



# Impact of Christian Orthodox Church dietary recommendations on metabolic syndrome risk factors: a scoping review

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## Abstract

Fasting has been a practice among followers of different religions for many years. Christian Orthodox Church (COC) fasting is a periodic vegetarian-type diet in which seafood and snails are allowed on most fasting days. The present scoping review aimed to present available data regarding the benefits of COC fasting on metabolic syndrome (MetS) risk factors. Databases were searched for available studies. Twenty publications, with a total of 1226 fasting participants, provided data on the effects on different variables of MetS, including blood pressure, blood lipids and anthropometric measurements. Fasters' diet is characterised by low saturated and trans fat intake, high complex carbohydrate and fibre consumption, due to permissible foods. COC fasting has no deficiency in essential amino acid intake since seafood and snails are allowed on fasting days. Fasters have healthier blood lipid profiles during and after COC fasting periods, and total cholesterol, LDL-cholesterol, systolic blood pressure, body weight and BMI are reduced after a fasting period. Due to restricted or forbidden intake of specific foods during the COC fasting periods, one might expect that fasters have reduced intake of macro- and micronutrients, but as shown in the available literature, there are no deficiencies. Future research on COC fasting is needed in areas not investigated at all, like MetS, before reaching definite conclusions.

**Keywords:** Religious fasting; Christian Orthodox Church fasting; Metabolic syndrome; Cardiovascular health; Plant-based diets

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## Introduction

Fasting is defined as voluntary abstinence from food for varying duration<sup>(1)</sup>, and it has been positively associated with longevity and boosting of human health<sup>(2)</sup>. Religious fasting (RF) is a nutritional model that has various levels of food restrictions as a dietary regimen of most popular religions<sup>(3)</sup>. The possible impact of RF on human health has been the subject of public debate for thousands of years. Over the last two decades, an increasing number of studies have been carried out on RF and its impact on human health. Evidence suggests that RF may have preventive effects on various diseases, such as obesity, cardiovascular diseases (CVD) and type 2 diabetes mellitus (T2DM)<sup>(1,2,4)</sup>.

The Christian Orthodox Church (COC) suggests that individuals who follow the long-term structured fasting type of diet abstain from meat, dairy products and eggs for 180–200 d annually, while their diet is characterised by increased consumption of cereals, legumes, fruits, vegetables, fish and seafood. COC fasting includes three main fasting periods: 40 d prior to Christmas (from 15 November to 24 December), 48 d prior to Easter (from Clean Monday to Holy Saturday), 14 d prior to Assumption (from 1 to 14 August), the fasting period prior to the feast of Holy Apostles (lasting 0–30 d depending on Easter feast), and three other daily feasts (5 January, 29 August, 14 September), as well as every Wednesday and Friday<sup>(3,5)</sup>.

Details about foods to be avoided and the duration of fasting periods can be found in Table 1.

COC fasting has unique dietary recommendations demonstrating an infrequent interchange from a mixed diet to a vegetarian diet that includes fish and seafood<sup>(6)</sup>. The periodic fasting followed by Orthodox Christians in Greece during all COC fasting periods resembles the traditional Greek diet, with plenty of legumes, vegetables, fruits, nuts, olives, bread, fish and seafood, such as shrimps, octopus and snails<sup>(3–5,7,8)</sup>. Since the results of the Seven Countries Study (SCS), the Mediterranean diet and more specifically the diet of Crete have been identified as a healthy diet associated with CVD protection and promoting longevity<sup>(9)</sup>. The population of Crete of the SCS had the lowest CHD mortality and the highest life expectancy in comparison with all other fifteen cohorts<sup>(10)</sup>. The term Mediterranean diet was generated from the SCS and the diet of Crete in 1960 when 60 % of Greek participants fasted strictly during all fasting periods of the COC<sup>(10–12)</sup>. The longest adult life expectancy and the lowest mortality rates from all chronic diseases seem to be related to the excellent dietary pattern of the population of Crete and the daily intense physical activity<sup>(12,13)</sup>. This lifestyle of the population of Crete in the 1960s resulted in the lowest body weight in comparison with all other fifteen cohorts of the SCS during the 50 years of follow-up<sup>(14)</sup>. Also, between 1994 and 1997, the European Prospective

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**Table 1.** Fasting periods according to COC fasting regimes

Fasting periods	Duration (d)	Foods excluded						Exceptions
		Meat	Dairy products	Eggs	Fish	Olive oil	Wine	
Wednesdays and Fridays	1	X	X	X	X	X	X	Apart from Wednesdays and Fridays already in other fasting periods
Great Lent (before Easter)	48	X	X	X	X	X	X	Olive oil and wine are allowed on Saturdays and Sundays Fish is allowed on 25 March and Palm Sunday
Nativity Fast (before Christmas)	40	X	X	X	X	X	X	Olive oil and wine are not allowed on Wednesdays, Fridays and 24 December
Fasting of the Apostles	0–30 <i>Unspecified due to the movable feast of Easter</i>	X	X	X	X	X	X	Fish is not allowed from 18 to 24 December Olive oil and wine are not allowed on Wednesdays and Fridays
Fasting of the Assumption of Theotokos	14	X	X	X	X	X	X	Olive oil and wine are allowed on Saturdays and Sundays Fish is allowed on 6 August
5 January (Theophany Eve)	1	X	X	X	X	X	X	Olive oil and wine are allowed if the feast is on Saturday or Sunday
29 August (Behanding of St. John the Baptist)	1	X	X	X	X	X	X	Olive oil and wine are allowed if the feast is on Saturday or Sunday
14 September (Exaltation of the Holy Cross)	1	X	X	X	X	X	X	Olive oil and wine are allowed if the feast is on Saturday or Sunday

Investigation into Cancer (EPIC) study was undertaken in Greece with 28 572 individuals aged 20–86 years participating. After a mean follow-up of 8.5 years, lower overall mortality was found in comparison with that of the individuals with closer adherence to the traditional Mediterranean diet,<sup>(15)</sup> and as it was observed, COC fasting was followed by 50 % and 65 % of men and women, respectively, who participated in the Greek cohort of EPIC<sup>(3)</sup>.

Metabolic syndrome (MetS) has become a public health concern and, as defined by the World Health Organization (WHO), is a cluster of disorders that includes abdominal obesity, insulin resistance, dyslipidaemia and hypertension<sup>(16)</sup>. Different definitions of MetS from several organisations exist, with the most commonly used for health care plans coming from the WHO<sup>(17)</sup>, the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III)<sup>(18)</sup> and the International Diabetes Federation (IDF)<sup>(19)</sup>. Criteria for clinical diagnosis of the MetS are (i) elevated waist circumference with cut-off points according to population- and country-specific definitions, (ii) elevated triglycerides with cut-off point  $\geq 150$  mg/dL, (iii) reduced HDL-cholesterol with cut-off points  $< 50$  mg/dL in females and  $< 40$  mg/dL in males, (iv) elevated blood pressure with cut-off points  $\geq 130$  mmHg for systolic and/or  $\geq 85$  mmHg for diastolic blood pressure and (v) elevated fasting glucose with cut-off point  $\geq 100$  mg/dL<sup>(20)</sup>. Prevalence of MetS is increasing rapidly throughout the world, and having it increases the risk of developing CVD twofold and T2DM fivefold<sup>(20)</sup>. The prevalence of MetS in Greece according to the METS-GREECE Multicentre Study is 23.6 %<sup>(21)</sup>, and according to the ATTICA study is 19.8 %<sup>(22)</sup>, with both studies using the NCEP ATP III definition for MetS prevalence.

The NCEP ATP III and the American Heart Association have recommended a diet approach to prevent MetS as part of a multifaceted lifestyle approach to reduce CVD risk<sup>(23)</sup>. Part of this approach is being physically active by following the national guidelines for moderate- and/or high-intensity physical activity, as it decreases chronic disease mortality<sup>(24)</sup>. Among the 1627 participants of the SUN cohort study that were followed up for 6 years, those with the highest adherence to the Mediterranean food pattern had the lowest levels of all risk factors of MetS<sup>(25)</sup>. Similar results were demonstrated by the PREDIMED study, as it was suggested that adherence to a Mediterranean diet had beneficial effects on the reversion of MetS. Among 5801 individuals, aged 55–80 years, with a 4.8 year follow-up, the ones having the highest adherence to the Mediterranean diet had a 56 % lower likelihood of having MetS<sup>(26,27)</sup>. Also, the ATTICA study revealed that, in a population of 2282 individuals over 18 years old who were followed for approximately 8.5 years, those who had higher adherence to the Mediterranean diet reduced their odds of having MetS by 20 %<sup>(22)</sup>.

Overall, there is growing scientific evidence of how the Mediterranean diet affects MetS risk factors, and limited evidence on the association between COC fasting dietary recommendations and MetS. This scoping review aimed to explore the evidence on the association between the COC long-term structured fasting and various aspects of human health and MetS risk factors. To our knowledge, no study has investigated the effects of the long-term fasting recommendation of the COC diet on MetS. Existing gaps in the available literature and future research are also discussed.

## Methods

This scoping review was conducted to find evidence on the association between COC fasting and MetS risk factors. We aimed to respond to this significant research question in a comprehensive manner via the scoping review method. This research method does not include a risk of bias of the evidence, as it reports evidence from existing studies and identifies gaps in the available literature<sup>(28)</sup>. The scoping review was made in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines<sup>(29)</sup>, and the protocol is presented in detail below. PRISMA 2009 Checklist is included as supplementary material.

### Literature search

The authors performed an extensive literature search for published articles from February until March 2020 from the following datasets: PubMed (via MEDLINE), CINAHL, Scopus and Google Scholar. An additional search was performed in June 2020 for new available publications.

To retrieve relevant literature, the search strategy involved the following keywords with any possible combination in the abstracts of the articles: 'religious fast' or 'religious fasting' or 'Christian Orthodox fast' or 'Christian Orthodox Church fasting' or 'Greek Orthodox fast' or 'Greek Orthodox fasting' or 'Greek Orthodox Church fasting' or 'Greek monks' and 'health' or 'obesity' or 'blood lipids' or 'cardiovascular diseases' or 'metabolic syndrome'.

### Inclusion and exclusion criteria

Criteria for the included studies were the following: (i) studies on humans; (ii) studies with anthropometric measurements, such as body weight and waist circumference; (iii) studies with nutrition results including food choices; (iv) studies with biochemical metabolic markers including total cholesterol, HDL-cholesterol, LDL-cholesterol, triacylglycerol, HbA1c and blood pressure levels; (v) studies published in English and Greek language; (vi) studies published from January 1990 to March 2020; and (vii) full-length papers. On the other hand, reviews, editorials, meta-analyses, animal studies, study protocols, abstracts and unpublished results were initially excluded from the review process. Additionally, studies were excluded if focused religion was different than COC and if reported measurements were not health related. No restrictions were made regarding study sample and/or fasting duration.

### Data collection and analysis

After duplicate publications removal, abstracts of full publications were assessed for eligibility in this review, in accordance with the inclusion and/or exclusion criteria. Data extracted from each publication are: name of the first author, publication year, aim of the study, study design, country of study, sample size and characteristics of participants, fasting periods, results concerning anthropometric measurements, arterial blood pressure and haematologic data. No meta-analysis was performed due to heterogeneity of studies and reported outcomes.

## Results

### Eligible articles

The initial search of the databases identified 1169 articles, and 35 more articles were found through manual searching. A total of 286 duplicates were removed, leaving 918 articles to be considered for inclusion after title and abstract screening. Fifty-one full publications were reviewed for eligibility, with twenty publications finally included in our scoping review. The process for identifying and selecting papers for this scoping review is in accordance with PRISMA guidelines and presented in the PRISMA flow diagram in Fig. 1. We also used the quality assessment tool as proposed by Hawker and colleagues<sup>(30)</sup> for the included publications, to screen the studies, which can be found in Appendix 1. Results show that most of the publications (18/20) were defined as high quality and only a few (2/20) defined as medium quality.

In total, twenty publications from eleven unique studies that investigate the relationship between COC fasting and health indices met the eligibility criteria and were finally included in this review. Out of them, two were cross-sectional studies (producing four publications<sup>(31–34)</sup>), one was a case-control study (producing five publications<sup>(6,35–38)</sup>) and eight were prospective studies (producing eleven publications<sup>(39–49)</sup>).

### Overview of the studies and study sample

Most of the data were collected from Greece, a country where the majority of the people are Christian Orthodox, with study sample coming from different origins of Greece: mainly from Crete and Northern Greece, as two studies were conducted in Crete with seven publications<sup>(6,35–38,42,43)</sup>; five different studies in Northern Greece produced eight articles<sup>(31–34,44–46,49)</sup>; and one study in Peloponnese with one published article<sup>(41)</sup>. Also, two unique studies were conducted in Egypt with two publications<sup>(47,48)</sup> and one in the USA with two different published articles<sup>(39,40)</sup>.

In five publications, fasters were people under religious orders, that is, nuns and monks, mainly living in monasteries<sup>(41–45)</sup>; in six, fasters were a mix of nuns, monks, priests and laypeople<sup>(6,35–38,46)</sup>; and in nine, fasters were only laypeople<sup>(31–34,39,40,47–49)</sup>. In nine publications, a control group was included in the analysis, with laypeople being non-fasters<sup>(6,31–33,35–38,48)</sup>.

In all studies, participants did not suffer from chronic illnesses and/or received medication and/or supplements. The exact number of recruited participants in all available publications cannot be summed, as there is potential overlap of cases and controls in publications conducted by the same research group<sup>(6,31–33,35–40,42,43,45,46)</sup>. Sample size in each publication varies from 1 person<sup>(42)</sup> to 609 participants<sup>(34)</sup>, and target age group varies from 18 to 84 years old in all including articles with the exception of one article focusing on a paediatric population aged 5–15.5 years old<sup>(34)</sup>.

Methodology and main outcomes of all COC fasting publications included in this review are displayed in Table 2.

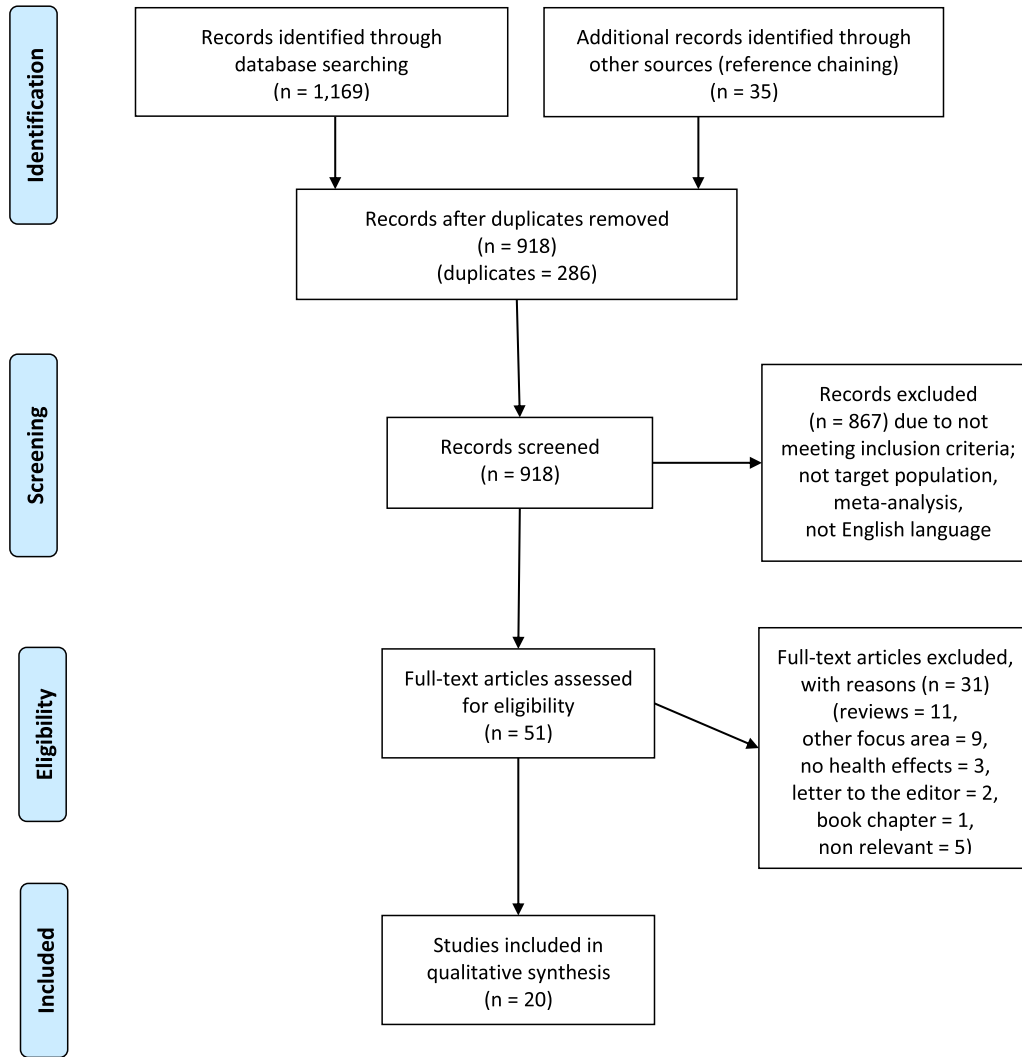


Fig. 1. Flow chart diagram according to the PRISMA guideline.

### Frequency of COC fasting practices

Publications included in the analysis vary in duration of examined COC fasting periods between 1 d<sup>(45,46)</sup>, 7 d<sup>(42,43)</sup> and longer fasting periods<sup>(6,35–44,47–49)</sup>. Data on longer COC fasting periods are available from five publications examining the effects of Easter fasting period (48 d)<sup>(39,40,44,48,49)</sup>, four examining the effects of Christmas fasting period (40–43 d depending on the country)<sup>(36,38,41,47)</sup> and three focused on three main COC fasting periods, that is, Easter, Christmas and Assumption (totalling 103 d of fasting)<sup>(6,35,37)</sup>. Lastly, five did not focus on specific COC fasting periods, but rather on the effect of adherence to the COC fasting principles<sup>(31–34)</sup>.

Some of them reported the duration of the COC fasting adherence. Fasters in one publication had been observing fast for 14 years<sup>(32)</sup>, one reported a mean of 24 ± 10.4 years adherence to the COC fasting rituals<sup>(43)</sup>, in others a mean of 20 ± 14 years was mentioned<sup>(6,35–38)</sup>, in one a mean of 31 years adherence was reported<sup>(31)</sup> and in another one a mean of 32 years average fasting time was reported<sup>(33)</sup>. In the case of participants being under religious orders, one study mentioned 12.5 ± 8.2 years in monastic life<sup>(43)</sup>, and in the case of the Athonian monks,

6 months adherence to COC fasting was sufficient to be included in the study<sup>(45,46)</sup>.

Different dietary assessment methods were used in the publications, and all results are comparable since the methods used are validated. One 24-h dietary recall in combination with a 3-d weighed food record was used in five publications<sup>(6,35–38)</sup>, three 24-h dietary recalls and a food frequency questionnaire in three publications<sup>(5,32,33)</sup>, 7-d weighed food records in three publications<sup>(41–43)</sup>, 7-d weighed food records in combination with a food frequency questionnaire in two publications<sup>(39,40)</sup>, 3-d weighed food records in one publication<sup>(34)</sup>, 2-d weighed food records in two publications<sup>(45,46)</sup> and a food frequency questionnaire in one publication<sup>(47)</sup>, while three publications did not focus on dietary intake at all<sup>(44,48,49)</sup>. Data regarding the dietary assessment method used in each publication and main nutritional outcomes are displayed in Table 3.

### Blood pressure levels

A few studies have investigated the effect of COC fasting regimes on blood pressure, with mixed results.

**Table 2.** Details of COC fasting publications included in the review

a/a	Author(s), year, country	Study design	Sample size (n)	Target age groups (years)	Fasting period	Anthropometric measurements	Arterial blood pressure	Haematologic data
1	Rodopaios <i>et al.</i> , 2020, Greece <sup>(33)</sup>	Cross-sectional study	100 F 100 NF	>50	NFP	4 % of F had osteoporosis compared with 14 % of NF	NA	NA
2	Rodopaios <i>et al.</i> , 2020, Greece <sup>(32)</sup>	Cross-sectional study	100 F 100 NF	18–35	NFP	BW and BMI did not differ between groups. Bone mineral density and bone mineral content did not differ between groups	SBP and DBP did not differ between groups	Serum calcium and vitamin D did not differ between groups, while urea was higher in NF
3	Bethancourt <i>et al.</i> , 2019, USA <sup>(40)</sup>	Prospective study	99 F	19–73	48 d, Easter FP	F reduced BW after a FP	NA	F had lowered total cholesterol and LDL-cholesterol after a FP
4	Bethancourt <i>et al.</i> , 2019b, USA <sup>(39)</sup>	Prospective study	99 F	19–73	48 d, Easter FP	NA	NA	NA
5	Rodopaios <i>et al.</i> , 2019, Greece <sup>(5)</sup>	Cross-sectional study	100 F 100 NF	50–78	NFP	BW and BMI did not differ between groups. Bone mineral density and bone mineral content did not differ between groups	F had lower DBP, but SBP did not differ between groups	Serum calcium, vitamin D and urea did not differ between groups
6	Karras <i>et al.</i> , 2019, Greece <sup>(46)</sup>	Prospective study	100 F (100 male)	20–45	1 fasting (Easter) and 1 non-fasting day	Athonian monks had lower BMI, BF mass, WC, VF mass	NA	All F had normal total cholesterol and LDL-cholesterol levels, and low HDL-cholesterol levels. Athonian monks had better fasting insulin concentrations and HOMA-IR values, PTH was higher, calcium level was normal and vitamin D level was low
7	El-Sayed <i>et al.</i> , 2018, Egypt <sup>(48)</sup>	Prospective study	49F (25 female, 24 male) 48 NF (22 female, 26 male)	22–84	48 d, Easter FP	F with and without T2DM lowered their BMI and WC after a FP	F with and without T2DM lowered their SBP, F with hypertension lowered both SBP and DBP after a FP.ç	F with T2DM had no changes in fasting blood glucose, lowered HbA1c and triacylglycerol levels, while no changes in cholesterol, LDL and HDL were found. F without T2DM increased fasting blood glucose levels after a FP
8	Makedou <i>et al.</i> , 2018, Greece <sup>(49)</sup>	Prospective study	35 F	19–66	48 d, Easter FP	NA	NA	F decreased WBC, granulocytes, haemoglobin, RBC, MCV, platelets, INR, aPTT and FVII activity, while lymphocytes and TAC level were increased after a FP
9	Elshorbagy <i>et al.</i> , 2017, Egypt <sup>(47)</sup>	Prospective study	36 F (24 female, 12 male)	29–32	43 d, before Christmas FP	BMI was decreased after the FP, while %BF remained the same after a FP	NA	F decreased cholesterol levels, while glucose and insulin remained the same after a FP. Leucine, isoleucine, valine, phenylalanine, tryptophan, plasma taurine and cystathionine decreased, while glutamic acid and glutamine increased after a FP

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Table 2. (Continued)

a/a	Author(s), year, country	Study design	Sample size (n)	Target age groups (years)	Fasting period	Anthropometric measurements	Arterial blood pressure	Haematologic data
10	Karras <i>et al.</i> , 2017, Greece <sup>(45)</sup>	Prospective study	50 F	38.8 ± 9.7	1 fasting (Easter) and 1 non-fasting day	BMI and %BF were within normal range after a FP	NA	F had normal total cholesterol, LDL and HDL-cholesterol, triglycerides, glucose, insulin and calcium levels and low vitamin D levels
11	Liali <i>et al.</i> , 2015, Greece <sup>(44)</sup>	Prospective study	41 F (41 female)	20–55	48 d, Easter FP	NA	NA	F had increased PT and decreased APTT, fibrinogen concentration and FVII activity
12	Papadaki <i>et al.</i> , 2011, Greece <sup>(42)</sup>	Prospective study	1 F	NA	1 fasting (Easter) and 1 non-fasting week	NA	NA	NA
13	Chryssoschoou <i>et al.</i> , 2010, Greece <sup>(34)</sup>	Cross-sectional study	609 children (286 female, 323 male)	5–15.5	NFP	12.1 % of children who never fast were obese in contrast to 7.3 % of those who fasted	NA	NA
14	Sarri <i>et al.</i> , 2009, Greece <sup>(38)</sup>	Case-control study	37 F (19 female, 18 male) 48 NF (27 female, 21 male)	F 43.0 ± 13.1 NF 38.6 ± 9.6	40 d, Christmas FP	F had higher BMI in general	NA	F decreased serum retinol, α-tocopherol, total cholesterol, LDL-cholesterol and triacylglycerol levels, and α-tocopherol:total cholesterol and retinol:total cholesterol ratios
15	Papadaki <i>et al.</i> , 2007, Greece <sup>(43)</sup>	Prospective study	10 F	37.5 ± 12.3	1 fasting (Easter) and 1 non-fasting week	F had increased BW and BMI during a NFP	F had lower SBP and DBP during a NFP	F increased total cholesterol and LDL- and HDL-cholesterol after a NFP, and had lower total cholesterol:HDL ratio during a FP
16	Sarri <i>et al.</i> , 2007, Greece <sup>(37)</sup>	Case-control study	38 F (19 female, 19 male) 29 NF (13 female, 16 male)	F 41.3 ± 11.9 NF 39.5 ± 11.3	3 FP; Christmas, Lent and Assumption	F had higher BMI and WC when compared with controls	F had higher SBP and DBP during all times. F decreased their SBP after all 3 FP	NA
17	Sarri <i>et al.</i> , 2005, Greece <sup>(36)</sup>	Case-control study	35 F (18 female, 17 male) 24 NF (13 female, 11 male)	F 43.6 ± 13.2 NF 39.8 ± 7.6	40 d, Christmas FP	NA	NA	F had lower pre serum ferritin, higher pre MCHC, higher pre TIBC and lower end TIBC. Serum ferritin levels were increased after fasting period in both groups
18	Sarri <i>et al.</i> , 2004, Greece <sup>(35)</sup>	Case-control study	60 F (29 female, 31 male) 60 NF (36 female, 24 male)	F 42 ± 12 NF 38 ± 9	3 FP; Christmas, Lent and Assumption	NA	NA	NA
19	Sarri <i>et al.</i> , 2003, Greece <sup>(6)</sup>	Case-control study	60 F (29 female, 31 male) 60 NF (36 female, 24 male)	F 41 ± 12 NF 38 ± 9	3 FP; Christmas, Lent and Assumption	Fasters dropped BMI by 1.4 %	NA	F had 12.5 % lower total cholesterol, 15.9 % lower LDL, and lower LDL/HDL ratio when compared with controls. Fasters had a 9.1 % reduction in total cholesterol, 12.4 % reduction in LDL and 8.5 % reduction in HDL. ApoE genotype distribution did not differ between groups
20	Basilakis <i>et al.</i> , 2002, Greece <sup>(41)</sup>	Prospective study	36 F (25 female, 11 male)	42.4 ± 14.6	40 d, Christmas FP	F dropped BMI and BW by 2–3 % and triceps skin fold by 10 % after a FP	NA	F lowered total cholesterol, LDL- and HDL-cholesterol, plasma urea and creatinine levels, increased triacylglycerol levels and blood glucose, iron and ferritin levels remained the same after a FP

\*NA, not applicable; F, faster; NF, non-faster; FP, fasting period; NFP, non-fasting period; BW, body weight; BMI, body mass index; BF, body fat; VF, visceral fat; PT, prothrombin time; APTT, activated partial thromboplastin time; FVII, coagulation factor VII; TAC, total antioxidant capacity.



**Table 3.** Results of dietary intake

a/a	Author(s), year, country	Dietary assessment method	Results in energy and food intake	Results in carbohydrate, protein and fat intake	Results in rest macronutrients	Results in minerals	Results in vitamins
1	Rodopaios <i>et al.</i> , 2020, Greece <sup>(33)</sup>	Three 24-h dietary recall and food frequency questionnaire	NA	F had lower protein and fat intake	NA	F had lower calcium, magnesium, selenium, iron and phosphorus intake	F had lower intake of vitamin B3, B12, D, E and folate
2	Rodopaios <i>et al.</i> , 2020, Greece <sup>(32)</sup>	Three 24-h dietary recall and food frequency questionnaire	F consumed fewer servings of dairy, soya products and alcohol per week	F had lower protein intake	NA	F had lower calcium intake	F had lower vitamin D intake
3	Bethancourt <i>et al.</i> , 2019, USA <sup>(40)</sup>	7-d weighed food records and food frequency questionnaire	F decreased red meat, poultry, processed meat, all dairy and egg consumption and increased fish, shellfish and plant-based food intake after FP	NA	NA	NA	NA
4	Bethancourt <i>et al.</i> , 2019b, USA <sup>(39)</sup>	7-d weighed food records and food frequency questionnaire	F lowered their energy intake, decreased meat, dairy products and eggs intake while increasing legume, soya product, nut and seed intake	F reduced protein and fat and increased carbohydrate intake	F reduced animal protein and increased plant protein intake, reduced saturated fat, trans-fatty acid and increased fibre intake	F had lower intake of calcium, zinc and higher intake of magnesium	F had lower intakes of vitamin B12, D
5	Rodopaios <i>et al.</i> , 2019, Greece <sup>(5)</sup>	Three 24-h dietary recall and food frequency questionnaire	F consumed less servings of dairy and soya products per week.	F had lower protein intake	NA	F had lower calcium intake	F had lower vitamin D intake
6	Karras <i>et al.</i> , 2019, Greece <sup>(46)</sup>	2-d weighed food record	Athonian monks had lower energy intake during both RD and NRD	Athonian monks had lower fat and carbohydrate intake, and higher protein intake on a RD, while higher carbohydrate, lower fat and protein intake during a NRD	Athonian monks had higher cholesterol intake and lower saturated fat intake on a RD. General F had higher intake of saturated fat and cholesterol intakes in a NRD	F had low intake of calcium, magnesium, sodium and potassium, and adequate iron intake	Intake of vitamins C and B12 were higher in Athonian monks, while vitamins D and E were below the recommended in all F
7	El-Sayed <i>et al.</i> , 2018, Egypt <sup>(48)</sup>	NA	NA	NA	NA	NA	NA
8	Makedou <i>et al.</i> , 2018, Greece <sup>(49)</sup>	NA	NA	NA	NA	NA	NA
9	Elshorbagy <i>et al.</i> , 2017, Egypt <sup>(47)</sup>	Food frequency questionnaire	NA	NA	NA	NA	NA
10	Karras <i>et al.</i> , 2017, Greece <sup>(45)</sup>	2-d weighed food record	F had lower total energy intake in a RD	F had higher fat and protein intake in a RD	F had high fibre intake during both RD and NRD	F had low intake of calcium, magnesium, and sodium, and adequate iron intake	F had low intake of vitamins A, B2 and D, while vitamins B12 and C were adequate during both RD and NRD
11	Liali <i>et al.</i> , 2015, Greece <sup>(44)</sup>	NA	NA	NA	NA	NA	NA
12	Papadaki <i>et al.</i> , 2011, Greece <sup>(42)</sup>	7-d weighed food record during 1	F reduced total energy intake during a FP	F had increased fat, $\omega$ -3 $\omega$ -6 fatty acids, and reduced saturated,	F had increased fibre and cholesterol intake	F had increased iron and	F had reduced vitamin E intake

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Table 3. (Continued)

a/a	Author(s), year, country	Dietary assessment method	Results in energy and food intake	Results in carbohydrate, protein and fat intake	Results in rest macronutrients	Results in minerals	Results in vitamins
		fasting and 1 non-fasting week		trans and mono-unsaturated fatty acids intake		sodium intake, while decreased calcium intake	
13	Chrysochoou <i>et al.</i> , 2010, Greece <sup>(34)</sup>	3-d weighed food record	Children who never fast had higher energy intake	Children who never fast had higher saturated fatty acids, trans fatty acids. Children who fast had higher carbohydrate, lower fat, saturated fatty acids and mono-unsaturated fatty acids intake	Children who never fast had higher cholesterol intake	Children who fast had lower intake of magnesium	Children who fast had lower intake of vitamin E
14	Sarri <i>et al.</i> , 2009, Greece <sup>(38)</sup>	One 24-h recall and 3-d weighed food record, before and after the 3 FP	F consumed more cereals, rice or pasta after FP	F increased carbohydrate and decreased fat intake.	F increased their fibre and decreased their cholesterol intake after FP	F consumed less calcium, phosphorus and sodium	F consumed less vitamins B1, B6, niacin
15	Papadaki <i>et al.</i> , 2007, Greece <sup>(43)</sup>	7-d weighed food record during 1 fasting and 1 non-fasting week	F consumed more legumes, fish, shellfish, snails and nuts during a FP	F increased carbohydrate intake and reduced protein, fat, saturated fat and trans fatty acids intake during a FP	F increased their fibre intake during a FP	F increased their folate and decreased their calcium intake during a FP	NA
16	Sarri <i>et al.</i> , 2007, Greece <sup>(37)</sup>	One 24-h recall and 3-d weighed food record, before and after the 3 FP	F consumed more fruits and vegetables after all 3 FP	NA	F increased their fibre intake after all 3 FP	F reduced sodium and calcium, and increased magnesium intake after all 3 FP	NA
17	Sarri <i>et al.</i> , 2005, Greece <sup>(36)</sup>	One 24-h recall and 3-d weighed food record, before and after the 3 FP	F decreased their energy intake after the FP. F consumed more pulses pre- and post-FP	NA	F increased fibre intake after the FP	F increased dietary iron intake after the FP	F increased their vitamin C intake after the FP
18	Sarri <i>et al.</i> , 2004, Greece <sup>(35)</sup>	One 24-h recall and 3-d weighed food record, before and after the 3 FP	F decreased energy intake after all 3 fasting periods. F consumed more potatoes, fruits and vegetables after all 3 FP	F increased carbohydrate consumption, reduced protein and fat intake after all 3 FP	F decreased saturated fatty, trans-fatty acids, dietary cholesterol intake, and increased fibre intake after all 3 FP. F decreased the n6:n3 ratio by 9 %	F had higher intake of folate and iron and lower intake of calcium after FP	No difference in vitamins A, C, E, B1, B6, B12 and niacin
19	Sarri <i>et al.</i> , 2003, Greece <sup>(6)</sup>	One 24-h recall and 3-d weighed food record, before and after the 3 FP	F had 10 % reduction, whereas NF had a 7 % increase in energy intake	F had 23 % increase in carbohydrates and 17 % reduction in fat	F had 43.5 % increase in fibre consumption, while NF had 3.3 % increase	NA	NA
20	Basilakis <i>et al.</i> , 2002, Greece <sup>(41)</sup>	7-d weighed food, before and during the last week of fasting	F had 20 % reduction in energy intake during FP	F had 17 % reduction in carbohydrate, 17 % reduction in protein and 33 % reduction in fat intake during FP	F had 77 % reduction in cholesterol, 39 % reduction in saturated fatty acids, 36 % reduction in polyunsaturated fatty acids and no reduction in monounsaturated fatty acids during FP	NA	NA

\*NA, not applicable; F, faster; NF, non-faster; FP, fasting period; NFP, non-fasting period; RD, restrictive day; NRD, non-restrictive day.



According to Sarri and colleagues, after the three main COC fasting periods, mean systolic blood pressure was lowered in thirty-eight fasters when comparing with twenty-nine non-fasters. Further analysis revealed that fasters with high levels of blood pressure, during all fasting periods, were people of older age and with higher BMI, resulting in high levels of blood pressure<sup>(37)</sup>. Also, another study showed that ten members of monasteries in Greece had higher values of systolic blood pressure after an Easter fasting week, probably as a result of lower calcium intake and/or the use of salt during fasting periods to improve the taste of meals<sup>(43)</sup>. Elsayed and colleagues reported that, after an Easter fasting period, fasters with and without T2DM decreased systolic blood pressure and increased diastolic blood pressure, and fasters with hypertension lowered both systolic blood pressure and diastolic blood pressure after the fasting period<sup>(48)</sup>. A cross-sectional study in Greece demonstrated that both systolic and diastolic blood pressure did not differ between 100 fasters and 100 non-fasters<sup>(32)</sup>.

### Haematological outcomes

Total cholesterol and LDL-cholesterol decreased by 9.1 % and 12.4 %, respectively, and the LDL:HDL ratio was significantly lower after all three major fasting periods in Greece in sixty fasters who were members of monasteries. This could be a result of the 43.5 % increase in fibre consumption and 17 % reduction in fat intake, as shown from the 24-h recalls and the 3-d weighed food records collected from fasters during all fasting periods. Notably, in the same study, when fasters returned to their usual dietary habits, the levels of total cholesterol and LDL-cholesterol were increased<sup>(6)</sup>. During an Easter fasting period, in ninety-nine fasters in the United States, it was reported that each serving decrease in meat, dairy product and egg consumption, foods not allowed in this period, was associated with an average decrease of 3.7 % in total cholesterol levels and 3.6 % decrease in LDL-cholesterol<sup>(40)</sup>. Also, Papadaki and colleagues showed that, after an Easter fasting week, there were lower levels of total cholesterol and LDL-cholesterol, and the total-cholesterol:HDL-cholesterol ratio was lower, probably as a result of increased fruit, vegetable, legume, fish, shellfish, snail and nut consumption as it was reported in 7-d weighed food records during the fasting period<sup>(43)</sup>. Furthermore, total cholesterol<sup>(38,41,46,47)</sup> and LDL-cholesterol<sup>(38,41,46)</sup> were both decreased after different COC fasting periods, while HDL was found to be increased during a restrictive period<sup>(46)</sup> and lower after the Christmas fasting period<sup>(41)</sup>.

Triacylglycerol levels were reduced in fasters with T2DM<sup>(48)</sup> and in laypeople following the Christmas fasting period<sup>(38)</sup>, while one publication showed that triglycerides were not affected in addition to no changes in glucose metabolism and C-reactive protein levels (CRP)<sup>(40)</sup>.

Elsayed and colleagues focused their study on people with and without T2DM. Fasters with T2DM had no changes in fasting blood glucose, while some fasters without T2DM increased their fasting blood glucose levels after the fasting period. Some fasters with T2DM dropped their HbA1c levels, and no changes were found in total cholesterol or LDL- and HDL-cholesterol levels<sup>(48)</sup>.

After the Easter fasting period, blood sample analysis showed reduced leucine, isoleucine, valine, phenylalanine, tryptophan,

taurine, cystathionine, glutamic acid and glutamine concentrations in fasters<sup>(47)</sup>. In addition, plasma retinol and  $\alpha$ -tocopherol concentrations, as well as  $\alpha$ -tocopherol:total cholesterol and retinol:total cholesterol ratios were all reduced after an Easter fasting period<sup>(38)</sup>. According to Basilakis *et al.*, plasma protein, urea and creatinine levels were decreased and blood glucose remained the same, while iron and ferritin levels did not change in fasters after the Christmas fasting period<sup>(41)</sup>. Higher serum ferritin levels were also noted after the Christmas fasting period in both fasters and non-fasters<sup>(36)</sup>. In the same study, total iron-binding capacity (TIBC) and mean corpuscular Hb concentration (MCHC) were decreased in fasters<sup>(36)</sup>.

In a study focused on fifty Athonian monks, results showed that they had better fasting insulin concentrations and HOMA-IR values, parathyroid hormone levels were higher, serum calcium was in normal range and all monks were vitamin D deficient. This was probably a result not only of the dietary intake, which was low in vitamin D, but also because of the mandatory clothing of a black cassock they have to wear during outdoor activities<sup>(45)</sup>.

Coagulation factor VII (FVII) activity was found to be lower after a fasting period<sup>(44,49)</sup>. Also, after Easter fasting, prothrombin time (PT) was increased, while activated partial thromboplastin time (APTT) and fibrinogen concentration were lower when comparing with pre-fast values<sup>(44)</sup>. Another publication reported that, after Easter fasting, there was a decrease in leucocytes, granulocytes, haemoglobin, erythrocytes, mean erythrocyte volume (MCV) and platelets, while total antioxidant capacity (TAC) levels were increased<sup>(49)</sup>.

Lastly, one study found that ApoE genotype distribution did not differ between fasters and controls after different fasting periods<sup>(6)</sup>.

### Anthropometric parameters

Following the Christmas fasting regimen, fasters dropped their body weight and BMI by 2–3 %, while the triceps skinfold was reduced by 10 %<sup>(41)</sup>. Among a Greek population following the three major fasting periods, there was a 1.4 % decline in fasters' BMI<sup>(37)</sup>. Body weight was found to be lower in fasters when compared with non-fasters after a fasting period<sup>(40,43,47)</sup>, with same outcomes in BMI<sup>(43,48)</sup>, waist circumference<sup>(48)</sup> and lean body mass<sup>(47)</sup>. In the only study with children participants, obesity was reported in 12.1 % of those who never fasted in contrast to 7.3 % of children fasters<sup>(34)</sup>.

Rodopaios and colleagues reported that overweight and obese participants were over 50 % in both fasters and non-fasters, an outcome that needs further investigation regarding the quantity of foods eaten during fasting periods apart from the quality<sup>(31)</sup>. Also, in the same study, it was shown that bone mineral density and bone mineral content at the lumbar spine, right and left hip, and right and left femoral neck did not differ between fasters and non-fasters when evaluated with dual-energy X-ray absorptiometry<sup>(31,32)</sup>, which revealed a 4 % incidence of osteoporosis in fasters compared with 14 % in non-fasters, and bone mineral density was high in overweight and obese men and postmenopausal women over the age of 50 years who followed the COC fasting regimen, without the use of dietary supplements<sup>(33)</sup>.



## Discussion

This scoping review aimed to present available evidence regarding the impact of COC fasting on human health in relation to MetS. As it was shown in some publications, fasting periods were characterised by less daily energy intake when comparing with non-fasting periods<sup>(6,35,36,39,41,42,46)</sup>, with some reporting a 10 %<sup>(6)</sup> or even a 20 %<sup>(41)</sup> reduction in energy intake. Low fat intake<sup>(6,33,35,38,41–43)</sup>, low saturated and trans fatty acid intake<sup>(35,42,43)</sup>, and low monounsaturated fatty acid and high  $\omega$ -3 and  $\omega$ -6 fatty acids<sup>(42)</sup> intakes were shown for fasters following COC fasting regimes in different fasting periods. Increased complex carbohydrate and fibre<sup>(6,32,33,35,36,40)</sup> intakes were noted in fasters. In terms of protein consumption, results were mixed; increased protein intake was noted in Athonian monks, probably due to the high intake of shellfish, seafood and snails<sup>(45,46)</sup>, and in fasters living in the United States, where an increase in plant protein was noted during fasting periods due to high intake of legumes, nuts and seeds<sup>(39)</sup>, while lower protein intake was shown in other studies<sup>(31–33,36,43)</sup>.

Also, it was shown that people who fasted according to COC recommendations<sup>(35–37,42)</sup> had increased consumption of fruits, legumes and vegetables that had been associated with a protective effect against CVD, diabetes<sup>(50)</sup> and blood pressure<sup>(51)</sup>. In a study with 486 females living in Tehran, Esmailzadeh and colleagues showed that those with the highest intake of fruits and vegetables had a 34 % and 30 % reduced chance of having MetS, respectively, when comparing with those who did not consume the above foods<sup>(52)</sup>. Also, as shown in the EPIC-InterAct prospective cohort study, with a representative sample of 16 154 participants and 11 years of follow-up, consumption of a great variety of root and green leafy vegetables was associated with lower risk of diabetes in Europe<sup>(53)</sup>. In the PREDIMED study, among 808 participants with high cardiovascular risk, those who had the highest adherence to the Mediterranean diet had 56 % lower odds ratios of having MetS<sup>(26)</sup>. Furthermore, research from the Singapore Chinese Health Study, with 43 176 participants and 11 years of follow-up, indicated that a dietary pattern with high intake of fruits, vegetables and soy products is linked with lower risk of diabetes, while a dietary pattern characterised by higher consumption of meat and processed meat has been linked with higher risk of diabetes in China<sup>(54)</sup>. As far as the current popular intermittent fasting is concerned, limited evidence exist about its effects in people with diabetes; most of its results are similar to those of caloric restrictions, and it should be followed only with the involvement of a physician, according to a recent review by Horne and colleagues<sup>(55)</sup>.

High fibre consumption has been observed to be associated with beneficial effects on waist circumference and HDL-cholesterol, both components of MetS<sup>(56)</sup>. Notably, in the ATTICA study, the Mediterranean diet was associated with 13 % lower likelihood of having the MetS, as shown in 3042 participants in Greece<sup>(57)</sup>. Olive oil, which is allowed during some fasting periods, has been proven to have beneficial effects on lowering blood pressure, reducing plasma glucose and improving the total-cholesterol:HDL-cholesterol ratio, all different variables of MetS<sup>(58)</sup>. Nuts have been shown to reduce plasma cholesterol, triacylglycerol and waist circumference, all being variables of MetS<sup>(59)</sup>. Lastly, another study has shown that 84 g of nut

consumption per day has beneficial effects on body fat levels and body weight reduction<sup>(60)</sup>.

In addition, findings from the COC fasting studies are similar to Adventist Health Study 2 (AHS-2) results, in which 38 118 strict, lacto-ovo-, pesco- and semi-vegetarians and 33 634 non-vegetarians were included. AHS-2 results revealed that vegetarians had reduced calorie intake, and had higher total fibre and plant protein intake as a consequence of increased fruit, vegetable, legume and nut consumption, and higher intake of  $\omega$ -3 fatty acids due to consumption of fishes, when compared with non-vegetarians. Results have shown that vegetarians have a significantly lower risk of having MetS when compared with non-vegetarians<sup>(61,62)</sup>. Similarly, 9850 adults over 19 years old participated in the Korean National Health and Nutrition Examination Survey, where it was shown that a dietary pattern that included grains, vegetables and fish was associated with a 14 % reduced risk of MetS<sup>(63)</sup>. One recent review and meta-analysis of different dietary patterns showed that adherence to a 'healthy' diet pattern, mainly characterised by high consumption of fruits, vegetables, whole grains, poultry, fish, nuts, legumes and low-fat dairy products, significantly decreased MetS risk by 15 %, when compared with a 'meat/western' diet pattern, which increased MetS risk by 19 % and was characterised by high intake of red and processed meat, eggs, refined grains and sweets<sup>(64)</sup>.

The effects of COC fasting period on blood pressure results were mixed. Two publications reported no changes in both systolic blood pressure and diastolic blood pressure<sup>(31,32)</sup>, and one showed low levels of systolic blood pressure under all fasting periods<sup>(37)</sup>. Also, Papadaki *et al.* showed that both systolic blood pressure and diastolic blood pressure were lower only in non-fasting periods<sup>(43)</sup>. Taking into consideration that salt intake was never investigated in any study, high blood pressure could be possibly be due to the addition of salt during cooking in favour of taste<sup>(43)</sup>. Also, it could be a result of low calcium intake during COC fasting periods, given that calcium has been associated with blood pressure control<sup>(65)</sup>. In some cases, this could be due to the undiagnosed prevalence of arterial hypertension as people under religious orders living in monasteries might have limited access to health care services<sup>(37,66)</sup>. Results from the SUN cohort study, in 9408 participants with a follow-up of 6 years, showed that people with higher adherence to the Mediterranean diet had lower mean levels of systolic and diastolic blood pressure when compared with those with the lowest adherence in Spain<sup>(67)</sup>. Similarly, in Greece, the results of the EPIC study indicated that adherence to the Mediterranean diet is inversely associated with blood pressure levels<sup>(68)</sup>, and the ATTICA study showed that a food pattern characterised by consumption of fish, vegetables, fruits, legumes and cereals was inversely associated with blood pressure<sup>(57)</sup>. What is more, among 6627 vegans, vegetarians and fish eaters and 4737 meat eaters participating in the EPIC-Oxford study in the UK, vegans had the lowest prevalence of hypertension and the lowest mean systolic and diastolic blood pressure, while meat eaters had the highest values<sup>(69)</sup>. Same findings were shown in 500 non-Black individuals in AHS-2<sup>(70)</sup>, as well as in 592 Black individuals in AHS-2 across the United States and Canada<sup>(71)</sup>, where vegans had significantly lower values in systolic and diastolic blood pressure when compared with non-vegetarians. In contrast, blood pressure was not different for people

following alternate-day fasting, which accounts for one fast day and one usual intake, for 6 and 12 months when comparing with a control group<sup>(72)</sup>. Also, a similar reduction in both systolic and diastolic blood pressure was observed in premenopausal women following intermittent fasting and in those who followed a low-calorie diet<sup>(73)</sup>.

A potential benefit for lipid profile is indicated, as total cholesterol and LDL-cholesterol concentrations were reduced at the end of COC fasting periods<sup>(6,38,40,41,43,45,47)</sup>. Some studies showed a reduction in HDL-cholesterol concentrations<sup>(6,41,46)</sup>, a finding that is common in low-fat and vegetarian diets<sup>(74,75)</sup>. Similar results were shown in the PREDIMED study, where participants with higher adherence to the Mediterranean diet had 54 % lower odds of having high triacylglycerol levels<sup>(26)</sup> and 47 % lower odds of having low HDL-cholesterol levels<sup>(27)</sup>, both MetS criteria. The EPIC-Oxford study, with 11 004 participants in the UK, showed that mean LDL-cholesterol was 12 % lower in vegetarians than in omnivores<sup>(69)</sup>. Also, the ATTICA study in Greece, with 3042 participants, showed that the Mediterranean diet was inversely associated with triacylglycerol levels and positively associated with HDL-cholesterol levels<sup>(57)</sup>.

Fasting blood glucose has not been investigated thoroughly, apart from one study with participants having both lower and higher fasting blood glucose levels after a fasting period<sup>(48)</sup>. The Tzu Chi Health Study, with 4384 Taiwanese participants, found that vegetarian diet characterised by increased intake of soy products, vegetables, nuts and whole-grain products was negatively associated with impaired fasting blood glucose. The prevalence of diabetes was 0.6 % in vegetarian pre-menopausal women versus 2.3 % in meat eater ones, 2.8 % versus 10 % in vegetarian menopausal women versus meat eaters, and 4.3 % and 8.1 % in vegetarian men and omnivores, respectively<sup>(76)</sup>. Lower prevalence and incidence of diabetes were also found in 41 387 vegetarians from the United States and Canada who participated in the AHS-2 study<sup>(77)</sup>.

Results concerning body weight and BMI are limited. Studies showed a reduction in body weight<sup>(40,41,43)</sup> and BMI<sup>(43,47,48)</sup>, while one showed optimal body weight in fasters before and after all fasting periods<sup>(45)</sup>, but others do not report any data, meaning that conclusions cannot be drawn. Similarly, due to the effect of low energy intake in vegetarian diets, people who follow these diets have lower BMI when compared with meat eaters<sup>(78)</sup>. Furthermore, Mediterranean diet seems to contribute to weight loss and maintaining a healthy body weight<sup>(79,80)</sup>. Also, results from the EPIC-Oxford<sup>(81)</sup>, AHS-2 study<sup>(61)</sup> and Tzu Chi Health Study<sup>(76)</sup> showed that vegetarians had lower BMI when compared with non-vegetarian people, and these differences were reflected in a lower prevalence of obesity in vegetarians. In general, it has been observed that vegetarians are leaner than omnivores<sup>(82,83)</sup>, probably due to high intake of fibre in these diets<sup>(81,84)</sup>. Trepanowski and colleagues showed in a recent randomised clinical trial that participants who followed the strategy of alternate-day fasting did not have a significantly different weight loss after 6 and 12 months when compared with people who did not fast<sup>(72)</sup>.

Although studies regarding COC fasting regimen were carried out in three different countries, that is, Greece, United States and Egypt, the main results were similar and demonstrated low

energy intake, low fat intake, low animal protein and high vegetable protein intake, high complex carbohydrate and fibre intake, and low calcium and vitamin D intake in laypeople following the COC fasting guidelines during different fasting periods. It is of great importance to mention that the fifth-largest Orthodox population in the world is found in Greece, followed by Egypt in tenth place and the United States in sixteenth<sup>(85)</sup>. It should also be mentioned that different variants of the COC fasting diet are included in the review, from Cretan and Mediterranean diet where meat consumption is allowed in non-fasting periods, to Athonian diet where meat is not allowed at all, but fish, seafood and snails are allowed. This contributes to the increased protein intake in Athonian monks seen throughout the year<sup>(46)</sup>.

Results from available studies with participants following the COC fasting recommendations revealed some positive outcomes on different variables of the MetS, although conclusions cannot be drawn on individual studies regarding any aspect of health.

### Limitations

Our scoping review has several limitations which have to be taken into consideration when results are being evaluated, with some already being mentioned. First, the number of available and included articles is low, with small number of subjects involved from the same research group<sup>(6,31,32,35–40,42,43,45,46)</sup>. There is lack of control group in eleven out of twenty publications investigating the health effects of COC fasting regimen<sup>(34,39–47,49)</sup> and the possibility of under- or over-estimating dietary intake either when subjects report it on questionnaires or when investigators analyse the information on available nutrition software in sixteen studies<sup>(6,31,32,34–43,45–47)</sup>, which are among the confounding variables that influence the cause-and-effect relationship we are noticing. Moreover, the time intervals during which fasters were followed were short with no long-term follow-up period in all included articles. Also, the level of adherence and the years of compliance with the COC fasting guidelines were different in most of the included articles. No study was focused on foods eaten during non-fasting periods that might affect the results of studies investigating the long-term results of COC fasting regimen, and heterogeneity was high regarding design method and study sample. Finally, the included studies focus on different risk factors of MetS, meaning that results are interpreted individually and we cannot draw a clear conclusion.

### Conclusion

The COC fasting diet pattern could be advised for the prevention of chronic diseases, as well as for people who want to follow a plant-based diet in terms of a healthier and/or more sustainable way of living. As already mentioned, the COC fasting dietary pattern has been the origin and the main characteristic of the diet of Crete since the 1960s, and was later called the Mediterranean diet. Adherence to the traditional diet of Crete is the main way of decreasing the MetS score. Thus, the COC fasting dietary pattern or its most beneficial components together with physical activity may be effective advice to decrease the MetS score.



Although evidence in favour of health benefits is available, the COC fasting dietary recommendations should always be followed under personalised guidance on proper meal planning, like any other dietary pattern. Adding to this, the quality and the quantity of foods consumed during fasting and non-fasting periods have to be examined thoroughly. What is more, long-term follow-up studies should be carried out to investigate if the positive effects on health parameters are sustainable over time.

Further investigation is needed in relation to several health parameters, disease indices that are influenced by diet and in diverse ethnic populations, in order to assess the impact of this type of periodic vegetarianism that includes fish and seafood on nutritional status and chronic diseases. Taking into consideration the significant impact it has on public health, future studies should be focused on the interaction between COC fasting regimen and all risk factors of MetS.

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### Author contributions

Anna Kokkinopoulou: Conceptualisation, Methodology, Data collection, Data analysis, Data interpretation, Writing original draft, Writing - review & editing, Visualisation, Final approval of the submitted version

Anthony Kafatos: Conceptualisation, Methodology, Data collection, Data analysis, Data interpretation, Writing original draft, Writing - review & editing, Visualisation, Final approval of the submitted version, Supervision

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### Supplementary material

To view supplementary material for this article, please visit <https://doi.org/10.1017/S0954422421000184>

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Appendix 1: Results of the quality assessment tool for the qualitative studies ( $n = 20$ )

Study	Abstract and title	Introduction and aims	Method and data	Sampling	Data analysis	Ethics and bias	Finding/ results	Transferability/ generalisability	Implications and usefulness	Total	Grade
Rodopaios <i>et al.</i> , 2020 <sup>(33)</sup>	4	4	4	4	4	3	4	4	3	34	A
Rodopaios <i>et al.</i> , 2020 <sup>(32)</sup>	4	4	4	4	4	3	4	4	3	34	A
Bethancourt <i>et al.</i> , 2019 <sup>(40)</sup>	4	4	4	4	4	3	4	4	3	34	A
Bethancourt <i>et al.</i> , 2019b <sup>(39)</sup>	4	4	4	4	4	3	4	4	4	35	A
Rodopaios <i>et al.</i> , 2019 <sup>(5)</sup>	4	4	4	4	4	3	4	4	3	34	A
Karras <i>et al.</i> , 2019 <sup>(46)</sup>	4	4	4	4	4	3	4	4	3	34	A
El-Sayed <i>et al.</i> , 2018 <sup>(48)</sup>	4	4	4	4	4	3	4	4	4	35	A
Makedou <i>et al.</i> , 2018 <sup>(49)</sup>	4	3	3	2	3	3	3	3	3	27	B
Elshorbagy <i>et al.</i> , 2017 <sup>(47)</sup>	4	4	4	4	4	3	4	4	3	34	A
Karras <i>et al.</i> , 2017 <sup>(45)</sup>	4	4	4	4	4	4	4	4	3	35	A
Liali <i>et al.</i> , 2015 <sup>(44)</sup>	4	3	4	3	3	3	3	3	3	29	B
Papadaki <i>et al.</i> , 2011 <sup>(42)</sup>	4	4	4	4	4	3	4	4	3	34	A
Chryssochoou <i>et al.</i> , 2010 <sup>(34)</sup>	4	3	4	4	4	3	4	4	3	33	A
Sarri <i>et al.</i> , 2009 <sup>(38)</sup>	4	4	4	4	4	3	4	4	3	34	A
Papadaki <i>et al.</i> , 2007 <sup>(43)</sup>	4	4	4	4	4	3	4	4	3	34	A
Sarri <i>et al.</i> , 2007 <sup>(37)</sup>	4	4	4	4	4	3	4	4	3	34	A
Sarri <i>et al.</i> , 2005 <sup>(36)</sup>	4	4	4	4	4	3	4	4	3	34	A
Sarri <i>et al.</i> , 2004 <sup>(35)</sup>	3	4	4	4	4	3	4	4	3	33	A
Sarri <i>et al.</i> , 2003 <sup>(6)</sup>	4	4	4	4	4	3	4	4	3	34	A
Basilakis <i>et al.</i> , 2002 <sup>(41)</sup>	4	3	4	3	4	3	4	4	3	32	A