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Moderate Coffee Intake and Mediterranean Diet Adherence Alleviate Lipid and Oxidative Stress Markers in Older Women

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Abstract Adherence to the Mediterranean diet (MedDiet) and coffee consumption offer several health benefits and could be recommended for the elderly. The objective of this study was to investigate oxidative stress markers and lipid levels in relation to MedDiet adherence and coffee intake in Algerian older women. Volunteer women aged over 65 years were recruited. Specific questionnaires were used to assess MedDiet adherence, nutritional status (MNA) and coffee intake. Blood lipids and oxidant/antioxidant markers were investigated with biochemical methods. The results showed that older women with low MedDiet adherence were at risk of malnutrition, with lower BMI, altered lipids (reduction in triglycerides, total cholesterol, LDL- and HDL-cholesterol) and redox profile (reduction in antioxidants and increase in pro-oxidants) compared to older women with high MedDiet adherence, regardless of coffee consumption. Coffee consumption modulated plasma lipids and markers of oxidative stress similarly in women with low or high MedDiet adherence. High coffee intake increased total cholesterol and LDL-cholesterol levels in older women while moderate coffee intake did not affect plasma lipids but induced a reduction in pro-oxidant markers (peroxynitrite, malondialdehyde and carbonyl proteins) and an increase in antioxidants (reduced glutathione, catalase and superoxide dismutase). In conclusion, a Mediterranean-style diet may have protective effects against oxidative stress and may improve lipid profile in older women. At the same time, moderate coffee consumption is also responsible for beneficial antioxidant effects.

Keywords: *older women, Mediterranean diet, coffee intake, oxidative stress, lipids*

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1. Introduction

Aging is a complex and multifaceted process, encompassing a range of physical, social, and physiological changes that occur in human beings throughout their lives. As countries worldwide experience a growing proportion of older adults, understanding the mechanisms behind aging becomes increasingly crucial with advancements in healthcare and improved living conditions.

Several factors, such as genetic and metabolic changes, as well as oxidative stress, interact to influence age-related physiological changes [1]. Among these factors, a diverse and balanced diet in terms of quality and quantity is one of the most accessible elements to influence the aging process and, above all, prevent pathological aging associated with diseases, functional deficits, and even disability and frailty. Indeed, nutrition in the older population is an important domain for maintaining their health and well-being [2,3,4]. Several epidemiological and clinical studies emphasize the link between nutrition and health in older subjects, highlighting the relationship between various nutritional deficiencies and the frequency of age-related degenerative pathologies [2,5].

The aging process is also influenced by oxidative stress—an imbalance between the production of free radicals and the body's antioxidant defense. Oxidative stress induces molecular alterations, involving lipids, proteins and DNA, and affecting cellular and tissue function. These oxidative modifications can contribute to the development of age-related diseases such as cardiovascular diseases, neurodegenerative disorders, and cancer [4,6]. Oxidative stress is involved in chronic inflammation which adversely influences age-related conditions [7]. Older women are particularly vulnerable to oxidative stress. Aging-related changes, combined with hormonal fluctuations during menopause, make women

more susceptible to oxidative damage [8]. The complex interplay between aging, sex and redox status requires advanced researches on preventive or therapeutic factors that can help to reduce oxidative stress and to maintain good health of the elderly. Adequate nutrition, encompassing a balanced diet rich in essential vitamins, minerals, and antioxidants, could play an important role in promoting health and reducing oxidative stress.

The Mediterranean diet (MedDiet) is a dietary pattern characterized by a high consumption of seasonal vegetables, fruits, nuts, seeds, legumes and cereals, and high intake of olive oil as the main source of fat. This diet also includes moderate consumption of dairy products, fish, and poultry, and low intake of red meat and sweets [9]. Previous studies have shown that adherence to the MedDiet reduced the prevalence of chronic diseases [10]. This diet is particularly recommended during aging [4,11].

Furthermore, the adoption of MedDiet has been shown to reduce oxidative stress by neutralizing free radicals and protecting cells against oxidative damage, promoting optimal aging [10]. Thus, oxidative stress has negative effects on the health of the general population and certain groups of elderly patients with chronic and acute diseases, which can be modulated by micronutrients and dietary habits.

Coffee is one of the most widely consumed beverages worldwide and has been a subject of interest in various health studies, including its potential effects in elderly people [12,13]. Previous studies have shown the beneficial effects of coffee consumption in reducing the risk of cardiovascular disease and plasma cholesterol concentrations, in reducing the risk and prevalence of obesity, diabetes, cancers and neurodegenerative diseases such as Alzheimer's and Parkinson's disease, in improving mental performance, and also in reducing many disease complications [12,14,15,16]. All these health benefits are now thought to be achieved through antioxidant activity of coffee, due to the presence of several bioactive compounds such as caffeine and polyphenols. Indeed, coffee intake has been reported to attenuate oxidative stress and to modulate lipid concentrations with conflicting results [12,16,17,18].

To our knowledge, no previous study has investigated the adherence to MedDiet and coffee consumption and their impacts on oxidative stress and lipid levels in older women. As far as we know, MedDiet adherence, coffee consumption, oxidative stress and lipid levels have not been previously investigated simultaneously in older people. The aim of this study was then to investigate oxidative stress markers and lipid levels in relation to MedDiet adherence and coffee intake in the older women in Tlemcen area (Algeria).

2. Material and Methods

2.1. Participants

The present study is part of a large national survey sponsored by the Ministry of Higher Education and Scientific Research, that was performed in Tlemcen University (Algeria) and was designed to the management of the nutritional status in the elderly (Pnr.dgrsdt.dz). The study has been approved by Tlemcen University ethical committee, by Tlemcen Hospital Committee for Research on Human Subjects (OPENAG 2022), and the Helsinki Declaration's ethical principles were followed.

Volunteer women aged over 65 years were recruited through different departments of Tlemcen Hospital Center including the physical medicine and rehabilitation department, cardiology, gynecology, ENT, ophtalmology and diabetology departments, among women who voluntarily underwent checkups. Written information about the study was given and written consent was obtained from all women selected. Confidentiality and anonymity of the participants were maintained. The exclusion criteria were refusal consent, age under 65 years, traumatic pathology, alterations of the central or peripheral nervous system, having a medical history including stroke, dementia, Parkinson's disease, or depression, and the presence of any metabolic diseases which can include the potential effects of confounding variables. All women selected were in good health and none of the subjects was taking any product potentially interfering with antioxidant status (vitamins or minerals).

Data on sociodemographic and anthropometric characteristics were collected by expert nurses. Face-to-face questionnaire interview was implemented for each participant to collect information related to the adherence to MedDiet and the MNA score. Indeed, the daily cofee intake was quantifed for each woman and was categorized into three groups with less than 1 cup/day (low), 1–3 cups/day (moderate) and more than 3 cups/day (high).

2.2. Adherence to the Mediterranean Diet

A specific questionnaire consisting of 14 items is used to assess adherence to the MedDiet [19,20]. Each of these 14 questions is scored. This Mediterranean diet score has been used and validated in many global populations and also in the elderly [20]. The test includes 14 questions related to the use of olive oil, the consumption of salads, vegetables and fruits, meat or fish, butter, margarine, or cream, sugary drinks, commercial pastries and sweets, nuts (or equivalents), dishes containing tomatoes, onions, garlic, or equivalent seasonal products. The question on drinking wine was deleted due to religious reasons and the 14-point MedDiet adherence screener was adjusted for muslim people as previously reported [21]. A score below 5 indicates low MedDiet adherence. A score between 5 and 7 represents moderate adherence, while a score higher than 7 represents strong MedDiet adherence.

2.3. Mini Nutritional Assessment

Nutritional status was assessed, using the Mini Nutritional Assessment (MNA) [22,23]. The MNA test is composed of simple measurements and brief questions including anthropometric measurements (weight, height, and weight loss); global assessment with six questions related to lifestyle, medication, and mobility; dietary intake with eight questions, related to number of meals, food and fluid intake, and autonomy of feeding; and finally subjective assessment with questions related to self-perception of health and nutrition. Interpretation of scores was done as follows: Score <17: Malnourished, Score 17-23.5: At risk of malnutrition and Score >23.5: Well nourished.

2.4. Blood Collection

Between 8:00 and 9:00 AM, fasting blood samples were collected from the antecubital vein into EDTA tubes. The tubes were centrifuged and plasma was separated for lipid, vitamin C and peroxynitrite determinations. The remaining erythrocytes were washed in isotonic saline and hemolyzed by cold distilled water. After centrifugation (2000 g for 15 min) to remove cell debris, the hemolysates were used to assay for antioxidant/oxidant markers.

2.5. Lipid Determinations

Plasma total cholesterol and triglyceride concentrations were measured using enzymatic colorimetric methods (kits from Bio-Assay Systems, Hayward, CA, USA). LDL and HDL cholesterol were assayed after precipitation by quantitative colorimetric methods using specific kits (Crystal Chem, USA). LDL-C/HDL-C ratio was calculated as an atherogenicity index.

2.6. Oxidant / Antioxidant Markers Analysis

Erythrocyte malondialdehyde (MDA, lipid peroxidation marker) was assayed by thiobarbituricacid method (Sigma Aldrich kit; St. Louis, MO, USA). Erythrocyte carbonyl proteins (protein oxidation marker) were estimated by 2,4-dinitrophenyl hydrazine reaction (Sigma Aldrich kit; St. Louis, MO, USA). Plasma vitamin C testing was conducted by the Ascorbic acid Assay Kit II (Sigma Aldrich kit; St. Louis, MO, USA), using Ferric reducing/antioxidant and ascorbic acid assay. Erythrocyte reduced glutathione (GSH) levels were assayed by a colorimetric method using the reduction of 5,5'- dithiobis-(2-nitrobenzoic) acid (DTNB) by GSH to generate 2-nitro-5-thiobenzoic acid with yellow color, according Sigma Aldrich Kit (Saint Louis, MO, USA). To determine the activity of Erythrocyte catalase (CAT, EC 1.11.1.6), the Cayman Chemical Catalase assay kit (Cayman Chemical Company, Ann Arbor, MI) was utilized. The method involves the enzyme's reaction with methanol in the presence of an optimal concentration of H2O2. For the evaluation of Erythrocyte superoxide dismutase (SOD) activity, the Cayman kit (Cayman Chemical Company, Ann Arbor, MI) was employed. The assessment is based on measuring the dismutation of superoxide radicals generated by xanthine oxidase and hypoxanthine. The serum peroxynitrite concentration was assessed following the procedure outlined previously [24]. This method relies on the nitration of phenol induced by peroxynitrite.

2.7. Statistical Analysis

The participants were divided into two groups according to their adherence to MedDiet (High/Low). The level of coffee intake (low, moderate, high) was classified into these groups accordingly. The results are presented as percentages or as means and standard deviations. After checking the normal distribution of the variables (Shapiro–Wilk test), unpaired Student's t-test was used to assess significant differences between two groups (adherence to MedDiet). Statistical significance was set at $p < 0.05$. One-way ANOVA was used to determine the differences between three groups according to coffee intake (low, moderate, high). When significant changes were observed in ANOVA tests, Tukey post hoc test was applied to identify the specific significant differences between each pair. Statistical differences between groups are represented by various letters (a, b, c). Analyses were performed using STATISTICA 4.1 program (Statsoft, Paris, France).

3. Results

3.1. Characteristics of the Older Women

172 older women were enrolled in this study. Of these, 92 (53.49%) were included in the low MedDiet adherence group (mean score 4.13) and 80 (46.51%) in the high MedDiet adherence group (mean score 9.50). Baseline characteristics of these patients are shown in Table 1. No significant differences were found in age between the two groups studied. However, BMI was significantly reduced in the low MedDiet adherence group. Indeed, nutritional status, evaluated by MNA score was significantly decreased in the low MedDiet adherence group compared to the high MedDiet adherence group. We found adequate nutritional status in the high MedDiet adherence group (mean MNA score 25.58) but at risk for malnutrition in the low MedDiet adherence group (mean MNA score 21.35). Regarding their marital status, on average, 30 to 37% of the older women were married, with the remainder either widowed or single. In the low MedDiet adherence group, 21.73% of the women had a low coffee intake (< 1 cup/day), 34.78% had moderate coffee intake (1-3 cups/day) and 43.48% high coffee intake (> 3 cups/day). In the high MedDiet adherence group, older women reported coffee intake with 25% as low, 37.50% as moderate or high.

Table 1. General characteristics of the older women

Variables (n (%) / Mean ± SD)	High MedDiet adherence	Low MedDiet adherence
Number	80	92
Marital status		
Single	10 (12.50%)	16 (17.39%)
Married	30 (37.50%)	28 (30.43%)
Widowed	40 (50%)	48 (52.17%)
Age (year)	70 ± 4	71 ± 3
Body mass index, BMI (kg/m2)	25.67 ± 1.25	22.65 ± 1.06 *
Med Diet adherence score	9.50 ± 1.02	4.13 ± 0.88 *
MNA score	25.58 ± 1.57	21.35 ± 1.31 *
Coffee intake (cups/day)		
< 1 (Low)	20 (25%)	20 (21.73%)
1 – 3 (Moderate)	30 (37.50%)	32 (34.78%)
> 3 (High)	30 (37.50%)	40 (43.48%)

Values are number (%) or mean ± SD. Low MedDiet adherence versus High MedDiet adherence: * $P < 0.01$.

3.2. Plasma Lipid Levels in the Older Women

The participants' plasma lipid concentrations according to MedDiet adherence and coffee intake are shown in Table 2. Plasma TG, TC, LDL-C, and HDL-C levels were

significantly reduced in elderly women with low MedDiet adherence compared to women in the high MedDiet adherence group, regardless of coffee consumption. However, the LDL-C/HDL-C, atherogenicity index, was significantly increased only in women in the low MedDiet adherence - high coffee intake group compared to women in the high MedDiet adherence - high coffee intake group. Coffee consumption had no significant effects on plasma levels of TG and HDL-C regardless of MedDiet adherence. Nevertheless, high coffee intake induced a significant increase in TC, LDL-C levels, and in LDL-C/HDL-C ratio in both groups of women. Furthermore, moderate coffee consumption did not affect plasma lipid levels regardless of MedDiet adherence.

Table 2. Plasma lipid levels in older women

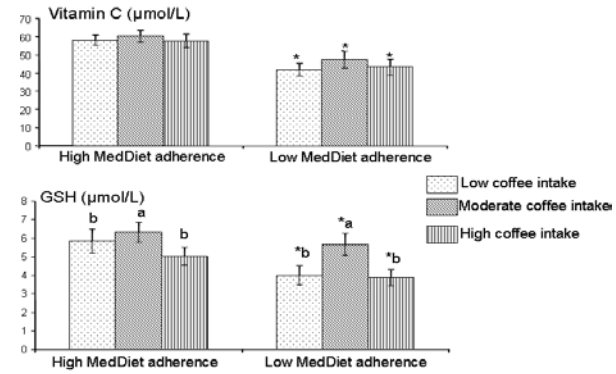
Plasma lipids	High MedDiet adherence	Low MedDiet adherence
TG (mg/dL)		
Low coffee intake	132.54 ± 6.33	108.33 ± 10.64 *
Moderate coffee intake	127.33 ± 11.85	98.32 ± 8.44 *
High coffee intake	130.58 ± 9.79	105.47 ± 11.08 *
TC (mg/dL)		
Low coffee intake	197.51 ± 7.46 ^{b}	165.33 ± 11.17 * ^{b}
Moderate coffee intake	205.82 ± 11.95 ^{b}	168.33 ± 10.78 * ^{b}
High coffee intake	228.64 ± 12.37 ^{a}	198.77 ± 12.64 * ^{a}
LDL-C (mg/dL)		
Low coffee intake	120.38 ± 8.37 ^{b}	98.11 ± 6.88 * ^{b}
Moderate coffee intake	124.64 ± 7.28 ^{b}	100.45 ± 7.36 * ^{b}
High coffee intake	140.62 ± 10.39 ^{a}	120.83 ± 10.78 * ^{a}
HDL-C (mg/dL)		
Low coffee intake	55.34 ± 4.12	44.61 ± 3.42 *
Moderate coffee intake	58.22 ± 3.67	48.83 ± 5.58 *
High coffee intake	58.74 ± 4.38	45.88 ± 4.67 *
LDL-C / HDL-C		
Low coffee intake	2.17 ± 0.04 ^{b}	2.18 ± 0.07 ^{b}
Moderate coffee intake	2.14 ± 0.08 ^{b}	2.07 ± 0.08 ^{b}
High coffee intake	2.40 ± 0.06 ^{a}	2.63 ± 0.05 * ^{a}

Values are means ± SD. Statistical comparisons between high and low MedDiet adherence groups were performed by Student's t-test. *P < 0.01. Statistical comparisons between the three groups according to coffee intake (low, moderate, high) were performed by one-way ANOVA test followed by Tukey post hoc test. Values for each parameter with different superscripts (a,b,c) are significantly different for P <0.01.

3.3. Oxidant/antioxidant Status in the Older Women

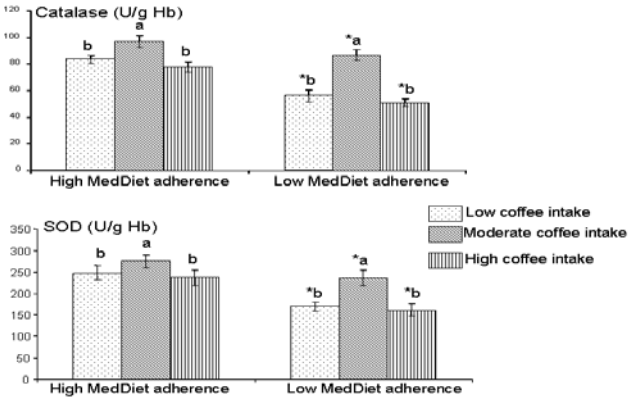
The participants' oxidant/antioxidant status according to MedDiet adherence and coffee intake is shown in Figures 1, 2 and 3. Plasma levels of vitamin C and erythrocyte levels of GSH, as well as erythrocyte antioxidant activities of catalase and SOD enzymes, were significantly reduced in elderly women with low MedDiet adherence compared to women in the high MedDiet adherence group, regardless of coffee consumption (Figures 1, 2).

On the other hand, plasma levels of peroxynitrite and erythrocyte levels of MDA and carbonyl proteins were significantly elevated in elderly women with low MedDiet adherence compared to women in the high MedDiet adherence group, regardless of coffee consumption (Figure 3).



Values are means ± SD. GSH: reduced glutathion. Statistical comparisons between high and low MedDiet adherence groups were performed by Student's t-test. *P < 0.01. Statistical comparisons between the three groups according to coffee intake (low, moderate, high) were performed by one-way ANOVA test followed by Tukey post hoc test. Values for each parameter with different superscripts (a,b,c) are significantly different for P <0.01.

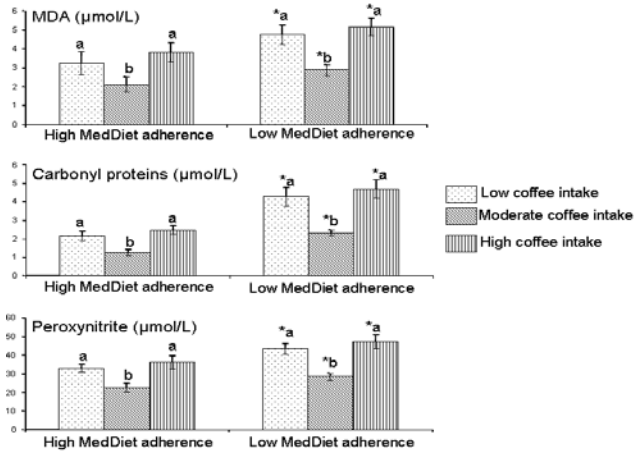
Figure 1. Plasma vitamin C and erythrocyte GSH levels in older women



Values are means ± SD. SOD: superoxide dismutase. Statistical comparisons between high and low MedDiet adherence groups were performed by Student's t-test. *P < 0.01. Statistical comparisons between the three groups according to coffee intake (low, moderate, high) were performed by one-way ANOVA test followed by Tukey post hoc test. Values for each parameter with different superscripts (a,b,c) are significantly different for P <0.01.

Figure 2. Erythrocyte catalase and SOD activities in older women

Coffee consumption had no significant effect on plasma vitamin C concentrations regardless of MedDiet adherence. However, moderate coffee consumption induced a significant increase in antioxidants, namely GSH levels and catalase and SOD activities in elderly women, regardless of MedDiet adherence. Additionally, levels of pro-oxidants (MDA, carbonyl proteins, peroxynitrite) were significantly reduced by moderate coffee consumption, regardless of MedDiet adherence. High coffee consumption appeared to reduce antioxidants and to increase pro-oxidants in women from both groups, but the differences remained nonsignificant compared to values obtained with low coffee consumption.



Values are means ± SD. MDA: malondialdehyde. Statistical comparisons between high and low MedDiet adherence groups were performed by Student's t-test. *P < 0.01. Statistical comparisons between the three groups according to coffee intake (low, moderate, high) were performed by one-way ANOVA test followed by Tukey post hoc test. Values for each parameter with different superscripts (a,b,c) are significantly different for P <0.01.

Figure 3. Plasma peroxynitrite and erythrocyte MDA and carbonyl protein levels in older women

4. Discussion

To the best of our knowledge, this is the first work with Algerian older women to evaluate the relationship between coffee consumption, adherence to MedDiet, lipid and oxidative stress markers. Increasing evidence associates aging and age-related diseases with oxidative damage [6,25]. Indeed, oxidative stress has been associated with many metabolic disorders due to unhealthy dietary patterns [26]. Dyslipidemia refers to a several lipid metabolism disorders and is a key causal factor for development and progression of cardiovascular diseases in the elderly [27,28]. Decreasing the risk of dyslipidemia and oxidative stress in older people could lead to considerable health benefits, and this can be achieved by implementing a MedDiet and by coffee consumption [10,16].

In this study, older women with low MedDiet adherence were more likely to be at risk of malnutrition, acording to MNA scoring (mean MNA score 21.35). In parallel, these women also had lower BMI and altered lipid and redox profile compared to older women with high MedDiet adherence, regardless of coffee consumption.

Our finding showed a significant reduction in plasma lipid concentrations, TG, TC, LDL-C and HDL-C, in older women with low MedDiet adherence compared to older women with high MedDiet adherence. Low lipid levels can be a marker of malnutrition, nutritional deficiencies or impaired biosynthesis in older people [29]. Previous studies have concluded an inverse relationship between TC and LDL-C and all-cause mortality in an elderly cohort [29,30]. Low TC levels were also found to be an independent mortality predictor in the elderly population [31]. The well known impact of increased TC and LDL-C on cardiovascular and all-cause mortality in the general population is not related to the elderly [29,30,31]. Similarly, the relationship between high TG and cardiovascular risk is weak with older age [32]. HDL-C remains to be protective against cardiovascular and all-cause mortality in older population [33]. In our study, low lipid levels may then be an indicator of poor health status in older women with low MedDiet adherence.

Furthermore, older women with low MedDiet adherence exhibited an increase in pro-oxidants (MDA, Carbonyl proteins, Peroxynitrite) and a reduction in antioxidants (Vitamin C, GSH, Catalase, SOD), indicating the presence of oxidative stress, regardless of their coffee consumption. Our findings confirmed previous results showing a high risk of oxidative stress in malnourished elderly [26,34]. Aging is associated with a decline in the activity and expression of antioxidant defense systems, such as superoxide dismutase, catalase, and glutathione peroxidase. This decline reduces the ability of cells to neutralize ROS effectively, further exacerbating oxidative stress [6]. Additionally, adherence to the MedDiet may play a role in modulating oxidative stress levels. Oxidative stress is more pronounced in older women in the low MedDiet adherence group compared to the high MedDiet adherence group. Notably, the effect of MedDiet adherence on oxidant/antioxidant status was observed regardless of the participants' coffee consumption, indicating that the diet itself could be a significant factor in determining the oxidative balance in the body. Our findings were aligned with the findings from previous studies in which adherence to the MedDiet was inversely associated with oxidative stress [35,36]. This protective effect might be due to its nutrient content. MedDiet contains a high amount of MUFAs and omega-3 fatty acids, vitamins and polyphenols and other compounds that have anti-inflammatory and antioxidant properties [19].

On the other hand, coffee consumption appeared to modulate plasma lipids and markers of oxidative stress similarly in women with low or high MedDiet adherence. Plasma levels of TG and HDL-C were not affected by coffee consumption regardless of MedDiet adherence. However, a significant increase in TC, LDL-C levels, and in LDL-C/HDL-C ratio was observed with high coffee intake in both groups of women. Taking into account the negative association of blood lipids and mortality, high coffee consumption could be beneficial for older women with low MedDiet adherence. In our study, moderate coffee intake did not affect plasma lipid levels regardless of MedDiet adherence. The results regarding the impact of coffee consumption on plasma lipids vary significantly across previous studies. Previous researches indicated a significant contribution of coffee consumption to elevated levels of TC, LDL-C, and TG, with no notable impact on HDL-C; these alterations were found to be correlated with the extent of intake [37,38]. Other study demonstrated strong evidence of the impact of high coffee consumption on lipid profile, significantly higher serum TC, TG and VLDL-C concentrations, but not on LDL-C and HDL-C [17]. It is important to note that in our study, all the older women drank unfiltered coffee. The diterpenes cafestol and kahweol in unfiltered coffee have been found to increase plasma levels of total cholesterol and triglycerides [37]. Indeed, with moderate coffee consumption, no significant associations with lipids was observed [17], in line with our findings.

Referring to oxidative stress, our results showed that

there were favorable changes in oxidative stress parameters in older women with moderate coffee consumption. Changes of the oxidative stress biomarkers in the elderly with low MedDiet adherence were similar to those observed in in the elderly with high MedDiet adherence, which may indicate a beneficial effect of coffee antioxidant compounds. Actually, extensive literature supports that coffee consumption counteracts the action of reactive oxygen species and the development of oxidative stress [18]. In this sense, taking into account the obtained results, we can see that those older women who had moderate cooffe intake presented a reduction in pro-oxidant markers such as peroxynitrite, MDA and carbonyl protein concentrations and an increase in antioxidants such as GSH, catalase and SOD activities. Beneficial health effects of coffee are attributed to its high antioxidant activity, related to its compounds such as chlorogenic, ferulic, caffeic, and n-coumaric acids, caffeine and trigonelline [39]. Previous studies reported an increase in erythrocyte antioxidant enzyme activity in healthy subjects following coffee consumption, in particular, SOD, GPx and catalase activities, and an increase in GSH levels [18,40,41]. In addition, a significant effect of coffee was found by some authors, who observed a significant decrease of protein and lipid damages after coffee intake [18,42]. On the other hand, the current study found that high coffee intake seemed to reduce antioxidants and to increase pro-oxidants in older women irrespective of their MedDiet adherence, despite nonsignificant differences compared to low coffee intake. It can be supposed that high coffee intake can be pro-oxidant and can increase oxidative stress in older women. Previous study revealed that the production of H2O2 is responsible for the genotoxic impact of coffee [43]. Another investigation highlighted that the presence of chlorogenic and caffeic acids, along with their pyrolysis by-products found in coffee, induces the generation of reactive oxygen species (ROS) [44]. Furthermore, caffeine has been demonstrated to exhibit pro-oxidant properties under particular conditions [45].

In conclusion, the findings in this study have important implications for the health and well-being of older women, especially those at risk of malnutrition. A Mediterranean-style diet may have protective effects against oxidative stress and may improve lipid profile. Promoting the consumption of antioxidant-rich foods, such as fruits, vegetables, nuts, and olive oil, could be beneficial for older women's health. At the same time, moderate coffee consumption is also responsible for beneficial effects such as antioxidant effects.

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Declaration of interest

The authors report no conflicts of interest.

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