

Lifestyle Factors and Symptom Burden in Endometriosis: An Exploratory Mixed-Methods Analysis of Nutrition, Physical Activity, and Psychosocial Well-being

Laura Wulforth

Martin Luther University Halle-Wittenberg

Andrea Henze

Martin Luther University Halle-Wittenberg

Dorothea Portius

`dorothea.portius@landw.uni-halle.de`

Martin Luther University Halle-Wittenberg

Research Article

Keywords: Endometriosis, Lifestyle factors, Dietary habits, Physical activity, Psychosocial well-being, Symptom burden, Mixed-methods study

Posted Date: June 30th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10040648/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at BMC Women's Health on September 17th, 2026. See the published version at <https://doi.org/10.1186/s12905-026-04886-1>.

**Lifestyle Factors and Symptom Burden in Endometriosis: An Exploratory Mixed-Methods
Analysis of Nutrition, Physical Activity, and Psychosocial Well-being**

Wulfhorst L^{1#}, Henze A¹, Portius D^{1,2*#}

¹Institute for Agriculture and Nutrition Sciences, Martin-Luther-University Halle-Wittenberg,
Halle/Saale, Germany

² Personalized Nutrition, Corporative State University Baden-Württemberg, Heilbronn, Germany

*** Correspondence:**

Corresponding Author

dorothea.portius@landw.uni-halle.de

[#] *authors contributed equally to this work.*

**Keywords: Endometriosis; Lifestyle factors; Dietary habits; Physical activity; Psychosocial
well-being; Symptom burden; Mixed-methods study**

Abstract

Background: Endometriosis affects approximately 10% of reproductive-age women worldwide, with symptom burden significantly impacting quality of life. While current treatment guidelines focus primarily on hormonal and surgical interventions, the role of lifestyle factors in symptom management remains underexplored. Major clinical guidelines acknowledge insufficient evidence for specific lifestyle recommendations, highlighting the need for exploratory research. Therefore, our aim is to explore potential associations between lifestyle factors (nutrition, physical activity, psychosocial well-being) and symptom burden in women with endometriosis using a mixed-methods approach.

Methods: A convergent mixed-method design combining cross-sectional online surveys (n=378) with semi-structured expert interviews (n=5) was conducted between January and March 2025. Lifestyle factors were assessed using newly developed indices for dietary habits, physical activity, and psychosocial well-being. Symptom burden was evaluated using validated endometriosis-specific instruments and numeric rating scales.

Results: In exploratory analyses, the Dietary Habits Index was not significantly associated with overall symptom burden in the study cohort. However, subgroup analysis revealed a weak negative correlation in participants without food intolerances ($\beta = -0.144$, $p = 0.021$). Physical activity and psychosocial well-being indices showed weak associations with symptom burden (physical activity: $\beta = 0.133$, $p = 0.010$; psychosocial well-being: $\beta = -0.261$, $p < 0.001$). Expert interviews emphasized the importance of individualized, multimodal approaches and highlighted psychosocial factors as particularly relevant for symptom management.

Conclusions: This exploratory study suggests modest associations between certain lifestyle factors and endometriosis symptom burden. The findings support the need for individualized lifestyle interventions as adjuncts to conventional medical treatment. Given the limited evidence base and methodological constraints, these hypothesis-generating results require validation through well-designed longitudinal studies and randomized controlled trials.

1 Background

Endometriosis affects approximately 10% of women of reproductive age and is characterized by chronic pelvic pain, fatigue, and infertility, severely affecting quality of life [1, 2]. Despite its high prevalence, endometriosis remains underdiagnosed and poorly understood, with diagnostic delays

commonly reported to range between 7 and 10 years [1, 3]. Many women experience persistent symptoms despite hormonal and surgical treatment, leading to a widespread search for complementary strategies to manage (chronic) pain, inflammation, and fatigue [4].

Over recent years, an increasing number of women have adopted lifestyle modifications as part of their self-management. Surveys from Western populations indicate that approximately 70–80% of women with endometriosis engage in self-management strategies, including dietary modification, physical activity, and mind–body practices, to alleviate symptoms [3, 5, 6]. A cross-sectional survey in Germany, Austria, and Switzerland reported that 75.4% of participants engaged in self-management strategies, with 63.3% reporting exercise and approximately 54% practicing yoga/Pilates or meditation [3]. In Australia, 76% of women reported using self-management strategies, of whom ~47% used breathing/meditation and ~44% used dietary changes [5, 6]. These self-initiated efforts often occur without professional guidance, reflecting a growing reliance on patient-led symptom management in the absence of structured clinical support for non-pharmacological care. This pattern highlights a critical gap between patients’ lived experiences and evidence-based recommendations for managing endometriosis.

Emerging research provides biological plausibility for these patient-driven behaviors. Endometriosis is increasingly recognized as a multisystem disease involving reproductive endocrine imbalance, immune dysfunction, neuroinflammation, and psychosocial distress [7, 8]. Aberrant immune activity and systemic inflammation interact with hormonal dysregulation to sustain chronic pain and lesion growth, while psychological stress may further amplify pain sensitivity through neuroendocrine mechanisms [9-11]. These intertwined biological and psychosocial processes suggest that lifestyle factors that modulate inflammation, anxiety, and emotional well-being may have a meaningful impact on symptom burden and quality of life.

66 Nevertheless, the scientific evidence supporting lifestyle interventions remains sparse and fragmented.
67 The 2022 European Society of Human Reproduction and Embryology (ESHRE) guidelines identified
68 an urgent need for well-designed studies to assess the efficacy of lifestyle-oriented approaches in
69 endometriosis [12]. Although several small-scale trials have explored dietary interventions, such as
70 anti-inflammatory or Mediterranean-style diets, and mind–body programs, the heterogeneity of study
71 designs, limited sample sizes, and inconsistent outcome measures prevent firm conclusions [13, 14].
72 Similarly, evidence regarding exercise remains inconclusive. Existing studies suggest potential
73 benefits of moderate, low-impact activity, but the available data are insufficient to support clear clinical
74 recommendations. In contrast, some studies have reported less favorable associations with high-
75 intensity exercise, possibly related to transient increases in pro-inflammatory responses [15-17].

76 The absence of robust evidence leaves healthcare providers without clear guidance for incorporating
77 lifestyle counseling into the clinical care of endometriosis. At the same time, many patients with
78 endometriosis report substantial symptom relief from personalized combinations of dietary
79 adjustments, physical activity, and stress-reduction or mind–body practices [6, 16, 18]. This paradox
80 between limited empirical data and high patient uptake underscores the need for translational research
81 to bridge the gap between real-world practice and scientific understanding.

82 Traditional randomized controlled trials, while essential for assessing causality, often fail to capture
83 the complexity and contextual variation inherent to lifestyle interventions. Factors such as individual
84 comorbidities, hormonal milieu, psychosocial stress, and cultural behavior patterns can profoundly
85 influence intervention outcomes. Therefore, methodological approaches that integrate both quantitative
86 and qualitative perspectives are required to understand not only the magnitude of associations but also
87 the mechanisms, acceptability, and implementation challenges of lifestyle interventions in daily life.

88 In this context, mixed-method research offers a uniquely powerful framework. Quantitative analyses
89 identify measurable associations between lifestyle domains and symptom burden, whereas qualitative
90 insights clarify the contextual and individualized factors that influence implementation and
91 effectiveness. Together, these complementary perspectives generate a more nuanced understanding of
92 how lifestyle factors contribute to symptom burden and shape the lived experience of endometriosis.
93 This study explores these interconnections between lifestyle, symptom burden, and clinical practice.
94 Using a convergent mixed-methods design, it combines quantitative survey data from a cohort of
95 women with endometriosis with qualitative insights from clinical experts across various disciplines.
96 The analysis focuses on three central lifestyle dimensions: nutrition, physical activity, and psychosocial
97 well-being, which mirror the areas most frequently modified by patients themselves and are most often
98 discussed in the literature as potentially beneficial. By examining these dimensions simultaneously,
99 the study aims to move beyond isolated intervention research and capture the broader, systemic context
100 of endometriosis as a chronic, multifaceted condition.

101 **2 Methods**

102 Study Design and Setting

103 We employed a convergent parallel mixed-methods design, combining quantitative cross-sectional
104 surveys with independent qualitative expert interviews. This approach was selected to capture both
105 measurable associations and contextual insights from clinical experts, thereby enabling triangulation
106 of findings and a more comprehensive understanding of the complex relationships between lifestyle
107 factors and symptom burden.

108 Participants and Recruitment

109 For the quantitative component, women aged 18–40 years with a physician-confirmed diagnosis of
110 endometriosis were recruited between January and March 2025. Recruitment was conducted in
111 Germany via online channels, including social media platforms, patient advocacy groups, and
112 endometriosis support networks, enabling nationwide reach and access to individuals actively
113 managing their condition. Inclusion criteria were: (1) medical diagnosis of endometriosis, (2) current
114 experience of endometriosis-related symptoms, (3) age between 18 and 40 years, and (4) sufficient
115 German language proficiency to complete the questionnaires.

116 Participants were excluded if they were currently pregnant or within one year postpartum, due to
117 potential confounding effects on symptom burden and lifestyle behaviors.

118 A total of 1181 individuals initiated the survey. After excluding incomplete responses and cases that
119 did not meet the inclusion criteria, 378 participants were retained for the final analysis. The sample
120 size provided sufficient statistical power for exploratory correlation and regression analyses, including
121 subgroup comparisons.

122 Quantitative Measures

123 As no existing questionnaire comprehensively captured lifestyle-related factors relevant to
124 endometriosis, a study-specific instrument was developed based on the current scientific literature and
125 incorporated items adapted from validated questionnaires commonly used in health research. Items
126 related to endometriosis diagnosis and symptomatology were based on the *International Endometriosis*
127 *Evaluation Program 1* (IEEP) [19]. Physical activity items were adapted from the *International*
128 *Physical Activity Questionnaire* (IPAQ) [20], and dietary items were adapted from the validated food
129 frequency questions of the German Health Interview and Examination Survey for Adults (DEGS1)
130 [21]. Endometriosis-related symptom burden was assessed using disease-specific items and numeric

rating scales (0–10) to capture pain intensity, symptom frequency, interference with daily activities, and quality of life. Composite scores were calculated to reflect overall symptom burden.

The questionnaire comprised 50 core items, with up to 14 conditional filter questions depending on prior responses, to ensure relevance and improve data quality. Items were organized into ten thematic domains: diagnostics, therapy, symptomatology, comorbidities, pregnancy, nutrition, physical activity, psychosocial well-being, lifestyle, and demographic background, including self-reported height and weight. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2).

Lifestyle Indices

To capture overarching lifestyle patterns and reduce analytical complexity, lifestyle-related items were aggregated into three composite indices. For each index, individual item responses were coded in a uniform direction, summed to yield total scores. To facilitate comparability across indices and interpretation of regression coefficients, composite lifestyle indices were z-standardized prior to regression analyses.

Dietary Habits Index: Dietary behavior over the preceding six months was assessed using food-frequency items adapted from the German Health Interview and Examination Survey for Adults (DEGS1), covering the consumption of key food groups (e.g., fruits, vegetables, whole grains, legumes, and processed foods). Response categories in ordinal scores are aggregated to form a composite index. Items were coded such that higher values consistently reflected more favorable dietary patterns. For food groups considered less favorable (e.g., refined grain products, processed foods, fast food, and snack consumption), reverse coding was applied prior to index construction, so that higher consumption corresponded to lower index scores. The resulting Dietary Habits Index represents overall diet quality, with higher scores indicating greater adherence to a health-oriented

154 dietary pattern. A detailed overview of included food groups and coding procedures is provided in
155 Supplementary Table S8.

156
157 **Physical Activity Index:**

158 Physical activity was assessed using items from the International Physical Activity Questionnaire
159 (IPAQ) to capture the frequency, duration, and intensity of activity across domains, including
160 structured exercise, daily activities, and movement-based behaviors. Response categories were
161 standardized and combined to form a composite index of overall physical activity. Items were coded
162 such that higher values consistently indicated higher levels of physical activity. Where necessary (e.g.,
163 sedentary behavior such as time spent sitting), reverse coding was applied prior to aggregation to ensure
164 a consistent conceptual direction. The resulting Physical Activity Index represents overall physical
165 activity level, with higher scores indicating greater engagement. For regression analyses and graphical
166 presentation, the index was z-standardized to facilitate comparability across lifestyle domains and
167 interpretation of regression coefficients. Consequently, values below zero represent below-average
168 activity levels, whereas values above zero indicate above-average activity levels within the study
169 sample.

170
171 **Psychosocial Well-being Index:** Psychosocial well-being was assessed using items that captured
172 perceived stress, coping strategies, relaxation practices, and dimensions of social functioning,
173 including perceived social support and the quality of social interactions. Response categories were
174 transformed into ordinal scores and aggregated to form a composite index. Items were coded such that
175 higher values consistently reflected more favorable psychosocial well-being. Where necessary (e.g.,
176 for negatively framed items such as perceived stress or emotional burden), reverse coding was applied

177 prior to aggregation to ensure a consistent conceptual direction. The resulting Psychosocial Well-being
178 Index represents overall psychosocial functioning, with higher scores indicating better psychosocial
179 well-being.

180 Qualitative Component

181 To contextualize and enrich the quantitative findings, semi-structured expert interviews were
182 conducted with five clinicians experienced in endometriosis care, including gynecology, nutrition, and
183 psychotherapy. Experts were purposively selected to represent diverse professional perspectives
184 relevant to lifestyle-based management approaches.

185 Interviews lasted on average 30 minutes (18-44 minutes) and followed a semi-structured format that
186 addressed experiences with lifestyle counseling, perceived effectiveness of various interventions,
187 implementation challenges, and the role of individualization in clinical practice. All interviews were
188 conducted via secure videoconferencing or in person, audio recorded with informed consent, and
189 transcribed verbatim.

190 Data Analysis

191 Quantitative Analysis: Descriptive statistics were computed to summarize sociodemographic
192 characteristics, clinical variables, symptom burden, and the distribution of lifestyle indices. Continuous
193 variables are reported as means with standard deviations (SD) or medians with interquartile ranges
194 (IQR), as appropriate. Categorical variables are presented as frequencies and percentages. Bivariate
195 associations between lifestyle indices (nutrition, physical activity, psychosocial well-being) and overall
196 symptom burden were initially examined using Pearson or Spearman correlation coefficients,
197 depending on data distribution. To assess the independent associations of the lifestyle factors with
198 symptom burden, multiple linear regression models were fitted, including all lifestyle indices as

predictors. Standardized regression coefficients (β) with 95% confidence intervals (CI) were reported to facilitate comparison of effect magnitudes across lifestyle domains. Given the exploratory design, the interpretation prioritized effect size estimates, directionality, and consistency of associations over dichotomous significance thresholds.

Pre-specified subgroup analyses were conducted to explore potential moderating effects of gastrointestinal comorbidities (e.g., self-reported food intolerances). Interaction terms were tested where appropriate to evaluate whether associations between lifestyle indices and symptom burden differed across subgroups.

Qualitative Analysis: Qualitative data were analyzed using an inductive thematic analysis. All interviews were transcribed verbatim and thoroughly reviewed to become familiar with the data. Initial codes were generated systematically across the dataset and subsequently organized into broader themes. Themes were refined through iterative comparison of coded data and ongoing discussion within the research team to ensure conceptual clarity and internal coherence.

Ethical Considerations

The study protocol received approval from the Commission for Research Ethics of the Martin-Luther-University Halle-Wittenberg. All participants provided informed consent, and quantitative data were collected anonymously, and qualitative data were pseudonymized to ensure confidentiality. Given the sensitive nature of health-related information and the potential psychological burden of reporting chronic symptoms, participants in the quantitative survey were provided with information about available support resources.

3 Results

Participant Characteristics

A total of 378 women with a confirmed diagnosis of endometriosis participated in the study. Participants ranged in age from 18 to 40 years, with a mean (SD) age of approximately 30 ($\pm$ 5.48) years. Most participants were receiving hormonal therapy, and over 70% reported previous surgical interventions related to endometriosis. Gastrointestinal comorbidities such as irritable bowel syndrome or food intolerances were reported by roughly one-third of participants. Overall, the cohort represented a clinically and demographically diverse sample of reproductive-age women with endometriosis. Detailed demographic and clinical characteristics are presented in Table 1.

Table 1 Descriptive Statistics of the Study Population

	M	SD	Min	Max	n valid	n missing
Age (years)	30.03	5.48	18	40	373	5
Weight (kg)	68.55	14.11	42	130	365	13
Height (m)	1.68	0.06	1.49	1.88	374	4
BMI (kg/m²)	24.32	4.90	14.88	46.99	364	14

M = mean; SD = standard deviation; Min = minimum; Max = maximum; n = number of valid cases; kg = kilogram; m = meter; BMI = body mass index. Total sample size: n = 378.

Quantitative Findings

Distribution of Symptom Burden and Lifestyle Indices

Symptom burden and lifestyle index scores varied substantially across participants, indicating marked heterogeneity in disease impact and lifestyle behaviors. Score distributions spanned a wide range, enabling meaningful exploratory analyses of associations among variables (Table S9).

Association Between Dietary Habits and Symptom Burden Varies by Food Intolerance Status

In the overall sample, the Dietary Habits Index ($M = 2.07$, $SD = 0.26$) was not significantly associated with overall symptom burden ($r = -0.056$, $p = 0.282$; $\rho = -0.077$, $p = 0.138$) (Figure S1). Symptom burden likewise did not differ significantly across low, intermediate, and high dietary habit categories (one-way ANOVA, $p = 0.681$; Figure S2). Healthier dietary patterns were therefore not uniformly associated with lower symptom burden among all participants.

Subgroup analyses revealed a differentiated pattern. Among participants without food intolerances, higher Dietary Habit Indices were weakly but significantly associated with lower symptom burden ($\beta = -0.144$, $p = 0.021$; Table S1) (Figure 1). In contrast, no such association was observed in participants reporting food intolerances ($r = 0.031$, $p = 0.743$; $\rho = 0.031$, $p = 0.747$).

These findings indicate that the association between dietary behavior and symptom burden varies with the presence of food intolerances.

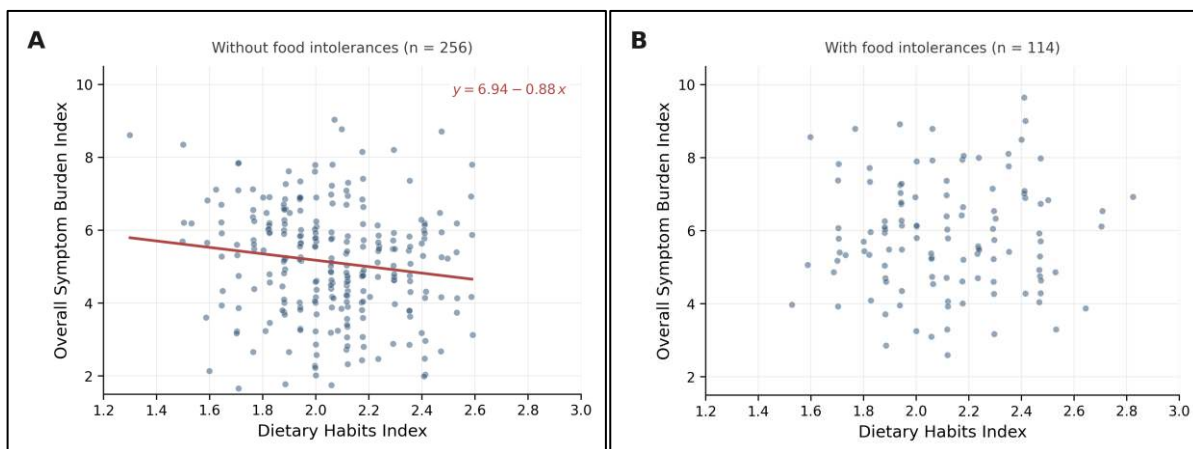
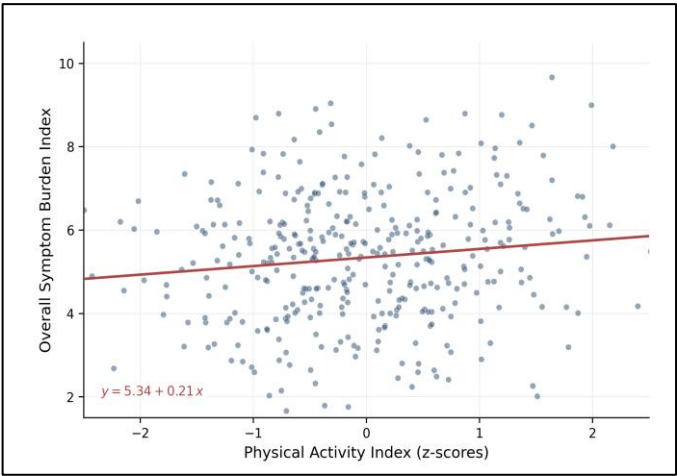


Figure 1 Association between dietary habits and overall symptom burden stratified by food intolerance status. Scatter plots illustrate the relationship between the Dietary Habits Index and the Overall Symptom Burden Index in participants without food intolerances (panel A) and with food intolerances (panel B). In participants without food intolerances, a weak negative association was identified, indicating lower symptom burden with higher dietary habit scores (Pearson's $r = -0.144$, $p = 0.021$; Spearman's $\rho = -0.163$, $p = 0.009$; $\beta = -0.144$; $R^2 = 0.021$; adjusted $R^2 = 0.017$). No significant association was observed in participants with food intolerances. Regression lines represent the fitted linear relationship.

Physical Activity Is Weakly Associated with Symptom Burden

257 Overall physical activity levels were weakly associated with symptom burden ($\beta = 0.133$, $p = 0.010$;
258 Table S2) (Figure 2). Participants reporting moderate levels of physical activity had lower symptom
259 burden than those reporting low or high levels. In contrast, high-intensity physical activity was not
260 associated with reduced symptom burden and, in some analyses, was associated with higher reported
261 symptom severity.

262 Group comparisons between low, moderate, and high activity categories demonstrated significant
263 differences ($F(2) = 4.393$, $p = 0.013$, $\eta^2 = 0.024$), with post hoc analyses indicating that moderate
264 activity levels were associated with the most favorable symptom profiles (Figure 3).



265

266 **Figure 2 Relationship Between Physical Activity Index and Overall Symptom Burden.** Scatter plot illustrating the
267 relationship between the Physical Activity Index (z-standardized scores) and the Overall Symptom Burden Index. A weak
268 positive association was observed, indicating slightly higher symptom burden with increasing physical activity levels ($\beta =$
269 0.133 , $p = 0.010$; Pearson's $r = 0.133$; Spearman's $\rho = 0.120$). The regression line represents the fitted linear relationship.
270

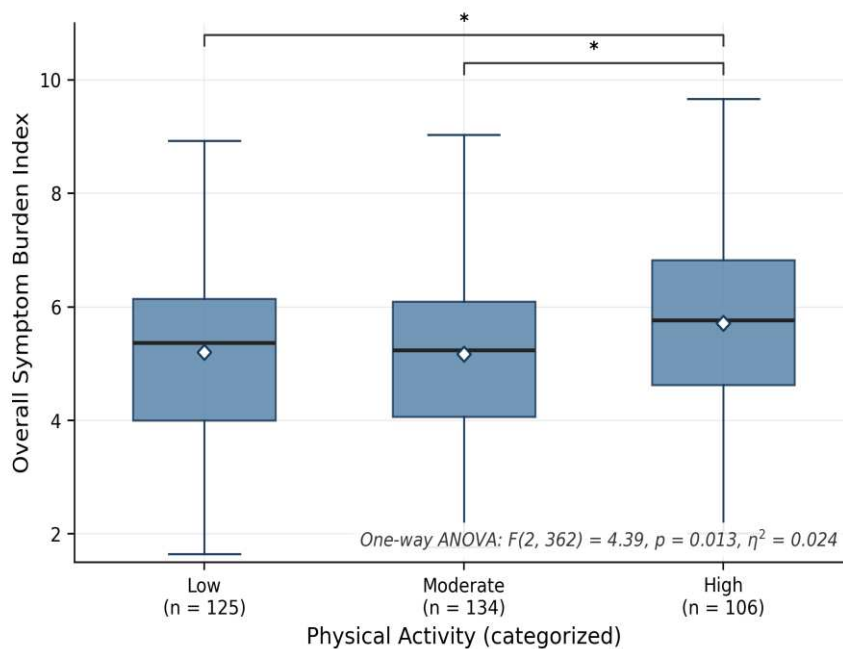


Figure 3 Higher Physical Activity Levels Are Associated with Greater Symptom Burden. Boxplots illustrate overall symptom burden in participants with low, moderate, and high levels of physical activity. A significant group difference was observed (ANOVA: $F(2) = 4.393$, $p = 0.013$). Post hoc comparisons indicated higher symptom burden in the high-activity group than in the low- and moderate-activity groups, while no significant difference was found between the low- and moderate-activity groups.

Higher Psychosocial Well-being Is Associated with Lower Symptom Burden

Psychosocial well-being showed the strongest and most consistent association with symptom burden among all lifestyle indices. Higher Psychosocial Well-being Index scores were significantly associated with lower overall symptom burden ($\beta = -0.261$, $p < 0.001$; Table S3) (Figure 4).

Participants with high psychosocial well-being reported significantly less pain interference and better daily functioning than those with moderate or low well-being. These associations remained robust across multiple symptom-related outcome measures.

Group comparisons among low, moderate, and high psychosocial well-being demonstrated significant differences ($F(2) = 9.904$, $p < 0.001$, $\eta^2 = 0.051$), with post hoc analyses indicating that the highest level of psychosocial well-being was associated with the most favorable symptom profiles (Figure 5).

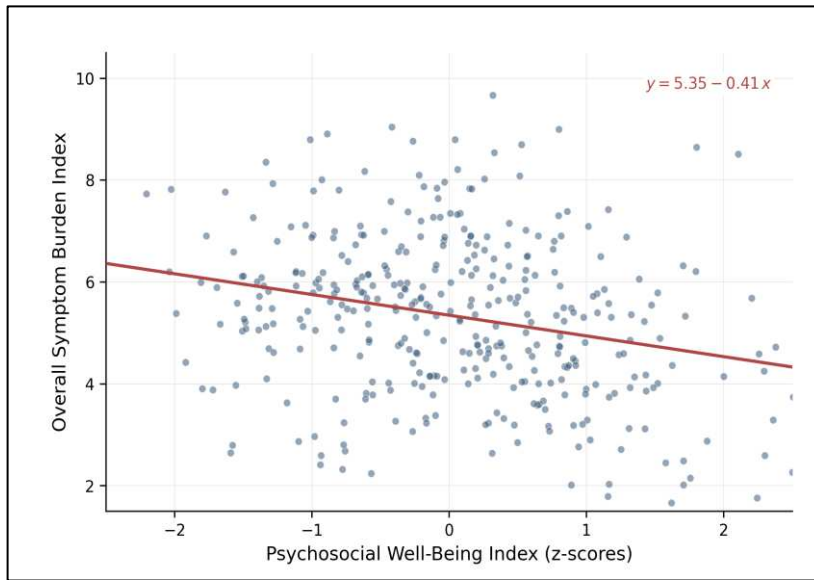


Figure 4 Association between psychosocial well-being and overall symptom burden. Scatter plot illustrating the relationship between the Psychosocial Well-being Index (z-standardized scores) and the Overall Symptom Burden Index. A significant inverse association was observed, indicating lower symptom burden with higher levels of psychosocial well-being ($\beta = -0.261$, $p < 0.001$; Pearson's $r = -0.261$; Spearman's $\rho = -0.264$). The regression line represents the fitted linear relationship.

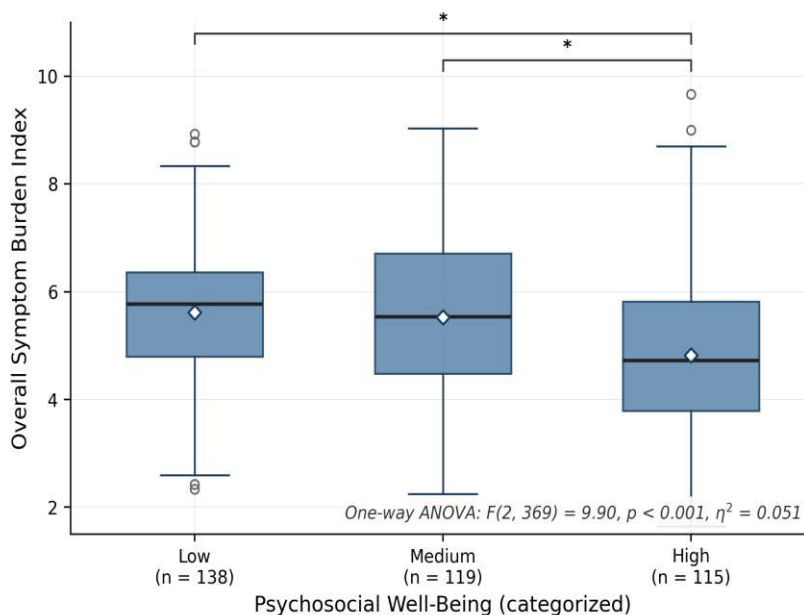


Figure 5. Overall symptom burden across categorized psychosocial well-being levels. Boxplots illustrate the distribution of overall symptom burden in participants with low ($n = 138$), moderate ($n = 119$), and high ($n = 115$) psychosocial well-being. A significant overall group difference was observed (one-way ANOVA: $F(2) = 9.904$, $p < 0.001$). Post hoc analyses indicated significantly lower symptom burden in the high well-being group compared with both the low

299 (p < 0.001) and moderate (p = 0.001) groups, whereas no significant difference was observed between the low and moderate
300 well-being groups (p = 1.00).

301

302 Predictors of Symptom Burden: Multiple Linear Regression Analysis

303 In the multiple linear regression model, the Dietary Habits Index was not independently associated
304 with overall symptom burden ($\beta = -0.044$, 95% CI $[-0.200, 0.112]$, $p = 0.581$) (Table S4). In contrast,
305 both the Physical Activity Index ($\beta = 0.293$, 95% CI $[0.139, 0.447]$, $p < 0.001$) and the Psychosocial
306 Well-Being Index ($\beta = -0.450$, 95% CI $[-0.607, -0.294]$, $p < 0.001$) emerged as significant predictors,
307 with psychosocial well-being demonstrating the largest standardized effect (Figure 6). Adjustment for
308 potential confounders did not materially alter these associations. Including age and BMI as covariates
309 had no meaningful impact on the regression coefficients of the primary predictors. Hormone status and
310 surgical history accounted for a small but statistically significant proportion of variance in symptom
311 burden ($R^2 = 0.021$, $p = 0.020$). The addition of the lifestyle indices significantly improved overall
312 model fit, increasing the explained variance to 11.9% ($\Delta R^2 = 0.098$, $p < 0.001$). No evidence of
313 multicollinearity was observed (all VIFs < 2; tolerance > 0.50).

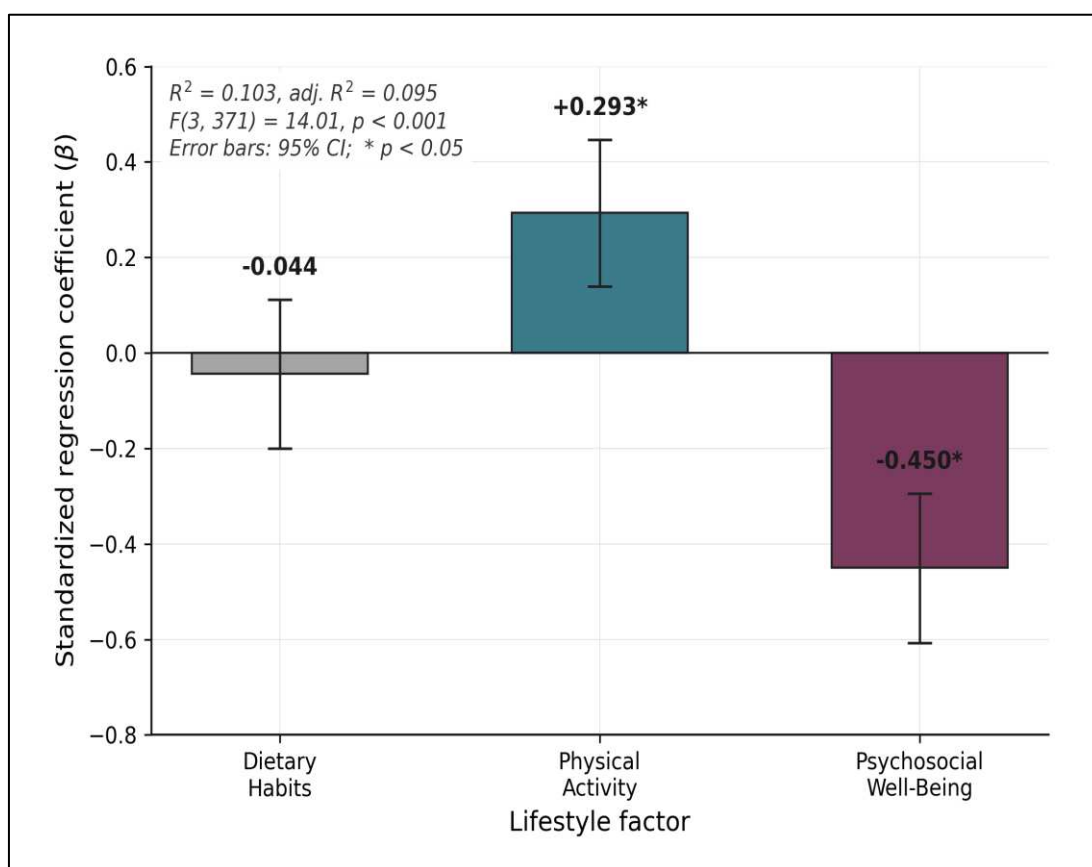


Figure 6 **Independent associations of lifestyle factors with overall symptom burden.** Standardized regression coefficients (β) from the multiple linear regression model are shown for dietary habits, physical activity, and psychosocial well-being. Psychosocial well-being was inversely associated with symptom burden, while physical activity was positively associated. No significant association was observed for dietary habits. Error bars represent 95% confidence intervals.

Inter-Index Correlations and Interaction Effects

To explore whether the three lifestyle indices share common variance and whether their combined effect on symptom burden exceeds the sum of their individual contributions, we conducted exploratory inter-index correlation and interaction analyses (complete-case $n = 372$). All three indices were weakly but significantly positively intercorrelated (DHI–PAI: $r = +0.175$, $p < 0.001$; DHI–PWI: $r = +0.211$, $p < 0.001$; PAI–PWI: $r = +0.179$, $p < 0.001$), indicating modestly overlapping but largely independent lifestyle dimensions (Figure 7A, B; Table S5). Spearman’s ρ yielded the same pattern (range 0.16–0.22, all $p < 0.01$). A hierarchical multiple regression with z-standardized predictors was then estimated to test whether two- and three-way interactions improved the prediction of overall symptom burden beyond the main-effects model ($R^2 = 0.103$; reported above). Adding the three two-way interactions

330 (DHI×PAI, DHI×PWI, PAI×PWI) did not significantly improve model fit ($\Delta R^2 = +0.002$, $F(3, 365) =$
 331 0.23 , $p = 0.877$), nor did the subsequent inclusion of the three-way interaction ($\Delta R^2 = +0.007$, $F(1,$
 332 $364) = 2.67$, $p = 0.103$). None of the individual interaction terms reached statistical significance (all p
 333 ≥ 0.10 ; Figure 7C; Table S6). The lifestyle indices thus appear to operate additively rather than
 334 synergistically, as psychosocial well-being remained the strongest independent predictor ($\beta = -0.27$, p
 335 < 0.001), followed by physical activity ($\beta = +0.21$, $p < 0.001$), with no evidence that the combination
 336 of dietary habits and physical activity, or any other pair, amplified or attenuated the effect of
 337 psychosocial well-being.

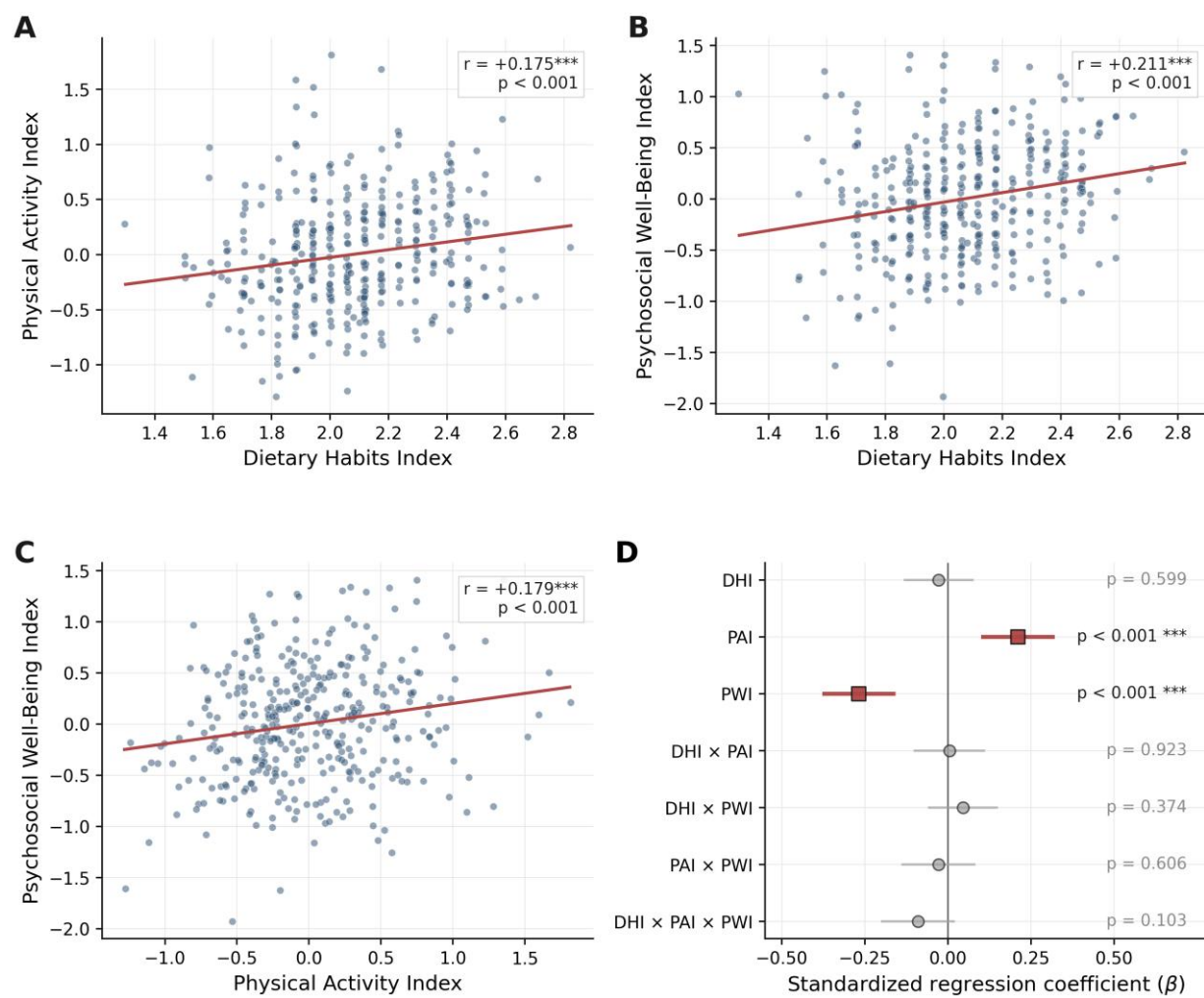


Figure 7 Inter-relationships among lifestyle indices and their interactive effects on overall symptom burden. Pairwise scatter plots illustrating the inter-relationships between the three lifestyle indices in the complete-case sample (n = 372): (A) Dietary Habits Index (DHI) versus Physical Activity Index (PAI); (B) Dietary Habits Index versus Psychosocial Well-Being Index (PWI); (C) Physical Activity Index versus Psychosocial Well-Being Index. Red lines indicate the fitted linear regression; Pearson's r and the corresponding p-value are shown in each panel. (D) Standardized regression coefficients (β) with 95% confidence intervals from the full interaction model predicting overall symptom burden (main effects: $R^2 = 0.103$; addition of two-way interactions: $\Delta R^2 = +0.002$, $p = 0.877$; addition of the three-way interaction: $\Delta R^2 = +0.007$, $p = 0.103$). Significant main effects of PAI and PWI were observed, but no two- or three-way interaction reached statistical significance, supporting an additive rather than multiplicative pattern of lifestyle effects on symptom burden. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Expert Perspectives on Multimodal and Lifestyle Management of Endometriosis

The expert interviews were analyzed using a structured qualitative content analysis, yielding 471 coded text segments. These segments were organized into five main categories with 13 subcategories (Table S7), reflecting recurring patterns across interviews. The categories describe experts' perspectives on (1) disease burden, (2) established therapies, (3) the role of lifestyle factors, (4) multimodal treatment concepts, and (5) implementation conditions in clinical practice.

Category 1: Disease Burden and Symptom Complexity

Experts consistently described endometriosis as a condition associated with high and multifaceted disease burden. Pain was reported as the dominant symptom, but experts emphasized that pain presentations differed substantially between patients. Described patterns included cycle-related pelvic pain, ovulation-associated pain, and persistent chronic pain independent of the menstrual cycle.

In addition to pain, experts highlighted gastrointestinal symptoms, such as bloating, bowel discomfort, and food-related complaints, as frequent and clinically relevant. Psychological strain, particularly in the context of chronic pain, uncertainty, and infertility, was described as a further dimension contributing to reduced quality of life. Experts noted that the combination of physical and psychological symptoms often resulted in considerable functional limitations in daily life.

Category 2: Pharmacological and Surgical Therapies as the Foundation of Care

367 Across interviews, experts identified hormonal therapy and surgery as the central pillars of
368 endometriosis treatment. Hormonal therapy was commonly described as a long-term or maintenance
369 strategy aimed at symptom reduction and recurrence prevention, following surgical interventions.

370 Experts also reported that treatment decisions are frequently shaped by patient preferences, tolerability,
371 and life circumstances. Situations in which hormonal therapy was declined or not tolerated were
372 described as common, requiring alternative or supportive strategies to address ongoing symptoms.
373 Nevertheless, experts consistently framed medical therapies as the foundation of care rather than
374 optional components.

375 Category 3: Role of Lifestyle Factors in Symptom Management

376 Lifestyle-related strategies were described as clinically relevant but positioned as adjunctive
377 components, rather than as primary interventions, to support symptom relief and coping. Experts
378 consistently emphasized that lifestyle measures are not a substitute for medical or surgical treatment
379 in patients with confirmed endometriosis.

380 Experts reported that lifestyle changes were perceived as particularly relevant for symptom domains
381 that are often insufficiently controlled by medical therapy alone. Dietary adjustments were frequently
382 reported in relation to gastrointestinal symptoms, whereas physical activity and movement-based
383 interventions were associated with overall well-being and functional capacity. Experts also noted that
384 patients often attribute high expectations to lifestyle changes, underscoring the importance of clear
385 communication about realistic effects in counseling.

386 Category 4: Multimodal Treatment as a Clinical Principle

387 Rather than describing multimodality as an abstract concept, experts consistently portrayed it as a
388 practical treatment logic. Multimodal care was described as the combination of medical therapy,

389 surgical interventions where indicated, and supportive lifestyle-oriented approaches, adapted to
390 individual symptom patterns and treatment responses.

391 Experts emphasized that multimodal care is dynamic: treatment components are reassessed and
392 adjusted over time depending on symptom development, patient goals (e.g., fertility intentions), and
393 treatment tolerability. This iterative approach was described as essential for managing this chronic
394 condition, whose symptoms fluctuate.

395 Category 5: Structural and Contextual Factors Affecting Implementation

396 Experts identified several factors influencing the implementation of lifestyle-oriented and multimodal
397 care. A central issue was the limited availability of high-quality evidence, which experts perceived as
398 restricting both clinical confidence and broader implementation of lifestyle counseling.

399 Further constraints included limited consultation time, insufficient reimbursement structures for non-
400 medical interventions, and fragmented care pathways. At the same time, experts highlighted that
401 lifestyle counseling, when feasible, was valued for enhancing patient self-efficacy, as it provides
402 patients with strategies they can actively apply in everyday life. This perceived empowerment was
403 described as an important, albeit indirect, benefit of lifestyle-oriented care.

404 Overall, the qualitative analysis indicates that experts view endometriosis as a condition characterized
405 by complex symptoms, requiring medical therapy as a foundation, supplemented by lifestyle-oriented
406 measures within a multimodal framework. Lifestyle interventions were consistently described as
407 supportive rather than curative, with their implementation shaped by structural constraints and
408 evidence gaps, yet they were valued for enabling patients to actively engage in day-to-day symptom
409 management and coping

410 Integration of Quantitative and Qualitative Findings

To integrate findings across methodological approaches, quantitative and qualitative results were synthesized to provide a comprehensive understanding of the role of lifestyle factors in endometriosis. Across both data sources, psychosocial well-being emerged as the most consistent and clinically relevant domain, showing the strongest association with symptom burden and being emphasized by experts as central to patients' everyday experiences and coping processes.

In contrast, associations between physical activity and symptom burden were more modest and appeared to vary depending on activity patterns and individual context. Dietary effects were similarly heterogeneous and were primarily observed in specific subgroups, particularly among women without food intolerances. Importantly, the qualitative findings suggest that these domains should not be interpreted as isolated or independent determinants of symptom burden. Rather, experts consistently described physical activity and dietary strategies as supportive components that may contribute to symptom management, functional capacity, and self-management when integrated into individualized and multimodal treatment approaches.

Taken together, the findings indicate that lifestyle-related factors may operate in an interconnected, context-dependent manner rather than exert uniform effects across all patients. While psychosocial well-being demonstrated the strongest and most consistent association with symptom burden, physical activity and dietary behaviors may still play clinically meaningful supportive roles within a broader multimodal framework of endometriosis care. The integrated findings are summarized in Figure 8.

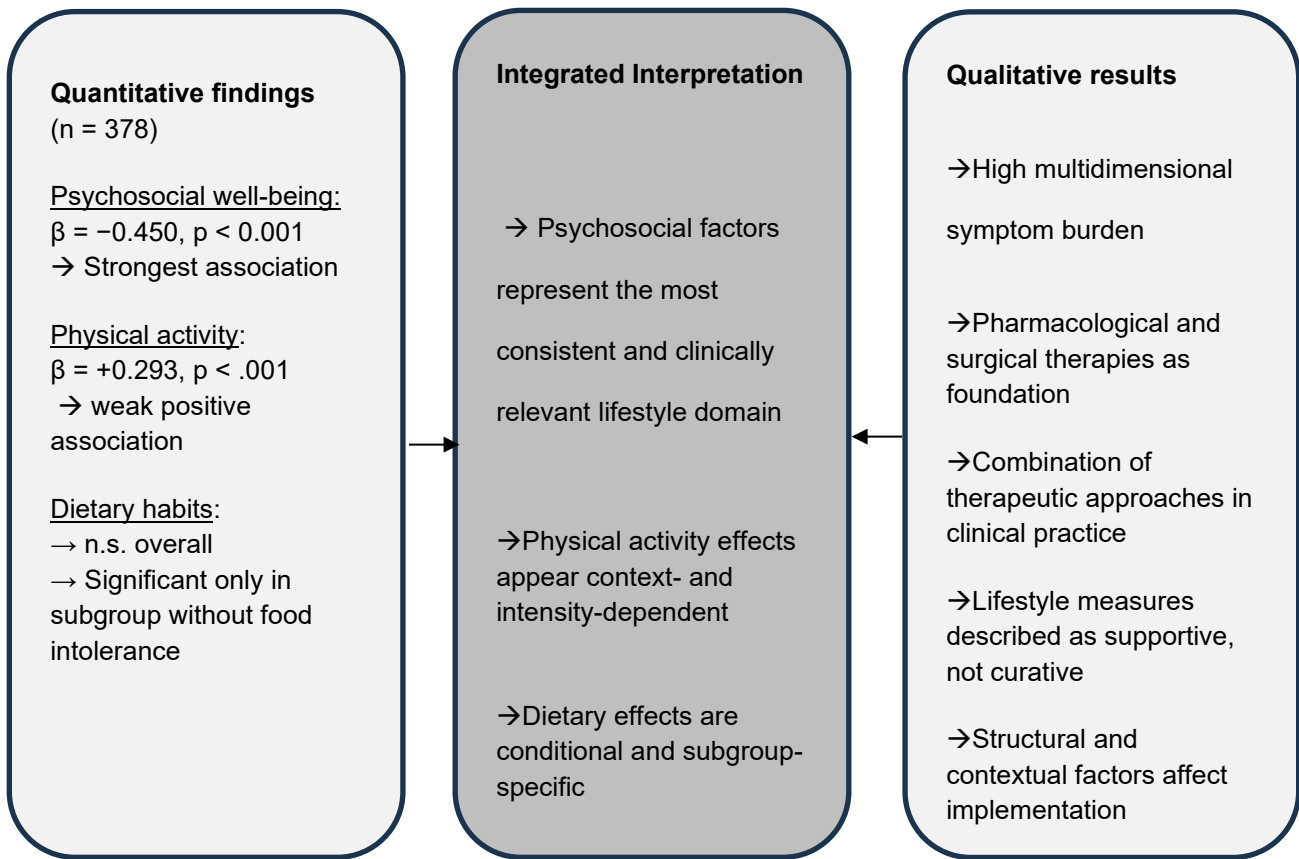


Figure 8 Integrated conceptual model of quantitative and qualitative findings on lifestyle factors and symptom burden in endometriosis. The figure synthesizes results from both quantitative and qualitative analyses, illustrating the differential roles of lifestyle domains in relation to symptom burden. Psychosocial well-being emerges as the most consistent and clinically relevant factor, while physical activity shows modest, context-dependent associations, and dietary effects appear heterogeneous and subgroup-specific. Qualitative findings further contextualize these relationships by positioning lifestyle factors as supportive, adjunctive components within a broader multimodal treatment framework, shaped by structural and contextual factors influencing implementation.

4 Discussion

In this mixed-methods study, we examined associations between lifestyle-related factors and symptom burden in women with endometriosis. Overall, lifestyle factors were associated with symptom burden to a weak-to-moderate extent, with psychosocial well-being emerging as the most consistently relevant domain, although overlap between psychosocial and behavioral factors should be considered in interpreting these associations. Dietary habits and physical activity showed more differentiated and

context-dependent associations. These findings support a nuanced view of lifestyle interventions as adjunctive modulators of symptom experience, rather than primary determinants of disease severity.

Exploratory analyses of the inter-relationships among the three lifestyle indices further refined this interpretation. All three indices were weakly but significantly positively intercorrelated ($r = 0.18\text{--}0.21$, all $p < 0.001$; Figures 7A and 7 B), indicating that women with healthier dietary patterns also tended to report somewhat higher physical activity and better psychosocial well-being. The shared variance between any two indices was small (3–4%), suggesting that the three domains capture largely independent lifestyle dimensions rather than a single underlying construct. Crucially, a hierarchical regression model testing all two- and three-way interactions between the indices revealed no evidence of synergistic effects on symptom burden (combined $\Delta R^2 = +0.009$ over the main-effects model, all interaction $p \geq 0.10$; Figure 7C). The protective association of psychosocial well-being with symptom burden was therefore neither amplified by nor dependent on concurrent dietary or physical activity behaviors. From a clinical perspective, this additive pattern implies that improvements in any single lifestyle domain may contribute meaningfully to symptom relief without requiring simultaneous changes in the others. A finding that may be reassuring for patients facing competing demands when initiating self-management, while also underscoring that no single lifestyle change is sufficient to substitute for the others. Power to detect higher-order interactions in a cross-sectional sample of this size is limited, however, and longitudinal or interventional designs are warranted to test whether combined lifestyle changes produce additive or interactive benefits over time.

Psychosocial well-being demonstrated the strongest and most robust association with symptom burden. Higher psychosocial distress was consistently associated with greater pain interference and reduced daily functioning. This finding aligns with a growing body of evidence indicating that endometriosis profoundly affects mental health and quality of life, with anxiety, depression, chronic stress, and fatigue often matching or exceeding the burden of physical pain itself [22].

481 Observational studies have repeatedly shown that women with endometriosis report elevated stress
482 levels and that perceived stress correlates with greater symptom severity and functional impairment
483 [22, 23]. The present findings reinforce this evidence by highlighting psychosocial well-being as a key
484 correlate of symptom burden in endometriosis. Importantly, emerging randomized controlled trial
485 evidence further supports the clinical relevance of this association. Meta-analyses of psychosocial
486 interventions, including cognitive-behavioral therapy and mindfulness-based stress reduction, have
487 reported reductions in pain (particularly dyspareunia and dyschezia) and anxiety, alongside
488 improvements in mental health outcomes [23]. Taken together, these findings indicate that
489 psychosocial factors are not peripheral but integral to the symptom experience of endometriosis and
490 support the integration of psychological and stress-regulation strategies into routine care.

491 Associations between physical activity and symptom burden were modest, with patterns suggesting
492 that the relationship may vary by activity level and type. Overall physical activity levels showed only
493 weak associations with symptom burden, consistent with previous cross-sectional studies reporting
494 limited direct relationships between routine exercise and pain severity [6, 16]. However, group
495 comparisons suggested that symptom burden varied across activity levels. Participants reporting
496 moderate physical activity exhibited somewhat lower symptom burden than those reporting low or
497 high levels of activity, whereas high levels of activity were not associated with more favorable
498 symptom profiles. These findings indicate that the relationship between physical activity and symptom
499 burden may be context-dependent rather than uniformly beneficial across all activity levels.

500 In addition, different forms of physical activity may exert distinct effects. While structured aerobic
501 exercise and strength training may improve physical functioning and overall well-being, movement-
502 based and mind-body approaches, such as yoga or stretching, may also support relaxation, stress
503 reduction, and coping with chronic pain. Evidence from intervention studies nonetheless suggests that
504 exercise can represent a meaningful adjunct in endometriosis care. A recent meta-analysis of six

505 randomized controlled trials (n = 251) reported that structured exercise programs improved quality of
506 life and modestly reduced pain [24]. However, considerable heterogeneity in intervention protocols,
507 ranging from aerobic exercise to yoga and stretching, limits conclusions about the optimal type,
508 intensity, or duration of exercise for women with endometriosis.

509 The qualitative findings provide additional contextual insight into the role of physical activity in the
510 management of endometriosis. Experts emphasized that the context in which physical activity is
511 performed strongly influences its feasibility and perceived usefulness for patients. Exercise approaches
512 that are supervised, individualized, and adaptable to fluctuating symptoms were described as
513 particularly suitable for women experiencing chronic pain and symptom variability. Together, these
514 perspectives suggest that physical activity should not be considered a universally effective intervention,
515 but rather a supportive component of multidisciplinary care when appropriately tailored to individual
516 symptom patterns and functional capacity.

517 Dietary factors showed no uniform association with symptom burden across the entire cohort.
518 However, subgroup analyses and qualitative findings indicated that diet may be particularly relevant
519 for women with gastrointestinal comorbidities, including bloating, constipation, and food intolerances.

520 This pattern is consistent with growing evidence of a clinically relevant association between the gut
521 and endometriosis. Up to 90% of women with endometriosis report bowel symptoms, and the
522 prevalence of irritable bowel syndrome is markedly higher than in the general population [25]. For this
523 subgroup, targeted dietary interventions may alleviate both gastrointestinal symptoms and pain.

524 Supporting this interpretation, a recent prospective study demonstrated that a low-FODMAP diet
525 improved gastrointestinal symptoms, quality of life, and emotional well-being in women with
526 endometriosis, with approximately two-thirds reporting subjective pain reduction [26]. However,

527 adherence challenges and high dropout rates underscore the importance of feasibility and professional
528 guidance.

529 Broader nutritional research in endometriosis yields mixed conclusions. While epidemiological studies
530 suggest an association between plant-based, fiber-rich diets and a lower risk of endometriosis, the
531 overall certainty of the evidence remains low due to observational designs and potential confounding
532 [27]. Our findings align with this literature, suggesting that one-size-fits-all dietary recommendations
533 are unlikely to be effective and that dietary interventions may be most beneficial when tailored to
534 specific symptom profiles, particularly those involving the gastrointestinal tract.

535 Although observed associations were modest in magnitude (typically $r \approx 0.2\text{--}0.3$), such effect sizes are
536 expected in a multifactorial condition like endometriosis. Lifestyle factors are unlikely to override the
537 disease's underlying pathophysiology. However, from a clinical perspective, even small improvements
538 can be meaningful for patients living with chronic pain.

539 Incremental reductions in symptom burden may translate into improved daily functioning, reduced
540 reliance on analgesics, or enhanced work and social participation. Moreover, lifestyle factors may
541 interact synergistically over time: improved nutrition can enhance energy levels, facilitating physical
542 activity. In turn, regular activity can improve sleep and mood, potentially reducing pain perception.
543 Such cumulative effects may not be fully captured in cross-sectional analyses but are frequently
544 observed in clinical practice [6, 28, 29].

545 Several limitations should be considered. The cross-sectional design precludes causal inference and
546 limits interpretation of directionality. Lifestyle behaviors and symptom burden likely influence each
547 other bidirectionally. The lifestyle indices, although theory-based, were newly developed and not
548 formally validated in an endometriosis population, potentially introducing measurement error. All data
549 were self-reported, raising the possibility of recall and reporting bias. Additionally, the qualitative

550 component included a small number of expert interviews and may not capture the full range of clinical
551 perspectives.

552 Despite these limitations, the mixed-methods design strengthens the study by enabling convergence
553 between quantitative patterns and qualitative insights. The findings should be interpreted as hypothesis-
554 generating, providing a foundation for future longitudinal and interventional research.

555 Our findings support integrating lifestyle and psychosocial considerations into endometriosis care
556 alongside established pharmacological and surgical treatments. In practice, this underscores the value
557 of multidisciplinary approaches involving dietitians, physiotherapists, and mental health professionals,
558 particularly for patients with persistent symptoms or specific comorbidities.

559 Future research should prioritize longitudinal studies and randomized trials to clarify causal pathways,
560 identify patient subgroups most likely to benefit, and determine optimal “doses” and formats of
561 lifestyle interventions. Continued integration of qualitative methodologies will remain essential to
562 capture patient preferences, feasibility, and contextual factors that quantitative measures alone cannot
563 address.

564 In summary, this mixed-methods study highlights that lifestyle factors, especially psychosocial well-
565 being, are meaningfully associated with symptom burden in endometriosis, albeit with modest effect
566 sizes. While lifestyle interventions are not curative, they represent valuable adjuncts within a
567 comprehensive, individualized care framework. Addressing psychological well-being, promoting
568 appropriate physical activity, and tailoring dietary advice to symptom profiles may collectively
569 improve quality of life for women with endometriosis.

570 **5 Conclusions**

In this exploratory mixed-methods study of women with endometriosis, lifestyle factors were associated with overall symptom burden to a weak-to-moderate extent. Psychosocial well-being emerged as the most consistent and clinically relevant domain, as physical activity showed a modest, context-dependent association, and dietary habits were related to symptom burden only in the subgroup without food intolerances. Inter-index analyses revealed weak positive correlations between the three lifestyle dimensions but no synergistic interaction effects, indicating that lifestyle factors act largely additively rather than multiplicatively in this population. Expert interviews underscored multimodality and psychosocial care as central to clinical management, while framing dietary and physical-activity strategies as supportive components. These findings support an individualized, multimodal view of lifestyle interventions in endometriosis as adjuncts to pharmacological and surgical care rather than as primary treatments. Given the cross-sectional design and self-reported nature of the data, the results should be considered hypothesis-generating. Longitudinal and intervention studies are warranted to test whether targeted, combined lifestyle changes meaningfully alter the trajectory of symptom burden over time.

6 List of Abbreviations

ANOVA: analysis of variance; BMI: body mass index; CI: confidence interval; DEGS1: German Health Interview and Examination Survey for Adults; DHI: Dietary Habits Index; ESHRE: European Society of Human Reproduction and Embryology; IBS: irritable bowel syndrome; M: mean; PAI: Physical Activity Index; PWI: Psychosocial Well-Being Index; RCT: randomised controlled trial; SD: standard deviation; VIF: variance inflation factor.

7 References

- 592 1. De Corte, P., et al., *Time to Diagnose Endometriosis: Current Status, Challenges and*
593 *Regional Characteristics—A Systematic Literature Review*. BJOG: An International Journal
594 of Obstetrics & Gynaecology, 2025. **132**(2): p. 118-130.
- 595 2. Niemirka, S., et al., *Impact of Sport on the Course of Endometriosis*. Quality in Sport, 2024.
596 **35**: p. 56300.
- 597 3. Werner, F., et al., *The role of self-management in endometriosis pain: insights from a cross-*
598 *sectional survey in Germany, Austria, and Switzerland*. Archives of Gynecology and
599 Obstetrics, 2025. **312**(2): p. 425-434.
- 600 4. Gholiof, M., et al., *Prevalence of Use and Perceived Effectiveness of Medical, Surgical, and*
601 *Alternative Therapies for Endometriosis Pain in Canadians*. Journal of Obstetrics and
602 Gynaecology Canada, 2023. **45**(1): p. 11-20.
- 603 5. Armour, M., et al., *Dietary Practices of Women with Endometriosis: A Cross-Sectional*
604 *Survey*. The Journal of Alternative and Complementary Medicine, 2021. **27**(9): p. 771-777.
- 605 6. Armour, M., et al., *Self-management strategies amongst Australian women with*
606 *endometriosis: a national online survey*. BMC Complementary and Alternative Medicine,
607 2019. **19**(1).
- 608 7. Nirgianakis, K., et al., *Effectiveness of Dietary Interventions in the Treatment of*
609 *Endometriosis: a Systematic Review*. Reproductive Sciences, 2022. **29**(1): p. 26-42.
- 610 8. Mazur-Bialy, A., et al., *Holistic Approaches in Endometriosis - as an Effective Method of*
611 *Supporting Traditional Treatment: A Systematic Search and Narrative Review*. Reproductive
612 Sciences, 2024. **31**(11): p. 3257-3274.

- 613 9. Gete, D.G., et al., *Associations between endometriosis and common symptoms: findings from*
614 *the Australian Longitudinal Study on Women's Health*. American Journal of Obstetrics and
615 Gynecology, 2023. **229**(5): p. 536.e1-536.e20.
- 616 10. Moradi, M., et al., *Impact of endometriosis on women's lives: a qualitative study*. BMC
617 Women's Health, 2014. **14**(1): p. 123.
- 618 11. Gstoettner, M., et al., *"I think to myself 'why now?'" – a qualitative study about*
619 *endometriosis and pain in Austria*. BMC Women's Health, 2023. **23**(1).
- 620 12. Becker, C.M., et al., *ESHRE guideline: endometriosis*. Human Reproduction Open, 2022.
621 **2022**(2).
- 622 13. Helbig, M., et al., *Does Nutrition Affect Endometriosis?* Geburtshilfe und Frauenheilkunde,
623 2021. **81**(02): p. 191-199.
- 624 14. Abulughod, N., S. Valakas, and F. El-Assaad, *Dietary and Nutritional Interventions for the*
625 *Management of Endometriosis*. Nutrients, 2024. **16**(23): p. 3988.
- 626 15. Tourny, C., et al., *Endometriosis and physical activity: A narrative review*. International
627 Journal of Gynecology & Obstetrics, 2023. **163**(3): p. 747-756.
- 628 16. Tennfjord, M.K., R. Gabrielsen, and T. Tellum, *Effect of physical activity and exercise on*
629 *endometriosis-associated symptoms: a systematic review*. BMC Women's Health, 2021.
630 **21**(1).
- 631 17. Hansen, S., U.Á. Sverrisdóttir, and M. Rudnicki, *Impact of exercise on pain perception in*
632 *women with endometriosis: A systematic review*. Acta Obstetrica et Gynecologica
633 Scandinavica, 2021. **100**(9): p. 1595-1601.
- 634 18. Nap, A. and N. De Roos, *Endometriosis and the effects of dietary interventions: what are we*
635 *looking for?* Reproduction and Fertility, 2022. **3**(2): p. C14-C22.

- 636 19. Diagnosis and therapy of endometriosis. Guideline of the DGGG, S.a.O., *S2k-Level, AWMF*
637 *Registry No. 045/015*. 2025.
- 638 20. Craig, C.L., et al., *International Physical Activity Questionnaire: 12-Country Reliability and*
639 *Validity*. *Medicine & Science in Sports & Exercise*, 2003. **35**(8): p. 1381-1395.
- 640 21. Haftenberger, M., et al., *Relative validation of a food frequency questionnaire for national*
641 *health and nutrition monitoring*. *Nutrition Journal*, 2010. **9**(1): p. 36.
- 642 22. Kovács-Szabó, Z., et al., *Psychological, Symptom-Related, and Lifestyle Predictors of*
643 *Health-Related Quality of Life in Hungarian Women with Endometriosis*. *Journal of Clinical*
644 *Medicine*, 2025. **14**(19): p. 7004.
- 645 23. Del Pino-Sedeño, T., et al., *Effectiveness of psychological interventions in endometriosis: a*
646 *systematic review with meta-analysis*. *Frontiers in Psychology*, 2024. **15**.
- 647 24. Xie, M., et al., *The effectiveness and safety of physical activity and exercise on women with*
648 *endometriosis: A systematic review and meta-analysis*. *PLOS ONE*, 2025. **20**(2): p.
649 e0317820.
- 650 25. Maroun, P., et al., *Relevance of gastrointestinal symptoms in endometriosis*. *Australian and*
651 *New Zealand Journal of Obstetrics and Gynaecology*, 2009. **49**(4): p. 411-414.
- 652 26. Keukens, A., et al., *Effects of a low-FODMAP diet on patients with endometriosis, a*
653 *prospective cohort study*. *BMC Women's Health*, 2025. **25**(1).
- 654 27. Neri, L.C.L., et al., *Diet and Endometriosis: An Umbrella Review*. *Foods*, 2025. **14**(12): p.
655 2087.
- 656 28. Geneen, L.J., et al., *Physical activity and exercise for chronic pain in adults: an overview of*
657 *Cochrane Reviews*. *Cochrane Database of Systematic Reviews*, 2017. **2020**(2).

658 29. Bushnell, M.C., M. Čeko, and L.A. Low, *Cognitive and emotional control of pain and its*
659 *disruption in chronic pain*. Nature Reviews Neuroscience, 2013. **14**(7): p. 502-511.

660

661 **8 Declarations**

662 Ethics approval and consent to participate

663 The study protocol received approval from the Commission for Research Ethics of the Martin-Luther-
664 University Halle-Wittenberg. All quantitative survey participants and all interview participants
665 provided informed consent prior to inclusion in the study. Quantitative data were collected
666 anonymously and qualitative data were pseudonymised to ensure confidentiality.

667 Consent for publication

668 Not applicable. The manuscript does not contain any individual person's data in any form.

669 Availability of data and materials

670 The de-identified datasets generated and analysed during the current study, together with the SPSS
671 syntax used for the analyses, are available from the corresponding author on reasonable request.

672 **9 Competing interests**

673 The authors declare that the research was conducted without any commercial or financial
674 relationships that could be construed as a potential conflict of interest.

675 **10 Authors' contributions**

676 L.W. conceived and designed the study, conducted data collection and analysis, and drafted the
677 manuscript. D.P. contributed to study design, contributed to conceptualization, project coordination,
678 and manuscript writing and revision. A.H. supervised the study, contributed to conceptualization and
679 study design, and critically revised the manuscript. All authors reviewed and approved the final
680 manuscript and agree to be accountable for the work.

681 **11 Funding**

682 This research received no external funding.

683 **12 Acknowledgements**

684 -

685

686

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryMaterialWulforthetal20260602.docx](#)