.8	60.9±5.4	F = 0.356; p = .703; $\eta^2 = 0.015$

Table 4. Cardiometabolic markers.

Cardiometabolic parameter	All (n = 50)	Athonian monks by physical activity: Low/Light (n = 16)	Moderate (n = 18)	Intense (n = 16)	Test statistics
CHOL (mg/dl)	183.4±41.7	194.2±52.0	176.3±36.8	180.7±35.4	$F = 1.302; p = .282; \eta^2 = .05$
HDL (mg/dl)	48.5±14.2	47.5±16.6	49.1±14.0	49.0±12.8	$F = 0.014; p = .986; \eta^2 = .00$
LDL (mg/dl)	120.6±37.6	132.2±48.0	113.2±28.7	116.1±34.0	$F = 1.606; p = .212; \eta^2 = .07$
Glucose (mg/dl)	84.4±10.1	88.62±9.9	84.0±8.7	80.7±10.9	$F = 2.642; p = .082; \eta^2 = .10$
TG (mg/dl)	72.2±31.3	70.1±21.3	69.0±27.9	77.8±42.5	$F = 0.414; p = .664; \eta^2 = .02$
Ferritin (ng/ml)	79.1±38.6	91.0±43.4	78.0±40.9	68.5±28.5	$F = 1.322; p = .277; \eta^2 = .05$
Uric acid (mg/dl)	4.7±0.8	4.7±0.6	4.7±1.0	4.6±0.8	$F = 0.078; p = .925; \eta^2 < .01$
Insulin (mIU/L)	4.6±3.1	4.7±3.4	5.0±3.3	4.1±2.9	$F = 0.321; p = .727; \eta^2 = .01$
AST (U/L)	26.2±7.8	25.8±9.4	27.7±6.6	25.0±7.6	$F = 0.478; p = .623; \eta^2 = .02$
ALT (U/L)	27.0±9.1	28.0 ± 11.8	27.2±7.7	25.7±7.7	$F = 0.831; p = .442; \eta^2 = .03$
PTH (pg/ml)	115.0±48.0	102.5±27.6	132.2 ±69.8	109.7±40.9	$F = 0.767; p = .470; \eta^2 = .03$
25(OH)D (ng/ml)	8.8± 6.2	7.7±3.8	9.7±7.2	9.1±7.3	$F = 0.187; p = .830; \eta^2 < .01$
Calcium (mg/dl)	8.9±3.2	8.8±1.0	9.0±1.4	9.1±1.3	$F = 0.189\ p=.778\ ; \eta^2= .02$
HOMA-IR	1.02±0.4	1.0±0.7	1.0±0.7	0.8±0.6	$F = 0.432; p = .652; \eta^2 = .02$
Fasting glucose (mg/dl)	84.4±10.1	80.2±11.2	84.1±12.1	83.2±11.2	$F = 0.641; p = .450; \eta^2 = .02$

(CHOL: total cholesterol, HDL: high density lipoprotein cholesterol, LDL: low-density lipoprotein cholesterol, TG: triglycerides, AST: aspartate transaminase, ALT: alanine transaminase, PTH: Parathyroid hormone, HOMA-IR: homeostasis model assessment of insulin resistance)