

ARTICLE



Diet quality and perceived effects of dietary changes in Dutch endometriosis patients: an observational study

**BIOGRAPHY**

Iris Krabbenborg is a master's student at Wageningen University with a specialization in Food Digestion and Health. Her interests are early life nutrition and gut microbiota development. Her current research interest is the potential role of nutrition in reproductive health. This study is part of her master thesis.

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KEY MESSAGE

Many Dutch endometriosis patients make dietary changes to reduce endometriosis-related symptoms and increase quality of life. No dietary change was found to increase quality of life; however, specific dietary adjustments were often reported to reduce endometriosis pain-related symptoms. More research is necessary to develop dietary guidelines for this patient group.

ABSTRACT

Research question: What is the current diet of women with endometriosis, in terms of adherence to dietary guidelines and use of diets, and what are the perceived effects of dietary modifications?

Design: In this online explorative observational study, the Dutch Healthy Diet 2015 index (DHD-15) and quality of life (QoL) with the Endometriosis Health Profile-30 questionnaire (EHP-30) were used to assess diet quality.

Results: The questionnaires were completed by 157 participants. Many participants made one or more dietary adaptations for their endometriosis, in the form of a specific diet (46.5%), with the use of dietary supplements (56.1%), with other dietary adjustments (64.3%), or all. Endometriosis patients had a significantly lower DHD-15 score, indicating a lower diet quality than a healthy reference group ($P = 0.004$). In the endometriosis group, diet users had a significantly higher total DHD-15 score than non-diet users ($P < 0.0001$). Diet quality was not correlated with QoL (Pearson's $r = -0.010$, $P = 0.904$). Many specific dietary adjustments (71.3%), however, were reported to reduce endometriosis pain-related symptoms. The removal of gluten, dairy or soy, as well as the addition of vegetables, showed the greatest perceived reductions of symptoms in participants.

Conclusions: Although no specific dietary adjustment was found to increase QoL, endometriosis patients do feel that dietary adjustments have a beneficial effect on their symptoms. Therefore, more research is needed to gain evidence about the specific effects of nutrients on endometriosis symptoms.

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KEYWORDS

Dietary behaviour, endometriosis
Nutrition
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INTRODUCTION

Endometriosis is a debilitating disease, defined by the presence of functioning endometrium-like tissue outside the uterus. It is the most prevalent benign gynaecological disease worldwide, estimated to affect 10% of women in reproductive ages (Zondervan *et al.*, 2020). Symptoms include chronic pelvic pain, fatigue, dysmenorrhoea, dysuria, dyspareunia, dyschezia and infertility (Dunselman *et al.*, 2014; Lin *et al.*, 2018). These can greatly affect the physical, mental, sexual and social wellbeing of patients (Zondervan *et al.*, 2020) and cause high societal costs (Simoens *et al.*, 2012). Costs are further incurred by the considerable diagnostic delay of endometriosis, which varies throughout studies, but can take up to 10 years from the onset of symptoms (Hadfield *et al.*, 1996; Arruda *et al.*, 2003; Ballard *et al.*, 2006; Hudelist *et al.*, 2012; Staal *et al.*, 2016). Although the exact pathogenesis is yet unknown, retrograde menstruation is currently the most accepted theory for the cause of endometriosis (Lin *et al.*, 2018). Various genetic, hormonal, environmental (including organochlorine pesticides, which can be ingested through fish, fatty foods and dairy products) (Cooney *et al.*, 2010; Upson *et al.*, 2013) and immunological factors are thought to influence the development of this oestrogen-dependent inflammatory disease (Vercellini *et al.*, 2014).

At present, no definitive cure exists for endometriosis; treatment consists of hormonal medication, surgical removal of lesions, or both, often with side-effects and suboptimal efficacy (Rafique and Decherney, 2017; Zondervan *et al.*, 2020). Therefore, many patients feel the need to take control of their chronic disease themselves, to assist the management of their endometriosis and possibly increase their quality of life (O'Hara *et al.*, 2019). According to an Australian national online survey among 484 women with endometriosis, up to 76% apply self-management strategies consisting of diverse self-care and lifestyle choices, such as nutrition, exercise and meditation. Disease management by dietary choices, such as the adherence to a vegan or gluten-free diet, was reported by 44% of these women. The effectiveness of dietary choices in this survey was graded with

a score of 6.4 out of 10 (Armour *et al.*, 2019).

Little scientific evidence exists on the effect of nutrition on endometriosis (Huijs and Nap, 2020; Nirgianakis *et al.*, 2021). In addition, most of the current studies are case-control studies investigating dietary intake and the risk of developing endometriosis instead of endometriosis treatment. These studies provide limited evidence for disease management and their results are often inconsistent (Parazzini *et al.*, 2013). Nevertheless, numerous sources promoting dietary adjustments and full diets to treat endometriosis can be found online, often created by patients themselves. As these diets regularly exclude various food products, i.e. grains and dairy, without adequate replacements, nutritional deficiencies could occur. Furthermore, adherence to a diet can be costly in time and money, and failure to adhere to a diet can cause feelings of stress and guilt (Huijs and Nap, 2020). The few intervention studies that have investigated the role of nutrition in the treatment of endometriosis provide low to very low-quality evidence. In many studies, the sample size was small, no control groups were included, blinding was not applied or a heterogeneous patient group was used. In studies that assessed dietary components and diets in the treatment of endometriosis, vitamin D, antioxidants, soy, gluten, fatty acids, combinations of nutritional supplements or a diet low in fermentable oligosaccharides, disaccharides, monosaccharides and polyols (FODMAPs) were mainly targeted (Huijs and Nap, 2020). It has often been suggested that endometriosis-related pain was reduced with the addition of nutrients with anti-inflammatory, anti-oestrogen activities, such as antioxidants and omega-3 fatty acids, or both. The main sources of these are fruits, vegetables and fatty fish. These are important components of a healthy diet, according to the Dutch Healthy Diet (DHD)-guidelines formulated in 2015 (DHD-15) (Looman *et al.*, 2017). To date, convincing evidence about the relationship between nutrition, endometriosis treatment, and a healthy diet is limited.

The aim of the present study was to obtain insight into the current diet of women with endometriosis, in terms of adherence to dietary guidelines, use of

diets and perceived effects of dietary modifications.

MATERIALS AND METHODS

Study population

The participants were recruited from Rijnstate Hospital and the Dutch endometriosis society. In Rijnstate hospital, patients from the gynaecology department with diagnosed endometriosis and no other diseases, confirmed by ultrasound, MRI or surgery between 2017 and 2019, were approached ($n = 170$). Participants from the Dutch endometriosis society were approached on their website (<https://www.endometriose.nl/>), Facebook page and newsletter. An official diagnosis for endometriosis was not always confirmed for these participants. Participants of reproductive age were included, as endometriosis is most prevalent then (Vercellini *et al.*, 2014). Non-Dutch speaking participants were excluded. The aim was to recruit a minimum of 100 participants to obtain a reliable distribution of the dietary intake data (Willett, 2012). As a declaration conforming to the Medical Research Involving Human Subjects Act (WMO) was not necessary, a non WMO declaration (n-WMO) was received from the Medical Act Review Committee on 30 January 2020, indicating approval of the study (reference number: 2019-1465). After inclusion in the study, written informed consent was obtained from all participants. Demographic characteristics were assessed. Quality of life, pain, diet quality and dietary behaviour were investigated using questionnaires. The physical pain measure, referring to average pain during the last month, was scored between 0 and 100, a higher score indicates more experienced physical pain. All questionnaires were offered to the participants digitally by the online survey programme QualtricsXM, with a link sent by email. The questionnaires could be completed by the participants anywhere, in their own time.

Endometriosis Health Profile-30 questionnaire (EHP-30)

The Endometriosis Health Profile questionnaire (EHP-30) was used to investigate physical complaints, mental status and quality of life in endometriosis patients. This measure is validated to assess quality of life in endometriosis patients (van de Burgt

et al., 2011). The Dutch version of this questionnaire contains four parts. The first part is applicable to all women with endometriosis and focuses on pain, emotion, control, social support and self-image, and forms the core score of the EHP-30. The second, modular part targets the scales that do not necessarily apply to all women with endometriosis, including work, children, sexual activity, interaction with doctors, treatment and fertility. The third part consists of general questions about the participants, such as diagnostic method, and the last part evaluates the general health of participants. The participants could score the questions between one and five, one represented 'never' and five 'always' in reference to the experienced effect of endometriosis on the various aspects in the EHP-30 questionnaire. The outcomes of the separate EHP-30 modules ranged between 0 (optimal score) and 100 points (maximum score).

Dutch Healthy Diet 2015 index

Participants were asked to complete a short online food frequency questionnaire (FFQ): the Eetscore (Eatscore) to identify the quality of their diet. This FFQ is validated to assess diet quality in the Dutch population (*van Lee et al., 2016*). This online questionnaire contains 76 questions about 54 food items and, when converted according to the Dutch Healthy Diet guidelines from 2015 (*Van Lee et al., 2012*), provides DHD-15 scores. In total 16 DHD-15 components are scored between 0 and 10 and were classified in adequacy, optimum, moderation, qualitative and ratio components. Jointly, they form the total adherence DHD-15 score (*Looman et al., 2017*). The requirements, distribution of points and the DHD-15 score interpretations are presented in the Supplementary Table. To compare adherence to the DHD-15 index of the women with endometriosis, a reference population consisting of self-reported healthy Dutch women from the 'EetMeetWeet' study aged between 19 and 50 years with comparable variables was assessed (*de Rijk et al.,* personal communication of unpublished observations).

Dietary behaviour

In addition to the DHD-15 and EHP-30 questionnaires, further questions were asked online about the dietary self-management strategies of participants. Diet and supplement use were assessed,

as well as specific dietary adjustments. A diet was defined as a prescribed course of eating and drinking in which the amount and kind of food are regulated for a particular purpose, such as losing weight. For diet and supplement use, it was specifically asked whether these were applied to reduce endometriosis symptoms. For the specific dietary adjustments, defined as the removal, limited consumption or the addition of specific food products or groups, participants were asked about the type of adjustment, the perceived effect on symptoms and for how long the adjustment was implemented. The perceived effects were scored between -5 and 5, in which -5 indicates maximal reduction and 5 maximal increase of symptoms. Moreover, questions about the general experienced effect of nutrition on endometriosis symptoms and the information source for the dietary adjustments were included.

Statistical analysis

The statistical programme SPSS IBM version 25.4 was used for data analysis. The normal distribution of the data was tested with histograms and QQ-plots. Continuous variables are presented as averages (mean \pm SD), nominal variables as numbers (*n*) and percentages (%). A level of statistical significance of $P < 0.05$ was used. The DHD-15 scores of the endometriosis group and the reference group were compared with independent sample t-tests. The t-tests were carried out for the total DHD-15 score and the individual components. Also, independent samples t-tests were conducted to see whether DHD-15 and EHP-30 scores were different between diet-users and non-diet users. Subsequently, a one-way analysis of variance of no diet use and the various diets was carried out for the DHD-15 and EHP-30 scores. A post-hoc multiple comparisons analysis (Tukey honestly significant difference) was used to identify where the differences between these diet groups were located. The association between the EHP-30 core scores and total adherence DHD-15 scores was calculated as a correlation (Pearson's *r*).

RESULTS

After information about the study had been shared on the Dutch Endometriosis Society website, 129 patients showed interest. From Rijnstate Hospital, 104 out of the 170 women that had been

invited for the study were included; therefore, the total number of patients that expressed interest was 233.

The questionnaires were completed by 157 patients, of whom 88 (56%) were recruited through the Dutch Endometriosis Society and 69 via Rijnstate Hospital (44%; overall response rate in Rijnstate hospital was 66%). Reasons for refusing to participate in the study ($n = 66$) for patients from Rijnstate were no time or no interest in participating in a study. If women showed interest in participating but did not complete the questionnaires, they were reminded twice. Reasons for lack of response after two reminders ($n = 35$) were not determined. Participants did not report having any illnesses other than endometriosis, especially no irritable bowel syndrome or thyroid disease. Characteristics of participants are presented in [TABLE 1](#). Participants' characteristics of women who responded to the advertisement of the website of the Endometriosis Society were self-reported. Characteristics of patients from Rijnstate Hospital were confirmed from their medical records.

The general health score of the participants was 58.5 ± 11.8 and their physical pain score was 57.3 ± 23.4 , both on a 100-point scale. Lack of energy, pelvic pain and menstrual pain were the most reported endometriosis symptoms. Gastrointestinal problems were also common ([FIGURE 1](#)).

The EHP-30 core score was 193.6 ± 111.4 on a 500-point scale. In the additional EHP-30 modules, endometriosis-related quality of life was least affected by work and most affected by infertility ([TABLE 2](#)).

Dietary behaviour

More than one-half of the respondents (55.5%) indicated that nutrition affected their endometriosis symptoms. Of these participants, most (70.0%) reported that nutrition decreased their symptoms, whereas others reported an increase of symptoms (30.0%). Nutrition also had effects on other symptoms, not related to endometriosis: 51 participants (32.5%) reported having one or several food allergies, intolerances, or both. Lactose intolerance ($n = 28$) and gluten intolerance or allergy ($n = 17$) were most frequently mentioned.

Seventy-three participants (46.5%) followed a diet, of whom 74.0% did this

TABLE 1 DEMOGRAPHIC AND MEDICAL CHARACTERISTICS OF THE STUDY POPULATION (N = 157)

Characteristic	Values
Age, years	37.2 ± 7.1
BMI, kg/m ²	24.6 ± 4.3
Weight, kg	71.6 ± 14.0
Height, m	1.7 ± 0.07
Education, n (%)	
High school	4 (2.5)
Secondary vocational education	47 (29.9)
Higher professional education	63 (40.1)
University	43 (27.4)
Living condition, n (%)	
Single	31 (19.7)
Living with partner	124 (79.0)
Unknown	2 (1.3)
Diagnosis, n (%)	
Peritoneal endometriosis	19 (12.1)
Ovarian endometriosis	42 (26.8)
Deep endometriosis	42 (26.8)
Peritoneal + ovarian + deep endometriosis	30 (19.1)
Adenomyosis	4 (2.5)
Adenomyosis + other	16 (10.2)
Abdominal wall	2 (1.3)
Unknown	2 (1.3)
Diagnostic method, n (%)	
Based on symptoms	5 (3.2)
Physical examination	17 (10.8)
Ultrasound or MRI	70 (44.6)
Surgery	65 (41.4)
AFS 1	4 (6.2)
AFS 2	6 (9.2)
AFS 3	1 (1.5)
AFS 4	12 (18.5)
AFS not reported	42 (64.6)
Number of symptoms	4.2 ± 2.5
Time between onset of symptoms and diagnosis (years) (n = 156)	9.7 ± 8.8
Time since diagnosis, years	6.3 ± 5.8
Treatment, n (%)	
Medication	56 (35.7)
Unspecified	1 (1.8)
Analgesics	3 (5.4)
Oral contraceptive	19 (33.9)
Progesterone oral/IUD	22 (39.3)
GnRH analogue	10 (17.9)
Unknown	1 (1.8)
Surgery	83 (52.9)
Unspecified	35 (42.2)
Removal of peritoneal lesions	7 (8.4)
Removal of ovarian cyst	15 (18.1)
Removal of the uterus, ovaries, or both	13 (15.7)
Removal of deep endometriosis	7 (8.4)
Unknown	6 (7.2)
None or alternative	9 (5.7)
Combination unspecified	3 (1.9)
Unknown	6 (3.8)

Values are expressed as means ± SD unless stated otherwise.

AFS, American Fertility Society; BMI, Body Mass Index, GnRH, gonadotrophin releasing hormone; IUD, intrauterine device; MRI, magnetic resonance imaging.

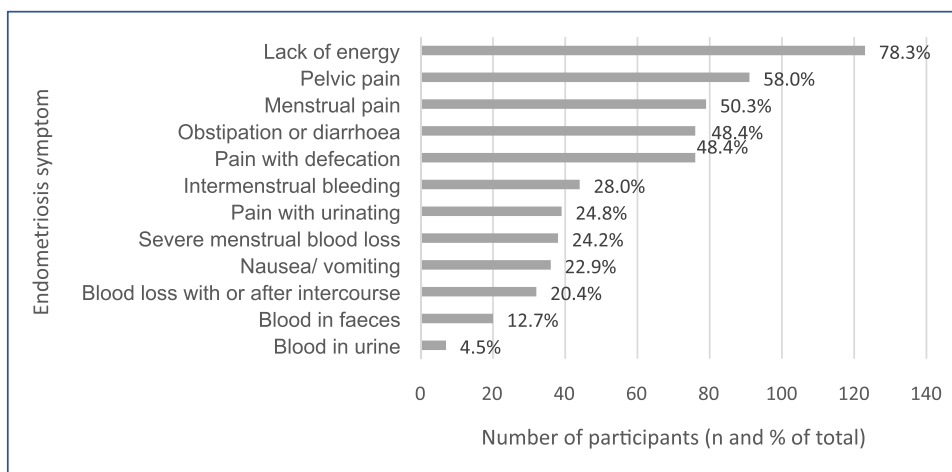


FIGURE 1 Prevalence of self-reported symptoms of endometriosis ($n = 157$).

specifically to reduce their endometriosis symptoms. Of the participants that followed a diet, 46.6% mentioned adhering to the endometriosis diet, a diet specifically designed by certain groups of patients to reduce endometriosis symptoms (www.endometriosedieet.nl). Other specific diets mentioned were the gluten-free (16.4%), the low-carbohydrate (6.8%), the low-FODMAP (5.5%), the low-lactose (5.5%) and weight-loss diets (4.1%). Of the diet users, 40 participants adhered to a diet for a year or longer.

The use of dietary supplements was reported by 88 participants (56.1%), of whom 42.0% used dietary supplements to reduce their endometriosis symptoms. Commonly cited supplements were multivitamins (50.0%), vitamin D (42.0%), magnesium (30.7%), vitamin B12 (22.7%), omega-3 fatty acids (14.8%) and serrapeptase (12.5%); these were often combined.

In addition to adhering to complete diets and the use of supplements, 101 participants (64.3%) reported having made at least one dietary adjustment

because of their endometriosis. Of these, 22 participants made one adjustment, 16 made two, 18 made three, 14 made four and 31 made five. These adjustments could be divided into three specific categories: first, the elimination of foods or drinks (reported 148 times), i.e. gluten or dairy; second, a limitation of the consumption, i.e. of sugar (139 times); and third the addition or increased consumption of certain foods (27 times), i.e. fruits and vegetables. Other, non-specific adjustments were reported five times. Therefore, in total, 314 specific adjustments were mentioned, of which 224 were reported to reduce pain symptoms (71.3%). Of the food products that were mentioned at least four times, the removal of gluten showed the greatest reduction of symptoms (FIGURE 2).

Participants reported to having made these dietary adjustments for less than a week until a maximum of 10 years, with a median duration of a year. A negative correlation was found between the duration of both the removal and the limited consumption of food products and the perceived effect on

endometriosis symptoms (Pearson $R = -0.378$, $P < 0.0001$; Pearson $R = -0.280$, $P = 0.005$). This indicates that the longer a food product was removed or limited in consumption, the greater the perceived reduction effect was.

Most of these dietary adjustments were based on the participants' own experiences (34.9%) or on Internet sources (30.3%).

DHD-15 adherence

The adherence of participants to the Dutch Healthy Diet guidelines was 105.9 ± 18.1 out of a 160-point scale. This was significantly lower than the score in the reference population ($n = 189$), which was 111.4 ± 16.5 ($P = 0.004$).

Compared with the women in the reference group, the participants with endometriosis had significantly lower adherence to the guidelines for whole grain products ($P = 0.004$ for total score and $P < 0.001$ for amount in grams), legumes ($P < 0.001$), dairy ($P < 0.001$), tea ($P = 0.036$) and fats and oils ($P < 0.001$). In contrast, their adherence to

TABLE 2 EHP-30 SCORES IN PARTICIPANTS WITH ENDOMETRIOSIS ($N = 157$)

Core questions	<i>n</i>	Mean \pm SD	Additional questions	<i>n</i>	Mean \pm SD
Self-image	157	33.2 \pm 27.7	Work	128	24.1 \pm 25.6
Emotion	157	36.4 \pm 22.9	Doctors	104	25.4 \pm 26.9
Pain	157	36.7 \pm 23.8	Children	75	25.5 \pm 26.4
Social Support	157	43.3 \pm 27.1	Treatment	98	44.0 \pm 27.3
Control	157	44.0 \pm 27.0	Intercourse	140	46.5 \pm 28.9
			Infertility	73	51.4 \pm 31.3

All single component EHP-30 scores have an optimal score of 0 and a maximum score of 100. The scores are arranged from best to worst scores. EHP, Endometriosis Health Profile.

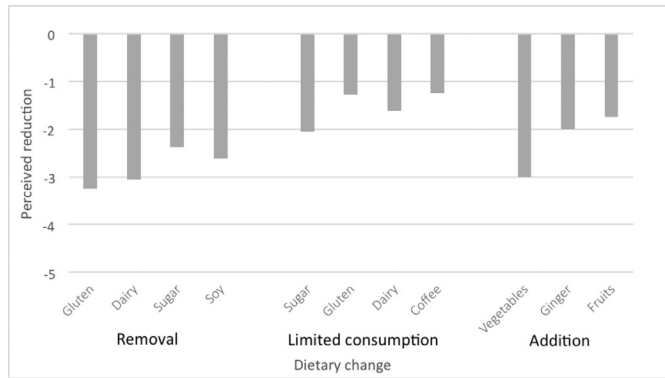


FIGURE 2 Mean perceived effects on endometriosis pain-related symptoms of the most frequently cited dietary adjustments, classified as removal, limitation or the addition of specific food products (n = 101). The perceived effects were scored between -5 and 5, in which -5 indicates maximal reduction and 5 maximal increase of symptoms. WP, whole grain products.

the guidelines for coffee ($P < 0.001$), salt ($P = 0.004$) and unhealthy choices ($P < 0.001$) was significantly higher (FIGURE 3). Concerning the dairy optimal range, the endometriosis group scored an average of 0.2 ± 0.5 , which was significantly lower than the reference group (0.3 ± 0.6 , $P = 0.018$).

Association between dietary behaviour, DHD-15 and EHP-30 scores

The adherence to the DHD-15 guidelines in participants following any diet was 112.7 ± 17.3 . This was significantly higher than the score of the group not following a diet, which was 100.0 ± 16.8 ($P < 0.0001$). Moreover, the total DHD-15 adherence score differed significantly between diets ($P = 0.001$). Participants who adhered to the endometriosis

diet (n = 34) had the highest DHD-15 score: 16.1 points higher than the no-diet group ($P < 0.0001$) (TABLE 3). The higher total DHD-15 score in participants who followed a diet was mainly due to their significantly higher scores for vegetables, fruits, nuts and fish, despite the higher intakes of processed meat, sugar-sweetened beverages and fruit juices, and other unhealthy choices. The no-diet group on the other hand scored significantly higher on grams of whole grain products and intake of dairy products; this seems logical as various grain and dairy products are restricted in many of the diets (data not shown).

No significant difference was found between the EHP-30 core scores of the participants following any diet and the

no-diet group ($P = 0.140$). Similarly, the EHP-30 core score was not significantly different for different diets ($P = 0.315$) (TABLE 3). Interestingly, participants that followed any diet scored significantly higher in the doctors and treatment EHP-30 modules ($P = 0.042$; $P = 0.026$), indicating a less optimal score.

For the participants that removed, limited or added specific food products or groups to their diet, a wide range of outcomes were observed for the total adherence DHD-15 scores and EHP-30 core scores (TABLE 4).

Association between DHD-15 and EHP-30

Better adherence to the Dutch dietary guidelines was not associated with patients' wellbeing: no correlation was found between the total DHD-15 and the EHP-30 core scores (Pearson's $r = -0.010$, $P = 0.904$). Similarly, no significant correlations were found between the total DHD-15 and the EHP-30 core scores in the participants that followed a diet (Pearson's $r = -0.068$, $P = 0.568$) or in those that did not follow a diet (Pearson's $r = -0.043$, $P = 0.696$).

DISCUSSION

In this observational study, we found that Dutch women with endometriosis have a slightly lower diet quality (according to the DHD-15) than a healthy reference population. This finding is of interest, as many of the patients indicated to having

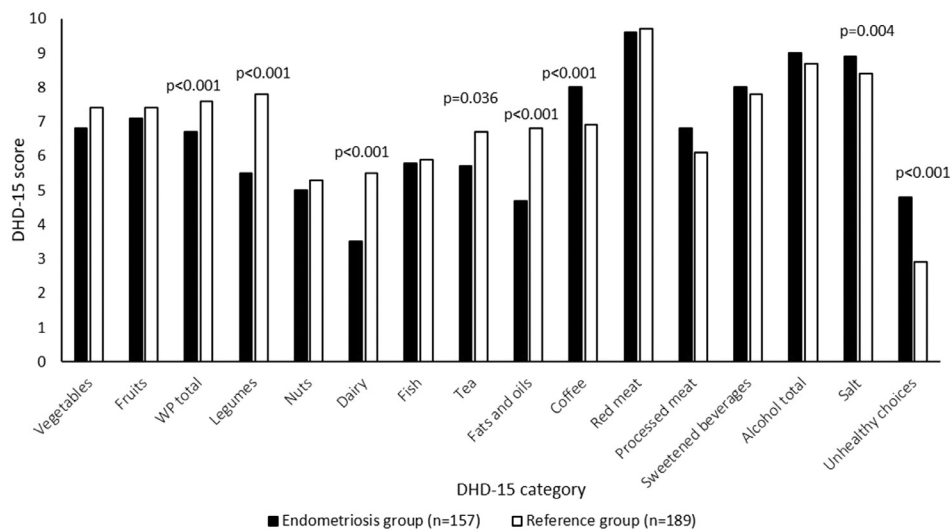


FIGURE 3 Mean Dutch Healthy Diet 2015 index (DHD-15) scores for vegetables, fruits, whole grain products (WP) total, legumes, nuts, dairy, fish, tea, fats and oils, coffee, red meat, processed meat, sweetened beverages and fruit juices, alcohol total, salt, and unhealthy choices between endometriosis group (n = 157) and the reference group (EetMeetWeet study, n = 189). The individual DHD-15 components have an optimal score of 10 and a minimum score of 0.

TABLE 3 MEAN EHP-30 CORE SCORES AND TOTAL ADHERENCE DHD-15 SCORES PER DIET (N =157)

Diet	n	EHP-30 core score \pm SD	Total adherence DHD-15 score \pm SD
No diet	84	181.3 \pm 111.1	100.0 \pm 16.8
Any diet, specifically:	73	207.7 \pm 110.9	112.7 \pm 17.3 ^a
Endometriosis diet	34	211.3 \pm 116.2	116.1 \pm 14.5 ^a
Gluten-free diet	12	226.5 \pm 85.6	105.8 \pm 20.4
Low-carbohydrate diet	5	125.0 \pm 141.9	114.2 \pm 20.7
Low-FODMAP diet	4	202.1 \pm 12.7	112.5 \pm 35.0
Low-lactose diet	4	249.7 \pm 165.1	109.8 \pm 17.3
Weight-loss diet	3	288.1 \pm 13.9	106.3 \pm 4.7
Other specific diets	11	178.2 \pm 110.0	111.9 \pm 15.6

The EHP-30 core score has an optimal score of 0 and a maximum score of 500. The DHD-15 total adherence score has an optimal score of 160 and a minimum score of 0.

EHP, Endometriosis Health Profile; FODMAP, fermentable oligosaccharides, disaccharides, monosaccharides and polyols.

^a $P < 0.0001$ compared with the no diet group.

made one or more dietary changes for their endometriosis-related symptoms, including the use of diets, supplements, specific dietary adjustments, or all. Many specific dietary adjustments were reported to reduce endometriosis pain-related symptoms. The removal of gluten, dairy or soy, as well as the addition of vegetables, showed the greatest perceived reductions of these symptoms in participants. In addition, dietary adjustments that were associated with more benefit were implemented for a longer period. Quality of life (QoL), however, was not different between women who adjusted their diet and

women who did not. Diet users had a significantly higher total adherence DHD-15 score, compared with non-diet users. This was mainly due to the higher intakes of vegetables, fruits, nuts and fish in diet users. Surprisingly, the 'endometriosis diet' resulted in the best DHD-15 score of all diets, despite its restrictive nature because of the elimination of food products such as gluten, dairy, and soy.

To our knowledge, this study is the first to investigate the relationship between diet quality, dietary changes, and QoL of Dutch endometriosis patients. Most women in this study made changes to

their diet to influence endometriosis-related symptoms. Because of the severity of this disease and the current lack of curative treatment, it is understandable that patients apply self-management strategies. This has also been observed in the survey by *Armour et al. (2019)*, in which 76% of Australian endometriosis patients applied self-management strategies, of which 44% by dietary choices, to assist the management of their endometriosis. Nevertheless, in the present study, no differences in QoL because of diets or adherence to dietary guidelines were observed and no correlations between QoL (EHP-30)

TABLE 4 MEAN EHP-30 CORE SCORES AND TOTAL ADHERENCE DHD-15 SCORES OF THE MOST OFTEN MENTIONED DIETARY ADJUSTMENTS, CLASSIFIED AS THE REMOVAL, LIMITATION OR THE ADDITION OF SPECIFIC FOOD PRODUCTS (N = 101)

Dietary adjustments	n	EHP-30 core score \pm SD	Total adherence DHD-15 score \pm SD
Removal			
Gluten	21	215.3 \pm 25.8	117.4 \pm 13.0
Dairy	18	197.1 \pm 69.6	115.8 \pm 11.7
Sugar	16	205.3 \pm 82.9	112.8 \pm 3.7
Soy	15	184.4 \pm 83.7	111.6 \pm 15.4
Limitation			
Sugar	23	207.8 \pm 22.3	117.6 \pm 8.4
Gluten	15	255.4 \pm 51.0	115.4 \pm 4.5
Dairy	14	201.4 \pm 33.5	109.3 \pm 5.6
Coffee	13	230.6 \pm 105.2	122.9 \pm 12.4
Addition			
Vegetables	6	178.7 \pm 129.9	103.7 \pm 14.5
Ginger	5	211.5 \pm 60.4	99.4 \pm 15.9
Fruits	4	203.3 \pm 161.2	112.8 \pm 29.5

No statistical testing was carried out owing to the absence of a control group. The EHP-30 core score has an optimal score of 0 and a maximum score of 500. The DHD-15 total adherence score has an optimal score of 160 and a minimum score of 0.

DHD, Dutch Healthy Diet; EHP, Endometriosis Health Profile.

and diet quality (DHD-15) were found. It was hypothesized that higher adherence to the DHD-15 guidelines could result in a better EHP-15 score. Important components of the DHD-15 are food products rich in anti-inflammatory, anti-oestrogen compounds, or both, i.e. omega-3 fatty acids and antioxidants present in fruits, vegetables, fatty fish and others (Looman *et al.*, 2017). Therefore, it was hypothesized that a higher intake of these DHD-15 components could potentially reduce endometriosis-related pain, thereby improving QoL. On the other hand, participants with a lower perceived QoL might have been more willing to make adjustments to their dietary pattern to possibly improve pain and other endometriosis-related aspects. Their QoL could have increased as their quality of diet improved, but could still be considered low in general. Moreover, it is possible that participants with a higher perceived QoL might not feel the need to change anything, including their diet, to improve their QoL. The lack of correlation between QoL and diet quality is not related to a limited variation in the study population; the statistical outcomes of both DHD-15 scores and EHP-30 scores showed a wide variation.

Interestingly, the women who had the least optimal scores pertaining to their relationship with doctors and treatments were most likely to follow a diet. This might suggest that women who are less satisfied with their medical treatment feel the need to take their own initiative to make endometriosis symptoms less severe. In the systemic review by O'Hara *et al.* (2019), it was reported that 'Negative experiences were reported more commonly than positive experiences' when it came to relationships between endometriosis patients and health providers. This review also mentioned that: 'Positive experiences with health care providers were associated with a feeling of greater "control" and a sense of relief as the provider could explain the disease and available options.' This could potentially substantiate the higher adherence to a diet in the group of patients that was less satisfied with their medical treatment, because of their greater need to take control over their disease themselves.

The finding that no specific dietary adjustment was associated with a higher QoL indicates that, to date, it is unknown which dietary intervention could have a

positive effect on endometriosis-related pain. Therefore, currently, no specific endometriosis diet can be recommended to patients to alleviate their symptoms. More research is needed to increase our knowledge about the mechanisms underlying nutritional influences on endometriosis-related symptoms.

The strengths of the present study include sample size, questionnaires and recruitment strategy. The sample size of 157 participants is more than sufficient to provide reliable, normally distributed results from dietary intake measurements (de Vries, 2019). In addition, the use of validated questionnaires to obtain insights into the diet quality ('Eetscore') and QoL (EHP-30) in participants is a strength of this study. The diet quality FFQ is validated to provide an acceptable score of the adherence to the DHD-15 guidelines in the Dutch population (van Lee *et al.*, 2016). The EHP-30 questionnaire is specifically created to obtain QoL of endometriosis patients and was tested and validated in Dutch patients (van de Burgt *et al.*, 2011). Also, as the questionnaires used for the study were distributed online, participants could complete them anywhere in their own time.

Another strength of this study is that participants were recruited from two recruitment sites: a hospital and a patients' association (the Dutch Endometriosis Society), to obtain a population representative for the Dutch population of women with endometriosis. As expected, differences were observed between the data of these two sites. The participants recruited from the Dutch Endometriosis Society had a significantly higher total adherence DHD-15 score ($P = 0.040$) than the participants recruited from the hospital. On the other hand, the EHP-30 core score of the Dutch Endometriosis Society participants was about 30 points higher (not significant, $P = 0.087$) than the score of the hospital participants, showing that these patients experience a lower QoL. This could result in a higher willingness to apply self-management strategies in the Dutch Endometriosis Society group, such as through dietary adjustments. Indeed, the prevalence of diet use, supplement use and specific dietary adjustments were higher in the Dutch Endometriosis Society group. The participants that were recruited via the Dutch Endometriosis Society group actively responded to a recruitment post for this study on their

website. In contrast, the participants recruited from the hospital received a letter and a phone call to encourage them to participate in this study. This could explain the differences in data between the two recruitment sites, as the Dutch Endometriosis Society participants might have a more proactive attitude towards the self-management of their disease because of the greater effect endometriosis has on their QoL.

Lastly, the comparable reference group could be considered a strength of this study. This group of self-reported healthy Dutch women from the 'EetMeetWeet' study was selected on age (19–50 years) and had a comparable BMI.

The recruitment of participants from two recruitment sites can also be seen as a limitation of the study as well as a strength. In participants recruited from the advertisement on the website of the Dutch Endometriosis Society, confirmation of endometriosis and its type were self-reported, whereas in participants recruited from the Rijnstate hospital, data concerning confirmation of diagnosis and type of endometriosis could be checked from the patient files. For this reason, using two recruitment sites could cause a bias. The fact that we recruited our participants from a hospital as well as from a patient association makes our study population more representative of Dutch endometriosis population than it would have been if we had only used one recruitment site.

Another limitation of this study is that the questions formulated for the specific dietary adjustments were not asked for the diets. For every specific dietary adjustment, participants were asked, on a scale from one to 10, if the adjustment reduced or aggravated their endometriosis pain-related symptoms. For the diets, it was solely asked whether these were used to reduce endometriosis-related pain. This excluded gathering information about the perceived effects of diet use on endometriosis pain-related symptoms. Moreover, it made it impossible to compare the specific adjustments against diet use on perceived effects. If a similar future study is conducted, we would recommend including these questions for diet use as well.

The use of the 'Eetscore' could also be a limitation of this study. In this FFQ, it was not possible to report dietary

substitutes, such as gluten-free bread and plant-based milk. Because of the frequency of self-reported food allergies and intolerances, this could have led to an underestimation of the adherence to dietary guidelines. Also, participants following restrictive diets indicated their difficulties in filling out this FFQ. Lastly, another limitation of the study is that data were self-reported. This could have resulted in socially desirable answers and mistakes when filling out the questionnaires. As these questionnaires were completed online, however, we hypothesized that socially desirable answers could have occurred to a lesser extent than if the data were gathered through an interview. This hypothesis has been supported (*Heerwegh, 2009*), but not by all (*Dodou and de Winter, 2014; Gnams and Kaspar, 2017*).

In conclusion, in this observational study, we found that Dutch women with endometriosis have a lower diet quality compared with a healthy reference population. In the endometriosis group, those who adhered to a diet had a higher total DHD-15 score compared with non-diet users, despite the widespread use of restrictive diets. Diet quality was not associated with QoL. Specific dietary changes, however, such as the removal of gluten, dairy or soy, were reported to reduce endometriosis pain symptoms. The results suggest that women with endometriosis feel the need to adjust their diet to suppress endometriosis-related pain and they feel that dietary adjustments have a positive effect on their symptoms. More research is necessary to gain evidence about the specific effects of nutrients on endometriosis activity. This could be investigated through an intervention study in which attention should be paid to providing information concerning healthy dietary choices. Moreover, specific (combinations of) nutrients could be either added or removed from the diet of endometriosis patients and compared with their habitual diet to ascertain the effects on endometriosis-related symptoms. With these studies, dietary guidelines for this patient group could potentially be developed, to assist in the treatment of this debilitating disease.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.rbmo.2021.07.011](https://doi.org/10.1016/j.rbmo.2021.07.011).

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