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Original Research

Construction of a Column Chart Model for Predicting TCRP Recurrence in Gravid Women

Xuqing Chen[1,*], Jing Li[1], Hui Liang[1], Nanxiang Lei[1]

[1]Department of Gynecology, Meizhou People's Hospital, 514000 Meizhou, Guangdong, China
*Correspondence: 1700210651@stu.sqxy.edu.cn (Xuqing Chen)
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Abstract

Background: This study aims to investigate the factors affecting the recurrence in women of childbearing age after transcervical resection of polyps (TCRP) and to construct a nomogram model predicting this recurrence. **Methods**: We selected 190 patients with Endometrial polyps (EP) who underwent surgical treatment in our hospital between December 2017 and December 2018. Multivariate logistic regression analysis was used to analyze the factors affecting the recurrence of TCRP in women of childbearing age, and the calibration curve. The receiver operating characteristic (ROC) was used to assess the efficacy of the nomogram model for predicting recurrence in women of childbearing age; Kaplan Meier curve analysis of recurrence rates among patients with different factors. **Results**: Body mass index (odds ratio (OR) = 5.417, 95% confidence interval (CI) = 1.344–21.834), polyp diameter (OR = 3.595, 95% CI = 1.27–10.703), gravidity (OR = 3.647, 95% CI = 1.224–10.869), and polycystic ovary syndrome (OR = 3.625, 95% CI = 1.169–11.244) are independent risk factors for recurrence after TCRP in women of childbearing age ($p < 0.05$). The slope of the calibration curve is close to 1, the area under the receiver operating characteristic is 0.781 (95% CI = 0.669–0.894), and the Hosmer Lemeshow goodness of fit test = 8.720, p = 0.366. **Conclusion**: The nomogram model constructed in this study is conducive to predicting the recurrence of women of childbearing age after TCRP, and may be helpful for preventing and treating polyp recurrence.

Keywords: endometrial polyps; women of childbearing age; transcervical resection of polyps; influencing factors; nomogram

1. Introduction

Endometrial Polyps (EP) are gynecological diseases characterized by abnormal uterine bleeding, representing local overgrowth of stroma and endometrial glands. The prevalence of EP in different populations is 7.8%–34.9%, primarily diagnosed in women of childbearing age. While most are benign lesions, there's a potential for malignancy. In the postmenopausal population, 4–6% of polyps are due to precancerous or malignant changes, and 1–2% of premenopausal patients are due to precancerous or malignant changes [1–3]. With the continuous improvement and development of hysteroscopy in the gynecological field, it has not only become the gold standard for diagnosing EP but is also widely recommended for the surgical treatment of symptomatic patients or those presenting with larger volumes, such as Transcervical Resection of Polyps (TCRP) under hysteroscopy [4,5]. However, given the current uncertainty around the causes of EP onset and its potential for malignancy, there's a notable risk of recurrence post-surgery. In recent years, the postoperative recurrence rate of endometrial polyps has been 2.5%–43.6%, depending on the follow-up time and the nature of the polyp. The risk of recurrence after surgery for non atypical proliferative polyps is higher than that for benign polyps (43.6% *vs* 8.3%, respectively), which affects the surgical outcome [6,7]. Therefore, it is crucial to determine the risk factors post-TCRP to pinpoint and proactively intervene with high-risk individuals. To date, there is no existing research on personalized prediction of recurrence in women of reproductive age following TCRP. Nomograms, which are prediction model charts based on evidence-based medicine, can individually calculate the postoperative recurrence rate of a disease, offering high practicality [8], for example, application in endometriosis, cervical cancer, endometrial cancer, etc. [9–11]. In light of this, our study analyzes factors influencing the recurrence of TCRP in women of reproductive age, and constructs a nomogram to predict the recurrence after TCRP, aiming to assist in the early prevention and treatment of EP recurrence.

2. Materials and Methods

2.1 Study Subjects

A total of 190 EP patients, aged between 20–40 years with an average age of (30.29 $\pm$ 7.65) years and a body mass index (BMI) ranging from 19–28 kg/m^2 (average of 24.07 $\pm$ 3.90 kg/m^2), who underwent surgical treatment in our hospital between December 2017 and December 2018 were selected for the study (modeling group). Another 150 EP patients who underwent surgical treatment in our hospital from January 2019 to October 2019 were selected as the validation group to externally validate the nomogram model. This study complies with the requirements of the Medical Ethics Committee of our hospital. Inclusion criteria: (1) All were diagnosed by combined hysteroscopy and ultra-

Table 1. Comparison of clinical data between recurrent and nonrecurrent patients in the modeling group.

Clinical data	Recurrent group (n = 20)	nonrecurrent group (n = 163)	χ^2	p
Age (year)				
<30	4 (20.00)	75 (46.01)	4.913	0.027
≥30	16 (80.00)	88 (53.99)		
BMI (kg/m^2)				
<24	3 (15.00)	82 (50.31)	8.928	0.003
≥24	17 (85.00)	81 (49.69)		
Hypertension	5 (25.00)	24 (14.72)	0.745	0.388
Diabetes	3 (15.00)	17 (10.43)	0.057	0.811
Abnormal lipids metabolism	6 (30.00)	30 (18.40)	0.871	0.351
Polyp site				
Anterior wall	5 (25.00)	44 (26.99)	0.195	0.907
Posterior wall	9 (45.00)	65 (39.88)		
Side wall	6 (30.00)	54 (33.13)		
Number of polyps				
Single	8 (40.00)	104 (63.80)	4.251	0.039
Multiple	12 (60.00)	59 (36.20)		
Polyp diameter (cm)				
<2	7 (35.00)	122 (74.85)	13.598	0.000
≥2	13 (65.00)	41 (25.15)		
Gravidity (order)				
<3	8 (40.00)	121 (74.23)	10.036	0.002
≥3	12 (60.00)	42 (25.77)		
Parity (order)				
<2	8 (40.00)	101 (61.96)	3.568	0.059
≥2	12 (60.00)	62 (38.04)		
Fibroid	4 (20.00)	19 (11.66)	0.497	0.481
Endometriosis	6 (30.00)	29 (17.79)	1.018	0.313
Polycystic ovary syndrome	5 (25.00)	9 (5.52)	7.008	0.008

BMI, body mass index.

sound, and postoperative pathology confirmed EP [12]; (2) Complete medical records; (3) All participants were married women with a desire to conceive; (4) All voluntarily underwent TCRP and signed the informed consent for surgery; (5) Could cooperate with follow-up; (6) All surgeries completed without complications. Exclusion criteria: (1) History of EP; (2) Use of hormones within six months before surgery; (3) Patients with unexplained infertility; (4) Those with contraindications to hysteroscopic surgery.

2.2 Data Collection

Patient age, BMI, hypertension, diabetes, lipid metabolism disorder, polyp location (anterior wall, posterior wall, or side wall), number of polyps (single or multiple), polyp diameter (<2 cm or ≥2 cm), parity (<3 times or ≥3 times), gravidity (<2 or ≥2), uterine fibroids, endometriosis, and polycystic ovary syndrome (PCOS) conditions were collected.

2.3 TCRP Method

All patients completed preoperative examinations, and TCRP was performed 5–7 days after the end of menstruation. An Olympus electrosurgical endoscope (model: A2031A, Guangzhou Chuangyi Medical Technology Co., Ltd., Guangzhou, Guangdong, China) was used. Intraoperative parameters: distension fluid was 0.9% saline (flow rate: 120 mL/min), distension pressure was 90–110 mmHg, coagulation and cutting power were 40–50 W and 70–90 W respectively. The lithotomy position was adopted, utilizing either epidural or general anesthesia. Hysteroscope was slowly inserted, the location, number, and diameter of the polyps were observed, and they were cut from the posterior wall of the uterine fundus gradually downward, checking visually for any residuals. After surgery, all patients took oral drospirenone and ethinyl estradiol tablets (trade name: Yasmin, National Medicine Permission No. J20171071, Jenapharm GmbH & Co. KG, Jena, Germany, specification: 21 tablets/box), 1 tablet/d, taken continuously for 21 days, then stopped for 7 days before starting the next course, in the same manner, for a total of 3 courses.

2.4 Follow-Up

All patients underwent a 2-year follow-up via telephone or outpatient services every 3 months, ending on December 31, 2020, for the modeling group and October 31, 2021, for the validation group. If there were signs of recur-

Table 2. Risk factors analysis of recurrence after TCRP in women of childbearing age.

Variable	β	SE	*wald*	*p*	OR	95% CI
Age	0.487	0.573	0.722	0.395	1.628	0.529~5.005
BMI	1.690	0.711	5.643	0.018	5.417	1.344~21.834
Number of polyps	–0.242	0.574	0.177	0.674	0.785	0.255~2.418
Polyp diameter	1.279	0.557	5.282	0.022	3.595	1.207~10.703
Gravidity	1.294	0.557	5.394	0.020	3.647	1.224~10.869
Polycystic ovary syndrome	1.288	0.578	4.974	0.026	3.625	1.169~11.244

TCRP, transcervical resection of polyps; OR, odds ratio; CI, confidence interval; SE, Standard Error.

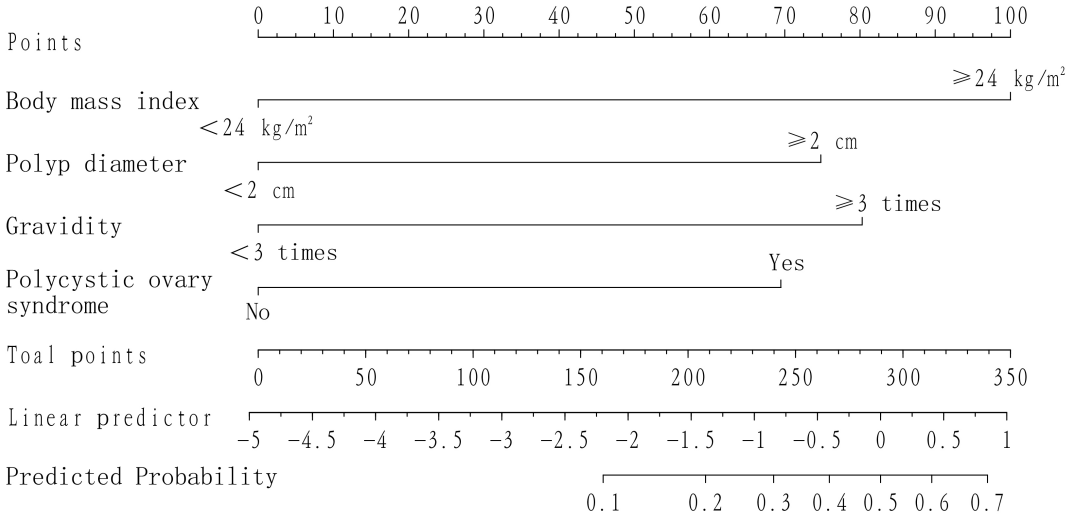

Fig. 1. Line graph model for predicting recurrence after TCRP in women of childbearing age.

rence such as menstrual irregularity and abnormal bleeding, the patient was advised to return to the clinic for a check-up. A diagnosis of recurrence was made if ultrasound and hysteroscopy indicated EP. Seven patients in the modeling group were lost to follow-up, a loss rate of 3.68% (7/190), leaving a total of 183 cases included; there were no lost patients in the validation group. Based on the results of the final follow-up, both groups categorized EP patients into either recurrence or non-recurrence groups.

2.5 Statistical Methods

SPSS 22.0 (IBM Corp., Chicago, IL, USA) and R3.6.3 software (R Development Core Team, Auckland, New Zealand) were used to process data and generate graphs. Count data were expressed as (n (%)). The recurrence and non-recurrence groups were compared using chi-square tests χ^2 or adjusted chi-square tests χ^2. Measured data have been converted into binary variables, and indicators with statistical significance (age, BMI, polyp number, etc.) were used for multifactor logistic regression analysis to determine the independent risk factors affecting the recurrence of childbearing women after TCRP, and were included in the R3.6.3 software to build a nomogram model predicting the recurrence of childbearing women after TCRP. Calibration curves and receiver operating characteristic (ROC) curves were drawn to judge the effect of the nomogram model predicting the recurrence of childbearing women after TCRP. The Kaplan-Meier curve was used to analyze the relationship between different BMI, polyp diameters, gravidity, polycystic ovary syndrome, and the patient's recurrence rate. $p < 0.05$ indicates a statistically significant difference.

3. Results

3.1 Comparison of Clinical Data between Recurrence Group and Non-Recurrence Group in the Modeling Group

In the modeling group of 183 EP patients, the 2-year postoperative recurrence rate was 10.93% (20/183). The measured data of age, BMI, polyp diameter, gravidity, and parity were converted into binary variables using the median as the boundary. The results showed that the recurrence of childbearing women after TCRP was not related to hypertension, diabetes, lipid metabolism disorder, polyp location, parity, uterine fibroids, and endometriosis ($p > 0.05$), but was related to age, BMI, polyp number, polyp diameter, gravidity, and polycystic ovary syndrome ($p < 0.05$). See Table 1.

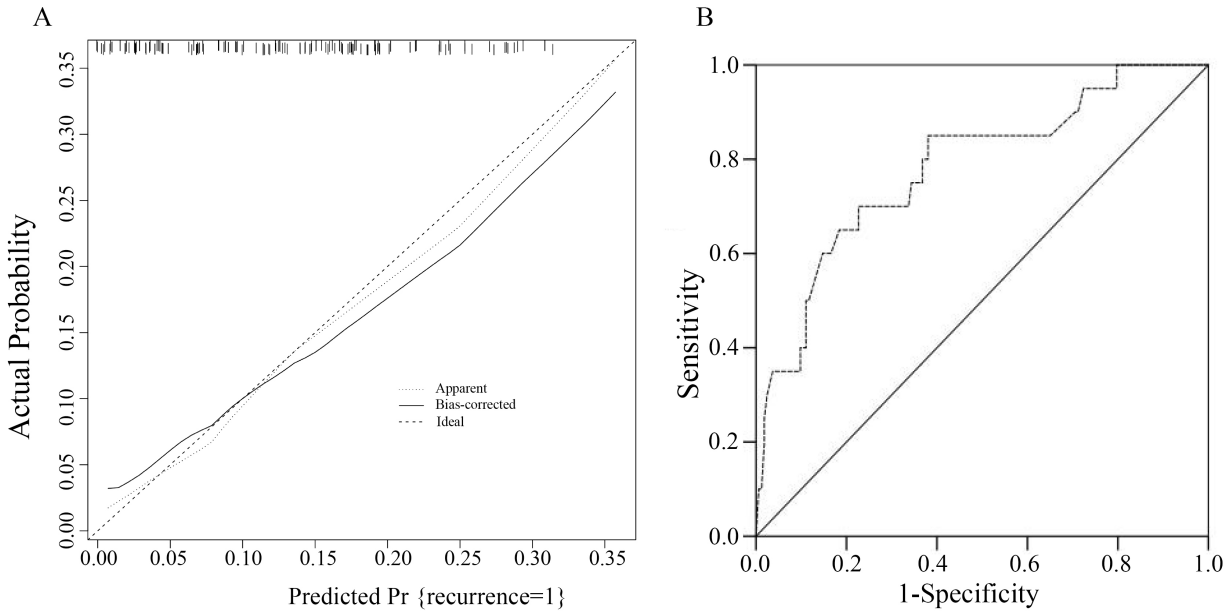

Fig. 2. Internal validation of the nomogram model for predicting the recurrence of childbearing women after TCRP. (A) Calibration curve for predicting recurrence using the column chart model. (B) ROC curve: receiver operating characteristic of the nomogram model for predicting recurrence.

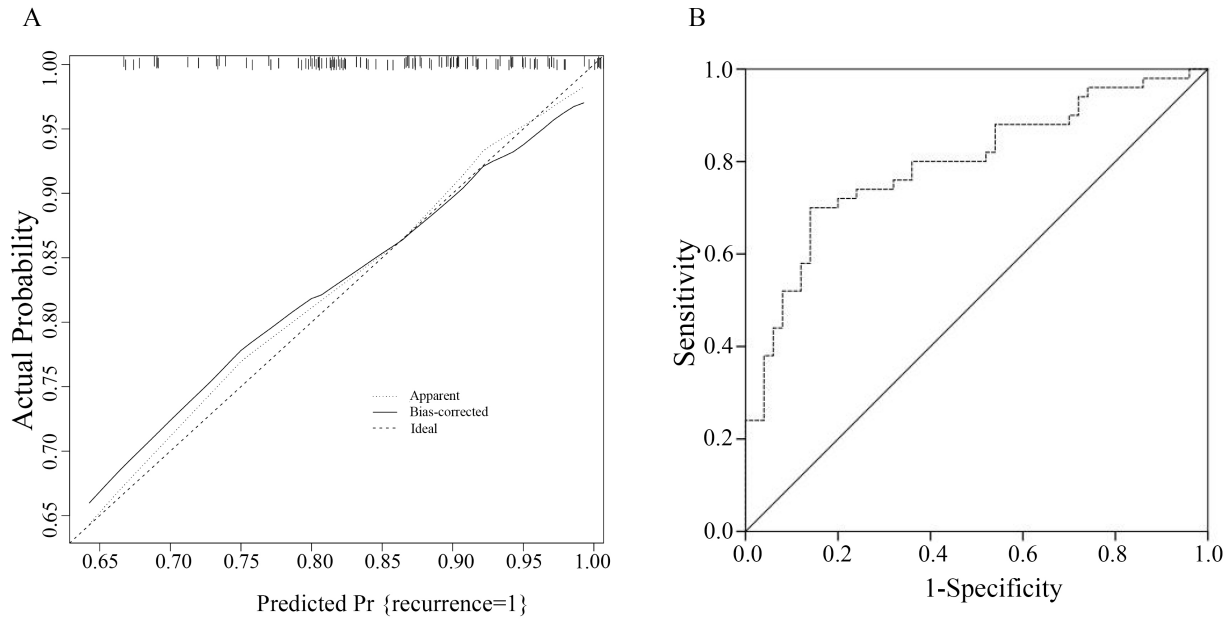

Fig. 3. External validation of the nomogram model for predicting the recurrence in childbearing women after TCRP. (A) Calibration curve for predicting recurrence using column chart model. (B) ROC curve: receiver operating characteristic of nomogram model for predicting recurrence.

3.2 Analysis of Risk Factors Affecting the Recurrence of Childbearing Women after TCRP

Whether or not there was a recurrence after TCRP in childbearing women was taken as the dependent variable (no = 0, yes = 1), and the statistically significant indicators in Table 1: age (<30 years = 0, ≥30 years = 1), BMI (<24 kg/m^2 = 0, ≥24 kg/m^2 = 1), polyp number (single = 0, multiple = 1), polyp diameter (<2 cm = 0, ≥2 cm = 1), gravidity (<3 times = 0, ≥3 times = 1), and polycystic ovary syndrome (no = 0, yes = 1) were taken as independent variables for multivariate logistic analysis. The results showed that BMI (odds ratio (OR) = 5.417, 95% confidence

Table 3. Comparison of clinical data between recurrent and nonrecurrent patients in the validation group.

Clinical data	Recurrent patients (n = 17)	Nonrecurrent patients (n = 133)	χ^2	p
BMI (kg/m^2)				
<24	2 (11.76)	65 (48.87)	8.398	0.004
≥24	15 (88.24)	68 (51.13)		
Polyp diameter (cm)				
<2	5 (29.41)	87 (65.41)	8.238	0.004
≥2	12 (70.59)	46 (34.59)		
Gravidity				
<3	7 (41.18)	98 (73.68)	7.585	0.006
≥3	10 (58.82)	35 (26.32)		
Polycystic ovary syndrome	4 (23.53)	7 (5.26)	4.957	0.026

interval (CI) = 1.34421.834), polyp diameter (OR = 3.595, 95% CI = 1.20710.703), gravidity (OR = 3.647, 95% CI = 1.22410.869), and polycystic ovary syndrome (OR = 3.625, 95% CI = 1.16911.244) were independent risk factors affecting the recurrence of childbearing women after TCRP ($p < 0.05$). See Table 2.

3.3 Construction of the Nomogram Model for Predicting the Recurrence of Childbearing Women after TCRP

The independent risk factors (BMI, polyp diameter, gravidity, polycystic ovary syndrome) determined by multivariate logistic analysis in the modeling group were introduced into R software to construct a nomogram model for predicting the recurrence of childbearing women after TCRP. The results showed that BMI ≥24 kg/m^2 was scored 100, polyp diameter ≥2 cm was scored 74.8, gravidity ≥3 times was scored 80, and the presence of polycystic ovary syndrome was scored 69.7. See Fig. 1.

3.4 Internal Validation of the Nomogram Model for Predicting the Recurrence of Childbearing Women after TCRP

Fig. 2A shows that the slope of the calibration curve of the nomogram model predicting the recurrence of childbearing women after TCRP is close to 1; Fig. 2B shows that the area under the ROC curve of the nomogram model predicting the recurrence of childbearing women after TCRP is 0.781 (95% CI = 0.669–0.894); and the Hosmer-Lemeshow goodness of fit test $\chi^2 = 8.720$, $p = 0.366$.

3.5 External Validation of the Nomogram Model for Predicting the Recurrence in Childbearing Women after TCRP

Among the 150 EP patients in the validation group, the 2-year postoperative recurrence rate was 11.33% (17/150). The recurrence of childbearing women after TCRP was related to BMI, polyp diameter, gravidity, and polycystic ovary syndrome ($p < 0.05$) (Table 3). The external validation of the nomogram model with the data in Table 3 showed that the slope of the calibration curve is close to 1 (Fig. 3A); the area under the ROC curve is 0.794 (95% CI = 0.705–0.883), see Fig. 3B.

3.6 Analysis of Recurrence Rate in Groups with Different BMI, Polyp Diameters, Gravida, and Polycystic Ovary Syndrome

The Kaplan-Meier curve analysis found that the recurrence rate of patients with a BMI ≥24 kg/m^2, polyp diameter ≥2 cm, gravidity ≥3 times, and polycystic ovary syndrome was significantly higher than that of patients with a BMI <24 kg/m^2, polyp diameter <2 cm, gravidity <3 times, and no polycystic ovary syndrome ($p < 0.05$) (Fig. 4A–D).

4. Discussion

TCRP is the preferred treatment method for EP patients, with the advantages of accurate positioning and minimal trauma [13]. At the same time, it was found that the location and morphology of the polyps under direct hysteroscopy can be clearly displayed, the polyp base in the endometrial basal layer can be accurately removed, and the surrounding endometrial tissue is not damaged [14]. Although TCRP has obvious advantages, due to the strong regenerative ability of the endometrium, surgical treatment cannot fundamentally change the intrauterine environment. Therefore, there is a risk of polyp recurrence after surgery [15]. This study followed up women of childbearing age for two years after TCRP and found a recurrence rate of 10.93%, indicating a high risk of polyp recurrence in women of childbearing age after TCRP. Therefore, exploring the risk factors for recurrence in women of childbearing age after TCRP has important significance for improving the effect of TCRP and avoiding or reducing polyp recurrence.

In this study, factors such as age, BMI, polyp location, number of polyps, polyp diameter, gravidity, parity, uterine fibroids, endometriosis, and polycystic ovary syndrome were selected to analyze the relationship with the recurrence of women of childbearing age after TCRP. The results showed that BMI, polyp diameter, gravidity, and polycystic ovary syndrome are independent risk factors for recurrence in women of childbearing age after TCRP. However, this result cannot calculate the polyp recurrence rate of women of childbearing age after TCRP in a personalized way, and its

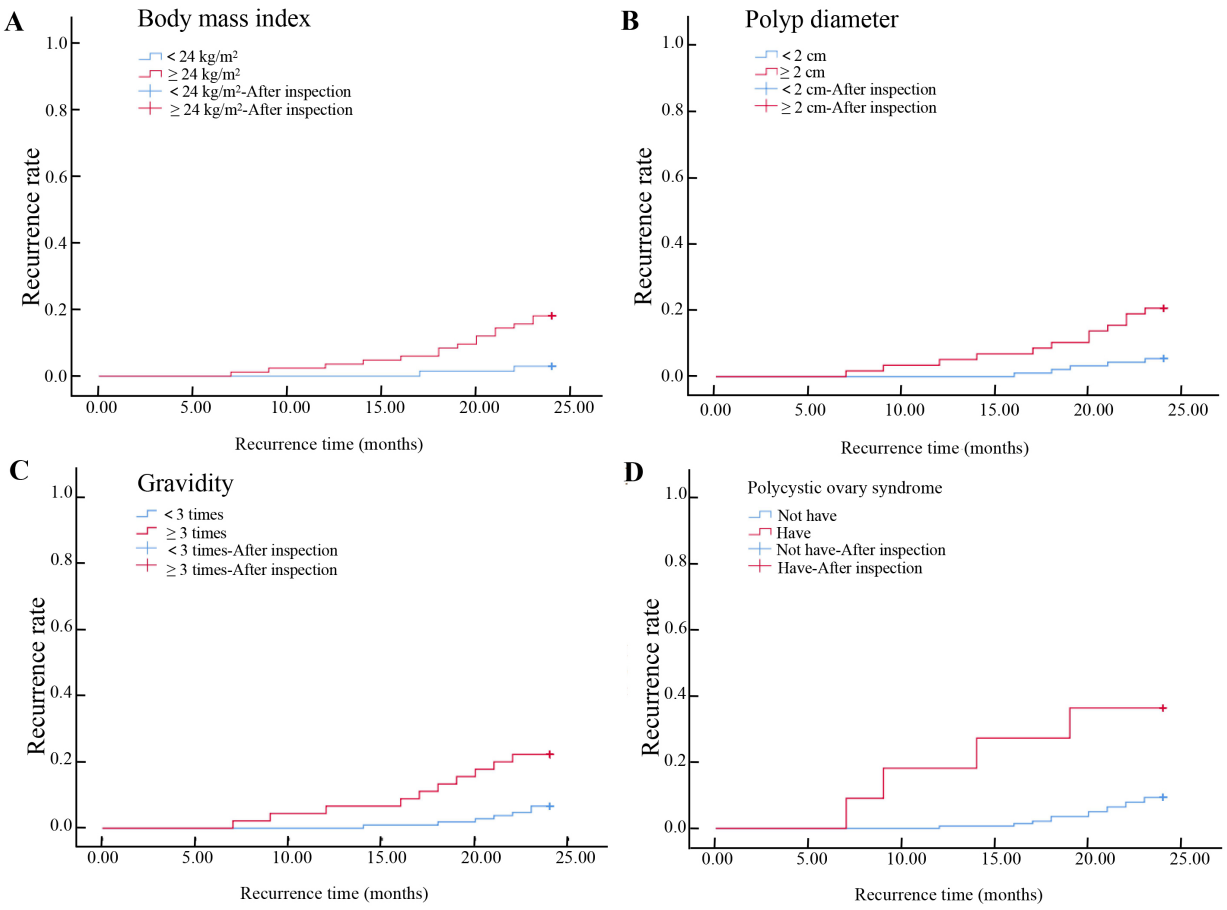

Fig. 4. Kaplan Meier curves for recurrence rates in different body mass indices, polyp diameters, gravidities, and polycystic ovary syndrome subgroups.

practicality is relatively poor. The nomogram has the ability to predict individual clinical outcomes and has been applied to the recurrence of cervical dysplasia [8], recurrence after ischemic stroke [16], and recurrence after radiofrequency ablation in patients with non-valvular atrial fibrillation [17], with good results. Therefore, this study further introduced BMI, polyp diameter, gravidity, and polycystic ovary syndrome into R software to construct a nomogram for predicting the recurrence of polyps in women of childbearing age after TCRP, providing a relatively clear basis for personalized prevention and treatment of polyp recurrence.

The model developed in this study to predict the recurrence of polyps in women of childbearing age after TCRP shows that the nomogram score for those with a BMI $\geq$24 kg/m^2 is 100 points higher than for those with a BMI $<$24 kg/m^2, and patients with a BMI $\geq$24 kg/m^2 have a higher recurrence rate. The reason may be when the BMI exceeds 24 kg/m^2, especially in obese patients, the level of androgens in the body is often higher. The aromatase in adipose tissue can convert androgens into estrogens, and the more adipose tissue, the stronger its conversion ability, which leads to an excessive level of estrogen, thereby stimulating excessive growth of the endometrium and increasing the risk of polyp recurrence [18]. BMI is a controllable factor, so it is recommended that such patients should do appropriate exercise and eat a reasonable diet to control their weight within the normal range in order to reduce the recurrence of polyps after TCRP. The results of this study found that those with polycystic ovary syndrome have a nomogram score of 69.7 points higher than those without polycystic ovary syndrome, and the 2-year recurrence rate of patients with polycystic ovary syndrome is significantly higher than those without polycystic ovary syndrome. The possible mechanism is: long-term anovulation and the use of gonadotropins for ovulation induction treatment can cause an increase in estrogen levels, and patients often have abnormal glucose metabolism, which can easily stimulate the occurrence and development of EP. It has been reported that polyp diameter is related to successful pregnancy after hysteroscopic electrosection [19]. The results of this study found that those with a polyp diameter $\geq$2 cm have a nomogram score of 74.8 points higher than those with a polyp diameter $<$2 cm, and patients with a polyp diameter $\geq$2 cm have a higher recurrence rate. It is consid-

ered to be related to the larger the polyp diameter, the more severe the disease may be, which increases the risk of recurrence. Therefore, although polypectomy was performed using a residual free bipolar device and oral contraceptives were used after polypectomy, the high recurrence rate can be explained by the high number of polyp patients $\geq$2cm and high BMI. Similarly, Liu *et al*. [20] also found that BMI and polyp size are independent risk factors for recurrence after endometrial polypectomy. In addition, the results of this study also found that those with gravidity $\geq$3 times have a nomogram score of 80 points higher than those with gravidity $<$3 times, and compared with patients with gravidity $<$3 times, the 2-year recurrence rate of patients with gravidity $\geq$3 times has significantly increased. The reason may be that patients with more pregnancies, may have more births or abortions, which can easily lead to an increase in endometrial inflammatory reactions, thus causing EP. The internal verification of the nomogram model in this study found that the calibration curve slope for predicting the recurrence of women of childbearing age after TCRP is close to 1, the area under the ROC curve is 0.781 (95% CI = 0.6690.894), and the Hosmer-Lemeshow goodness of fit test χ^2 equals 8.720, with $p = 0.366$. The external verification results show that the calibration curve slope is close to 1, and the area under the ROC curve is 0.794 (95% CI = 0.705–0.883). This indicates that the nomogram for predicting the recurrence of women of childbearing age after TCRP has good accuracy and conformity, and has good application prospects. However, there are still deficiencies in this study, such as the limited number of patients included, and only 2 years of follow-up after surgery, which may affect the stability and predictive power of the nomogram. More cases and longer follow-up years need to be continued in future research.

5. Conclusion

In summary, the nomogram model constructed in this study based on BMI, polyp diameter, number of pregnancies, and polycystic ovary syndrome has good predictive power. It is beneficial for the early identification of high-risk groups for recurrence after TCRP in women of childbearing age. Targeted follow-up can be conducted on patients to be able to timely administer medication for treatment, thus preventing and reducing the risk of polyp recurrence. However, all the analysis variables in this study have only two values, and the contribution of each variable to polyp recurrence cannot be effectively evaluated. Moreover, patients who start taking oral contraceptives after hysteroscopic polypectomy may have a lower recurrence rate than expected, and the results may be limited because only symptomatic patients who underwent ultrasound examinations were included, potentially missing asymptomatic recurrences. In the next phase of research, it's suggested to design experiments using larger sample sizes to obtain more accurate results.

Availability of Data and Materials

The datasets used and/or analyzed during the present study are available from the corresponding author upon reasonable request.

Author Contributions

XC and JL designed the research study. JL, HL, and NL collected the data. XC and NL analyzed the data. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This retrospective study involving human participants adhered to the ethical standards of the institutional research committee and the 1964 Helsinki Declaration, including its later amendments or comparable ethical standards. The study received approval from Meizhou People's Hospital ethics review board (approval number: 2022-C-126). All subjects provided their informed consent for inclusion before participating in the study.

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Conflict of Interest

The authors declare no conflict of interest.

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