

## Original article

## Diet characteristics in patients with endometriosis

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## ABSTRACT

**Objective:** Endometriosis is a chronic hormonal and inflammatory condition, characterized by the presence and proliferation of endometrial tissue outside the uterine cavity, causing pelvic pain and infertility. A number of controversial studies have suggested that consumption of specific nutrients or food groups are associated with higher risk of endometriosis.

Thus, the aim of the present study is to evaluate the dietary characteristics of patients with newly diagnosed endometriosis, specifically the frequency and quantity of various food categories consumed, by using a specific tool to investigate their dietary patterns.

**Material and methods:** The study included a group of patients newly diagnosed with endometriosis (n = 80) compared to a group of healthy women (n = 80). A self-administered questionnaire, specifically designed for this purpose on dietary habits, was administered. Food categories were also differentiated into pro- and anti-inflammatory, to approximately evaluate the ratio between omega 6 and omega 3 fatty acids intake.

**Results:** Women with endometriosis exhibited different dietary habits compared to the control group, both in terms of frequency of consumption and quantity of various food categories. The consumption of green, red, and white vegetables was less frequent among those affected compared to the control group, as well as the amount of orange vegetables consumed ( $p < 0.01$ ). Conversely, the intake of red meat and raw ham, as well as the daily consumption of salt, were significantly more represented in the group of women with endometriosis ( $p < 0.01$ ).

**Conclusion:** Women with newly diagnosed endometriosis reported an unbalanced dietary pattern with high consumption of meat, cured meats, salt and a low intake of vegetables, with an unfavorable balance between pro-inflammatory and anti-inflammatory food. The involvement of nutrition specialists as part of a multidisciplinary team in managing patients with endometriosis is advisable.

## Introduction

Endometriosis is a chronic, benign condition characterized by the presence and proliferation of endometrial tissue outside the uterine cavity [1]. This disease typically affects women during their reproductive years and impacts fertility and quality of life, with a prevalence estimated between 2% and 10% [2]. The most common symptoms associated with endometriosis include dyspareunia, dysmenorrhea, dyschezia, chronic pelvic pain, and infertility, with different degree of severity [3]. Although the exact pathogenetic mechanisms are not fully understood, resistance to progesterone and increased sensitivity to estrogen play critical roles in the onset and development of endometriosis, allowing to define it as a hormone-dependent disease [4,5].

Surgical interventions and hormonal therapies are the primary treatment options for endometriosis, aimed at reducing pain and improving quality of life (QoL) [5–7]. However, long-term management

plans for endometriosis also suggest the inclusion of non-hormonal medications, physical activity, and dietary modifications [8,9]. Diet is of particular interest, as studies have indicated that dietary patterns may influence the pathogenesis of endometriosis, including factors like estrogen activity, inflammation, and menstrual cyclicity [10,11]. Several studies have examined whether diet correlates with the risk of developing endometriosis, exploring dietary factors that might decrease or increase the risk and proposing potential dietary recommendations for affected women [12–14]. However, the available data on the protective role of fruits and vegetables and the adverse effects of red meat, dairy products, and unsaturated fats are inconsistent, and there is not sufficient evidence yet to establish a disease-specific diet [15].

Some studies have shown a significant reduction in disease risk among women who consume large amounts of green vegetables and fresh fruits [13]. Additionally, the intake of omega-3 fatty acids has been linked to a reduced risk of disease occurrence, being the omega-3 to omega-6 ratio

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particularly important [16]. Omega-3 supplementation may reduce pain and inflammation, thereby improving QoL of patients with endometriosis [17]. Women consuming more than two servings of red meat per week have shown a higher risk of endometriosis compared to those consuming less than one serving per week [18], although this correlation was not found in some other case-control studies [19].

Thus, the aim of the present study was to evaluate the dietary habits of patients newly diagnosed with endometriosis compared to controls, specifically the frequency and quantity of various food categories consumed, focusing also on pro- and anti-inflammatory items.

## Materials and methods

An observational cross-sectional study was conducted on a group of patients with endometriosis ( $n = 80$ ) at their first referral to our Endometriosis Centre at Careggi University Hospital between March 2021 and December 2022. The diagnosis was made using transvaginal ultrasound and/or magnetic resonance imaging (MRI), revealing ovarian ( $n = 27$ ), deep ( $n = 33$ ), or both ovarian and deep endometriosis ( $n = 20$ ). Participants were recruited according to the following inclusion criteria: female gender, age between 18 and 50 years, fluent in Italian, newly diagnosed endometriosis. Exclusion criteria were: illiteracy or inability to provide informed consent, current hormonal treatment. An age-matched control group of 80 women was also recruited. The age range in both groups was 18–50 years (mean age:  $33 \pm 4.5$ ). Body weight ranged from 43 kg to 110 kg, with BMI values ranging from 16 to 36.75. No significant differences were found between cases and controls in terms of underweight (BMI < 18) (7.5%) and obesity (BMI > 30) (2.5%) categories.

A self-administered questionnaire was specifically designed for this purpose on dietary habits. The questionnaire was developed in a digital format for use on local or online platforms through computers, smartphones or tablets, after patients' clinical evaluation. It consisted of 39 questions:

- The first question concerned the patients' division of meals throughout the day.
- The next 38 questions investigated the types of food consumed, the frequency, and portion sizes.

The questionnaire included 32 food groups: milk; yogurt; cereals or muesli; biscuits; bakery products; rusks with sweet spreads; bread slices; pasta; rice; legumes; potatoes; parmesan, gruyère, caciotta, brie; tomino, robiola, stracchino; ricotta and milk flakes; mozzarella; eggs; chicken; beef; pork; cooked ham; raw ham; mortadella; salame and capocollo; lean fish; fatty fish; green vegetables; red vegetables; yellow or orange vegetables; white vegetables; purple vegetables; fruit; snacks and sweets; wine and/or other spirits; sweetened drinks. Patients were guided to select portion sizes (with associated weights) by using illustrative pictures

**Table 1**

List of food with either pro- or anti-inflammatory properties.

Pro-inflammatory food	Anti-inflammatory food
<ul style="list-style-type: none"> <li>• Beef</li> <li>• Pork</li> <li>• Raw ham</li> <li>• Cooked ham</li> <li>• Mortadella</li> <li>• Salame and capocollo</li> <li>• Snacks and sweets</li> <li>• Sweetened drinks</li> <li>• Salt</li> <li>• Processed carbs (present in white bread, white pasta, and many baked goods)</li> </ul>	<ul style="list-style-type: none"> <li>• Dairy products</li> <li>• Legumes</li> <li>• Fatty fish</li> <li>• Green vegetables (e.g. lettuce, spinach, zucchini, broccoli)</li> <li>• Red vegetables (e.g. tomatoes, bell peppers, radishes, red beet)</li> <li>• Yellow or orange vegetables (e.g. carrots, pumpkin, bell peppers)</li> <li>• White vegetables (e.g. cauliflower, fennels, mushrooms)</li> <li>• Purple vegetables (e.g. eggplants, radicchio, red cabbage)</li> <li>• Fruits</li> <li>• Nuts</li> <li>• Red wine</li> <li>• Extra virgin olive oil</li> </ul>

provided in the questionnaire as examples (Supplementary Materials). The frequency of food consumption was described as follows:

- more than once a day
- once a day
- at least twice a week
- less than twice a week
- never

Additionally, questions were included regarding daily consumption of salt and olive oil (expressed in 'tablespoons'), alcohol, water, and coffee (daily cups). Table 1 shows the classification into pro-inflammatory and anti-inflammatory food according to the food categories mentioned in the questionnaire [20].

All participants were asked to provide written informed consent. Deidentified data were automatically entered in an electronic database and analyzed by using Jamovi software. A descriptive analysis was conducted with the evaluation of position measures (mean, median) and dispersion indices (standard deviation, range) for the quantitative variables. Continuous data were checked for normality by using normal probability plots. Mann Whitney U test or independent-samples t-test was carried out to compare continuous variables between cases and controls. The binomial variables were described by calculating the absolute and percentage frequencies. Chi-square test was used for the qualitative variables to compare the endometriosis population with controls population for each food item. A P-value < 0.05 was considered statistically significant.

## Results

The majority of included subjects reported an optimal distribution of meals throughout the day with breakfast, lunch and dinner, and at least a snack in between the main meals; however, patients with endometriosis exhibited different dietary habits compared to the control group, both in terms of frequency of consumption and quantity of various food categories. Table 2 presents the frequency of consumption of all foods studied, while Fig. 1 highlights the food items found to be significantly different between endometriosis and control group, regarding their weekly consumption frequency. The intake of raw ham ( $p < 0.021$ ) and mortadella ( $p < 0.030$ ) was significantly more frequent in the weekly diets of women with endometriosis compared to healthy women. Conversely, the consumption of green vegetables (e.g., lettuce, spinach, zucchini, broccoli, etc.), red vegetables (e.g., tomatoes, peppers, radishes, beetroot, etc.), and white vegetables (e.g., cauliflower, fennel, mushrooms, etc.) was less frequent ( $p < 0.01$ ) among affected women compared controls (Fig. 1). Table 3 shows the statistically significant differences between the two groups in terms of amount of each food item consumption. The intake of red meat and raw ham was significantly higher in endometriosis patients compared to controls ( $p < 0.01$ ).

**Table 2**

Food consumption frequency in patients with endometriosis vs controls. Data are expressed as n (%).

Food item	Endometriosis (n = 80)	Controls (n = 80)	P-Value
Milk	<ul style="list-style-type: none"> <li>• more than once a day: 2 (2.5%)</li> <li>• once a day: 27 (33.8%)</li> <li>• at least twice a week: 7 (8.8%)</li> <li>• less than twice a week: 4 (5%)</li> <li>• never: 40 (50%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 34 (42.5%)</li> <li>• at least twice a week: 7 (8.8%)</li> <li>• less than twice a week: 4 (5%)</li> <li>• never: 35 (43.8%)</li> </ul>	0.535
Yogurt	<ul style="list-style-type: none"> <li>• more than once a day: 1 (1.3%)</li> <li>• once a day: 12 (15%)</li> <li>• at least twice a week: 22 (27.5%)</li> <li>• less than twice a week: 14 (17.5%)</li> <li>• never: 31 (38.8%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 1 (1.3%)</li> <li>• once a day: 12 (15%)</li> <li>• at least twice a week: 18 (22.5%)</li> <li>• less than twice a week: 16 (20%)</li> <li>• never: 33 (41.3%)</li> </ul>	0.964
Cereals or muesli	<ul style="list-style-type: none"> <li>• more than once a day: 1 (1.3%)</li> <li>• once a day: 12 (15%)</li> <li>• at least twice a week: 12 (15%)</li> <li>• less than twice a week: 19 (23.8%)</li> <li>• never: 0</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 1 (1.3%)</li> <li>• once a day: 15 (18.8%)</li> <li>• at least twice a week: 11 (13.8%)</li> <li>• less than twice a week: 12 (15%)</li> <li>• never: 1 (1.3%)</li> </ul>	0.674
Biscuits	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 25 (31.3%)</li> <li>• at least twice a week: 22 (27.5%)</li> <li>• less than twice a week: 11 (13.8%)</li> <li>• never: 22 (27.5%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 3 (3.8%)</li> <li>• once a day: 32 (40%)</li> <li>• at least twice a week: 14 (17.5%)</li> <li>• less than twice a week: 12 (15%)</li> <li>• never: 19 (23.8%)</li> </ul>	0.207
Bakery products	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 6 (7.5%)</li> <li>• at least twice a week: 17 (21.3%)</li> <li>• less than twice a week: 24 (30%)</li> <li>• never: 33 (41.3%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 8 (10%)</li> <li>• at least twice a week: 8 (10%)</li> <li>• less than twice a week: 33 (41.3%)</li> <li>• never: 31 (38.8%)</li> </ul>	0.171
Rusks with sweet spreads	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 5 (6.3%)</li> <li>• at least twice a week: 23 (28.7%)</li> <li>• less than twice a week: 19 (23.8%)</li> <li>• never: 33 (41.3%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 6 (7.5%)</li> <li>• at least twice a week: 14 (17.5%)</li> <li>• less than twice a week: 31 (38.8%)</li> <li>• never: 29 (36.3%)</li> </ul>	0.144
Bread slices	<ul style="list-style-type: none"> <li>• more than once a day: 12 (15%)</li> <li>• once a day: 41 (51.2%)</li> <li>• at least twice a week: 12 (15%)</li> <li>• less than twice a week: 5 (6.3%)</li> <li>• never: 10 (12.5%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 16 (20%)</li> <li>• once a day: 26 (32.5%)</li> <li>• at least twice a week: 23 (28.7%)</li> <li>• less than twice a week: 2 (2.5%)</li> <li>• never: 13 (16.3%)</li> </ul>	0.060
Pasta	<ul style="list-style-type: none"> <li>• more than once a day: 1 (1.3%)</li> <li>• once a day: 35 (43.8%)</li> <li>• at least twice a week: 30 (37.5%)</li> <li>• less than twice a week: 9 (11.3%)</li> <li>• never: 5 (6.3%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 1 (1.3%)</li> <li>• once a day: 26 (32.5%)</li> <li>• at least twice a week: 38 (47.3%)</li> <li>• less than twice a week: 12 (15%)</li> <li>• never: 3 (3.8%)</li> </ul>	0.525
Rice	<ul style="list-style-type: none"> <li>• more than once a day: 1 (1.3%)</li> <li>• once a day: 2 (2.5%)</li> <li>• at least twice a week: 31 (38.8%)</li> <li>• less than twice a week: 35 (43.8%)</li> <li>• never: 11 (13.8%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 1 (1.3%)</li> <li>• at least twice a week: 26 (32.5%)</li> <li>• less than twice a week: 48 (60%)</li> <li>• never: 5 (6.3%)</li> </ul>	0.195
Legumes	<ul style="list-style-type: none"> <li>• more than once a day: 2 (2.5%)</li> <li>• once a day: 3 (3.8%)</li> <li>• at least twice a week: 37 (46.3%)</li> <li>• less than twice a week: 23 (28.7%)</li> <li>• never: 15 (18.8%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 7 (8.8%)</li> <li>• at least twice a week: 37 (46.3%)</li> <li>• less than twice a week: 24 (30%)</li> <li>• never: 12 (15%)</li> </ul>	0.412
Potatoes	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week: 18 (22.5%)</li> <li>• less than twice a week: 47 (58.8%)</li> <li>• never: 15 (18.8%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week: 20 (25%)</li> <li>• less than twice a week: 52 (65%)</li> <li>• never: 8 (10%)</li> </ul>	0.288
Parmesan, Gruyère, Caciotta, Brie	<ul style="list-style-type: none"> <li>• more than once a day: 1 (1.3%)</li> <li>• once a day: 8 (10%)</li> <li>• at least twice a week: 27 (33.8%)</li> <li>• less than twice a week: 30 (37.5%)</li> </ul>	<ul style="list-style-type: none"> <li>• more than once a day: 0</li> <li>• once a day: 12 (15%)</li> <li>• at least twice a week: 22 (27.5%)</li> <li>• less than twice a week: 21 (26.3%)</li> </ul>	0.136

*(continued on next page)*

Table 2 (continued)

Food item	Endometriosis (n = 80)	Controls (n = 80)	P-Value
Tomino, robiola, stracchino	<ul style="list-style-type: none"> <li>• never: 14 (17.5%)</li> <li>• more than once a day: 1 (1.3%)</li> <li>• once a day: 3 (3.8%)</li> <li>• at least twice a week: 12 (15%)</li> <li>• less than twice a week: 23 (28.7%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 25 (31.3%)</li> <li>• more than once a day: 0</li> <li>• once a day: 2 (2.5%)</li> <li>• at least twice a week: 18 (22.5%)</li> <li>• less than twice a week: 32 (40%)</li> </ul>	0.176
Ricotta and milk flakes	<ul style="list-style-type: none"> <li>• never: 41 (51.2%)</li> <li>• more than once a day: 0</li> <li>• once a day: 2 (2.5%)</li> <li>• at least twice a week: 9 (11.3%)</li> <li>• less than twice a week: 32 (40%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 28 (35%)</li> <li>• more than once a day: 0</li> <li>• once a day: 1 (1.3%)</li> <li>• at least twice a week: 9 (11.3%)</li> <li>• less than twice a week: 31 (38.8%)</li> </ul>	0.940
Mozzarella	<ul style="list-style-type: none"> <li>• never: 37 (46.3%)</li> <li>• more than once a day: 0</li> <li>• once a day: 2 (2.5%)</li> <li>• at least twice a week: 13 (16.3%)</li> <li>• less than twice a week: 43 (53.8%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 39 (48.8%)</li> <li>• more than once a day: 1 (1.3%)</li> <li>• once a day: 1 (1.3%)</li> <li>• at least twice a week: 15 (18.8%)</li> <li>• less than twice a week: 45 (56.3%)</li> </ul>	0.750
Eggs	<ul style="list-style-type: none"> <li>• never: 22 (27.5%)</li> <li>• more than once a day: 0</li> <li>• once a day: 1 (1.3%)</li> <li>• at least twice a week: 25 (31.3%)</li> <li>• less than twice a week: 50 (62.5%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 18 (22.5%)</li> <li>• more than once a day: 0</li> <li>• once a day: 1 (1.3%)</li> <li>• at least twice a week: 19 (23.8%)</li> <li>• less than twice a week: 51 (63.7%)</li> </ul>	0.432
Chicken	<ul style="list-style-type: none"> <li>• never: 4 (5%)</li> <li>• more than once a day: 0</li> <li>• once a day: 1 (1.3%)</li> <li>• at least twice a week: 42 (52.5%)</li> <li>• less than twice a week: 28 (35%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 9 (11.3%)</li> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week: 38 (47.5%)</li> <li>• less than twice a week: 28 (35%)</li> </ul>	0.515
Beef	<ul style="list-style-type: none"> <li>• never: 9 (11.3%)</li> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week: 15 (18.8%)</li> <li>• less than twice a week: 52 (65%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 14 (17.5%)</li> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week; 15 (18.8%)</li> <li>• less than twice a week: 44 (55%)</li> </ul>	0.280
Pork	<ul style="list-style-type: none"> <li>• never: 13 (16.3%)</li> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week: 3 (3.8%)</li> <li>• less than twice a week: 36 (45%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 21 (26.3%)</li> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week; 5 (6.3%)</li> <li>• less than twice a week: 39 (48.8%)</li> </ul>	0.624
Cooked ham	<ul style="list-style-type: none"> <li>• never: 41 (51.2%)</li> <li>• more than once a day: 0</li> <li>• once a day: 2 (2.5%)</li> <li>• at least twice a week: 25 (31.2%)</li> <li>• less than twice a week: 27 (33.8%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 36 (45%)</li> <li>• more than once a day: 0</li> <li>• once a day: 2 (2.5%)</li> <li>• at least twice a week: 15 (18.8%)</li> <li>• less than twice a week: 29 (36.3%)</li> </ul>	0.335
Raw ham	<ul style="list-style-type: none"> <li>• never: 26 (32.5%)</li> <li>• more than once a day: 0</li> <li>• once a day: 1 (1.3%)</li> <li>• at least twice a week: 26 (32.6%)</li> <li>• less than twice a week: 28 (35%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 34 (42.6%)</li> <li>• more than once a day: 0</li> <li>• once a day: 2 (2.5%)</li> <li>• at least twice a week: 10 (12.5%)</li> <li>• less than twice a week: 40 (50%)</li> </ul>	0.021
Mortadella	<ul style="list-style-type: none"> <li>• never: 25 (31.3%)</li> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week: 9 (11.3%)</li> <li>• less than twice a week: 15 (18.8%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 28 (35%)</li> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week: 1 (1.3%)</li> <li>• less than twice a week: 19 (23.8%)</li> </ul>	0.030
Salame and capocollo	<ul style="list-style-type: none"> <li>• never: 56 (70%)</li> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week: 6 (7.5%)</li> <li>• less than twice a week: 23 (28.7%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 60 (75%)</li> <li>• more than once a day: 0</li> <li>• once a day: 1 (1.3%)</li> <li>• at least twice a week: 1 (1.3%)</li> <li>• less than twice a week: 24 (30%)</li> </ul>	0.197
Lean fish	<ul style="list-style-type: none"> <li>• never: 51 (63.7%)</li> <li>• more than once a day: 0</li> <li>• once a day: 1 (1.3%)</li> <li>• at least twice a week: 22 (27.5%)</li> <li>• less than twice a week: 40 (50%)</li> </ul>	<ul style="list-style-type: none"> <li>• never: 54 (67.5%)</li> <li>• more than once a day: 0</li> <li>• once a day: 0</li> <li>• at least twice a week: 20 (25%)</li> <li>• less than twice a week: 44 (55%)</li> </ul>	0.725
Fatty fish	<ul style="list-style-type: none"> <li>• never: 17 (21.3%)</li> <li>• more than once a day: 0</li> </ul>	<ul style="list-style-type: none"> <li>• never: 16 (20%)</li> <li>• more than once a day: 0</li> </ul>	0.259

Table 2 (continued)

Food item	Endometriosis (n = 80)	Controls (n = 80)	P-Value
Green vegetables	• once a day: 0	• once a day: 0	0.024
	• at least twice a week: 11 (13.8%)	• at least twice a week: 6 (7.5%)	
	• less than twice a week: 38 (47.5%)	• less than twice a week: 47 (58.8%)	
	• never: 31 (38.8%)	• never: 27 (33.8%)	
	• more than once a day: 14 (17.5%)	• more than once a day: 10 (12.5%)	
Red vegetables	• once a day: 20 (25%)	• once a day: 34 (42.5%)	<.001
	• at least twice a week: 35 (43.8%)	• at least twice a week: 29 (36.3%)	
	• less than twice a week: 5 (6.3%)	• less than twice a week: 7 (8.8%)	
	• never: 6 (7.5%)	• never: 0	
	• more than once a day: 6 (7.5%)	• more than once a day: 4 (5%)	
Yellow or orange vegetables	• once a day: 7 (8.8%)	• once a day: 24 (30%)	<.001
	• at least twice a week: 39 (48.8%)	• at least twice a week: 43 (53.8%)	
	• less than twice a week: 18 (22.5%)	• less than twice a week: 4 (5%)	
	• never: 10 (12.5%)	• never: 5 (6.3%)	
	• more than once a day: 1 (1.3%)	• more than once a day: 1 (1.3%)	
White vegetables	• once a day: 6 (7.5%)	• once a day: 7 (8.8%)	0.706
	• at least twice a week: 23 (28.7%)	• at least twice a week: 35 (43.8%)	
	• less than twice a week: 20 (25%)	• less than twice a week: 32 (40%)	
	• never: 30 (37.5%)	• never: 5 (6.3%)	
	• more than once a day: 1 (1.3%)	• more than once a day: 1 (1.3%)	
Purple vegetables	• once a day: 4 (5%)	• once a day: 4 (5%)	0.432
	• at least twice a week: 29 (36.3%)	• at least twice a week: 21 (26.3%)	
	• less than twice a week: 25 (31.3%)	• less than twice a week: 32 (40%)	
	• never: 21 (26.3%)	• never: 22 (27.5%)	
	• more than once a day: 0	• more than once a day: 1 (1.3%)	
Fruits	• once a day: 4 (5%)	• once a day: 3 (3.8%)	0.779
	• at least twice a week: 34 (42.5%)	• at least twice a week: 38 (47.5%)	
	• less than twice a week: 30 (37.5%)	• less than twice a week: 21 (26.3%)	
	• never: 12 (15%)	• never: 17 (21.3%)	
	• more than once a day: 16 (20%)	• more than once a day: 22 (27.5%)	
Snacks and sweets	• once a day: 30 (37.5%)	• once a day: 29 (36.3%)	0.065
	• at least twice a week: 19 (23.8%)	• at least twice a week: 15 (18.8%)	
	• less than twice a week: 9 (11.3%)	• less than twice a week: 7 (8.8%)	
	• never: 6 (7.5%)	• never: 7 (8.8%)	
	• more than once a day: 5 (6.3%)	• more than once a day: 5 (6.3%)	
Wine and/or other spirits	• once a day: 13 (16.3%)	• once a day: 25 (31.3%)	0.127
	• at least twice a week: 36 (45%)	• at least twice a week: 22 (27.5%)	
	• less than twice a week: 26 (32.5%)	• less than twice a week: 28 (35%)	
	• never: 0	• never: 0	
	• more than once a day: 1 (1.3%)	• more than once a day: 1 (1.3%)	
Sugar-sweetened beverages	• once a day: 5 (6.3%)	• once a day: 2 (2.5%)	0.870
	• at least twice a week: 19 (23.8%)	• at least twice a week: 22 (27.5%)	
	• less than twice a week: 35 (43.8%)	• less than twice a week: 46 (57.5%)	
	• never: 20 (25%)	• never: 9 (11.3%)	
	• more than once a day: 0	• more than once a day: 0	
	• once a day: 3 (3.8%)	• once a day: 2 (2.5%)	
	• at least twice a week: 5 (6.3%)	• at least twice a week: 4 (5%)	
	• less than twice a week: 20 (25%)	• less than twice a week: 24 (30%)	
	• never: 52 (65%)	• never: 50 (62.5%)	

Additionally, the daily consumption of salt was higher among women with endometriosis (2–3 teaspoons) compared to the control group (0.5–1 teaspoon per day) ( $p < 0.01$ ). No significant differences were reported in the category of dairy products, pasta, bakery products, eggs and white meat. In the vegetables category, the consumption of orange-colored vegetables (e.g., carrots, pumpkin, peppers, etc.) was significantly lower among patients with endometriosis than among healthy controls. Fatty fish consumption was higher among women with endometriosis compared to controls ( $p < 0.01$ ). By stratifying the study population according to BMI (cut off 25), comparable results in terms of consumption frequency and intake of each food category were obtained.

From the overall analysis of the dietary pattern of patients with endometriosis included in our study, an unfavorable balance between pro-inflammatory and anti-inflammatory food was noted and the estimated ratio between omega 6 and omega 3 essential fatty acids did not reach the recommended ratio.

## Discussion

The present study indicates that women with endometriosis consume more red meat and processed meats, and fewer vegetables, compared to controls. These findings align with the studies by Parazzini et al. and

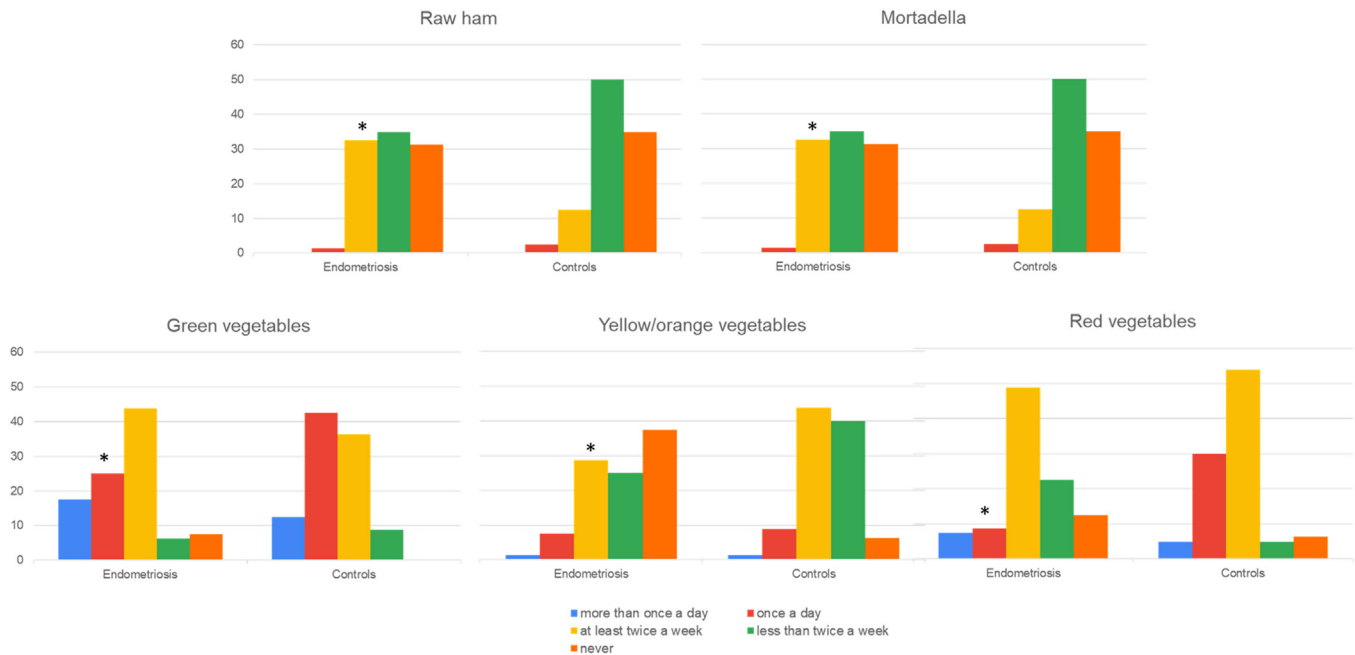


Fig. 1. Food items consumption frequency significantly different between patients with endometriosis and controls.

Yamamoto et al. [15,18], that documented an increased risk of endometriosis among patients who have a high intake of meat and a low consumption of vegetables. One possible pathophysiological explanation is that a high intake of meat leads to excessive consumption of saturated fats, which are pro-inflammatory substances not adequately counterbalanced by the anti-inflammatory and antioxidant substances found in white, red, yellow, and orange vegetables [21]. Additionally, a diet rich in meat with few vegetables could alter the intestinal microbiota, leading to a condition known as intestinal dysbiosis. Over time, this can disrupt intestinal homeostasis, increasing intestinal permeability and allowing the passage of pro-inflammatory substances that exacerbate the clinical symptoms [22].

An interesting finding was the high intake of omega-3 essential fatty acids, given the high consumption of fatty fish among women with endometriosis compared to controls. Several studies showed the beneficial effect of an adequate consumption of omega-3 in improving the symptoms and above all the QoL of patients suffering from endometriosis. However, it is not the absolute value of the omega 3 intake to be important, rather the ratio between omega 6 and omega 3 [16]. The optimal ratio should be 4:1, but in Western diets it can be as high as 15:1 due to excessive consumption of processed foods [23]. This imbalance has a significant impact on prostaglandin synthesis, with a high omega-6 to omega-3 ratio leading to increased production of pro-inflammatory prostaglandins [24]. In our study, the dietary habits of women with endometriosis did not allow to achieve the recommended ratio.

Another novel finding was the higher consumption of salt by patients with endometriosis than controls. Recent studies have indicated that excessive dietary salt intake may represent an environmental risk factor for the development or exacerbation of autoimmune diseases by disrupting the balance between the suppressive and inflammatory actions of the immune system [25]. High salt intake stimulates the induction of pro-inflammatory cells like TH17 and M1 macrophages while inhibiting the reparative actions of regulatory T cells and M2 macrophages [26].

The sub analysis based on BMI confirmed the same results of the overall study population, suggesting that other mechanisms should be taken into account in the higher risk of endometriosis among women with low BMI (less than 18) [[27] [28],], rather than only the dietary pattern. Among these, stress pathways seems to play a relevant role in both

predisposing to the disease and being a consequence of endometriosis [29].

The importance of a proper dietary pattern is highlighted by the studies of Nap et al. which found that over half of the participants (55.5%) believed that food influenced their endometriosis-related clinical presentation. Moreover, dietary changes helped alleviate symptoms of endometriosis [30], especially increased consumption of fruits, vegetables, and ginger was associated with pain relief [31]. Even though no specific dietary adjustment was found to increase the QoL, the removal of gluten, dairy or soy, as well as the addition of vegetables, showed the greatest perceived reduction of symptoms [8]. Recently, the use of “endometriosis diet” in a Dutch population with endometriosis resulted in an increased QoL, if a strict adherence was reported [9].

Despite the existence of a number of studies proposing various dietary adjustments to manage endometriosis, it remains unclear which dietary interventions are most effective [32,33]. Many women with endometriosis adopt self-management strategies, altering their diets in the hope of reducing pain symptoms. Current research suggests that adherence to a specific, tailored diet is the best option [34]. Given the implications for individual well-being and the potential beneficial effects of certain nutrients on endometriosis, maintaining a lifestyle that includes proper nutrition and physical activity may be crucial. Furthermore, the involvement of nutrition specialists as part of a multidisciplinary team in managing patients with endometriosis is advisable.

Some limitations of the study should be acknowledged, as the sample size is limited, even though it is an age-matched case-control study and the enrolled population included only newly diagnosed endometriosis. This aspect allowed to investigate, by limiting recall bias, which were the current dietary habits before any intervention, both nutritional and medical. Furthermore, we recognize that the correlation between dietary patterns and clinical presentation of patients (pain score, QoL measures) would have been interesting. However, the study was designed as a case-control to investigate the baseline dietary characteristics of newly diagnosed endometriosis patients versus healthy subjects.

In conclusion, women with newly diagnosed endometriosis reported an unbalanced dietary pattern with high consumption of meat, cured meats, salt and a low intake of vegetables, with an unfavorable balance between pro-inflammatory and anti-inflammatory food. A varied diet rich in fruits and vegetables, with an appropriate omega-6 to omega-3 ratio, and moderate consumption of meats and salt, may help balance pro-

**Table 3**  
Amount of food consumed in endometriosis patients vs controls.

Food items consumption	Endometriosis (n = 80)	Controls (n = 80)	P-Value
Legumes	<ul style="list-style-type: none"> <li>● 0: 15 (18.8%)</li> <li>● 50g: 24 (30%)</li> <li>● 110g: 41 (51.2%)</li> <li>● 225g: 0</li> </ul>	<ul style="list-style-type: none"> <li>● 0: 12 (15%)</li> <li>● 50g: 37 (46.3%)</li> <li>● 110g: 28 (35%)</li> <li>● 225g: 3 (3.8%)</li> </ul>	0.036
Beef	<ul style="list-style-type: none"> <li>● 0: 14 (17.5%)</li> <li>● 80g: 18 (22.5%)</li> <li>● 120g: 46 (57.5%)</li> <li>● 180g: 2 (2.5%)</li> </ul>	<ul style="list-style-type: none"> <li>● 0: 21 (26.3%)</li> <li>● 80g: 37 (46.3%)</li> <li>● 120g: 21 (26.3%)</li> <li>● 180g: 1 (1.3%)</li> </ul>	<.001
Raw ham	<ul style="list-style-type: none"> <li>● 0: 24 (30%)</li> <li>● 20g: 8 (10%)</li> <li>● 40g: 19 (23.8%)</li> <li>● 60g: 29 (36.3%)</li> </ul>	<ul style="list-style-type: none"> <li>● 0: 27 (33.8%)</li> <li>● 20g: 19 (23.83%)</li> <li>● 40g: 24 (30%)</li> <li>● 60g: 10 (12.5%)</li> </ul>	0.002
Lean fish	<ul style="list-style-type: none"> <li>● 0: 18 (22.5%)</li> <li>● 70g: 19 (23.8%)</li> <li>● 100g: 22 (27.5%)</li> <li>● 150g: 21 (26.3%)</li> </ul>	<ul style="list-style-type: none"> <li>● 0: 16 (20%)</li> <li>● 70g: 31 (38.8%)</li> <li>● 100g: 26 (32.5%)</li> <li>● 150g: 7 (8.8%)</li> </ul>	0.016
Fatty fish	<ul style="list-style-type: none"> <li>● 0: 31 (38.8%)</li> <li>● 100g: 21 (26.3%)</li> <li>● 150g: 27 (33.8%)</li> <li>● 200g: 1 (1.3%)</li> </ul>	<ul style="list-style-type: none"> <li>● 0: 27 (33.8%)</li> <li>● 100g: 43 (53.8%)</li> <li>● 150g: 9 (11.3%)</li> <li>● 200g: 1 (1.3%)</li> </ul>	<.001
Yellow and orange vegetables	<ul style="list-style-type: none"> <li>● 0: 30 (37.5%)</li> <li>● 60g: 19 (23.8%)</li> <li>● 90g: 26 (32.5%)</li> <li>● 140g: 5 (6.3%)</li> </ul>	<ul style="list-style-type: none"> <li>● 0: 5 (6.3%)</li> <li>● 60g: 48 (60%)</li> <li>● 90g: 21 (26.3%)</li> <li>● 140g: 6 (7.5%)</li> </ul>	<.001
Purple or blue vegetables	<ul style="list-style-type: none"> <li>● 0: 12 (15%)</li> <li>● 100g: 42 (52.5%)</li> <li>● 150g: 24 (30%)</li> <li>● 200g: 2 (2.5%)</li> </ul>	<ul style="list-style-type: none"> <li>● 0: 16 (20%)</li> <li>● 100g: 27 (33.8%)</li> <li>● 150g: 26 (32.5%)</li> <li>● 200g: 11 (13.8%)</li> </ul>	0.017
Salt	<ul style="list-style-type: none"> <li>● 0.5 teaspoon: 22 (27.5%)</li> <li>● 1 teaspoon: 23 (28.7%)</li> <li>● 1.5 teaspoon: 1 (1.3%)</li> <li>● 2 teaspoon: 29 (36.3%)</li> <li>● 3 teaspoon: 5 (6.3%)</li> </ul>	<ul style="list-style-type: none"> <li>● 0.5 teaspoon: 37 (46.3%)</li> <li>● 1 teaspoon: 31 (38.8%)</li> <li>● 1.5 teaspoon: 0</li> <li>● 2 teaspoon: 10 (12.5%)</li> <li>● 3 teaspoon: 2 (2.5%)</li> </ul>	0.002
Extravirgin olive oil	<ul style="list-style-type: none"> <li>● 0.5 tablespoon: 4 (5%)</li> <li>● 1 tablespoon: 19 (23.8%)</li> <li>● 2 tablespoon: 29 (36.3%)</li> <li>● 3 tablespoon: 28 (35%)</li> </ul>	<ul style="list-style-type: none"> <li>● 0.5 tablespoon: 11 (13.8%)</li> <li>● 1 tablespoon: 19 (23.8%)</li> <li>● 2 tablespoon: 36 (45%)</li> <li>● 3 tablespoon: 14 (17.5%)</li> </ul>	0.034

inflammatory and anti-inflammatory substances, thereby reducing inflammation associated with the disease.

#### Author contributions (credit roles)

Agostino Ruotolo: Conceptualization, Writing- Original draft preparation, Investigation.

Silvia Vannuccini: Writing - review & editing, Data curation, formal analysis.

Tommaso Capezzuoli: Visualization, Validation.

Francesca Pampaloni: Visualization, Validation.

Sofia Cedere: Investigation, formal analysis.

Ernesto Gallucci: Visualization, Investigation.

Felice Petraglia: Supervisor, Methodology, Project administration, Writing - review & editing.

#### Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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#### Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.jeud.2024.100094>.

#### References

- [1] Chapron C, Marcellin L, Borghese B, Santulli P. Rethinking mechanisms, diagnosis and management of endometriosis. *Nat Rev Endocrinol* 2019;15(11):666–82.
- [2] Saunders PTK, Horne AW. Endometriosis: etiology, pathobiology, and therapeutic prospects. *Cell* 2021;184(11):2807–24.
- [3] Gete DG, Doust J, Mortlock S, Montgomery G, Mishra GD. Associations between endometriosis and common symptoms: findings from the Australian Longitudinal Study on Women's Health. *Am J Obstet Gynecol* 2023;229(5):536.e1–536.e20.
- [4] Bulun SE, Yilmaz BD, Sison C, Miyazaki K, Bernardi L, Liu S, et al. Endometriosis. *Endocr Rev* 2019;40(4):1048–79.

- [5] Vannuccini S, Clemenza S, Rossi M, Petraglia F. Hormonal treatments for endometriosis: the endocrine background. *Rev Endocr Metab Disord* 2022;23(3):333–55.
- [6] Clemenza S, Vannuccini S, Ruotolo A, Capezzuoli T, Petraglia F. Advances in targeting estrogen synthesis and receptors in patients with endometriosis. *Expert Opin Invest Drugs* 2022;31(11):1227–38.
- [7] Capezzuoli T, Rossi M, La Torre F, Vannuccini S, Petraglia F. Hormonal drugs for the treatment of endometriosis. *Curr Opin Pharmacol* 2022;67:102311.
- [8] Krabbenborg I, De Roos N, Van Der Grinten P, Nap A. Diet quality and perceived effects of dietary changes in Dutch endometriosis patients: an observational study. *Reprod BioMed Online* 2021;43(5):952–61.
- [9] Van Haaps A, Wijbers J, Schreurs A, Mijatovic V. A better quality of life could be achieved by applying the endometriosis diet: a cross-sectional study in Dutch endometriosis patients. *Reprod BioMed Online* 2023;46(3):623–30.
- [10] Szukiewicz D. Insight into the potential mechanisms of endocrine disruption by dietary phytoestrogens in the context of the etiopathogenesis of endometriosis. *Int J Mol Sci* 2023;24(15):12195.
- [11] Savaris AL, do Amaral VF. Nutrient intake, anthropometric data and correlations with the systemic antioxidant capacity of women with pelvic endometriosis. *Eur J Obstet Gynecol Reprod Biol* 2011;158(2):314–8.
- [12] Piecuch M, Garbicz J, Waliczek M, Malinowska-Borowska J, Rozyntryt P. I am the 1 in 10—What Should I Eat? A research review of nutrition in endometriosis. *Nutrients* 2022;14(24):5283.
- [13] Parazzini F, Chiaffarino F, Surace M, Chatenoud L, Cipriani S, Chiantera V, et al. Selected food intake and risk of endometriosis. *Hum Reprod* 2004;19(8):1755–9.
- [14] Missmer SA, Chavarro JE, Malspeis S, Bertone-Johnson ER, Hornstein MD, Spiegelman D, et al. A prospective study of dietary fat consumption and endometriosis risk. *Hum Reprod* 2010;25(6):1528–35.
- [15] Parazzini F, Viganò P, Candiani M, Fedele L. Diet and endometriosis risk: a literature review. *Reprod Biomed Online* 2013;26(4):323–36.
- [16] Khanaki K, Nouri M, Ardekani AM, Ghassemzadeh A, Shahnavi V, Sadeghi MR, et al. Evaluation of the relationship between endometriosis and omega-3 and omega-6 polyunsaturated fatty acids. *Iran Biomed J* 2012;16(1):38–43.
- [17] Fjerbaek A, Knudsen UB. Endometriosis, dysmenorrhea and diet—what is the evidence? *Eur J Obstet Gynecol Reprod Biol* 2007;132(2):140–7.
- [18] Yamamoto A, Harris HR, Vitonis AF, Chavarro JE, Missmer SA. A prospective cohort study of meat and fish consumption and endometriosis risk. *Am J Obstet Gynecol* 2018;219(2):178.e1–178.e10.
- [19] Trabert B, Peters U, De Roos AJ, Scholes D, Holt VL. Diet and risk of endometriosis in a population-based case-control study. *Br J Nutr* 2011;105(3):459–67.
- [20] Marcinkowska A, Górnicka M. The role of dietary fats in the development and treatment of endometriosis. *Life (Basel)* 2023;13(3):654.
- [21] Grosso G, Laudisio D, Frias-Toral E, Barrea L, Muscogiuri G, Savastano S, et al. Anti-inflammatory nutrients and obesity-associated metabolic-inflammation: state of the art and future direction. *Nutrients* 2022;14(6):1137.
- [22] Malesza LJ, Malesza M, Walkowiak J, Mussin N, Walkowiak D, Aringazina R, et al. High-fat, western-style diet, systemic inflammation, and gut microbiota: a narrative review. *Cells* 2021;10(11):3164.
- [23] Simopoulos AP. The importance of the ratio of omega-6/omega-3 essential fatty acids. *Biomed Pharmacother* 2002;56(8):365–79.
- [24] Harris WS. The Omega-6:Omega-3 ratio: a critical appraisal and possible successor. *Prostaglandins Leukot Essent Fatty Acids* 2018;132:34–40.
- [25] Wenzel UO, Bode M, Kurts C, Ehmke H. Salt, inflammation, IL-17 and hypertension. *Br J Pharmacol* 2019;176(12):1853–63.
- [26] Kleinewietfeld M, Manzel A, Titze J, Kvakan H, Yosef N, Linker RA, et al. Sodium chloride drives autoimmune disease by the induction of pathogenic TH17 cells. *Nature* 2013;496(7446):518–22.
- [27] Lafay Pillet M-C, Schneider A, Borghese B, Santulli P, Souza C, Streuli I, et al. Deep infiltrating endometriosis is associated with markedly lower body mass index: a 476 case-control study. *Hum Reprod* 2012;27(1):265–72.
- [28] Farland LV, Missmer SA, Bijon A, Gusto G, Gelot A, Clavel-Chapelon F, et al. Associations among body size across the life course, adult height and endometriosis. *Hum Reprod* 2017;32(8):1732–42.
- [29] Reis FM, Coutinho LM, Vannuccini S, Luisi S, Petraglia F. Is stress a cause or a consequence of endometriosis? *Reprod Sci* 2020;27(1):39–45.
- [30] Sverrisdóttir UÁ, Hansen S, Rudnicki M. Impact of diet on pain perception in women with endometriosis: a systematic review. *Eur J Obstet Gynecol Reprod Biol* 2022;271:245–9.
- [31] Nap A, de Roos N. Endometriosis and the effects of dietary interventions: what are we looking for? *Reprod Fertil* 2022;3(2):C14–22.
- [32] Huijs E, Nap A. The effects of nutrients on symptoms in women with endometriosis: a systematic review. *Reprod Biomed Online* 2020;41(2):317–28.
- [33] Nirgianakis K, Egger K, Kalaitzopoulos DR, Lanz S, Bally L, Mueller MD. Effectiveness of dietary interventions in the treatment of endometriosis: a systematic review. *Reprod Sci* 2022;29(1):26–42.
- [34] Armour M, Sinclair J, Chalmers KJ, Smith CA. Self-management strategies amongst Australian women with endometriosis: a national online survey. *BMC Complement Altern Med* 2019;19(1):17.



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