

Abdominal Bloating: An Under-recognized Endometriosis Symptom

Georgina M. Luscombe, PhD,¹ Robert Markham, PhD,¹ Mirari Judio, MD,¹ Ariadna Grigoriu, MD,² Ian S. Fraser, MD, FRANZCOG¹

¹Department of Obstetrics and Gynaecology, Queen Elizabeth II Research Institute for Mothers and Infants, The University of Sydney, Australia

²Department of Obstetrics and Gynaecology, The University of Western Ontario, London ON

Abstract

Objective: To explore the association between the symptom of abdominal bloating and the diagnosis of endometriosis.

Methods: Twenty-six patients with endometriosis diagnosed by laparoscopy and 25 women without endometriosis were recruited to a case-control study. Subjects completed detailed questionnaires regarding perception of abdominal bloating, bloating-related symptoms, and effect on lifestyle. Abdominal girth was measured three times daily for one whole menstrual cycle, as were ratings of perceived abdominal bloating severity and discomfort. Experiences of abdominal and gastrointestinal symptoms were compared.

Results: A significantly larger proportion of women with endometriosis than control subjects experienced abdominal bloating (96% vs. 64%). In women with abdominal bloating, the following were more common in those who had endometriosis: associated severe discomfort (30% vs. 0%), wearing loose clothes during bloating (87% vs. 38%), and simultaneous hand swelling (30% vs. 6%). The experiences of cyclically related diarrhea and constipation were more frequent with endometriosis. While there were significant changes in bloating and discomfort ratings across the menstrual cycle, there was a trend towards a difference between the control subjects and unmedicated endometriosis groups only in how the pattern of bloating severity fluctuated across the cycle. Lower abdominal girth measurements changed significantly across menstrual cycle phases. Control and unmedicated endometriosis groups differed significantly in girth changes across the menstrual cycle, controls experiencing much less variation. Compared with the unmedicated endometriosis group, women receiving hormonal treatment had higher bloating severity ratings and discomfort scores, but there was no objective difference in abdominal girth.

Conclusion: Painful abdominal bloating appears to be common in women with endometriosis and causes considerable symptomatic distress.

Key Words: Endometriosis, abdominal bloating, abdominal discomfort, cyclical symptoms

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Résumé

Objectif : Explorer l'association entre le symptôme de ballonnement abdominal et le diagnostic d'endométriose.

Méthodes : La participation de 26 patientes présentant une endométriose diagnostiquée par laparoscopie et de 25 femmes sans endométriose à une étude cas-témoins a été sollicitée. Les sujets ont rempli des questionnaires détaillés au sujet de la perception du ballonnement abdominal, des symptômes liés au ballonnement et de leurs effets sur le mode de vie. Le tour de l'abdomen a été mesuré trois fois par jour pendant un cycle menstruel en entier, tout comme les cotes quant à la gravité du ballonnement abdominal perçu et à l'inconfort. La présence de symptômes abdominaux et gastro-intestinaux a été comparée.

Résultats : Une proportion considérablement supérieure de femmes présentant une endométriose ont connu un ballonnement abdominal, par comparaison avec les témoins (96 %, par comp. avec 64 %). Chez les femmes ayant connu un ballonnement abdominal, les facteurs suivants étaient plus courants chez celles qui présentaient une endométriose : grave inconfort connexe (30 %, par comp. avec 0 %), port de vêtements amples pendant le ballonnement (87 %, par comp. avec 38 %) et enflure simultanée des mains (30 %, par comp. avec 6 %). La présence de diarrhée et de constipation cycliques connexes était plus fréquente chez les femmes qui présentaient une endométriose. Bien que l'on ait constaté des modifications significatives en matière de cotes quant au ballonnement et à l'inconfort tout au long du cycle menstruel, une tendance cherchant à indiquer une différence entre les témoins et les femmes présentant une endométriose et ne prenant pas de médicaments n'a été perçue qu'en ce qui concerne la façon dont la gravité du ballonnement fluctuait tout au long du cycle. Les mesures du tour de la partie inférieure de l'abdomen ont connu des modifications significatives au cours de toutes les phases du cycle menstruel. Les modifications du tour de l'abdomen tout au long du cycle menstruel qu'ont connues les témoins et les femmes présentant une endométriose et ne prenant pas de médicaments présentaient des différences significatives, les témoins connaissant beaucoup moins de variations. Par comparaison avec les femmes présentant une endométriose et ne prenant pas de médicaments, les femmes qui ont reçu une hormonothérapie présentaient des cotes de gravité du ballonnement et des scores d'inconfort plus élevés; toutefois, aucune différence objective n'a été constatée en matière de tour de l'abdomen.

Conclusion : Le ballonnement abdominal douloureux semble être courant chez les femmes qui présentent une endométriose et cause une détresse symptomatique considérable.

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INTRODUCTION

Endometriosis is a reproductive tract disease that affects approximately 15 to 20 in every 100 women during their reproductive life.¹ While endometriosis is typically located within the reproductive system, it can affect other structures within the pelvic cavity and, in rare cases, outside the pelvic region. Indeed, up to one quarter of women with pelvic endometriosis may have intestinal lesions.² The clinical symptoms of endometriosis are highly variable but encompass dysmenorrhea, non-cyclical pelvic pain, dyspareunia, heavy menstrual bleeding, and infertility. It is important to note that a small number of women with endometriosis can be completely asymptomatic or experience only mild symptoms.^{3–4}

Women with endometriosis sometimes report gastrointestinal symptoms similar in presentation to irritable bowel syndrome, including cyclical and painful abdominal bloating. Since confirmation of diagnosis can usually be made only by laparoscopy with biopsy, epidemiological data, particularly concerning the prevalence of specific symptoms, are difficult to ascertain. Consequently, data on specific symptoms are scarce. However, the president of the Endometriosis Association in the US described results from two surveys of members, one conducted in early to mid 1980s (N = 3020) and the second in 1998 (N = 4000).⁵ Data from the second survey were restricted to those 3680 subjects with surgical confirmation of endometriosis.⁶ Dysmenorrhea was reported by the majority of each of the two samples (95–96%), with fatigue the second most frequent symptom (82–87%), and gastrointestinal upset at the time of menses (including diarrhea and painful bowel movements) reported by 79% to 85%. The fourth most frequent symptom was abdominal bloating, recorded by 84% of the second registry sample. Louden and colleagues⁷ surveyed 50 women from a secondary referral clinic with recently diagnosed endometriosis and found approximately 41% reported bloating, 26% constipation, and 13% diarrhea. It is important to note that both of these studies used only retrospective or historical data.

Despite the apparent high prevalence of abdominal bloating and other gastrointestinal complaints, these have not been well recognized as part of the complex of endometriosis symptoms. Many doctors are unaware that

endometriosis may sometimes present primarily with cyclical bloating, abdominal pain, and other symptoms suggestive of irritable bowel syndrome, such as altered bowel habits.^{8–10} Some patients with endometriosis report bloating around the time of ovulation, but more typically report bloating a few days prior to menstruation.¹¹ Anecdotally, this bloating is described as uncomfortable or painful, often accompanied by a sensation of abdominal fullness, and it often forces women with endometriosis to wear loose clothing. However, there is little systematic evidence of the effect of bloating on women with endometriosis.

Several authors have debated whether endometriosis and gastrointestinal symptoms may coexist by chance (if, for example, women develop endometriosis and IBS independently) or whether endometriosis causes IBS-like gastrointestinal symptoms.^{9–13} Ferrero and colleagues⁹ reported that approximately one third of women with endometriosis without bowel lesions had a diagnosis of IBS by the Rome II criteria, whereas all of the women with bowel lesions of endometriosis had symptoms mimicking IBS (a diagnosis that is precluded if bowel pathology is present). They also demonstrated a relationship between the extent of lesions into the abdominal wall and the severity of symptoms.¹³ Recently, Searman and colleagues,¹⁴ in a large case-control study (5540 women with endometriosis and 21 239 control subjects), found that women with endometriosis were more likely than controls to have a diagnosis of IBS (OR 3.5; 95% CI 3.1 to 3.9).

Abdominal bloating is thought to be mediated through increased production and retention of gas and fluid within the gastrointestinal luminal contents.¹⁵ The enteric neural system is responsible for neural control in hollow organs, including gastrointestinal, reproductive, urinary, and biliary tracts.¹¹ Thus, through this neural system complex, any “inflammation” or other condition in one pelvic visceral structure might influence functioning and responses to pathophysiology in other visceral structures.¹⁶ This means that dysfunction of the enteric nervous system in the uterus¹⁷ and fallopian tubes of women with endometriosis may also occur in the gastrointestinal tract, which then may relate to the bloating sensation felt by endometriosis sufferers.

The current study was not intended to answer controversies regarding comorbidity versus etiology, but rather to add to our knowledge about the type, severity, and frequency of gastroenterological symptoms experienced by women with and without endometriosis. A preliminary study of symptoms associated with endometriosis has suggested a relationship between endometriosis and abdominal bloating.¹⁸ This study suggested that women with endometriosis are more severely affected by abdominal bloating than are

ABBREVIATIONS

GLM	general linear model
IBS	irritable bowel syndrome
OC	oral contraceptive

women without the condition. The present pilot study explored the relationship between painful and severe cyclical abdominal bloating and endometriosis in more detail. More specifically, women with and without symptoms indicative of endometriosis were surveyed regarding their general experience of abdominal symptoms, the relationship of these symptoms to the menstrual cycle, and the impact of these symptoms. Furthermore, prospective daily measurements of abdominal girth and of the severity and impact of abdominal symptoms were taken to correlate objective changes with symptoms.

In women with confirmed endometriosis, the relationship between treatment for endometriosis and experience of abdominal symptoms was also investigated. Anecdotally, some treatments for endometriosis have been reported to exacerbate bloating, and bloating is a known side effect of some medications used in treatment (e.g., goserelin, Mirena).¹⁹ However, it is not clear whether the exacerbation of bloating is a side effect of the therapy itself or if it is the result of an adverse interaction between the agent used and endometriosis. Furthermore, there are known effects of female hormones on the gastrointestinal tract,²⁰ and there have been suggestions that use of an oral contraceptive may affect gastrointestinal symptoms.²¹

METHODS

Women aged between 20 and 55 years were invited to participate in the study, independent of whether or not they experienced abdominal bloating or other gastrointestinal symptoms. Women with endometriosis were recruited from a specialist gynaecology clinic within the University of Sydney between January 2001 and December 2003. All diagnoses of endometriosis were made at laparoscopy. During the same period, a convenience sample of women without evidence of endometriosis or other gynaecological problems was recruited for inclusion in the control group. The inclusion criteria for the control group were women with no current gynaecological complaint, with no ongoing gynaecological or gastroenterological condition and with ages in the same range as the women with endometriosis. These women were mainly staff and students of the University of Sydney. There were no exclusion criteria. Individual women received a written information sheet and gave written informed consent.

Each participant was asked to complete a questionnaire on demographic details, gynaecological history (with emphasis on endometriosis if appropriate), menstrual experiences and pain experiences, and other medical symptoms (especially gastrointestinal). The questionnaire also included questions on participants' experience of abdominal bloating. Women who reported experiencing abdominal bloating

were further questioned regarding how the bloating affected quality of life (no effect, mild discomfort, severe discomfort), if they experienced post-prandial exacerbation, if they thought that it was related to consumption of specific foods, if they had to wear loose fitting clothes because of bloating, if it was accompanied by swelling in other parts of the body (ankles or hands), and if they had associated symptoms such as nausea and flatulence.

Women were also asked to chart their abdominal symptoms, abdominal girth, and weight over a complete menstrual cycle, beginning charting on the first day of menstruation and continuing until the first day of the next cycle. They made three recordings per day (morning, afternoon, and evening prior to retiring). Experiences of the severity of abdominal bloating and the level of discomfort were made using a modified Likert scale (0 = none, 1 = mild, 2 = moderate, 3 = severe).

Participants were instructed to take two girth measurements at each recording: on the exact horizontal plane just under the tenth rib (upper girth), and on the horizontal plane through both anterior superior iliac spines (lower girth). These girth measurements were demonstrated for each subject, and an explanatory diagram was provided indicating the precise areas for measurements. To ensure uniformity, non-stretchable fibreglass tape measures were provided.

All data analyses were performed using SPSS Version 15 (SPSS Inc., Chicago IL). Unless otherwise specified, analyses compared all women with endometriosis and the control group.

The Mann-Whitney U test (denoted by M-WUz) was used for comparisons of the control and endometriosis groups on variables with significantly skewed distributions, and the Student *t* test was used where data were normally distributed. Chi-square analyses were conducted in the comparison of groups on categorical data such as experience of abdominal bloating. Fisher exact test was used when 2 × 2 tables had low expected frequencies. Data on the timing of abdominal bloating specifically related to the menstrual cycle were not considered applicable for those women from the medicated endometriosis groups.

The relationship between charted ratings of abdominal bloating severity and discomfort was examined using a Spearman's correlation (denoted by r_s).

BMI, age, and OC use were viewed as potential covariates in the analysis of the daily chart data on perceived and objective abdominal bloating. Both BMI and age were mean centred, a conservative procedure used when the relationship between the covariate and the dependent (such as age or BMI and bloating scores) was much larger than the

Table 1. Demographic, menstrual characteristics, and use of oral contraception

Characteristic	Control group n = 25	Unmedicated endometriosis n = 12	Medicated endometriosis n = 14	Statistics* Control vs. combined endometriosis groups
Current age				
Mean (SD)	28.6 (6.7)	34.2 (6.2)	36.4 (9.6)	M-WUz = -3.15, <i>P</i> = 0.002
Range	22–47	25–44	24–55	
BMI				
Mean (SD)	21.0 (2.7)	25.6 (5.1)	24.3 (4.6)	M-WUz = -3.12, <i>P</i> = 0.002
Range	17.3–26.2	18.2–34.9	18.0–32.4	
Age at menarche				
Mean (SD)	13.3 (1.1)	13.1 (1.9)	13.1 (2.6)	<i>t</i> = 0.34, <i>df</i> = 34.7, <i>P</i> = 0.736
Range	12–16	10–16	9–17	
Regularity of cycle, % (n)				
Regular	84.0 (21)	50.0 (6)	14.3 (2)	$\chi^2 = 17.82$, <i>df</i> = 2, <i>P</i> < 0.001
Irregular	12.0 (3)	41.7 (5)	7.1 (1)	
Not presently menstruating	0.0 (0)	0.0 (0)	78.6 (11)	
Unknown	4.0 (1)	8.3 (1)	0.0 (0)	
Cycle length, days				
Mean (SD)	28.8 (2.5)	28.9 (4.9)	n/a	M-WUz = -0.24, <i>P</i> = 0.808
Range	24–35	21–40		
Menses length, days				
Mean (SD)	4.9 (1.4)	5.7 (2.0)	n/a	M-WUz = -1.27, <i>P</i> = 0.205
Range	3–7	3–10		
Oral contraception, % (n)				
Current†	20.0 (5)	0.0 (0)	0.0 (0)	n/a
Used in past	24.0 (6)	58.3 (7)	85.7 (12)	
Never used	12.0 (3)	33.3 (4)	14.3 (2)	
Unknown	44.0 (11)	8.3 (1)	0.0 (0)	

*Statistics represent a comparison between controls and the combined endometriosis groups, with the exception of regularity of cycle, cycle length, and menses length where the medicated endometriosis group was excluded; cell sizes too small for valid analysis of oral contraception use (even with the endometriosis groups combined).

†One subject in the endometriosis group was categorized as “medicated” because she was taking OC in the two years prior to study, but OC use was not current at the time of the study.

variability seen across the repeated measures (in this case across phases of the menstrual cycle²²).

The first set of GLM repeated measures analyses examined the effect of menstrual cycle phase and endometriosis status on perception of severity and discomfort of abdominal bloating. Bloating and discomfort severity scores were explored using averaged morning and evening scores. Only the control group and the unmedicated endometriosis group were included in the analyses, because women in the endometriosis group who were on medication did not have a menstrual cycle. Prior to conducting comparisons of the control and unmedicated endometriosis group, the effect of current OC use was examined among the control subjects (none of the unmedicated endometriosis group was currently using an OC). There were no significant differences

in age or BMI between those control subjects using or not using OC. The control and unmedicated endometriosis groups differed significantly in current age and BMI (*P* = 0.008 and *P* = 0.004 respectively), the controls being younger and slimmer.

For the purposes of analysing the daily chart data, three menstrual cycle phases were defined: the first five days were classified as “menstrual,” the final five days as “premenstrual,” and the remaining days were considered “intermenstrual.” Measurements among each of these three phases were averaged to produce a phase score, which was used in the GLM repeated measures ANOVAs.

A measure of diurnal variation was developed by calculating the difference between the morning and evening severity and discomfort ratings. The relationship between menstrual

Table 2. Severity of pain experienced with menstrual period

Pain severity	Control group n = 25, n (%)	Unmedicated endometriosis n = 12, n (%)	Medicated endometriosis* n = 14, n (%)
Slight pain (not requiring medication)	9 (36.0)	2 (16.7)	1 (7.1)
Moderate pain (requiring analgesics)	13 (52.0)	1 (8.3)	3 (21.4)
Severe pain (affects living despite analgesics)	2 (8.0)	4 (33.3)	5 (35.7)
Incapacitating pain	0 (0.0)	3 (25.0)	5 (35.7)
Not reported	1 (4.0)	2 (16.7)	0 (0.0)

*Menstrual pain in hormonally treated endometriosis group referred to menstrual experience before hormonal therapy.

cycle phase, endometriosis status, and diurnal variation in abdominal severity and discomfort was also explored using GLM repeated measures ANOVA.

Two diaries were excluded from these longitudinal analyses, each from the control group, because of discrepancies between usual and charted cycle lengths. One chart, from the medicated endometriosis group, was excluded from the comparison of diurnal variation between the endometriosis subgroups because of the short recording period (17 days). There were insufficient measurements to include charted data from the middle of the day in any of the analyses.

Alpha was set at 0.05 for all analyses.

Approval to conduct this research was granted by the Human Research Ethics Committee of the University of Sydney.

RESULTS

Among 51 subjects, 26 (51%) had a laparoscopically confirmed diagnosis of endometriosis. The average age at diagnosis was 24.9 years (SD 8.2, range 15–40). Demographics for the entire sample, including menstrual characteristics and use of oral contraception, are presented in Table 1. The women with endometriosis and the control group differed significantly in average age, BMI, and regularity of cycle.

Among the 26 women with endometriosis, 14 (54%) were currently receiving pharmaceutical treatment or had received treatment within the previous two years. Treatments used included oral norethisterone (n = 5, one combined with celecoxib), oral medroxyprogesterone acetate (n = 3), goserelin implants (n = 2), tibolone (n = 1), danazol (n = 1), an unspecified oral contraceptive (n = 1), and tamoxifen (n = 1).

Subjects were asked to nominate the level of pelvic pain they experienced with menstruation (none, slight, moderate, severe, or incapacitating). The control and endometriosis groups differed significantly in their pain profiles ($\chi^2 = 20.22$, $df = 3$, $P < 0.001$); two thirds of the

women with endometriosis experienced severe or incapacitating pain (71%), compared with only two of the women without endometriosis (8%) (Table 2).

Data on subjective experiences of abdominal bloating are presented in Table 3. A significantly larger proportion of women with endometriosis (96%) reported experiencing abdominal bloating than women in the control group (64%; $\chi^2 = 5.81$, $df = 1$, $P < 0.05$). Severe discomfort related to this abdominal bloating was acknowledged by approximately one third of women with endometriosis, compared with none of the control group ($\chi^2 = 7.64$, $df = 2$, $P < 0.05$). When considering bloating in the context of the menstrual cycle, a similar pattern emerged: 82% of the unmedicated women with endometriosis claimed they “always” experienced menstrually related abdominal bloating, compared with approximately one in six of the women in the control group (“sometimes” and “always” combined, Fisher exact test $P < 0.05$).

Subjects were also asked about their experience of other gastrointestinal symptoms related to their menstrual cycle (Table 3). Almost one third of the women with endometriosis “always” experienced diarrhea related to their cycle, compared with 9% of the control subjects (no significant difference). Constipation related to their cycle was “always” experienced by 16% of women with endometriosis and none of the control subjects, a statistically significant difference ($\chi^2 = 5.41$, $df = 1$, $P < 0.05$, with “sometimes” and “always” collapsed for the purpose of analysis).

If subjects experienced abdominal bloating, they were asked about experiences and symptoms they believed were related (Table 4). A significantly greater proportion of women with endometriosis felt that it was necessary to wear loose clothes when experiencing abdominal bloating ($P < 0.005$), and felt that swelling of their hands was associated with abdominal bloating ($P < 0.005$). Women with endometriosis tended to experience ankle swelling more frequently than control subjects, but the difference was not

Table 3. Subjective experiences of abdominal bloating

	Control group n = 25, n (%)	Unmedicated endometriosis n = 12, n (%)	Medicated endometriosis n = 14, n (%)
Do you experience abdominal bloating?			
Yes	16 (64.0)	12 (100.0)	11 (78.6)
No	9 (36.0)	0 (0.0)	1 (7.1)
Not reported	0 (0.0)	0 (0.0)	2 (14.3)
If yes to abdominal bloating, effect on life			
No effect	5 (31.3)	2 (16.7)	0 (0.0)
Mild discomfort	11 (68.8)	8 (66.7)	6 (54.5)
Severe discomfort	0 (0.0)	2 (16.7)	5 (45.5)
Do you experience abdominal bloating related to your menstrual cycle?			
Never	5 (20.0)	0 (0.0)	0 (0.0)
Sometimes	14 (56.0)	2 (16.7)	4 (28.6)
Always	4 (16.0)	9 (75.0)	10 (71.4)
Not reported	2 (8.0)	1 (8.3)	0 (0.0)
If yes to abdominal bloating related to menstrual cycle, when*			
Any time during menstrual cycle	2 (11.1)	1 (9.1)	n/a
Before period	7 (38.9)	3 (27.3)	n/a
During period	4 (22.2)	1 (9.1)	n/a
Before and during period	5 (27.8)	5 (45.5)	n/a
After period	0 (0.0)	1 (9.1)	n/a
Do you experience diarrhea related to your menstrual cycle?			
Never	8 (32.0)	1 (8.3)	3 (21.4)
Sometimes	13 (52.0)	6 (50.0)	8 (57.1)
Always	2 (8.0)	4 (33.3)	3 (21.4)
Not reported	2 (8.0)	1 (8.3)	0 (0.0)
Do you experience constipation related to your menstrual cycle?			
Never	16 (64.0)	5 (41.7)	4 (28.6)
Sometimes	7 (28.0)	4 (33.3)	8 (57.1)
Always	0 (0.0)	2 (16.7)	2 (14.3)
Not reported	2 (8.0)	1 (8.3)	0 (0.0)

*Timing of cyclic abdominal bloating considered not applicable for those with medicated endometriosis.

significant. A greater proportion of women with endometriosis who were using medication experienced post-prandial worsening of bloating, ankle and hand swelling, and increased flatulence in association with bloating than did women not on medication, but this difference could not be confirmed statistically.

Forty-one subjects submitted a daily symptom diary (control subjects: n = 24, unmedicated endometriosis: n = 8, medicated endometriosis: n = 9). All eight charts from the

unmedicated endometriosis group were retained in the analyses.

Several factors were considered possible contributors to differences between the groups in daily chart measures, particularly the objective measures of girth. These were the subject's age, BMI, and current use of an OC. There was a significant positive correlation between age and BMI among subjects with a charted cycle, such that older

Table 4. Other experiences and symptoms related to abdominal bloating for those who experience bloating (n = 39)

If subject experienced abdominal bloating	Control group n = 16, n (%)	Unmedicated endometriosis n = 12, n (%)	Medicated endometriosis n = 11, n (%)	Statistics* df = 1
Necessary to wear loose clothing?				
Yes	6 (37.5)	10 (83.3)	10 (90.9)	$\chi^2 = 8.28,$
No	10 (62.5)	2 (16.7)	1 (9.1)	$P = 0.004$
Abdominal bloating worse after meals?				
Yes	7 (43.8)	6 (50.0)	9 (81.8)	$\chi^2 = 1.88,$
No	7 (43.8)	2 (16.7)	2 (18.2)	$P = 0.171$
Don't know	2 (12.5)	4 (33.3)	0 (0.0)	
Do you think that some foods increase your abdominal bloating?				
Yes	9 (56.3)	4 (33.3)	7 (63.6)	$\chi^2 = 0.46,$
No	6 (37.5)	1 (8.3)	2 (18.2)	$P = 0.497$
Don't know	1 (6.3)	7 (58.3)	2 (18.2)	
When experiencing abdominal bloating, do you have:				
Any feelings of sickness, nausea?	4 (25.0)	5 (41.7)	5 (45.5)	$\chi^2 = 0.71, P = 0.399$
Swelling around the ankles?	1 (6.3)	2 (16.7)	5 (45.5)	$\chi^2 = 2.06, P = 0.151$
Swelling of the hands?	0 (0.0)	4 (33.3)	8 (72.7)	$\chi^2 = 9.73, P = 0.002$
An increase in wind (flatulence)?	10 (62.5)	9 (75.0)	10 (90.9)	$\chi^2 = 1.09, P = 0.297$

*Analyses compared controls versus combined endometriosis groups (cell sizes too small for three group comparison), and excluded don't know responses.

subjects tended to have greater BMI ($r_s = 0.47, n = 36, P = 0.004$). Two subjects did not have BMI recorded.

The severity and discomfort of abdominal bloating were rated on a modified Likert scale ranging from none (0) to severe (3). The average bloating severity scores were lowest in the control group (mean 0.18, SD 0.48, $n = 594$ daily ratings), followed by the unmedicated endometriosis group (0.50, 0.68, $n = 227$), and highest in the medicated endometriosis group (1.43, 0.92, $n = 232$). The discomfort scores followed a similar pattern: control subjects had the lowest scores with a mean of 0.17 (SD 0.49), followed by the unmedicated endometriosis group with 0.41 (0.63) and the medicated endometriosis group with 1.33 (0.93). There were significant positive correlations between the perceived severity of bloating and discomfort ($r_s = 0.89, n = 1053, P < 0.001$). This positive relationship remained when the groups were examined separately (control group $r_s = 0.78, n = 594, P < 0.001$; unmedicated endometriosis $r_s = 0.88, n = 227, P < 0.001$; and medicated endometriosis $r_s = 0.92, n = 232, P < 0.001$).

GLM repeated measures ANOVAs indicated that there were significant changes across the menstrual cycle in perceived severity of abdominal bloating and discomfort. However, the groups (control versus unmedicated endometriosis) did not differ significantly in how these ratings changed across menstrual cycle phases, each demonstrating the greatest severity of bloating and discomfort during menstruation, with a decline during the intermenstrual phase and worsening during the premenstrual phase (Table 5, Figures 1 and 2).

In the second set of analyses, BMI and age were used as covariates in an attempt to control for differences in these demographic variables between the groups. There was no effect of OC use on changes across the menstrual cycle amongst control subjects. Consequently, OC use was not considered in further analyses. After differences between the groups in age and BMI were accounted for, there remained significant changes in severity and discomfort scores across the menstrual cycle. For bloating severity, after accounting for age differences there was a non-significant trend towards a difference between the groups in how

Table 5. GLM Repeated Measures ANOVA for perceived severity of abdominal bloating and discomfort, averaged across morning and evening records, for the control and unmedicated endometriosis groups

	Change across menstrual cycle phases (phase effect)	Differences between groups in menstrual cycle changes (phase by group effect)	Impact of BMI or age on changes across menstrual cycle phases
Bloating score	F(2,54) = 20.63, <i>P</i> < 0.001	F(2,54) = 2.50, <i>P</i> = 0.092	n/a
After controlling for BMI	F(2,50) = 15.89, <i>P</i> < 0.001	F(2,50) = 0.24, <i>P</i> = 0.789	F(2,50) = 1.49, <i>P</i> = 0.236
After controlling for age	F(2,52) = 20.50, <i>P</i> < 0.001	F(2,52) = 2.77, <i>P</i> = 0.072	F(2,52) = 0.40, <i>P</i> = 0.674
Discomfort score	F(2,54) = 11.78, <i>P</i> < 0.001	F(2,54) = 0.89, <i>P</i> = 0.417	n/a
After controlling for BMI	F(2,50) = 9.97, <i>P</i> < 0.001	F(2,50) = 0.32, <i>P</i> = 0.731	F(2,50) = 0.11, <i>P</i> = 0.898
After controlling for age	F(2,52) = 11.73, <i>P</i> < 0.001	F(2,52) = 1.09, <i>P</i> = 0.344	F(2,52) = 0.36, <i>P</i> = 0.701

ratings changed across the menstrual cycle ($F[2,52] = 2.77$, $P = 0.072$).

GLM repeated measures ANOVAs were performed on the diurnal variation in abdominal severity and discomfort ratings, again taking group differences in BMI and age into account (Table 6, Figure 3). OC use did not have a significant effect on changes across the menstrual cycle in diurnal variation of scores amongst control subjects, and so it was not accounted for in subsequent analyses. Both subjective and objective bloating and discomfort scores and measurements were always greater in the evening.

The only significant result was a difference between the groups (control vs. unmedicated endometriosis) in changes across the menstrual cycle in diurnal variation of perceived bloating after accounting for group differences in BMI ($F[2,48] = 4.82$, $P = 0.025$, power = 66%). Amongst the unmedicated endometriosis group, the smallest diurnal variation in bloating severity was during the premenstrual phase, whereas for the control group this phase had the largest diurnal variation.

Two objective measurements of abdominal girth were recorded: upper girth (at the level of the tenth rib) and lower girth (at the level of the anterior superior iliac spines). For the purposes of analysis, morning and evening measurements were averaged, and then changes across menstrual cycle phase and between groups (control vs. unmedicated endometriosis) were explored using GLM repeated measures ANOVA. The results are shown in Table 7 and Figures 4 and 5. Significant changes across the menstrual cycle were apparent for both upper and lower girth. There was no significant difference between the endometriosis and control groups in these changes across the menstrual cycle for upper girth, but there was significance for lower girth ($F[2,52] = 5.98$, $P = 0.013$), the women with unmedicated endometriosis experiencing more fluctuation in girth across the menstrual cycle than the control group. This persisted after the group differences in age were accounted for, but

after group differences in BMI were countered the significance disappeared.

Measures of perceived bloating, discomfort, and girth measurements (averaged between morning and evening) and of diurnal variations on these measures were compared between women who were receiving hormonal therapy for endometriosis and those who were not. Menstrual cycle phase was not taken into account since women who were on therapy did not cycle. The endometriosis subgroups did not differ significantly on BMI or age. There were significant differences between the subgroups in perceived bloating scores (M-WUz = -10.89 , $P < 0.001$) and discomfort scores (M-WUz = -10.87 , $P < 0.001$), those women on treatment reporting greater severity and discomfort. However, objective abdominal girth measurements did not differ significantly between the subgroups.

The same pattern was apparent for diurnal variations, with the endometriosis subgroups differing significantly in diurnal variation of perceived abdominal bloating (M-WUz = -4.62 , $P < 0.001$) and perceived discomfort (M-WUz = -4.82 , $P < 0.001$), with those women receiving hormonal treatment reporting greater diurnal variation in perceived severity and discomfort. There was no significant difference in diurnal variation in the objective girth measures.

DISCUSSION

Whilst there has recently been interest in the relationship between bowel endometriosis and symptoms of abdominal bloating and discomfort,^{2,9,13} there is little systematic research on the presence of abdominal symptoms in women with endometriosis, regardless of the site of the lesion. Abdominal bloating has been generally recognized by gynaecologists as a non-classical symptom of endometriosis but has not been substantially acknowledged as part of the endometriosis “problem.” Clinicians may misinterpret this symptom as a gastrointestinal problem, painful abdominal bloating may not be methodically explored in the history, and patients will be dissatisfied with the results

Figure 1. Reported severity of bloating (scores presented by menstrual cycle phase and by group; higher scores indicate more severe perceived bloating)

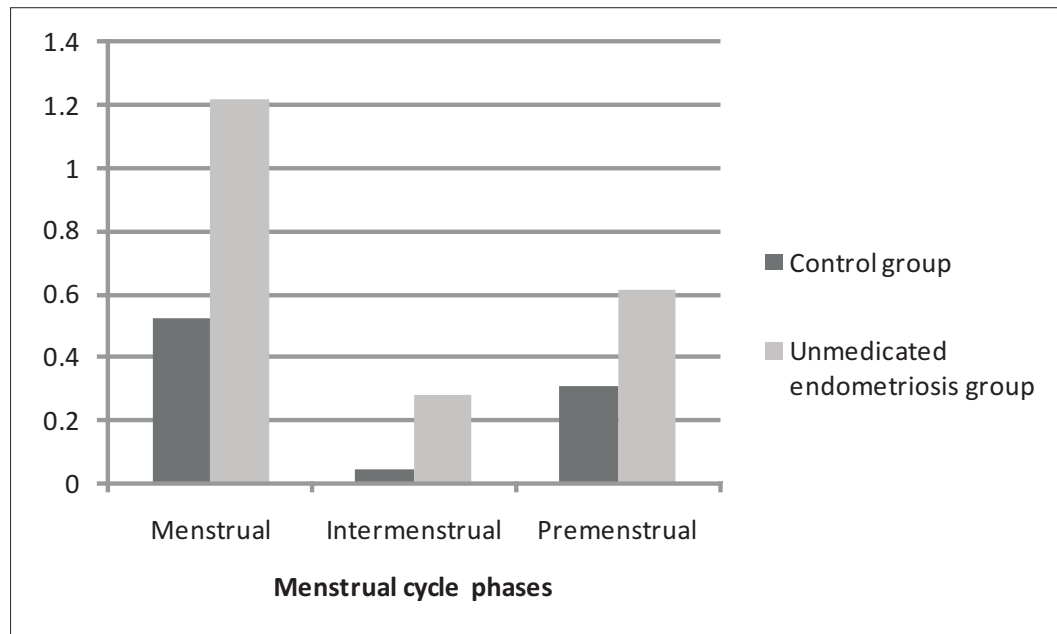
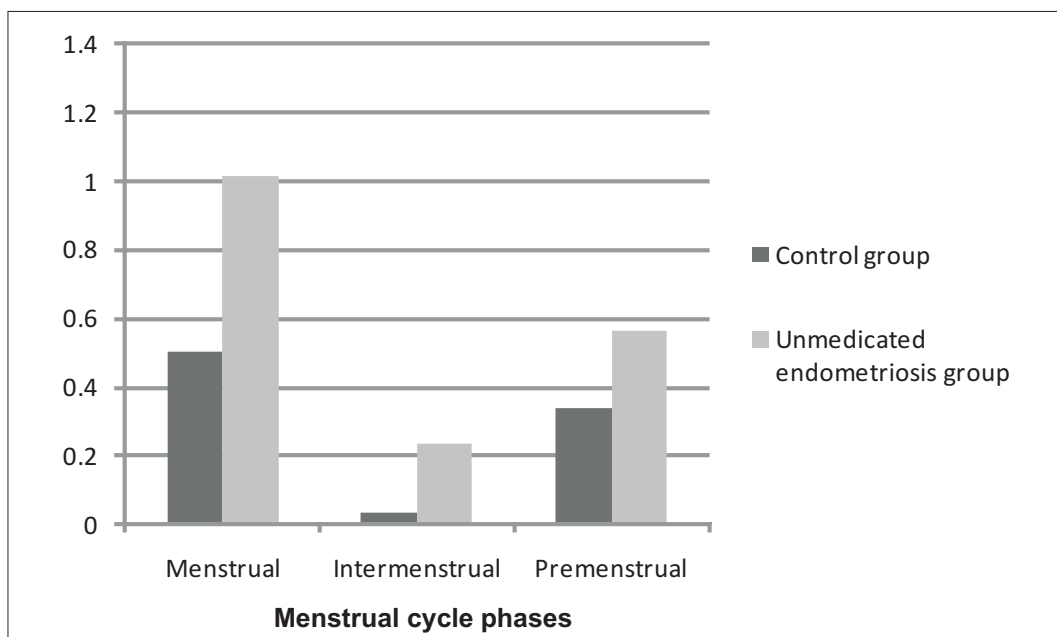


Figure 2. Reported discomfort associated with bloating



Scores presented by phase and group; higher scores indicate more severe perceived discomfort.

of misdirected treatment. Yet women with endometriosis may report these abdominal symptoms as severe and distressing. The findings from this study indicate that painful abdominal bloating appears to be a considerable problem for most women with endometriosis.

The current study represents the first attempt to investigate these abdominal symptoms prospectively, incorporating both subjective and objective measures of bloating and

discomfort in a group of women with severe persistent symptoms of endometriosis and a comparison group of women without symptoms or signs of endometriosis. There were clear differences, with greater severity and effect on lifestyle in women with endometriosis. Symptoms more common in the women with endometriosis included greater cyclically related diarrhea and constipation. While mild bloating is commonly experienced by women without

Table 6. GLM repeated measures ANOVA for diurnal variation in perceived severity of abdominal bloating and discomfort for the control and unmedicated endometriosis groups

	Change across menstrual cycle phases (phase effect)	Differences between groups in menstrual cycle changes (phase by group effect)	Impact of BMI or age on changes across menstrual cycle phases
Diurnal variation in bloating score	F(2,52) = 1.21, P = 0.297	F(2,52) = 2.68, P = 0.099	n/a
After controlling for BMI	F(2,48) = 1.83, P = 0.184	F(2,48) = 4.82, P = 0.025	F(2,48) = 2.32, P = 0.129
After controlling for age	F(2,50) = 1.21, P = 0.297	F(2,50) = 2.66, P = 0.101	F(2,50) = 0.18, P = 0.753
Diurnal variation in discomfort score	F(2,50) = 0.39, P = 0.626	F(2,50) = 0.03, P = 0.947	n/a
After controlling for BMI	F(2,46) = 0.30, P = 0.682	F(2,46) = 0.08, P = 0.872	F(2,46) = 0.08, P = 0.876
After controlling for age	F(2,48) = 0.20, P = 0.756	F(2,48) = 0.18, P = 0.776	F(2,48) = 1.10, P = 0.328

pathology, the majority of women with endometriosis in this study experienced at least mild abdominal bloating, and more often moderate or severe bloating that strongly correlated with the severity of the discomfort they endured. Most of the women with endometriosis (87%) reported needing to wear loose fitting clothing during days when abdominal bloating was present, compared with about one third of women in the control group. When abdominal bloating occurred, it was noticed that the symptom was accompanied by swelling of hands and to a lesser degree of ankles, the former being significantly more common in the women with endometriosis.

A strength of the current study was the finding of differences between the groups in objectively collected measurements. It should be noted that frequent objective measures across menstrual cycles require dedication from subjects and often result in relatively few accurately collected data sets. Although our group sizes were small, some interesting patterns appeared from the recorded data. Measures of lower abdominal girth changed significantly across the cycle for the control group and the unmedicated endometriosis group, and the latter group experienced greater girth changes across the cycle. When the endometriosis subgroups were compared, there were no differences in diurnal variations in abdominal girth, but there were differences in the subjective daily ratings, with those women being treated for their endometriosis rating their bloating and discomfort as more severe.

The overlap in gastrointestinal symptoms associated with both IBS and endometriosis contributes to diagnostic confusion. Given the high prevalence of IBS in women with endometriosis and the impact of bowel endometriosis, lower abdominal symptoms require both a gynaecological and gastrointestinal investigation.^{9,13,14} Seaman and colleagues noted that both disorders are relatively difficult to diagnose, there being no non-invasive diagnostic test for

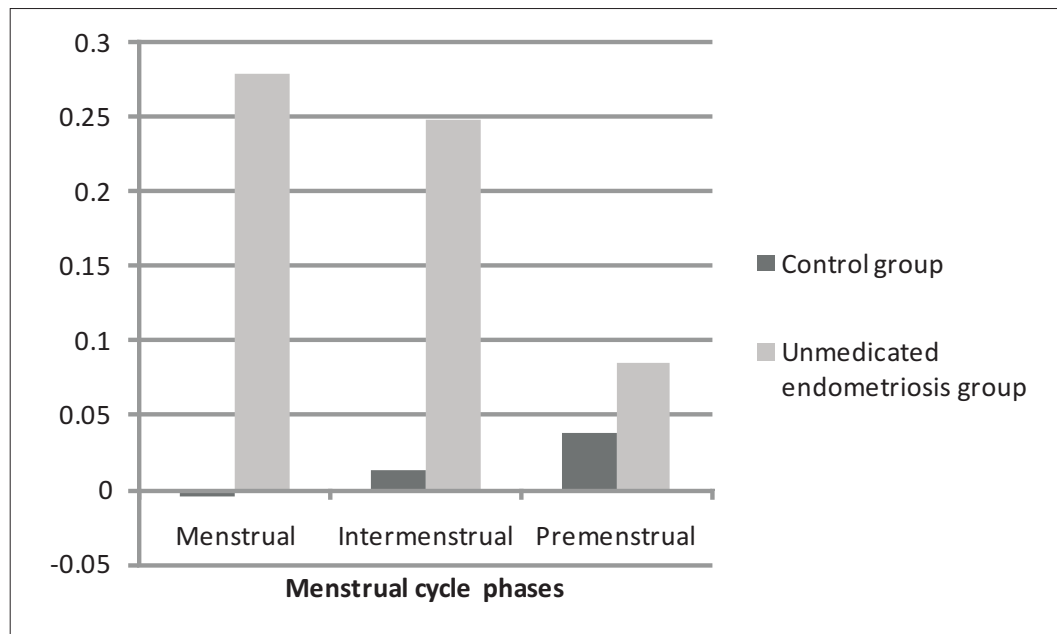
endometriosis, and IBS being a diagnosis of exclusion (made only after organic etiologies have been ruled out).¹⁴ In contrast, Remorgida et al.²³ discuss one notable difference: symptoms of IBS are typically relieved after defecation, which is not the case with symptoms of endometriosis.

Although bloating may be associated with fluid retention, it is generally believed that the pathophysiological mechanisms behind abdominal bloating are relaxation of the bowel wall with an associated increase in gas and fluid luminal contents.¹⁵ The exact mechanisms of these fluid retention, bowel relaxation, and increased luminal content phenomena are unclear. It has been postulated that gastrointestinal symptoms in endometriosis are actually related to altered motor activity of the enteric nervous system, which is responsible for neural control of muscular and some secretory activity of the hollow viscera including gastrointestinal and reproductive tracts.¹¹ It is possible that some women with endometriosis experience dysfunction of the enteric nervous system, which may link pain symptoms, bowel disturbance, and uterine disturbance. The end result may be a link between endometriosis, painful abdominal bloating, and other gastrointestinal symptoms.

Bowel symptoms with endometriosis do not necessarily indicate clinical involvement of endometriotic lesions on or in bowel wall, although the level of infiltration into the bowel wall correlates with the severity of symptoms.¹³ Troublesome bowel symptoms are sometimes caused by peritoneal lesions that are close to the bowel surface but not directly on it. Possibly the secretion of prostaglandins or cytokines may influence bowel function by diffusion through peritoneal fluid.

A nationwide study in the United Kingdom reported that the majority of patients with endometriosis had been referred to other specialists before seeing a gynaecologist, and before the correct diagnosis was made, over one half of

Figure 3. Diurnal variation in perceived bloating severity



Scores presented by phase and group; higher scores indicate more severe perceived bloating. Diurnal variation refers to change from morning to evening in self-rating of bloating severity (worse in the evening for all groups)

Table 7. GLM repeated measures ANOVA for abdominal girth measurements, averaged across morning and evening records for the control and unmedicated endometriosis groups

	Change across menstrual cycle phases	Differences between groups in menstrual cycle changes	Impact of BMI or age on changes across menstrual cycle phases
Upper girth	$F(2,52) = 4.34, P = 0.018$	$F(2,52) = 2.34, P = 0.107$	n/a
After controlling for BMI	$F(2,48) = 3.35, P = 0.044$	$F(2,48) = 1.14, P = 0.327$	$F(2,48) = 4.71, P = 0.014$
After controlling for age	$F(2,50) = 3.54, P = 0.036$	$F(2,50) = 1.45, P = 0.244$	$F(2,50) = 0.84, P = 0.437$
Lower girth	$F(2,52) = 6.56, P = 0.009$	$F(2,52) = 5.98, P = 0.013$	n/a
After controlling for BMI	$F(2,48) = 6.76, P = 0.007$	$F(2,48) = 3.22, P = 0.067$	$F(2,48) = 8.83, P = 0.002$
After controlling for age	$F(2,50) = 5.72, P = 0.016$	$F(2,50) = 4.27, P = 0.037$	$F(2,50) = 1.21, P = 0.293$

the patients had been told that there was nothing wrong, causing substantial disillusionment for individual patients and delay in treatment.²⁴ Several studies have described the economic impact of endometriosis related to the expense of medical treatment and time lost from work, as well as the diminished quality of life for those affected.^{25,26} Clearly, painful abdominal bloating contributes significantly to this, and recognition and management of this symptom may substantially enhance quality of life for these sufferers.

The fact that women in the control group were not confirmed as disease-free by laparoscopy is a limitation of the study. However, this should strengthen our conclusions, because if there were women with endometriosis in the

control group they would have diminished the chance of finding significant differences between the groups; that is, the comparison would have been more conservative. Although the two groups were not matched in all demographic characteristics, statistical measures attempted to account for possible confounding differences between the groups. The sample sizes were relatively small, and it was not possible to select subjects randomly from the general population. Recruitment was difficult because of the demands of thrice daily double girth, weight, and symptom assessments. However, this pilot study represents the first attempt to examine both subjective and objective measures

Figure 4. Upper girth measurement by menstrual cycle phase and by endometriosis or control group

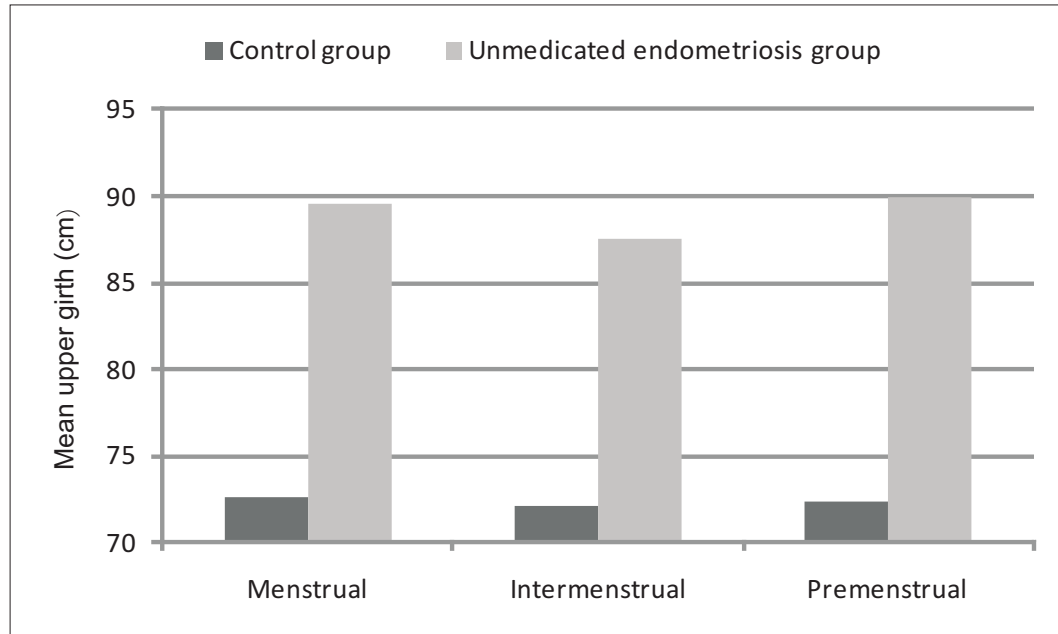
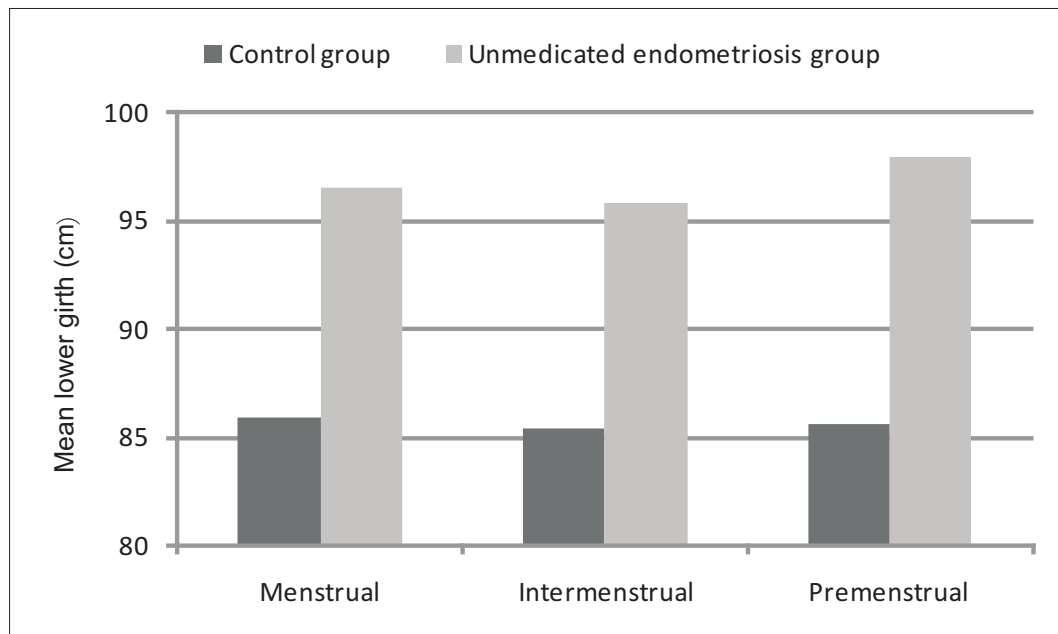


Figure 5. Lower girth measurement by menstrual cycle phase and by endometriosis or control group



of abdominal bloating in women with endometriosis and those without gynaecological complaint.

CONCLUSION

Abdominal bloating appears to be a significant problem for women with endometriosis, occurring more frequently and more severely in this group than in women without the disease. The current pilot study reports on some differences

between perceptions of bloating and girth measures, highlighting the need to obtain both subjective and objective data. Because of the impact of abdominal bloating, and the prevalence in women with endometriosis, we feel this study is worthy of replication in a larger sample, but acknowledge the difficulties associated with this type of research. The presentation of gastrointestinal symptoms together with pelvic symptoms make diagnosis difficult, and the precise

pathophysiological mechanisms behind gastrointestinal symptoms associated with endometriosis remain unclear. Further research on the relationship between abdominal bloating and the type, site, and function of endometriotic lesions may help to clarify the origins of this common and troublesome symptom.

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