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► To cite this version:

Claire Tourny, Ben-Moussa Amira Zouita, Samira El Kababi, Léa Feuillet, Ayoub Saeidi, et al..
Endometriosis and physical activity: A narrative review. *International Journal of Gynecology and
Obstetrics*, 2023, 10.1002/ijgo.14898 . hal-04166276

HAL Id: hal-04166276

<https://hal.science/hal-04166276>

Submitted on 8 Sep 2023

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Endometriosis and Physical Activity: A Narrative Review

Claire Tourny¹, Amira Zouita², Samira El Kababi³, Léa Feuillet¹, Ayoub Saeidi⁴, Ismail Laher⁵, Katja Weiss⁶, Beat Knechtle^{6,7*}, Hassane Zouhal^{8,9*}

¹ Univ Rouen Normandie, CETAPS - UR 3832- F-76821 Mont Saint Aignan, France.

² Higher Institute of Sport and Physical Education of Ksar-Said, Research Unit “Sports Performance, Health & Society” (UR17JS01), University of Manouba, Tunisia

³ Laboratoire d’immunologie, Institut supérieur des professions infirmières et techniques de Santé, Casablanca, Morocco.

⁴ Department of Physical Education and Sport Sciences, Faculty of Humanities and Social Sciences, University of Kurdistan, Sanandaj, Kurdistan, Iran.

⁵ Department of Anesthesiology, Pharmacology, and Therapeutics, Faculty of Medicine, University of British Columbia, Vancouver, Canada.

⁶ Institute of Primary Care, University of Zurich, Zurich, Switzerland.

⁷ Medbase St. Gallen Am Vadianplatz, St. Gallen, Switzerland.

⁸ Univ Rennes, M2S (Laboratoire Mouvement, Sport, Santé) - EA 1274, F-35000 Rennes, France.

⁹ Institut International des Sciences du Sport (2I2S), 35850, Irodouer, France.

* Corresponding author:

Prof. Hassane Zouhal (PhD) hassane.zouhal@univ-rennes2.fr

Univ Rennes, M2S (Laboratoire Mouvement, Sport, Santé) - EA 1274, F-35000 Rennes, France.

Running title: Endometriosis and Physical Activity.

31 **Abstract**

32 Endometriosis is a painful gynecological disorder that affects many women. Constant
33 treatments and contraception changes affect women looking for solutions to treat and limit the
34 problems caused by endometriosis. The current narrative review discusses the effects of
35 physical activity on the management, pain and quality of life in patients with endometriosis.
36 Findings suggest that body awareness practices such as halta yoga, the Jacobson method, and
37 progressive muscle relaxation reduce pain and stress and improve the quality of life associated
38 with endometriosis. It also highlights the current knowledge gap on available evidence and
39 future research. Moreover, care must be taken when considering patients' physical abilities and
40 goals and avoiding intense physical activities. The forms of endometriosis and its symptoms
41 vary from one woman to another, so it is important to carry out studies with various non-
42 medicinal or surgical techniques. It is important to continue randomized controlled trials to
43 obtain more data on the benefits of physical activity in women with endometriosis and also to
44 identify what types of activities could be beneficial to combat pain symptoms and improve the
45 daily lives of women with endometriosis.

46 **Keywords:** Exercise training; pain; quality of life; stress; systematic review

47

48 **Synopsis**

49

50 Body awareness practices such as halta yoga, the Jacobson method, and progressive muscle
51 relaxation reduce pain, stress and improve the quality in women with endometriosis.

52

53

54 **1. Introduction**

55 Endometriosis affects 1.5 to 2.5 million or 2- 10% of women of reproductive age [1]. The
56 funding allocation for endometriosis is expected to be \$16 million in the NIH budget in 2022.
57 The variable and broad symptoms of endometriosis mean that healthcare complicates
58 diagnosis, often causing lengthy delays between the onset of symptoms such as pain, abnormal
59 menstrual flow, excessive menstrual cramps, and diagnosis [2].

60 Endometriosis is a complex gynecological disease with poorly understood mechanisms. The
61 main theories utilized to explain the pathogenesis of endometriosis are Sampson's theory, the
62 coelomic metaplastic theory, the stem cell theory, the Müllerian remnant theory, and the
63 vascular and lymphatic metastasis theory [3].

64 Advances in the understanding of endometriosis now include less invasive and
65 nonpharmacological treatments [4]. International clinical guidelines suggest focusing on the
66 role of physical activity and exercise in managing endometriosis-associated symptoms [5]. The
67 inflammation that defines endometriosis sensitizes pelvic organs and leads to chronic pelvic
68 pain [6]. This mechanism makes suggests that the anti-inflammatory effects of physical activity
69 can likely ameliorate the pain associated with endometriosis [7].

70 Some interventions reduce the risk of developing endometriosis [8,9]. However, some authors
71 discuss the insufficiency of the existing literature on the effects of physical activity and exercise
72 on endometriosis-related symptoms [8].

73 Two previous systematic reviews on the effects of physical activity and exercise on
74 endometriosis-associated symptoms focused mainly on other complementary and alternative
75 treatment options, such as mind–body interventions and acupuncture [9,10]. There is growing
76 research interest in endometriosis. We conducted a narrative review to evaluate the benefits of
77 physical activity on pain and quality of life in women with endometriosis.

78 A narrative review was performed; we presented a non-systematic summation and critical
79 analysis of current knowledge on the benefits of physical activity on pain and quality of life in
80 women with endometriosis. To refine the scope of our narrative review, we established a set of
81 inclusion criteria: articles published up to November 2022 in the English language; original
82 scientific papers, clinical trials, meta-analyses, and reviews focusing on the effects of physical
83 activity on women with any degree of endometriosis. Physical activity is defined as “any body
84 movement produced by skeletal muscles that requires energy expenditure” [11]. Case reports
85 or series and letters were excluded. Moreover, articles addressing primary dysmenorrhea were
86 excluded as it usually occurs in women without pelvic pathology. PubMed, Scopus, EMBASE,

87 Web of Science, ScienceDirect and Cochrane Library were used as electronic databases for
88 this research.

89 **2. The endometriosis**

90 The diagnosis of endometriosis is complex since the disease takes various forms with different
91 symptoms. This often implies a wandering diagnosis, as it takes 5 to 7 years for many women
92 to appreciate the medical reasons for the deterioration of their quality-of-life markers.

93 The scientific community's attention has recently focused on the genetic mechanisms that may
94 be of significance for the increased rates of endometriosis. This hypothesis is supported by
95 findings of a 47% contribution from genetic factors to endometriosis, with the remaining 53%
96 attributed to unique environmental effects [12]. A recent meta-analysis demonstrated
97 significant genetic links between endometriosis and eleven pain conditions, including
98 migraine, back pain, multi-localized chronic pain conditions, and inflammatory pathologies
99 such as asthma or osteoarthritis [13]. It is likely that osteoarthritis may be associated with
100 fluctuations in estrogen and warrants a detailed exploration of genetic susceptibility [13].

101 In addition to this role of genetic factors, late pregnancy, early and late menopause, shortened
102 menstrual cycles with heavy and prolonged periods [14], malformation of the Müller canal, or
103 exposure to diethylstilbestrol in utero [15] appears to be risk factors for endometriosis.

104 Some studies suggest that having a lean body mass or low body fat may increase a woman's
105 risk for endometriosis [16]. An inverse relationship between endometriosis and body mass
106 index (BMI) is commonly acknowledged [17,18], although some studies of limited impact have
107 reported otherwise [19]. Reduction in the adipose stem cell population [20], an anorexigenic
108 effect through altered hepatic gene expression [21] and promotion of lipid dysfunction and fat
109 loss [22] are key mechanisms thought to be involved in the clinically low BMI phenotype
110 observed in women with endometriosis. Ferrero et al. [17] [reported that the BMI of 366
111 women with endometriosis was significantly lower compared to that of 248 controls and no
112 women with endometriosis were obese.

113

114 Endometriosis can be asymptomatic but can be accompanied by disabling pain, for example,
115 progressive and chronic pelvic cyclic pain before and during periods (dysmenorrhea) and
116 during sex (dyspareunia) [23].

117 The most common symptoms of endometriosis are painful sexual intercourse (deep
118 dyspareunia), pain before and/or during menstruation (dysmenorrhea), pain when urinating
119 (dysuria) and chronic pelvic pain [24]. The symptoms of endometriosis are differentiated by

120 the localization of the lesions. A lesion in the bladder can lead to dysuria resulting in difficulties
121 and pain during urination, urinary infections, and urinary stones [25]. Endometriosis may
122 superficially involve the peritoneum and the abdominal organs or the ovaries [26].

123 Endometriosis can also cause digestive disorders when it develops in the intestines, colon, and
124 rectum. Digestive endometriosis is a particularly severe form of the disease and accounts for 5
125 to 10% of endometriosis. In terms of symptoms, there is pain during defecation, alternating
126 diarrhea, constipation, rectorrhagia, occlusion phenomena with abdominal bloating, gas, and
127 constipation. Irritable bowel syndrome and endometriosis significantly overlap in symptom
128 presentation due to chronic inflammation, thus leading to chronic pelvic pain [27].

129

130 **3. The treatments of endometriosis**

131 The therapeutic management of endometriosis is related to the symptoms and the patient's
132 perspectives. There are cases of superficial endometriosis that do not require special treatment.
133 In a third of cases, superficial lesions will regress after a few months of treatment or without
134 treatment, allowing some women to use complementary medicines to stabilize the symptoms.
135 Treatment is usually offered when symptoms become severe. Hormonal therapy is the first
136 form of treatment that is offered in addition to pain medications [28]. The choice of treatment
137 is influenced by the patient's effectiveness, unfavorable side effects, long-term safety,
138 expenses, and accessibility. Because they interfere with ovulation, most current hormonal
139 treatments are not suitable for endometriosis patients who want to become pregnant [29,30].

140 Surgery can also be used to remove endometriosis lesions, adhesions, and scar tissue. However,
141 success in reducing pain symptoms and increasing pregnancy rates often depends on the extent
142 of the disease. In addition, lesions may reoccur even after successful eradication, and pelvic
143 floor muscle abnormalities (e.g., tense pelvic muscles, growth on the pelvis) can contribute to
144 chronic pelvic pain [31]. Patients with chronic pelvic pains with endometriosis rarely benefit
145 from hormonal and surgical management. Secondary changes in the pelvis, including the pelvic
146 floor, central nervous system sensitization, and myofascial dysfunction, can continue to
147 generate pain even after treatment [6]. Patients can benefit from physiotherapy and
148 complementary treatments. Physiotherapy for endometriosis should include physical therapy,
149 manual therapy (including visceral therapy), and spa treatments (including balneotherapy and
150 hydrotherapy) [32].

151

152 Non-medicinal management of endometriosis with acupuncture, osteopathy, and yoga can also
153 improve the quality of life and can be offered in addition to the medical management of
154 endometriosis.

155 The chronic inflammatory processes in endometriosis can alter the receptivity of the
156 endometrium. Intra-pelvic inflammatory processes affecting the oocyte and embryo can lead
157 to miscarriages [33] and infertility [34].

158 Women with endometriosis suffer from chronic fatigue that can be explained by severe, regular
159 pain [35]. This fatigue can lead to insomnia, depression, pain, and occupational stress [36].
160 Pain, physical and mental fatigue, infertility, and the risks associated with endometriosis will
161 affect the social interactions of these women [37]. Women reported that the endometriosis-
162 related experiences that most impacted their lives in a negative way included depression or
163 anxiety (80%), heavy menstrual bleeding (71%), the need to take prescription treatments (57%)
164 or undergo multiple surgeries (49%) or infertility (46%) [38]. These debilitating effects have
165 an immense impact on a patient's quality of life and overall well-being [39], strain social and
166 intimate relationships [40] and lead to losses in productivity, both at home and in the workplace
167 [41].

168 **4. The endometriosis and the benefits of physical activity**

169 Our understanding of the role of physical exercise in endometriosis can benefit from well-
170 controlled studies using validated instruments for evaluation and follow-up in well-defined
171 study groups and well-established exercise treatment protocols. Experimental models of
172 endometriosis permit the characterization of the time course of the disease in order to elucidate
173 whether physical exercise can alter the development of the endometriosis while also making it
174 possible to determine the conditions of physical exercise that can be used in both a preventive
175 and curative manner in endometriosis.

176 However, these interventions have been studied mostly in terms of their ability to reduce the
177 risk of developing endometriosis [7,42,43], and so little is known about the effect of PA and
178 exercise on symptom improvement in women with endometriosis [7]. The effect of PA and
179 exercise specifically remained unclear since reviews were limited to a few databases, the search
180 terms were not specified [10], or "PA" and "exercise" were not included as search terms [44].
181 Studies of interventions involving any type of PA and exercise were eligible for inclusion. PA
182 was defined as "any bodily movement produced by skeletal muscles that requires energy
183 expenditure" [11] and exercise was defined as "PA that is planned, structured, and repetitive
184 for the purpose of conditioning the body" [11], consisting of cardiovascular conditioning,
185 strength and resistance training, and flexibility. Low-intensity exercises are useful treatments
186 for women with endometriosis with or without conventional drug treatments. However,
187 physical activity is differentiated according to the intensity of the effort required. Physical
188 activities that combine breath control, physical postures and meditation (such as Halta Yoga or

189 Jacobson's progressive relaxation techniques, which consists of voluntarily contracting
190 different muscle groups for periods of 5 to 10 seconds and then releasing the tension) were
191 tested over periods of 6 to 12 weeks and compared with other more traditional physical
192 activities such as muscle strengthening, walking or more intense exercises [44].

193

194 The theory supporting PA and exercise as a beneficial approach involves viewing the skeletal
195 muscles as an endocrine organ, with the contraction of these muscles releasing myokines [45].
196 These myokines may exert direct effects on the muscle itself or distal organs such as the liver,
197 pancreas, or adipose tissue [45]. Furthermore, exercise increases the production of leucocytes,
198 cortisol, and adrenaline, all of which have potent acute anti-inflammatory effects [46].

199 Since endometriosis is an estrogen-dependent condition and physical activity may raise levels
200 of sex hormone binding globulin (SHBG), which would lower bioavailable estrogens, it has
201 been hypothesized that physical activity is protective [47]. Additionally, more physical activity
202 lowers insulin resistance and hyperinsulinemia, which have been linked to endometriosis
203 hypotheses [48, 49]. When compared to women who did not regularly exercise, regular
204 exercise was linked to a 40%–80% lower risk of endometriosis [50]. Previous evidence
205 suggests that exercise may be therapeutic in chronic inflammatory processes [15]. Regular
206 physical exercise has shown protective effects in patients with chronic inflammatory disease
207 because it increases systemic levels of anti-inflammatory cytokines [51]. Exercise has
208 previously been described as a possible protective factor for several chronic diseases that
209 involve inflammation, such as inflammatory bowel disease, diabetes mellitus type 2, and breast
210 and colon cancer [52]. Concerning endometriosis, exercise may lead to reduced estrogen levels
211 and frequency of ovulation, increased sex hormone-binding globulin with a subsequent
212 reduction in bio-available estrogen, as well as reduced insulin resistance and hyperinsulinemia.

213 Pain is a debilitating component in the daily lives of women with endometriosis and has been
214 monitored with the EHP-30 questionnaire to show that halta yoga improves the well-being and
215 self-image of women with endometriosis [8]. Likewise, physical activity based on exercises of
216 body consciousness, breathing, stretching and general movements combined with a cognitive
217 approach improved the vitality and physical functioning based on the SF-36 questionnaire [8].
218 To our knowledge, the study of Ensari et al. [53] was the first to quantify the association
219 between day-level pain symptoms and exercise in an international sample of women with
220 endometriosis and to identify habitual weekly exercise frequency as a moderator of this
221 relationship. They leveraged 90382 days of mHealth self-tracking data from 1009 women with

222 endometriosis to investigate the association between exercise behavior and day-level
223 fluctuations in pain.

224 These participants were likelier to report lower pain scores and smaller increases (or larger
225 decreases) in pain the day after an exercise bout than not having exercised the previous day. In
226 contrast, those who engaged in regular exercise less than twice a week were more likely to
227 experience pain symptoms on days after exercise. According to the physical activity
228 recommendations [54,55], which call for aerobic exercise at least three times per week and
229 muscle-strengthening exercise at least twice per week [56], this is in line with the recommended
230 levels of physical activity. However, the current guidelines make no specific recommendations
231 for endometriosis, and systematic reviews only advise "overall, general exercise" [7,57]
232 because there is insufficient data on the best amount of exercise to relieve endometriosis pain.
233 Only 24.5% (N=202) of the study sample exercised at least three times a week, with the mean
234 weekly frequency of exercise being 1.43/week (SD=1.57, IQR=2.29). This suggests that
235 individuals with endometriosis might be at increased risk of physical inactivity[56], which is a
236 risk factor for various comorbidities [58] and is further linked to exacerbation of chronic pain
237 Ensari et al [53] suggest that their findings of moderate pain in the pelvis as the most frequently
238 reported pain are in line with those from others on endometriosis [61] and various chronic pain
239 conditions[62].

240 A study by Bergström et al. [63] reported that a 12-month exercise program reduced the
241 intensity of pelvic pain associated with endometriosis, while Carpenter et al. [64] found that
242 physical exercise (6 months) relaxed the muscles of patients with endometriosis to alleviate
243 pain (Table 1). These results are in agreement with the findings of Awad et al. [65] who studied
244 the effects of exercise on pain and posture associated with endometriosis in 20 patients
245 diagnosed with mild or moderate forms of the disease. Their results indicated decreases in the
246 intensity of endometriosis pain after performing exercise and a statistically significant decrease
247 in the thoracic kyphosis angle related to postural kyphosis deformities, having found no
248 correlation between the patient's physical characteristics and intensity of endometriosis pain
249 [65]. The results of this study agree with those of a randomized controlled trial indicating that
250 progressive muscular relaxation training was more effective in improving pain, anxiety,
251 depression and fatigue in women with endometriosis regardless of concurrent hormonal
252 therapy [10].

253 Studies by Carpenter et al. [64] (Table 1) support the beneficial effects of physical exercise in
254 reducing testosterone levels and androgenic symptoms in patients treated with Danazol, a
255 medication used in the treatment of endometrium. Another study reported that physical exercise

256 mitigated the adverse effects of medications and assisted in the recovery of bone density in
257 women treated with gonadotropin-releasing hormone [63]. Pharmacological therapeutic
258 approaches are available to reduce tissue damage and endometriosis symptoms by suppressing
259 ovulation and suppressing estrogen's stimulative effect on lesions. One of these treatments is
260 with gonadotropin-releasing hormone (GnRH) analog GnRH acts by regulating the anterior
261 pituitary gland and suppressing circulating gonadotropins and sexual hormones [66]. This
262 causes hypoestrogen, resulting in the atrophy of the endometriotic tissue (3). GnRH analogues
263 produce hypoestrogenaemia and increase bone turnover, resulting in substantial bone loss with
264 an imbalance between bone resorption and bone formation [67]. Exercise boosts serotonin
265 levels and increases the firing rate of serotonin neurons in the brain, which stimulates the
266 production of mood-elevating chemicals [9]. Aerobic exercises such as walking increase
267 serotonin levels and muscle tone and improves cardiovascular function [44,63,64].

268 There is much support for the positive effects of mind-body interventions, such as relaxation
269 and yoga, on overall well-being and quality of life, reducing psychological distress and creating
270 a positive mental state, and decreasing pain intensity [68,69], and pain-associated
271 endometriosis[8,10,44]. Since stress relief should reduce inflammation and pain by activating
272 the HPA axis, it follows that doing so should also reduce painful reactions. Ectopic growth of
273 refluxed endometrium activates a vicious cycle of inflammation characterized by secretion of
274 prostaglandins, growth factors (nerve growth factor-NGF, vascular endothelial growth factor-
275 VEGF), neurotransmitters, and cytokines, into the peritoneal fluid that exacerbates the disease
276 by increasing pain and promoting lesion survival [70]. In a recent prospective study,
277 endometriosis patients who were using positive coping strategies were found to adapt to stress
278 better with less depression and associated pelvic pain [71]. Further, preliminary research found
279 a significant reduction in pain and depression scores when physiotherapy and psychological
280 interventions were carried out in women with endometriosis[72].

281 Prior research in the field of complementary and integrative medicine has found the beneficial
282 effects of stress-coping strategies, yoga, on chronic pain conditions [10,73], inflammation,
283 immune and brain function, as well as anxiety, depression, and stress levels[74]. Disease
284 processes exacerbated by stress can be interrupted by psychological and stress reduction
285 interventions, including social coping, psychotherapy, exercise, relaxation, meditation, and
286 yoga [73].

287 Yoga, classified as a mind–body practice by the WHO [75], covers a myriad of contemplative
288 techniques that use relaxation strategies, including breathing exercises, progressive muscle

289 relaxation, and relieve stress, helping to integrate the body and mind[76] and alleviates
290 symptoms of asthma and high blood pressure[77,78]. However, research on the various benefits
291 of yoga in the treatment of endometriosis is still scarce, although some studies indicate that 8
292 to 12 -weeks of yoga reduced pain associated with endometriosis [8,10,44] (**Table 1**).

293 Women with endometriosis have a high perception of stress, low quality of life, and low levels
294 of cortisol [73,79]. Some studies confirm the relationship between practicing yoga and the
295 reduction of pain and stress associated with improved body awareness and empowerment
296 [80,81]. The practice of yoga involves breathing stabilization, which allows for greater
297 regulation of mental and emotional states, leading to greater insight, better perception of the
298 body, and expanded strategies to reduce pain [82–84], as confirmed in a recent report that
299 practicing relaxation promotes relief from muscle tension and stimulates blood circulation in
300 the muscles and viscera[85].

301 Yoga reduces autonomic nervous system activity by regulating oxygen intake (i.e., increased
302 respiratory volume) to ease muscle tension and pain. The practice of yoga also regulates
303 psycho–neuro–endocrine structures by balancing the hypothalamic–pituitary–adrenal systems
304 to reorganize the autonomic nervous system [84,86]. As the neuroendocrine systems regulating
305 the stress response are involved in the regulation of mood and emotion[87], mental illnesses
306 such as clinical anxiety and depression are associated with increased expression of stress-
307 induced pro-inflammatory cytokines that stimulate the autonomic nervous system and hyper-
308 secretion of corticotropin-releasing hormone (CRH), and increase circulatory cortisol and the
309 production of pro-inflammatory cytokines [88,89].

310 Studies suggest that pain-associated endometriosis may be related to increased cellular
311 oxidative stress and low cortisol levels, which increase inflammatory responses[90–92].

312 Physical activity increases levels of sex hormone-binding globulin (SHBG) and reduces the
313 bioavailability of estrogens, which may be protective since endometriosis is an estrogen-
314 dependent disease[93].

315 **5. Conclusions**

316 The main objective of this narrative review was to identify the benefits of physical activity on
317 pain and quality of life in women with endometriosis. An important finding is that body
318 awareness practices such as halta yoga, the Jacobson method, and progressive muscle
319 relaxation reduce pain and stress and improve the quality of life associated with endometriosis.
320 Nevertheless, care must be taken when considering patients' physical abilities and goals and

321 avoiding intense physical activities. The forms of endometriosis and its symptoms vary from
322 one woman to another, so it is important to carry out studies with various non-medicinal or
323 surgical techniques.

324 It is important to continue randomized controlled trials to obtain more data on the benefits of
325 physical activity in women with endometriosis and also to identify what types of activities
326 could be beneficial to combat pain symptoms and improve the daily lives of women with
327 endometriosis, as suggested by Mira et al [44].

328

329 **Author contribution:** CT, AZ, LF and HZ. participated in the conception and design of the
330 study. LF, AZ and SEK were responsible for data collection and statistical analysis. CT, AZ,
331 SEK, LF, AS, IL, KW, BK and HZ were responsible for writing and finalization of the
332 manuscript. All authors contributed to the manuscript and approved the submitted version. All
333 authors have read and agreed to the published version of the manuscript.

334 **Conflict of interest:** The authors declare no conflict of interest.

335 **Funding:** None.

336

337 6. References

338

339 [1] Zondervan KT, Missmer S, Abrao MS, Einarsson JI, Horne AW, Johnson NP, et al.
340 Endometriosis Classification Systems: An International Survey to Map Current Knowledge
341 and Uptake. *Journal of Minimally Invasive Gynecology* 2022;29:716-725.e1.
342 <https://doi.org/10.1016/j.jmig.2022.01.014>.

343 [2] Agarwal SK, Chapron C, Giudice LC, Laufer MR, Leyland N, Missmer SA, et al.
344 Clinical diagnosis of endometriosis: a call to action. *American Journal of Obstetrics &*
345 *Gynecology* 2019;220:354.e1-354.e12. <https://doi.org/10.1016/j.ajog.2018.12.039>.

346 [3] Tsamantioti ES, Mahdy H. Endometriosis. StatPearls. Treasure Island, FL; 2022.

347 [4] Zondervan KT, Becker CM, Koga K, Missmer SA, Taylor RN, Viganò P.
348 Endometriosis. *Nature Reviews Disease Primers* 2018;4:9. [https://doi.org/10.1038/s41572-](https://doi.org/10.1038/s41572-018-0008-5)
349 018-0008-5.

- 350 [5] Chapron C, Marcellin L, Borghese B, Santulli P. Rethinking mechanisms, diagnosis
351 and management of endometriosis. *Nature Reviews Endocrinology* 2019;15:666–82.
- 352 [6] Aredo J, Heyrana K, Karp B, Shah J, Stratton P. Relating Chronic Pelvic Pain and
353 Endometriosis to Signs of Sensitization and Myofascial Pain and Dysfunction. *Seminars in*
354 *Reproductive Medicine* 2017;35. <https://doi.org/10.1055/s-0036-1597123>.
- 355 [7] Bonoche CM, Montenegro ML, Rosa e Silva JC, Ferriani RA, Meola J. Endometriosis
356 and physical exercises: a systematic review. *Reproductive Biology and Endocrinology*
357 2014;12:4. <https://doi.org/10.1186/1477-7827-12-4>.
- 358 [8] Tennfjord MK, Gabrielsen R, Tellum T. Effect of physical activity and exercise on
359 endometriosis-associated symptoms: a systematic review. *BMC Women’s Health*
360 2021;21:355. <https://doi.org/10.1186/s12905-021-01500-4>.
- 361 [9] Zhao L, Wu H, Zhou X, Wang Q, Zhu W, Chen J. Effects of progressive muscular
362 relaxation training on anxiety, depression and quality of life of endometriosis patients under
363 gonadotrophin-releasing hormone agonist therapy. *European Journal of Obstetrics &*
364 *Gynecology and Reproductive Biology* 2012;162:211–5.
365 <https://doi.org/10.1016/j.ejogrb.2012.02.029>.
- 366 [10] Evans S, Fernandez S, Olive L, Payne LA, Mikočka-Walus A. Psychological and mind-
367 body interventions for endometriosis: A systematic review. *Journal of Psychosomatic Research*
368 2019;124:109756. <https://doi.org/10.1016/j.jpsychores.2019.109756>.
- 369 [11] Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical
370 fitness: definitions and distinctions for health-related research. *Public Health Rep* 100(2):126-
371 131 1985;100.
- 372 [12] Saha R, Pettersson HJ, Svedberg P, Olovsson M, Bergqvist A, Marions L, et al.
373 Heritability of endometriosis. *Fertility and Sterility* 2015;104:947–52.
374 <https://doi.org/10.1016/j.fertnstert.2015.06.035>.
- 375 [13] Rahmioglu N, Mortlock S, Ghiasi M, Møller PL, Stefansdottir L, Galarneau G, et al.
376 The genetic basis of endometriosis and comorbidity with other pain and inflammatory
377 conditions. *Nature Genetics* 2023;55:423–36. <https://doi.org/10.1038/s41588-023-01323-z>.
- 378 [14] Medical management of endometriosis. *International Journal of Gynecology &*
379 *Obstetrics* 2000;71:183–96. [https://doi.org/10.1016/S0020-7292\(00\)80034-X](https://doi.org/10.1016/S0020-7292(00)80034-X).
- 380 [15] Petersen AMW, Pedersen BK. The anti-inflammatory effect of exercise. *Journal of*
381 *Applied Physiology* 2005;98:1154–62. <https://doi.org/10.1152/jappphysiol.00164.2004>.

- 382 [16] Farland L, Missmer S, Bijon A, Gusto G, Gelot A, Clavel-Chapelon F, et al.
383 Associations among body size across the life course, adult height and endometriosis. *Human*
384 *Reproduction* (Oxford, England) 2017;32:1–11. <https://doi.org/10.1093/humrep/dex207>.
- 385 [17] Ferrero S, Anserini P, Remorgida V, Ragni N. Body mass index in endometriosis.
386 *European Journal of Obstetrics & Gynecology and Reproductive Biology* 2005;121:94–8.
387 <https://doi.org/10.1016/j.ejogrb.2004.11.019>.
- 388 [18] Liu Y, Zhang W. Association between body mass index and endometriosis risk: a meta-
389 analysis. *Oncotarget*; Vol 8, No 29 2017.
- 390 [19] Tang Y, Zhao M, Lin L, Gao Y, Chen GQ, Chen S, et al. Is body mass index associated
391 with the incidence of endometriosis and the severity of dysmenorrhoea: a case–control study
392 in China? *BMJ Open* 2020;10. <https://doi.org/10.1136/bmjopen-2020-037095>.
- 393 [20] Zolbin MM, Mamillapalli R, Nematian SE, Goetz TG, Taylor HS. Adipocyte alterations
394 in endometriosis: reduced numbers of stem cells and microRNA induced alterations in
395 adipocyte metabolic gene expression. *Reproductive Biology and Endocrinology* 2019;17:36.
396 <https://doi.org/10.1186/s12958-019-0480-0>.
- 397 [21] Goetz TG, Mamillapalli R, Taylor HS. Low Body Mass Index in Endometriosis Is
398 Promoted by Hepatic Metabolic Gene Dysregulation in Mice¹. *Biology of Reproduction*
399 2016;95. <https://doi.org/10.1095/biolreprod.116.142877>.
- 400 [22] Dutta M, Anitha M, Smith PB, Chiaro CR, Maan M, Chaudhury K, et al. Metabolomics
401 Reveals Altered Lipid Metabolism in a Mouse Model of Endometriosis. *J Proteome Res*
402 2016;15:2626–33. <https://doi.org/10.1021/acs.jproteome.6b00197>.
- 403 [23] Pugsley Z, Ballard K. Management of endometriosis in general practice: The pathway
404 to diagnosis. *The British Journal of General Practice : The Journal of the Royal College of*
405 *General Practitioners* 2007;57:470–6.
- 406 [24] Falcone T, Lebovic DI. Clinical Management of Endometriosis. *Obstetrics &*
407 *Gynecology* 2011;118.
- 408 [25] Maccagnano C, Pellucchi F, Rocchini L, Ghezzi M, Scattoni V, Montorsi F, et al.
409 Ureteral Endometriosis: Proposal for a Diagnostic and Therapeutic Algorithm with a Review
410 of the Literature. *Urologia Internationalis* 2013;91:1–9. <https://doi.org/10.1159/000345140>.
- 411 [26] Ferrero S, Vellone VG, Barra F. Pathophysiology of pain in patients with peritoneal
412 endometriosis. *Annals of Translational Medicine*; Vol 7, Supplement 1 (March 27, 2019):
413 *Annals of Translational Medicine* 2019.
- 414 [27] DiVasta AD, Zimmerman LA, Vitonis AF, Fadayomi AB, Missmer SA. Overlap
415 Between Irritable Bowel Syndrome Diagnosis and Endometriosis in Adolescents. *Clinical*

- 416 Gastroenterology and Hepatology 2021;19:528-537.e1.
417 <https://doi.org/10.1016/j.cgh.2020.03.014>.
- 418 [28] Vannuccini S, Clemenza S, Rossi M, Petraglia F. Hormonal treatments for
419 endometriosis: The endocrine background. *Reviews in Endocrine and Metabolic Disorders*
420 2022;23:333–55. <https://doi.org/10.1007/s11154-021-09666-w>.
- 421 [29] Carey ET, Till SR, As-Sanie S. Pharmacological Management of Chronic Pelvic Pain
422 in Women. *Drugs* 2017;77:285–301. <https://doi.org/10.1007/s40265-016-0687-8>.
- 423 [30] Harrison JE, Weber S, Jakob R, Chute CG. ICD-11: an international classification of
424 diseases for the twenty-first century. *BMC Medical Informatics and Decision Making*
425 2021;21:206. <https://doi.org/10.1186/s12911-021-01534-6>.
- 426 [31] Zondervan KT, Becker CM, Missmer SA. Endometriosis. *New England Journal of*
427 *Medicine* 2020;382:1244–56. <https://doi.org/10.1056/NEJMra1810764>.
- 428 [32] Wójcik M, Szczepaniak R, Placek K. Physiotherapy Management in Endometriosis.
429 *International Journal of Environmental Research and Public Health* 2022;19.
430 <https://doi.org/10.3390/ijerph192316148>.
- 431 [33] Pirtea P, Cicinelli E, Nola RD, Ziegler D de, Ayoubi JM. Endometrial causes of
432 recurrent pregnancy losses: endometriosis, adenomyosis, and chronic endometritis. *Fertility*
433 *and Sterility* 2021;115:546–60. <https://doi.org/10.1016/j.fertnstert.2020.12.010>.
- 434 [34] Missmer S, Hankinson S, Spiegelman D, Barbieri R, Marshall L, Hunter D. Incidence
435 of Laparoscopically Confirmed Endometriosis by Demographic, Anthropometric, and
436 Lifestyle Factors. *American Journal of Epidemiology* 2004;160:784–96.
437 <https://doi.org/10.1093/aje/kwh275>.
- 438 [35] Soliman A, Rahal Y, Robert C, Defoy I, Nisbet P, Leyland N, et al. Impact of
439 Endometriosis on Fatigue and Productivity Impairment in a Cross-Sectional Survey of
440 Canadian Women. *Journal of Obstetrics and Gynaecology Canada* 2020;43.
441 <https://doi.org/10.1016/j.jogc.2020.06.022>.
- 442 [36] Ramin-Wright A, Kohl Schwartz A, Geraedts K, Rauchfuss M, Wölfler M, Haeberlin
443 F, et al. Fatigue - A symptom in endometriosis. *Human Reproduction (Oxford, England)*
444 2018;33. <https://doi.org/10.1093/humrep/dey115>.
- 445 [37] Bourdel N, Comptour A, Chauvet P, Canis M. Douleurs et endométriose. Douleurs :
446 Évaluation - Diagnostic - Traitement 2020;21:3–10.
447 <https://doi.org/10.1016/j.douler.2019.11.001>.
- 448 [38] Missmer SA, Tu F, Soliman AM, Chiuve S, Cross S, Eichner S, et al. Impact of
449 endometriosis on women’s life decisions and goal attainment: a cross-sectional survey of

450 members of an online patient community. *BMJ Open* 2022;12.
451 <https://doi.org/10.1136/bmjopen-2021-052765>.

452 [39] Gallagher JS, DiVasta AD, Vitonis AF, Sarda V, Laufer MR, Missmer SA. The Impact
453 of Endometriosis on Quality of Life in Adolescents. *Journal of Adolescent Health*
454 2018;63:766–72. <https://doi.org/10.1016/j.jadohealth.2018.06.027>.

455 [40] Culley L, Law C, Hudson N, Mitchell H, Denny E, Raine-Fenning N. A qualitative
456 study of the impact of endometriosis on male partners. *Human Reproduction (Oxford, England)*
457 2017;32:1–7. <https://doi.org/10.1093/humrep/dex221>.

458 [41] Soliman A, Coyne K, Gries K, Castelli-Haley J, Snabes M, Surrey E. The Effect of
459 Endometriosis Symptoms on Absenteeism and Presenteeism in the Workplace and at Home.
460 *Journal of Managed Care & Specialty Pharmacy* 2017;23:745–54.
461 <https://doi.org/10.18553/jmcp.2017.23.7.745>.

462 [42] Shafrir AL, Farland LV, Shah DK, Harris HR, Kvaskoff M, Zondervan K, et al. Risk
463 for and consequences of endometriosis: A critical epidemiologic review. *Best Practice &*
464 *Research Clinical Obstetrics & Gynaecology* 2018;51:1–15.
465 <https://doi.org/10.1016/j.bpobgyn.2018.06.001>.

466 [43] Ricci E, Viganò P, Cipriani S, Chiaffarino F, Bianchi S, Rebonato G, et al. Physical
467 activity and endometriosis risk in women with infertility or pain: Systematic review and meta-
468 analysis. *Medicine* 2016;95.

469 [44] Mira TAA, Buen MM, Borges MG, Yela DA, Benetti-Pinto CL. Systematic review and
470 meta-analysis of complementary treatments for women with symptomatic endometriosis.
471 *International Journal of Gynecology & Obstetrics* 2018;143:2–9.
472 <https://doi.org/10.1002/ijgo.12576>.

473 [45] Brandt C, Pedersen BK. The Role of Exercise-Induced Myokines in Muscle
474 Homeostasis and the Defense against Chronic Diseases. *Journal of Biomedicine and*
475 *Biotechnology* 2010;2010:520258. <https://doi.org/10.1155/2010/520258>.

476 [46] Nimmo MA, Leggate M, Viana JL, King JA. The effect of physical activity on
477 mediators of inflammation. *Diabetes, Obesity and Metabolism* 2013;15:51–60.
478 <https://doi.org/10.1111/dom.12156>.

479 [47] Verkasalo PK, Thomas HV, Appleby PN, Davey GK, Key TJ. Circulating levels of sex
480 hormones and their relation to risk factors for breast cancer: a cross-sectional study in 1092
481 pre- and postmenopausal women (United Kingdom). *Cancer Causes & Control* 2001;12:47–
482 59. <https://doi.org/10.1023/A:1008929714862>.

- 483 [48] Stoll B. Adiposity as a risk determinant for postmenopausal breast cancer. *International*
484 *Journal of Obesity* 2000;24:527–33. <https://doi.org/10.1038/sj.ijo.0801247>.
- 485 [49] Kaaks R. Nutrition, hormones, and breast cancer: Is insulin the missing link? *Cancer*
486 *Causes & Control* 1996;7:605–25. <https://doi.org/10.1007/BF00051703>.
- 487 [50] Heilier J-F, Donnez J, Nackers F, Rousseau R, Verougstraete V, Rosenkranz K, et al.
488 Environmental and host-associated risk factors in endometriosis and deep endometriotic
489 nodules: A matched case–control study. *Environmental Research* 2007;103:121–9.
490 <https://doi.org/10.1016/j.envres.2006.04.004>.
- 491 [51] Wu M-H, Shoji Y, Chuang P-C, Tsai S-J. Endometriosis: disease pathophysiology and
492 the role of prostaglandins. *Expert Reviews in Molecular Medicine* 2007;9:1–20.
493 <https://doi.org/10.1017/S146239940700021X>.
- 494 [52] Friedenreich CM, Orenstein MR. Physical Activity and Cancer Prevention: Etiologic
495 Evidence and Biological Mechanisms. *The Journal of Nutrition* 2002;132:3456S-3464S.
496 <https://doi.org/10.1093/jn/132.11.3456S>.
- 497 [53] Ipek Ensari, Sharon Lipsky-Gorman, Emma N Horan, Suzanne Bakken, Noémie
498 Elhadad. Associations between physical exercise patterns and pain symptoms in individuals
499 with endometriosis: a cross-sectional mHealth-based investigation. *BMJ Open*
500 2022;12:e059280. <https://doi.org/10.1136/bmjopen-2021-059280>.
- 501 [54] DiPietro L, Buchner DM, Marquez DX, Pate RR, Pescatello LS, Whitt-Glover MC.
502 New scientific basis for the 2018 U.S. Physical Activity Guidelines. *Journal of Sport and*
503 *Health Science* 2019;8:197–200. <https://doi.org/10.1016/j.jshs.2019.03.007>.
- 504 [55] Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World
505 Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British*
506 *Journal of Sports Medicine* 2020;54:1451–62. <https://doi.org/10.1136/bjsports-2020-102955>.
- 507 [56] Piercy K, Troiano R, Ballard R, Carlson S, Fulton J, Galuska D, et al. The Physical
508 Activity Guidelines for Americans. *JAMA* 2018;320.
509 <https://doi.org/10.1001/jama.2018.14854>.
- 510 [57] Armour M, Ee, CC, Naidoo, D, Ayati, Z, Chalmers, KJ, Steel, KA, de Manincor, MJ,
511 Delshad E. Exercise for dysmenorrhoea. *Cochrane Database of Systematic Reviews* 2019.
512 <https://doi.org/10.1002/14651858.CD004142.pub4>.
- 513 [58] KATZMARZYK PT, POWELL KE, JAKICIC JM, TROIANO RP, PIERCY K,
514 TENNANT B, et al. Sedentary Behavior and Health: Update from the 2018 Physical Activity
515 Guidelines Advisory Committee. *Medicine & Science in Sports & Exercise* 2019;51.

- 516 [59] Basen-Engquist K, Scruggs S, Jhingran A, Bodurka D, Lu K, Ramondetta L, et al.
517 Physical Activity and Obesity in Endometrial Cancer Survivors: Associations with Pain,
518 Fatigue, and Physical Functioning. *American Journal of Obstetrics and Gynecology*
519 2009;200:288.e1-8. <https://doi.org/10.1016/j.ajog.2008.10.010>.
- 520 [60] Dansie EJ, Turk DC, Martin KR, Van Domelen DR, Patel KV. Association of Chronic
521 Widespread Pain With Objectively Measured Physical Activity in Adults: Findings From the
522 National Health and Nutrition Examination Survey. *The Journal of Pain* 2014;15:507–15.
523 <https://doi.org/10.1016/j.jpain.2014.01.489>.
- 524 [61] Warzecha D, Szymusik I, Wielgos M, Pietrzak B. The Impact of Endometriosis on the
525 Quality of Life and the Incidence of Depression—A Cohort Study. *International Journal of*
526 *Environmental Research and Public Health* 2020;17. <https://doi.org/10.3390/ijerph17103641>.
- 527 [62] Bouhassira D, Lantéri-Minet M, Attal N, Laurent B, Touboul C. Prevalence of chronic
528 pain with neuropathic characteristics in the general population. *PAIN* 2008;136:380–7.
529 <https://doi.org/10.1016/j.pain.2007.08.013>.
- 530 [63] Bergström I, Freyschuss B, Jacobsson H, Landgren B-M. The effect of physical training
531 on bone mineral density in women with endometriosis treated with GnRH analogs: a pilot
532 study. *Acta Obstetrica et Gynecologica Scandinavica* 2005;84:380–3.
533 <https://doi.org/10.1111/j.0001-6349.2005.00558.x>.
- 534 [64] Carpenter SE, Tjaden B, Rock JA, Kimball A. The effect of regular exercise on women
535 receiving danazol for treatment of endometriosis. *International Journal of Gynecology &*
536 *Obstetrics* 1995;49:299–304. [https://doi.org/10.1016/0020-7292\(95\)02359-K](https://doi.org/10.1016/0020-7292(95)02359-K).
- 537 [65] Awad E, Hamada H, Yousef A, Abbas R. Efficacy of exercise on pelvic pain and
538 posture associated with endometriosis: Within subject design. *Journal of Physical Therapy*
539 *Science* 2017;29:2112–5. <https://doi.org/10.1589/jpts.29.2112>.
- 540 [66] Pierce SJ, Gazvani MR, Farquharson RG. Long-term use of gonadotropin-releasing
541 hormone analogs and hormone replacement therapy in the management of endometriosis: a
542 randomized trial with a 6-year follow-up. *Fertility and Sterility* 2000;74:964–8.
543 [https://doi.org/10.1016/S0015-0282\(00\)01537-5](https://doi.org/10.1016/S0015-0282(00)01537-5).
- 544 [67] Cheng C-H, Chen L-R, Chen K-H. Osteoporosis Due to Hormone Imbalance: An
545 Overview of the Effects of Estrogen Deficiency and Glucocorticoid Overuse on Bone
546 Turnover. *International Journal of Molecular Sciences* 2022;23.
547 <https://doi.org/10.3390/ijms23031376>.
- 548 [68] Gautam S, Tolahunase M, Kumar U, Dada R. Impact of yoga based mind-body
549 intervention on systemic inflammatory markers and co-morbid depression in active

550 Rheumatoid arthritis patients: A randomized controlled trial. *Restorative Neurology and*
551 *Neuroscience* 2019;37:41–59. <https://doi.org/10.3233/RNN-180875>.

552 [69] Zautra A, Davis M, Reich J, Nicassario P, Tennen H, Finan P, et al. Comparison of
553 Cognitive Behavioral and Mindfulness Meditation Interventions on Adaptation to Rheumatoid
554 Arthritis for Patients With and Without History of Recurrent Depression. *Journal of Consulting*
555 *and Clinical Psychology* 2008;76:408–21. <https://doi.org/10.1037/0022-006X.76.3.408>.

556 [70] Coxon L, Horne AW, Vincent K. Pathophysiology of endometriosis-associated pain: A
557 review of pelvic and central nervous system mechanisms. *Best Practice & Research Clinical*
558 *Obstetrics & Gynaecology* 2018;51:53–67. <https://doi.org/10.1016/j.bpobgyn.2018.01.014>.

559 [71] Donatti L, Ramos DG, Andres M de P, Passman LJ, Podgaec S. Patients with
560 endometriosis using positive coping strategies have less depression, stress and pelvic pain.
561 *Einstein (São Paulo)* 2017;15.

562 [72] Friggi Sebe Petrelluzzi K, Garcia MC, Petta CA, Ribeiro DA, de Oliveira Monteiro NR,
563 Céspedes IC, et al. Physical therapy and psychological intervention normalize cortisol levels
564 and improve vitality in women with endometriosis. *Journal of Psychosomatic Obstetrics &*
565 *Gynecology* 2012;33:191–8. <https://doi.org/10.3109/0167482X.2012.729625>.

566 [73] Gonçalves A, Barros N, Bahamondes L. The Practice of Hatha Yoga for the Treatment
567 of Pain Associated with Endometriosis. *Journal of Alternative and Complementary Medicine*
568 *(New York, NY)* 2016;23. <https://doi.org/10.1089/acm.2015.0343>.

569 [74] Cheong Y, Smotra G, Williams A. Non-surgical interventions for the management of
570 chronic pelvic pain. *The Cochrane Database of Systematic Reviews* 2014;3:CD008797.
571 <https://doi.org/10.1002/14651858.CD008797.pub2>.

572 [75] World Health Organization. Programme on Traditional Medicine. WHO traditional
573 medicine strategy 2002-2005 2002.

574 [76] Burke A, Lam C, Stussman B, Yang H. Prevalence and patterns of use of mantra,
575 mindfulness and spiritual meditation among adults in the United States. *BMC Complementary*
576 *and Alternative Medicine* 2017;17. <https://doi.org/10.1186/s12906-017-1827-8>.

577 [77] Qu S, Olafsrud SM, Meza-Zepeda LA, Saatcioglu F. Rapid Gene Expression Changes
578 in Peripheral Blood Lymphocytes upon Practice of a Comprehensive Yoga Program. *PLOS*
579 *ONE* 2013;8:e61910. <https://doi.org/10.1371/journal.pone.0061910>.

580 [78] Khalsa SB, Hickey Schultz L, Cohen D, Steiner N, Cope S. Evaluation of the Mental
581 Health Benefits of Yoga in a Secondary School: A Preliminary Randomized Controlled Trial.
582 *The Journal of Behavioral Health Services & Research* 2011;39:80–90.
583 <https://doi.org/10.1007/s11414-011-9249-8>.

584 [79] Sheng JA, Bales NJ, Myers SA, Bautista AI, Roueifar M, Hale TM, et al. The
585 Hypothalamic-Pituitary-Adrenal Axis: Development, Programming Actions of Hormones, and
586 Maternal-Fetal Interactions. *Frontiers in Behavioral Neuroscience* 2021;14.
587 <https://doi.org/10.3389/fnbeh.2020.601939>.

588 [80] Granath J, Ingvarsson S, Von Thiele Schwarz U, Lundberg U. Stress Management: A
589 Randomized Study of Cognitive Behavioural Therapy and Yoga. *Cognitive Behaviour Therapy*
590 2006;35:3–10. <https://doi.org/10.1080/16506070500401292>.

591 [81] Posadzki P, Ernst E. Yoga for low back pain: a systematic review of randomized clinical
592 trials. *Clinical Rheumatology* 2011;30:1257–62. <https://doi.org/10.1007/s10067-011-1764-8>.

593 [82] Eaves ER, Sherman KJ, Ritenbaugh C, Hsu C, Nichter M, Turner JA, et al. A qualitative
594 study of changes in expectations over time among patients with chronic low back pain seeking
595 four CAM therapies. *BMC Complementary and Alternative Medicine* 2015;15:12.
596 <https://doi.org/10.1186/s12906-015-0531-9>.

597 [83] Cramer H, Lauche R, Haller H, Dobos G. A Systematic Review and Meta-analysis of
598 Yoga for Low Back Pain. *The Clinical Journal of Pain* 2013;29.

599 [84] Jeter PE, Slutsky J, Singh N, Khalsa SBS. Yoga as a Therapeutic Intervention: A
600 Bibliometric Analysis of Published Research Studies from 1967 to 2013. *The Journal of*
601 *Alternative and Complementary Medicine* 2015;21:586–92.
602 <https://doi.org/10.1089/acm.2015.0057>.

603 [85] Toussaint L, Nguyen QA, Roettger C, Dixon K, Offenbacher M, Kohls N, et al.
604 Effectiveness of Progressive Muscle Relaxation, Deep Breathing, and Guided Imagery in
605 Promoting Psychological and Physiological States of Relaxation. *Evidence-Based*
606 *Complementary and Alternative Medicine* 2021;2021:5924040.
607 <https://doi.org/10.1155/2021/5924040>.

608 [86] Ross A, Williams L, Pappas-Sandonas M, Touchton-Leonard K, Fogel D. Incorporating
609 Yoga Therapy into Primary Care: The Casey Health Institute. *International Journal of Yoga*
610 *Therapy* 2015;25:43–9. <https://doi.org/10.17761/1531-2054-25.1.43>.

611 [87] Ranabir S, Reetu K. Stress and hormones. *Indian Journal of Endocrinology and*
612 *Metabolism* 2011;15.

613 [88] Silverman MN, Sternberg EM. Glucocorticoid regulation of inflammation and its
614 functional correlates: from HPA axis to glucocorticoid receptor dysfunction. *Annals of the New*
615 *York Academy of Sciences* 2012;1261:55–63. [https://doi.org/10.1111/j.1749-](https://doi.org/10.1111/j.1749-6632.2012.06633.x)
616 [6632.2012.06633.x](https://doi.org/10.1111/j.1749-6632.2012.06633.x).

617 [89] Kinlein SA, Wilson CD, Karatsoreos IN. Dysregulated Hypothalamic–Pituitary–
618 Adrenal Axis Function Contributes to Altered Endocrine and Neurobehavioral Responses to
619 Acute Stress. *Frontiers in Psychiatry* 2015;6. <https://doi.org/10.3389/fpsy.2015.00031>.

620 [90] Gopal A, Mondal S, Gandhi A, Arora S, Bhattacharjee J. Effect of Integrated Yoga
621 Practice on immune response in examination stress- A preliminary Study. *International Journal*
622 *of Yoga* 2011;4:26–32. <https://doi.org/10.4103/0973-6131.78178>.

623 [91] Sarkar G, Parui SK, Banerjee S. A Dielectric Resonator MIMO Antenna for Intelligent
624 Transportation Systems, 2021, p. 3–9. https://doi.org/10.1007/978-981-15-9433-5_1.

625 [92] Gowda S, .H R, Silvia C. Molecular Signature of the Immune Response to Yoga
626 Therapy in Stress-related Chronic Disease Conditions: An Insight. *International Journal of*
627 *Yoga* 2019;13. https://doi.org/10.4103/ijoy.IJOY_82_18.

628 [93] Garavaglia E, Ricci E, Chiaffarino F, Cipriani S, Cioffi R, Viganò P, et al. Leisure and
629 occupational physical activity at different ages and risk of endometriosis. *European Journal of*
630 *Obstetrics & Gynecology and Reproductive Biology* 2014;183:104–8.
631 <https://doi.org/10.1016/j.ejogrb.2014.10.031>.

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644 **Table 1:** Staging of endometriosis stages, (Zondervan et al.2022).

Stage	Classification	Description
1	Minimal	A small number of superficial implants and mild adhesions
2	Mild	More, slightly deeper implants
3	Moderate	Many deep implants, small endometriomas on one or both ovaries, and some fine adhesions
4	Severe	Many deep implants, large endometriomas on one or both ovaries, and many dense adhesions, sometimes with the rectum adhering to the posterior part of the uterus.

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647 GnRH: gonadotropin-releasing hormone.

648 BMD: Bone mineral density

649 AP

650 CD:

651 PMK: pacemaker

652 PA: physical activity

Table 1 21: Summary of data with physical activity effects on endometriosis.

Studies	Age	Symptom	Diagnostic	particularities	Intervention	Contribution of literature	Level of evidence
Bergström et al. [63]	23-28 yrs	Symptomatic	Laparoscopic diagnosis	Premenopausal / Untreated	GnRH analogue for 6 months + aerobic walking and training 1h/week 12 months	GnRH + brisk walking + aerobic training: femoral neck 6 months: limited loss of BMD At 12 months: increase in BMD	strong evidence (p=0.029)
						GnRH + brisk walking + aerobic training: spine At 6 months: limited loss of BMD At 12 months: BMD increase	weak evidence (p=0.30)
Carpenter et al. [64]	Average 31 yrs	Symptomatic	Laparoscopic diagnosis	Danazol treatment	Aerobic fitness at 50-70% of the maximum heart rate 40 minutes 4 times/week 24 weeks	AP + relaxation: decrease in side effects (for AFS 6 score 3)	strong evidence (p=0,007)
						AP + flexibilities: lower testosterone	weak evidence (P<0.020)
						Less weight gain	weak evidence (p=0.12)
Evans et al. [10]	Average 36.8 yrs	Symptomatic (Analog visual scale)	Laparoscopic diagnosis	none	Halta yoga 2h 2 times/week 8 weeks	Halta yoga: reduction in pain	strong evidence (p<0.001)
	18-48 yrs	not specified	not specified	1 dose of letuprolide	Progressive relaxation (PMR) 40 minutes muscle	PMK: pain improvement, anxiety, depression, fatigue	strong evidence

					2 times/week - 12 weeks Home practice: 2/day (relaxation brochure, CD)		(p<0.001)
Garavaglia et al. [93]	18-76 yrs. Mean = 35 yrs.	Not specified	Laparoscopic diagnosis	not specified	Interview with physical activity intensity and leisure	Professional “standing” PA: protective effect of endometriosis	weak evidence (p=0.22)
						Leisure PA: protective effect of endometriosis	strong evidence (p=0.0006)
						Moderate/Intense PA: increases risk of endometriosis	weak evidence (p=0.08)
						IMC ≤ 25 increase women with endometriosis	weak evidence (P=0.07)
Mira et al. [44]	Not specified	Not specified	Not specified	GnRH	Walking or aerobic training 6 months	Increased BMD gain rate in the femur after completion of treatment and prevents bone loss while taking medication	Not specified
	13 to 50 years	Symptomatic	Not specified	Treatment leuprolide	Jacobson method 12 weeks	Improvement of anxiety indices, depression, quality of life	weak evidence (p<0.05)
	Not specified			Danazol	Specific Exercises 24 weeks	Decreased pelvic symptoms in both groups	(No statistical difference)

						Recurrence of endometriosis later (16 months vs. 11 months)	weak evidence (Not significant)
						Decreased testosterone level	strong evidence (p<0.020)
	13 to 50 years		Surgery	Not specified	Halta yoga + postures + relaxation + breathing 2 times/week 8 weeks	Pain relief and quality of life improvement with no change in menstrual flow	Not specified
Ricci et al.[43]	Not specified	Not specified	Not specified	infertility clinic / Not specified	Not specified	PA can reduce the risk of endometriosis	Weak evidence (Not significant)
Tennfjord et al.[8]	34,88 ± 6,70	Symptomatic	Imaging or surgical modality	Previous hormonal and surgical treatment	Halta yoga + postures + relaxation + breathing + meditation 2 hours 2 times/week 8 weeks	Halta yoga + relaxation: reduction in pain	strong evidence (p < 0,001)
						Halta yoga: improvement of control, impotence, well-being, emotional and self-image (EHP-307)	strong evidence (p < 0.001)
	32.0 ± 1.3 yrs.	Symptomatic 7 years of delay in taking charge	No effect of medical or surgical treatment	Body awareness, breathing exercise, stretching, general movement, PFM strength + cognitive behavioral therapy	PA + cognitive approach: improvement in the areas of vitality and physical functioning	strong evidence (p<0,05)	

					1h + 1h30 1 time/Week 10 weeks	Decrease cortisol level	strong evidence (p=0.04)
Ensari et al.[53]	1009 participants 38 countries, Range 14.3–62.9		70% (N=702) had laparoscopic confirmation of their diagnosis, 19.8% (N=200) had a clinician diagnosis and 10.6% (N=107) had suspected endometriosis		-Prevalence of self-reported exercise modalities in the study sample. -cardiovascular activities -Muscle strength and endurance multimodal exercises (eg, high-intensity interval training of both -- cardiovascular and muscular endurance) -fitness activities	-association of previous-day (day <i>t-1</i>) exercise with pain symptoms on day <i>t</i> was moderated by habitual exercise frequency -indicating that those who regularly exercise at least ~3 times per week are less likely to report pain symptoms after having exercised on the previous day.	strong evidence (p<0.0007) for day-level pain score, p=0.026 for Δ-score).