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Exploring the role of serum interleukins in postoperative recurrence of pelvic organ prolapse: Development and validation of a predictive model

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Abstract

To explore the correlation between serum interleukins and postoperative recurrence of pelvic organ prolapse (POP). Additionally, a predictive model incorporating both clinical parameters and inflammatory markers was developed to support individualized recurrence prevention and management strategies. The analysis included 184 patients who underwent POP surgery between March 2022 and June 2024. Among them, 44 experienced recurrence (recurrence group), while 140 did not (non-recurrence group). The serum levels of Interleukin (IL)-1β, IL-6 and IL-8 in the recurrence group were higher than those in the non-recurrence group (P<0.001). Multivariate analysis showed that, IL-1β (OR: 1.420, 95%CI: 1.189 - 1.695), IL-6 (OR: 1.693, 95%CI: 1.298 - 2.207), IL-8 (OR: 1.443, 95%CI: 1.174 - 1.774), Age (OR: 1.138, 95%CI: 1.031 1.257), Menopause (OR: 6.484, 95%CI: 1.600 - 26.275), POP-Q stage (OR: 9.162, 95%CI: 2.180-38.510) and chronic constipation (OR: 5.029, 95%CI: 1.219-20.753) were independent risk factors for postoperative recurrence. The risk model based on this model showed excellent prediction performance in both the training set (AUC=0.965, sensitivity 93.75%, specificity 87.63%) and the validation set (AUC=0.946, sensitivity 91.67%, specificity 88.37%) (P<0.05). *(Afr J Reprod Health 2026; 30 [5]: 46-54).*

Keywords: interleukin, pelvic organ prolapse, recurrence, risk model, risk factor

Résumé

Cette étude explore la corrélation entre les interleukines sériques et la récidive postopératoire du prolapsus des organes pelviens (POP). Un modèle prédictif intégrant des paramètres cliniques et des marqueurs inflammatoires a été développé afin d'aider à l'élaboration de stratégies individualisées de prévention et de prise en charge des récidives. L'analyse a porté sur 184 patientes ayant subi une chirurgie pour POP entre mars 2022 et juin 2024. Parmi elles, 44 ont présenté une récidive (groupe récidive), tandis que 140 n'en ont pas présenté (groupe sans récidive). Les taux sériques d'interleukine (IL)-1β, d'IL-6 et d'IL-8 étaient significativement plus élevés dans le groupe récidive que dans le groupe sans récidive (p < 0,001). L'analyse multivariée a montré que l'IL-1β (OR : 1,420, IC à 95 % : 1,189-1,695), l'IL-6 (OR : 1,693, IC à 95 % : 1,298-2,207), l'IL-8 (OR : 1,443, IC à 95 % : 1,174-1,774), l'âge (OR : 1,138, IC à 95 % : 1,031-1,257), la ménopause (OR : 6,484, IC à 95 % : 1,600-26,275), le stade POP-Q (OR : 9,162, IC à 95 % : 2,180-38,510) et la constipation chronique (OR : 5,029, IC à 95 % : 1,219-20,753) étaient des facteurs indépendants. Facteurs de risque de récidive postopératoire. Le modèle de risque basé sur ce modèle a démontré d'excellentes performances de prédiction, tant dans l'ensemble d'entraînement (AUC = 0,965, sensibilité 93,75 %, spécificité 87,63 %) que dans l'ensemble de validation (AUC = 0,946, sensibilité 91,67 %, spécificité 88,37 %) (p < 0,05). *(Afr J Reprod Health 2026; 30 [5]: 46-54).*

Mots-clés: interleukine, prolapsus des organes pelviens, récidive, modèle de risque, facteur de risque.

Introduction

As a major type of female pelvic floor dysfunction (PFD), pelvic organ prolapse (POP) exhibits a worldwide prevalence ranging from 30% to 40%, with nearly a third of women beyond 60 years being diagnosed.[1] The disorder is associated with impaired urinary and defecatory functions, sexual difficulties, considerable deterioration in life quality, and often comorbid psychological issues.[2] Current management of moderate to severe POP relies heavily on surgery, which, despite providing rapid symptom alleviation, is hampered by considerable recurrence rates.[3] Conventional transvaginal techniques are linked to a 20%–30% POP recurrence rate, whereas pelvic floor reconstruction surgery shows recurrence in 10%–20% of cases.[4] In recurrent cases, repeated surgical interventions not only exacerbate patient discomfort and healthcare expenses but also underscore the persistent knowledge gaps in POP recurrence biomarkers.[5] Consequently, effective strategies to reduce postoperative POP recurrence are essential for refining clinical decision-making and improving long-term prognosis.

The involvement of inflammatory processes in POP development is now a growing focus of research, driven by deeper insights from molecular biology. Evidence suggests that chronic mechanical stretching and oxidative stress in the pelvic floor can induce a state of local immune activation in POP patients. Interleukin (IL) and other pro-inflammatory mediators are known to disrupt the homeostatic balance within pelvic floor support tissues by enhancing fibroblast growth, disturbing collagen turnover, and promoting irregular blood vessel formation.[6,7] The study by Chen Yi et al. showed a direct correlation between elevated IL-1β/IL-6 and risk of recurrence, indicating the potential value of these cytokines as biomarkers for predicting recurrence risk.[8] Nevertheless, available research on this topic consists mainly of limited, single-institution investigations, and the relationship between these biomarkers and recurrence has yet to be conclusively established. Furthermore, most clinical prediction models continue to rely on conventional clinical parameters and have not incorporated biomarker data, which limits their predictive accuracy.

Moving beyond conventional analysis, this study employs a systematic approach to examine whether IL serve as independent predictors for POP recurrence after surgical intervention. A key objective is the creation of a comprehensive risk stratification tool that synergizes these biochemical markers with traditional clinical predictors. The findings are anticipated to introduce a potential new paradigm for assessing POP treatment safety, thereby informing more personalized surgical decisions and tailored postoperative care protocols. Successfully implementing such a model is expected to directly improve long-term therapeutic outcomes for patients, boosting their satisfaction and overall well-being and reducing the broader economic impact of POP on healthcare systems.

Methods

Study subjects

This is a single-center retrospective cohort study, with the investigation period spanned from March 2022 through June 2024. All patient data were obtained from our institution's electronic medical record system and postoperative follow-up database.

Inclusion and exclusion criteria

Inclusion criteria: Female patients aged ≥ 18 years; Preoperative diagnosis of POP by gynecological examination, with stage II or higher prolapse in at least one compartment (anterior, apical, or posterior);[9] Associated surgical treatment in our hospital; Completed postoperative monitoring for a minimum duration of 12 months (recurrence was assessed beyond one year after the procedure); Provided informed consent (or consent was obtained from family members in cases involving de-identified data analysis only).

Exclusion criteria: Concurrent diagnosis of a malignancy or cancerous lesions affecting the urinary or intestinal tracts; Severe systemic illness contraindicating surgical intervention; A history of pelvic radiotherapy or neoadjuvant chemotherapy prior to surgery; Performance of concurrent non-pelvic floor-related surgery; Data missing ≥ 30%; Mental disorders or cognitive dysfunction that could compromise follow-up compliance.

Sample size and grouping

Sample size estimation was performed via logistic regression. With a presumed recurrence rate of 20%,[10] along with Type I error (α) = 0.05 (two-sided) and Type II error (β) = 0.20 (power=80%), and considering 10 confounding variables (age, body mass index, menopausal status, POP-Q stage, chronic constipation, prior pelvic surgery, hysterectomy, smoking, alcohol use, sexual activity frequency), the calculated minimum sample size was 128 cases. Ultimately, 184 patients were enrolled in the study after applying the inclusion and exclusion criteria, which satisfied the statistical power requirement. Based on postoperative recurrence status, the participants were categorized into a recurrence group (n = 44) and a non-recurrence group (n = 140).

Surgical protocol

All patients underwent POP surgical treatment in our hospital (including traditional transvaginal repair or pelvic floor reconstruction), operated on by a consistent surgical team. The preoperative workup consisted of routine blood tests, assessment of clotting function, infectious disease screening, and ultrasound imaging of the pelvis. Vaginal cleansing with povidone-iodine was administered for three days preceding surgery. Postoperative urinary catheters were discontinued within 24 to 48 hours. Additionally, a 24-hour prophylactic antibiotic regimen (cephalosporins + metronidazole) was implemented. Patients received guidance to refrain from strenuous activities during the initial postoperative week and to avoid sexual intercourse and tub bathing for two months. Follow-up evaluations were scheduled monthly throughout the first year after the operation.

Criteria for judging postoperative recurrence

Recurrence was defined by persistent patient-reported symptoms (e.g., vaginal bulge, voiding difficulty) AND either: at least one site (bladder neck, or anterior rectal wall) extended to or past the hymenal margin (corresponding to POP-Q stage II or above). For hysterectomized patients, vaginal cuff descent ≥50% total vaginal length was used. Secondary surgery was required due to POP-related symptoms (such as vaginal mass prolapse, voiding/defecatory dysfunction). Either condition was considered recurrent POP.

Data collection

At enrollment, basic clinical and demographic information was gathered, covering age, BMI, patterns of smoking and alcohol consumption, as well as menopausal status. Smoking status was classified based on a minimum consumption of one cigarette per day over twelve consecutive months. Alcohol drinkers were defined as individuals who ingested no less than two liang of Baijiu or two bottles of beer on a weekly basis. Frequency of sexual activity was considered regular if it occurred between one and two times weekly.

Sample collection and detection

All subjects provided 5 mL fasting venous blood collected in ethylene diamine tetraacetic acid (EDTA)-containing tubes. After centrifugation (10 minutes at 3000 rpm), serum was isolated, divided into portions, and cryopreserved at -80°C until analysis. Using enzyme-linked immunosorbent assay (ELISA) kits from R&D Systems, serum IL-1β, IL-6, and IL-8 concentrations were assessed. The detection process adhered strictly to kit specifications: Step 1: serum sample addition (100 μL/well);Step 2: 1-hour blocking with 1% BSA; Step 3: incubation with biotin-labeled anti-IL-6 antibody (1:1000, 37°C/1h); Step 4: streptavidin-horseradish peroxidase antibody (HRP) incubation; Step 5: color development; Step 6: termination. The detection wavelength was 450 nm, and the concentration was calculated using standard products to draw a standard curve (unit: pg/mL).

An automatic chemiluminescence immunoassay analyzer (Beckman DXI 800) conducted estrogen follicle-stimulating hormone (FSH), estradiol (E2), progesterone (P), luteinizing hormone (LH), and prolactin (PRL) measurements. After equilibrating serum samples to room temperature, samples, calibrators (3 concentration gradients), and quality control products (low, medium, and high concentrations) were loaded onto the sample rack in turn. The instrument automatically completed the detection process: sample addition → reagent addition → incubation → separation → luminescent reaction → reading.Quality control procedures mandated the analysis of two to three concentration levels (low-/medium-/high-quality control products, or certified third-party controls) with each batch, requiring a deviation between the result and the target value of no more than 10%.

Statistical analysis

All statistical procedures were performed with SPSS 33.0. Continuous data are reported as mean ± standard deviation ($\bar{\chi}$±s; normally distributed) or median (quartile; non-normally distributed). Count data are presented as frequency (percentage). Between-group differences were assessed using t-tests for normally distributed continuous variables, Mann-Whitney U tests for non-parametric data, and chi-square or Fisher's exact tests for categorical variables. Key variables, first screened by LASSO regression, were then incorporated into multivariate logistic regression modeling to build a prediction model, whose predictive performance was evaluated by the area under the receiver operating characteristic curve (ROC-AUC), calibration plots, and decision curve analysis (DCA). P<0.05 was considered statistically significant.

Statement of ethics

This study was approved by the Ethics Committee of, The Fifth Affiliated Hospital of Sun Yat-sen University (Approval Number:k109-1;Date:2022-05-10).

Results

Comparison of serum IL between recurrence and non-recurrence groups

Serum levels of IL-1β, IL-6, and IL-8 in the recurrence group were (20.17 ± 4.11) pg/mL, (16.22 ± 3.73) pg/mL, and (12.66 ± 3.02) pg/mL, respectively. A comparative analysis revealed markedly higher IL levels in patients from the recurrence group compared to their non-recurrence counterparts (P < 0.05, Table 1).

Univariate analysis of factors affecting postoperative recurrence in POP cases

The recurrence and non-recurrence groups were similar in smoking/drinking history, etc., (P > 0.05). However, recurrent patients were greater in age and BMI than non-recurrent cases. In the recurrence group, the proportion of individuals with menopause, chronic constipation, a history of pelvic surgery, and hysterectomy was also higher, while a significantly smaller proportion were diagnosed with POP-Q stage II (P < 0.05; Table 2).

Multivariate analysis of postoperative recurrence predictors in POP patients

A multivariate logistic regression was performed where recurrence was set as the dependent variable and univariate indicators and IL levels as covariates (Status of recurrence: non-recurrence group=1, recurrence group=2; menopause, history of pelvic surgery, hysterectomy, chronic constipation: No=1, yes=2; POP-Q stage: II=1, III-IV=2; IL-1β, IL-6, IL-8, Age, BMI: analysis was performed using raw data). The analysis results showed that BMI, history of pelvic surgery, and hysterectomy were not independent factors affecting postoperative recurrence of POP (P > 0.05). The analysis results showed that IL-1β (OR: 1.420, 95%CI: 1.189 - 1.695), IL-6 (OR: 1.693, 95%CI: 1.298 - 2.207),IL-8 (OR: 1.443, 95%CI: 1.174 - 1.774), Age (OR: 1.138, 95%CI: 1.031 - 1.257), Menopause (OR: 6.484, 95%CI: 1.600 - 26.275), POP-Q stage (OR: 9.162, 95%CI: 2.180-38.510) and chronic constipation (OR: 5.029, 95%CI:1.219-20.753) each independently served as risk factors for POP recurrence after surgery (P < 0.05) (Table 3).

Establishment of risk model for postoperative recurrence of POP

It was performed again after excluding the non-independent influencing factors in the above analysis (BMI, history of pelvic surgery, hysterectomy) to obtain the influence of all independent factors on the recurrence of POP after surgery (Table 4).

Using the multivariate B, a risk stratification model for POP recurrence after surgery was constructed: -27.102+0.346×IL-1β+0.488×IL-6+0.357×IL 8+0.116×age+1.777×menopause+1.739×POP-Q stage+1.596×chronic constipation. Subsequently, all research subjects were split via computer-generated random numbers with stratified sampling. The enhanced model’s performance in predicting recurrence was subsequently assessed.

Table 1: Comparison of IL

Groups	n	IL-1β (pg/mL)	IL-6 (pg/mL)	IL-8 (pg/mL)
Non-recurrence group	140	15.56±4.15	12.26±2.95	9.98±2.75
Recurrence group	44	20.17±4.11	16.22±3.73	12.66±3.02
t		6.449	7.266	5.505
P		<0.001	<0.001	<0.001

Table 2: Univariate analysis of factors influencing postoperative recurrence of POP

Factors	Non-recurrence group (n=140)	Recurrence group (n=44)	Value of statistics	P
Age (years old)	50.70±6.61	55.61±8.55	t=3.996	<0.001
BMI (kg/m^2)	23.31±1.48	24.02±1.81	t=2.599	0.010
History of smoking			χ^2=0.530	0.394
yes	20 (14.29)	8 (18.18)		
no	120 (85.71)	36 (81.82)		
History of drinking			χ^2=0.015	0.904
yes	15 (10.71)	5 (11.36)		
no	125 (89.29)	39 (88.64)		
Menopause			χ^2=9.790	0.002
yes	64 (45.71)	32 (72.73)		
no	76 (54.29)	12 (27.27)		
Number of births	2.45±0.68	2.34±0.68	t=0.926	0.356
History of pelvic surgery			χ^2=4.115	0.043
yes	15 (10.71)	10 (22.73)		
no	125 (89.29)	34 (77.27)		
POP-Q stage			χ^2=9.089	0.003
II	81 (57.86)	14 (31.82)		
III-IV	59 (42.14)	30 (68.18)		
Combined chronic diseases				
hypertension	46 (32.86)	16 (36.36)	χ^2=1.184	0.668
diabetes mellitus	38 (27.14)	15 (34.09)	χ^2=0.788	0.375
hyperlipidemia	21 (15.00)	8 (18.18)	χ^2=0.255	0.613
Surgical approach			χ^2=0.258	0.879
transvaginal	113 (80.71)	34 (77.27)		
open abdomen	5 (3.57)	2 (4.55)		
laparoscopy	22 (15.71)	8 (18.18)		
Hysterectomy			χ^2=8.525	0.004
yes	20 (14.29)	15 (34.09)		
no	120 (85.71)	29 (65.91)		
Regular sex life			χ^2=0.144	0.705
yes	19 (13.57)	5 (11.36)		
no	121 (86.43)	39 (88.64)		
Chronic constipation			χ^2=5.513	0.019
yes	32 (22.86)	18 (40.91)		
no	108 (77.14)	26 (59.09)		
Estrogen				
FSH (mIU/mL)	43.30±6.57	44.12±6.16	t=0.734	0.464
E2 (pg/mL)	11.50±3.65	10.61±3.10	t=1.448	0.149
P (ng/mL)	0.54±0.04	0.52±0.08	t=1.920	0.056
LH (mIU/mL)	26.25±11.83	25.88±12.48	t=0.180	0.857
PRL (ng/mL)	8.69±2.87	8.26±2.19	t=0.901	0.369

Table 3: Multivariate analysis of factors influencing postoperative recurrence of POP

Factors	B	SE	Wald χ^2	P	OR	95%CI Upper	Lower
IL-1β	0.350	0.090	14.988	<0.001	1.420	1.189	1.695
IL-6	0.526	0.135	15.124	<0.001	1.693	1.298	2.207
IL-8	0.367	0.105	12.155	<0.001	1.443	1.174	1.774
Age	0.130	0.051	6.588	0.010	1.138	1.031	1.257
BMI	0.292	0.223	1.717	0.190	1.339	0.865	2.073
Menopause	1.869	0.714	6.856	0.009	6.484	1.600	26.275
History of pelvic surgery	0.853	0.749	1.297	0.255	2.347	0.540	10.193
POP-Q stage	2.215	0.733	9.143	0.002	9.162	2.180	38.510
Hysterectomy	1.280	0.717	3.187	0.074	3.597	0.882	14.662
Chronic constipation	1.615	0.723	4.988	0.026	5.029	1.219	20.753

Note: Regression coefficient (B), Standard error (SE), Odds ratio (OR), Confidence interval (CI).

Table 4: Results of the analysis after presenting the non-independent factors

Factors	B	SE	Wals χ^2	P	OR	95%CI Upper	Lower
IL-1β	0.346	0.084	17.037	<0.001	1.413	1.199	1.665
IL-6	0.488	0.120	16.698	<0.001	1.630	1.289	2.060
IL-8	0.357	0.101	12.569	<0.001	1.429	1.173	1.741
Age	0.116	0.046	6.477	0.011	1.123	1.027	1.228
Menopause	1.777	0.659	7.269	0.007	5.910	1.624	21.504
POP-Q stage	1.793	0.639	7.862	0.005	6.005	1.624	21.020
Chronic constipation	1.596	0.666	5.741	0.017	4.931	1.337	18.188
Constants	-27.102	5.027	29.065	<0.001	Not reported	Not reported	Not reported

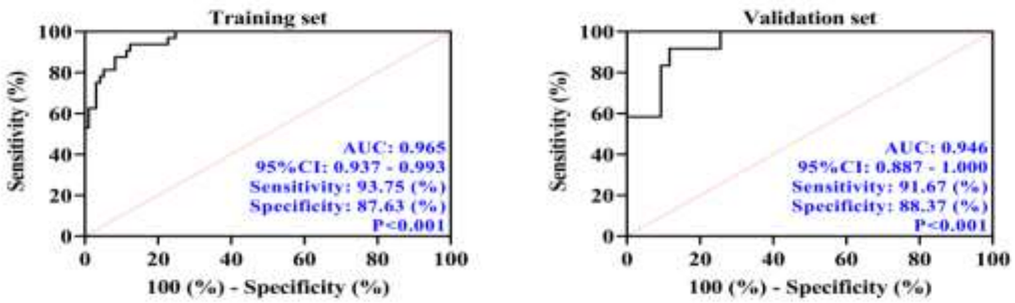

Figure 1: Effectiveness validation of the prediction model for recurrence after POP (validation set and training set)

In the training set, the model demonstrated a diagnostic sensitivity of 93.75% and specificity of 87.63% for post-POP recurrence, with an AUC of 0.965, indicating high clinical reference value (P < 0.05). In the validation set, although the AUC of the model decreased slightly (AUC = 0.946), the diagnostic sensitivity and specificity for post-POP surgery recurrence remained at 91.67% and 88.37%, respectively (P < 0.05) (Figure 1).

Discussion

Postoperative recurrence of POP, which lies at the core of pelvic floor dysfunction, continues to pose significant difficulties in clinical management. Despite the fact that pelvic floor reconstruction, employing either synthetic mesh or autologous tissue repair, has substantially reduced recurrence, certain patients remain susceptible to relapse and might need reoperation.[11] This study explored the correlation between serum IL (IL-1β/6/8) and postoperative POP recurrence through a large-sample retrospective cohort analysis, and constructed a recurrence risk prediction model integrating clinical indicators and IL. The results indicated statistically elevated IL-1β, IL-6, and IL-8 in recurrent patients relative to their non-recurrent counterparts, as well as their role as independent risk factors for postoperative POP recurrence. Besides, the risk model constructed demonstrated good predictive performance in both the training and validation sets, providing a new tool for clinical identification of high-risk groups.

The involvement of IL-1β, IL-6, and IL-8 in POP recurrence following surgery is underpinned by their distinct biological profiles and pathophysiological actions. As a potent pro-inflammatory cytokine primarily released by activated macrophages, monocytes, and injured tissue cells, IL-1β drives downstream inflammatory mediator expression via NF-κB pathway activation, resulting in a cascading amplification of inflammation.[12] Within pelvic floor tissues, IL-1β enhances fibroblast proliferation and matrix metalloproteinase (MMP) release, directly contributing to collagen degradation in pelvic support tissues. These enzymes degrade collagen and disrupt elastic fibers, thereby reducing the mechanical stability of pelvic supportive tissue.[13] Additionally, it induces reactive oxygen species (ROS) production through NLRP3 inflammasome activation, aggravating tissue oxidative damage.[14] As reported by Vaineau R et al., IL-1β also recruits immune cells like chemotactic neutrophils and macrophages, promoting a persistent local chronic inflammatory microenvironment that interferes with the healing process.[15] IL-6, on the other hand, exerts diverse pro-inflammatory effects, including fibroblast hyperactivation via the JAK-STAT3 cascade. This leads to a dysregulation in extracellular matrix (ECM) composition, characterized by aberrant collagen deposition and degradation of elastic fibers. Consequently, the structural integrity of the pelvic floor support system is severely weakened.[16] According to an animal study conducted by Zhang Z et al., pelvic floor connective tissues in IL-6-knockout mice exhibited markedly greater tensile strength compared to those in wild-type mice. This finding implies a direct role of IL-6 in disrupting tissue repair mechanisms.[17] Meanwhile, IL-8 facilitates neutrophil migration, intensifies localized oxidative stress, upregulates MMP production, and promotes ECM degradation.[18]

Of course, beyond IL, conventional clinical metrics like age and menopause are well-established predictors for the risk of POP recurrence. Similar views can be found in previous studies. For example, Schulten SFM et al. observed a 1.5-fold rise in recurrence risk per decade of aging, potentially attributable to pelvic floor atrophy following the decline in estrogen levels.[19] A noteworthy finding of this research is the identification of chronic constipation elevates intra-abdominal pressure, necessitating postoperative bowel management (e.g., osmotic laxatives, fiber supplementation). This is likely because constipation raises abdominal pressure and compounds injuries to the pelvic floor's nerves and muscles. Together, these effects worsen the tissue damage from inflammation. However, we found no significant difference in estrogen levels was observed, potentially due to perioperative hormonal fluctuations masking baseline variations between patients who experienced a recurrence and those who did not. One plausible explanation is the substantial perioperative fluctuations in estrogen levels. Estrogen secretion is intimately tied to uterine function, and surgical stress injury may induce profound and variable shifts in its production, potentially obscuring any baseline differences between the groups.[20]

By integrating IL biomarkers and conventional clinical indicators, we built a POP recurrence risk model, breaking through the limitations of single-center retrospective design underscores the need for multicenter prospective cohorts to validate generalizability. A high AUC value of 0.965 was recorded for the model on the training set, while the validation set yielded a comparable result of 0.946. These metrics support the model's potential for reliable application in multi-center settings. Of particular note is the marked association between IL and postoperative POP recurrence, which merits attention. This finding indicating a synergistic 'cytokine storm' effect where IL-1β amplifies IL-6/IL-8 production via NF-κB signaling, creating a self-sustaining inflammatory loop. The results of this study have direct implications for public health policy: the prediction model can be integrated into national POP prevention and control strategies to optimize medical resource allocation through risk stratification. For example, intensive management of high-risk patients could be covered by health insurance, reducing overall health care spending. Policy makers should prioritize support for multicenter validation to facilitate standardized application of models. Based on the model's prognostic stratification, patients can be categorized into low- or high-risk cohorts to guide personalized care plans. For high-risk patients (probability >0.7):6-month pelvic floor rehabilitation + biweekly IL-6 monitoring, tocilizumab (8 mg/kg IV) if IL-6 >20 pg/mL. For low-risk (probability <0.3):Standard 3-month rehabilitation + quarterly follow-up. Furthermore, the model holds potential for use in clinical trials, as it can help stratify patients testing new targeted drugs. Its value for guiding surgical strategy, however, must still be confirmed by future prospective studies.

This study breaks through the limitation of traditional prediction models that only rely on clinical parameters, and combines inflammatory markers such as serum IL-1β, IL-6 and IL-8 with conventional indicators such as age, menopausal status and POP-Q stage for the first time. This multidimensional approach provides a more comprehensive assessment of recurrence risk, helping to identify high-risk patients who may be missed by conventional approaches. Of course, this study also presents some methodological limitations. A key limitation stems from the cohort's origin at a single center and its modest size, factors that may compromise the generalizability of our results due to inherent selection bias. Subsequent research should therefore prioritize multi-center collaborations to enlarge the sample pool and employ prospective cohort designs to affirm the robustness of the predictive model. Second, the assessment of IL and estrogen was conducted at only a few time points, which does not allow for the observation of their longer-term trajectories. Third, although this study confirms the strong prognostic value of IL in predicting postoperative POP recurrence, the process itself is governed by a complex interplay within the immune microenvironment. Consequently, the functions of additional inflammatory mediators, including TNF-α and TGF-β, warrant further investigation.

Conclusion

IL-1β, IL-6, and IL-8 exhibit a significant correlation with POP recurrence following surgery. Age, menopause status, chronic constipation, POP-Q stage III-IV, and elevated IL-1β/IL-6/IL-8 collectively predict recurrence risk, which provides a scientific basis for stratified management of clinical high-risk patients and the development of personalized intervention programs. This approach has the potential to decrease recurrence rates and enhance prognostic outcomes. Nevertheless, to confirm the model's broader applicability and to assess the potential of tailored anti-inflammatory interventions as prophylactic strategies against recurrence, subsequent investigations must be conducted across multiple centers with larger cohorts.

Availability of data and materials

The data used to support the findings of this study are available from the corresponding author upon request

Authors’ contributions

GX.C. and KL.W. conceived and designed the study,GX.C. wrote and revised the manuscript,MX.Y. collected and analyzed the data,KL.W. supervised the study,All authors read and approved the final submitted manuscript.

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