Development and Validation of a Predictive Model for Hypoglycemia after Endoscopic Polypectomy

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Abstract: This study aimed to identify factors associated with hypoglycemia among patients following endoscopic colorectal polypectomy and to construct and validate a risk prediction model. A convenience sampling technique was employed to enroll 651 patients who had undergone this procedure at our hospital between January 2025 and July 2026. On the basis of blood glucose test findings, the enrolled patients were assigned to either a hypoglycemic group or a non-hypoglycemic group. Logistic regression was subsequently performed to identify factors associated with postoperative hypoglycemia, and a prediction model was then established. The receiver operating characteristic curve, Hosmer-Lemeshow test, and calibration plot were used to evaluate the predictive performance of the model, and an internal validation group was used for internal validation of the model. Among the 651 patients, 66 developed hypoglycemia, with an incidence rate of 10.14%. Multivariate logistic regression analysis demonstrated that a history of polyp treatment (OR=0.337), fructosamine (OR=1.012), AIS (OR=2.515), duration of postoperative fasting (OR=8.305), titanium clip count (OR=2.034), and length of preoperative dietary restriction (OR=5.906) independently predicted hypoglycemia in individuals who underwent endoscopic excision of colorectal polyps. The model achieved good discriminatory performance (AUC = 0.885), and its calibration was satisfactory according to the Hosmer–Lemeshow test (χ^2 = 4.033, P = 0.854). For internal validation, the model yielded an AUC of 0.876. The calibration curve further indicated that the predicted probabilities closely matched the ideal reference line. The predictive model developed in the present study demonstrated satisfactory performance, providing a useful reference for the clinical prevention of hypoglycemia in individuals who underwent endoscopic resection of colorectal polyps.

Keywords: Endoscopic Polypectomy; Hypoglycemia; Influencing Factors; Model Construction; Validation

1. Introduction

In terms of cancer-related mortality, colorectal cancer ranks second globally. [1]. With the increasing incidence of colorectal polyps, early resection is an effective means to reduce the incidence of colorectal cancer [2]. Endoscopic surgical approaches are widely used in clinical practice due to their advantages of minimal invasiveness and rapid postoperative recovery. Hypoglycemia is a common complication after endoscopic colorectal polypectomy. Because patients fast for more than 24 hours before and after surgery, they may perceive hunger as a normal phenomenon and overlook the occurrence of hypoglycemia. Acute hypoglycemia can cause cerebral edema and neuropsychiatric symptoms; severe hypoglycemia can lead to brain dysfunction, convulsions, and even coma and death [3]. Studies have shown [4,5] that hypoglycemia increases postoperative complications, prolongs hospitalization, and increases medical costs, posing a significant threat to patients' lives and well-being. Currently, there is no recognized analysis of risk factors for hypoglycemia following endoscopic resection of colorectal polyps in China. Hypoglycemia is an important risk factor after endoscopic colorectal polypectomy, and patients with hypoglycemia often do not present typical clinical symptoms after general anesthesia [6]. Accordingly, drawing on identified determinants of hypoglycemia among individuals who underwent endoscopic colorectal polypectomy, this investigation established and verified a model for predicting this complication following the

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procedure, intending to offer a reference for its prevention and management in such patients.

2. Materials and Methods

2.1 Study Subjects

A convenience sampling approach was adopted to recruit 651 patients undergoing endoscopic resection of colorectal polyps at our hospital from January 2025 to July 2026; these individuals served as the survey respondents and formed the model construction cohort. Participants were included if they met the following conditions: (1) an age of 18 years or above; (2) a confirmed diagnosis of colonic polyps based on electronic colonoscopy; and (3) voluntary provision of informed consent for this study. Subjects were excluded when any of the following applied: (1) coexistence of other systemic malignant neoplasms; (2) postoperative pathological examination of the polypectomy specimen showing malignancy; (3) coagulopathy; (4) incomplete clinical charts or endoscopic information. Dropout criteria: failure to complete the questionnaire and data collection for various reasons. According to the sample size estimation method for Logistic regression [7], each predictor must have 5–10 positive events. Based on previous research results of 1–15 possible predictors for sample size calculation, combined with the incidence of hypoglycemia in colonoscopy patients of 14.38%–17.50% [8], and considering a 20% sample loss rate, the minimum sample size for this study was $15 \times 5 \times (1 + 0.2) \div 14.38\% \approx 625$. Ethical approval for the present study was granted by the hospital's Medical Ethics Committee (approval number: 2023 No. 05-002).

2.2 Bowel Preparation

According to the "Chinese Guideline for Bowel Preparation for Digestive Endoscopy (2019, Shanghai)"[9] and patient condition assessment, two bowel preparation methods were used: (1) Polyethylene glycol (PEG) electrolyte powder: 4-6 hours before the examination, one box of PEG containing A+B+C agents (A contains potassium chloride 0.74g, sodium bicarbonate 1.68g; B contains sodium chloride 1.46g, sodium sulfate 5.68g; C contains polyethylene glycol 4000 60g) was dissolved in 1L warm water for consumption, with a total of 3L PEG solution consumed within 2 hours; (2) Magnesium sulfate: 4-6 hours before the examination, 50g magnesium sulfate was dissolved in 250ml warm water for consumption, followed by continuous drinking of 8 cups of 250ml warm water, with a total of 2250ml consumed within 2 hours. On the day before the examination, nurses provided oral and written instructions on bowel cleaning methods, and provided a WeChat public platform video for patients to learn; on the day before the examination, patients were required to consume a light liquid residue-free diet, and fast on the day of the examination. When taking the medication, patients were instructed to exercise appropriately and gently massage the abdomen to facilitate intestinal peristalsis until clear water-like stools were passed. If bowel preparation was inadequate, an additional 1L PEG could be administered; if bowel preparation was adequate, patients were required to fast and abstain from drinking until surgery. The intraoperative surgical approach and postoperative fasting and water restriction duration were determined by the physician based on polyp size and wound surface.

2.3 Endoscopic Surgery-Related Conditions

Forceps biopsy polypectomy (FBP), cold snare polypectomy (CSP), hot snare polypectomy (HSP), endoscopic mucosal resection (EMR), and endoscopic submucosal dissection (ESD) are among the endoscopic resection techniques frequently employed today. According to polyp size and narrow band imaging (NBI)-estimated pathological type classification, selection of the appropriate endoscopic resection method can improve the resection rate and reduce complications [10].

2.4 Survey Instruments

2.4.1 General demographic and clinical data questionnaire

Based on literature review, the researchers designed a general information questionnaire, including: (1) Basic information, including patient gender, age, height, weight (researchers calculated BMI), education level, blood type, diabetes history, diabetes duration, polyp treatment history, and hematochezia history. (2) Electronic medical records, including review of clinical biochemical indicators and endoscopic examination results, including alanine aminotransferase (ALT), serum total cholesterol (TC), first fasting plasma glucose (FPG), blood group (BG), number of polyps, polyp size, maximum polyp diameter, use of titanium clips, number of titanium clips, surgical approach,

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withdrawal time, surgery start time, and adequacy of bowel preparation. (3) Hypoglycemia registration form, including seven clinical manifestations: dizziness, headache, palpitations, cold sweats, blackout, trembling, and fatigue, and measured capillary blood glucose values.

2.4.2 Athens Insomnia Scale (AIS)

The Athens Insomnia Scale (AIS) was developed by Soldatos et al. in 2000, comprising 8 dimensions: sleep onset latency, nocturnal awakenings, early morning awakening, total sleep time, overall sleep quality, daytime mood, daytime physical functioning, and daytime sleepiness. Total score ranges from 0-24 points, with <4 points indicating no sleep disorder, 4-6 points indicating suspected insomnia, and >6 points indicating insomnia [11].

2.4.3 Boston Bowel Preparation Scale (BBPS)

This scale evaluates the adequacy of bowel preparation, graded from worst to clean in 4 levels (cecum and ascending colon, transverse and descending colon, rectum and sigmoid colon each scored 0-3, with additional points if total colonic fluid volume is 0, total score 9 points), with a score ≥6 indicating adequate bowel preparation. The score is directly proportional to bowel cleanliness [12].

2.5 Data Collection Methods

A study group comprising five nurses and two physicians was formed. Among its members, one possessed a doctoral degree, two held master's degrees, and four had earned bachelor's degrees. This study used on-site surveys for data collection. Two questionnaire collectors were trained on guiding language, questionnaire item meanings, and scoring methods, and inductive questioning was avoided to ensure information accuracy. Research team members explained the study aims to eligible inpatients in the ward. Once informed consent had been obtained, the patients independently completed the AIS questionnaire electronically through Questionnaire Star. Data collection was performed by double entry with reverse verification.

2.6 Diagnostic Criteria for Hypoglycemia

This study classified hypoglycemia occurring in patients after endoscopic colorectal polypectomy into two types: absolute hypoglycemia and relative hypoglycemia.(1) Absolute hypoglycemia: During the period from the end of surgery until the resumption of oral intake after surgery, the patient presents with symptoms of sympathetic overactivity, such as palpitations, cold sweats, trembling, and pallor, or central nervous system symptoms, such as dizziness, headache, and confusion, and meets the diagnostic criteria in the Chinese Guidelines for the Prevention and Treatment of Type 2 Diabetes (2020 Edition) [13], namely, blood glucose< 2.8 mmol/L in non-diabetic patients and blood glucose< 3.9 mmol/L in patients receiving medication for diabetes, with symptoms resolving after oral or intravenous glucose administration.(2)Relative hypoglycemia: Although some patients do not reach the above absolute hypoglycemia thresholds, if their preoperative blood glucose has been at a relatively high level for a long time and their postoperative blood glucose decreases too rapidly or by too large a magnitude within a short period, they may still experience sympathetic excitatory and central nervous system symptoms consistent with those of absolute hypoglycemia even if the measured blood glucose remains within the normal range; these symptoms also resolve after glucose supplementation. The underlying mechanism is an upward shift in the "alarm threshold" of hypothalamic glucose-sensitive neurons. Therefore, in addition to following the absolute criteria in the guidelines, postoperative blood glucose management should also take the preoperative blood glucose baseline into account and remain alert to relative hypoglycemia.

2.7 Statistical Methods

Statistical analyses were carried out with SPSS version 27.0 and R version 4.4.1. Categorical variables were summarized as frequencies and percentages, and the chi-square test was applied for between-group comparisons. Continuous variables that followed a normal distribution are reported as mean ± standard deviation (Mean ± SD), and between-group differences were assessed with the independent-samples t-test. For variables with a skewed distribution, results are presented as M ($P25$, $P75$), with the Wilcoxon rank-sum test employed for group comparisons. On this basis, multivariate statistical methods were used to screen variables with $P<0.05$ and establish a Logistic regression model. Collinearity among factors was assessed using the variance inflation factor (VIF) in collinearity diagnosis, with VIF>10 indicating collinearity. Through regression analysis of each variable, a hypoglycemia risk prediction model for patients undergoing endoscopic intestinal polyp surgery

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was established, and a nomogram was plotted using R 4.4.1 software. Bootstrap resampling was performed on the modeling group data to internally validate the model. Receiver operating characteristic (ROC) curves were plotted and the area under the curve (AUC) was calculated to evaluate model discrimination. Model calibration was assessed using the Hosmer-Lemeshow test. With respect to discrimination, an AUC closer to 1 reflected stronger discriminatory ability of the model. A Hosmer-Lemeshow test result of P>0.05 indicates good model fit.

3. Results

3.1 Current Status of Hypoglycemia after Endoscopic Colorectal Polypectomy

In this investigation, 700 questionnaires were issued, of which 651 were returned and deemed valid, corresponding to a valid response rate of 93.00%. Finally, 651 patients who underwent endoscopic colorectal polypectomy were included and divided into a hypoglycemia group and a non-hypoglycemia group according to the blood glucose test results. Among them, 66 patients developed hypoglycemia, with an incidence rate of 10.14%, while 585 patients did not develop hypoglycemia, accounting for 89.86%.

3.2 Univariate Analysis Results

In the development group, statistically significant differences were found between the two groups in polyp treatment history, diabetes history, diabetes duration, fructosamine, preoperative dietary restriction, AIS, surgical approach, withdrawal time, number of polyps, number of titanium clips, and postoperative fasting duration (P<0.05), see Table 1. Collinearity regression analysis of 11 factors revealed that all VIF values were <10, indicating no collinearity among variables.

3.3 Multivariate Analysis Results

Variables that reached statistical significance (P< 0.05) in univariate analysis—eleven in total—were entered into the logistic regression model. For the outcome variable, hypoglycemia was coded as 1 and non-hypoglycemia as 0, while the coding of predictors is presented in Table 2. Findings from the logistic regression model indicated that a history of polyp treatment, fructosamine level, AIS score, titanium clip count, duration of postoperative fasting, and length of preoperative dietary restriction were factors associated with hypoglycemia among patients undergoing endoscopic colorectal polypectomy (P<0.05), as shown in Table 3.

3.4 Predictive Model for Hypoglycemia Risk after Endoscopic Colorectal Polypectomy

The factors associated with the occurrence of low blood glucose following endoscopic removal of colorectal polyps were included as independent variables when developing a risk prediction model. The prediction formula is:

Logit (P) = -6.867 + 0.012×Fructosamine + 0.922×AIS + 2.117×Postoperative Fasting Duration + 1.776×Preoperative Dietary Restriction Duration + 0.710×Number of Titanium Clips - 1.088×Polyp Treatment History where AIS: >6=1, ≤6=0; Postoperative Fasting Duration: >24 h=1, ≤24 h=0; Preoperative Dietary Restriction Duration: ≥3 d=1, <3 d=0; Polyp Treatment History: Yes=1, No=0.

The Logistic regression analysis results were visualized as a nomogram using R 4.4.1 software, see Figure 1.

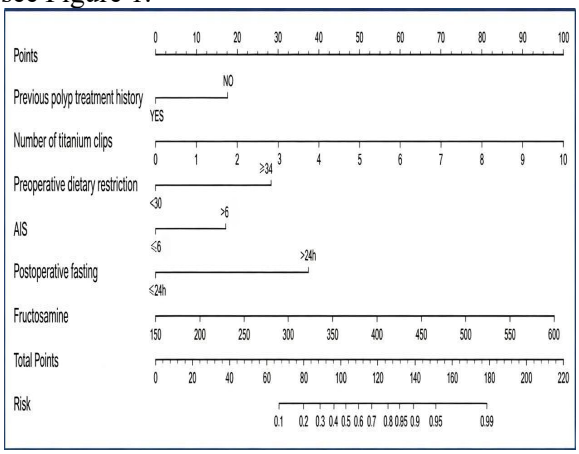


Figure 1. Nomogram for Predicting Hypoglycemia Risk after Endoscopic Colorectal Polypectom

Table 1. Comparison of General Data between Hypoglycemia and Non-Hypoglycemia Patients in the Modeling Group

Variable	(n=651)	Hypoglycemia Group(n=66)	Non-Hypoglycemia Group(n=585)	*P*	χ^2/Z
Gender [n(%)]				0.071	3.268
Male	407(62.52)	48(72.73)	359(61.37)		
Female	244(37.38)	18(27.27)	226(38.63)		
Age [years,$M(P_{25}, P_{75})$]	61.00	61.00(54.00,64.25)	61.00	0.507	0.665

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	(54.00,65.00)		(54.00,68.00)		
BMI [kg/m^2, $M(P_{25}, P_{75})$]	23.85 (21.60,26.00)	24.10(21.43,26.70)	23.80 (21.60,25.98)	0.656	-0.445
Education Level [n(%)]				0.911	0.012
High School and Above	272(41.78)	28(42.42)	244(41.71)		
Below High School	379(58.22)	38(57.58)	341(58.29)		
Diabetes History [n(%)]				0.001	10.799
yes	84(12.90)	17(25.76)	67(11.45)		
no	567(87.10)	49(74.24)	518(88.55)		
Polyp Treatment History [n(%)]				<0.001	15.109
yes	274(42.09)	13(19.70)	261(44.62)		
no	377(57.91)	53(80.30)	324(55.38)		
Hematochezia [n(%)]				0.889	0.019
yes	37(5.68)	4(6.06)	33(5.64)		
no	614(94.32)	62(96.94)	552(94.36)		
Titanium Clips Used During Surgery [n(%)]				0.457	0.554
yes	317(48.69)	35(53.03)	282(48.21)		
no	334(51.31)	31(46.97)	303(61.79)		
Adequate Bowel Preparation [n(%)]				0.192	1.699
yes	587(90.17)	63(95.45)	524(89.57)		
no	64(9.83)	3(4.55)	61(10.43)		
Type of Bowel Preparation Medication [n(%)]				0.722	0.127
Polyethylene Glycol Electrolyte Powder	339(52.07)	33(50.00)	306(52.31)		
Magnesium Sulfate	312(47.93)	33(50.00)	279(47.69)		
Diabetes Duration [n(%)]				0.002	9.850
≥10yeas	35(5.38)	9(13.64)	26(4.44)		
<10years	616(94.62)	57(86.36)	559(95.56)		
Maximum Polyp Diameter [n(%)]				0.084	4.947
>1cm	211(32.41)	17(25.76)	194(33.16)		
≤1cm	437(67.13)	49(74.24)	391(66.84)		
Withdrawal Time [n(%)]				<0.001	32.698
≥15min	227(34.87)	44(66.67)	183(31.28)		
<15min	424(65.13)	22(33.33)	402(68.72)		
Duration of Preoperative Dietary Restriction [n(%)]				<0.001	33.736
≥3d	65(9.98)	20(30.30)	45(7.69)		
<3d	586(90.09)	46(69.70)	540(92.31)		
Duration of Postoperative Fasting [n(%)]				<0.001	83.222
>24	16(2.46)	13(19.70)	3(0.51)		
≤24h	635(97.54)	53(80.30)	582(99.49)		
Surgery Time [n(%)]				0.190	1.715
Before 12AM	452(69.65)	40(62.50)	412(70.43)		
After 12AM	197(30.35)	24(37.50)	173(29.57)		
AIS [n(%)]				0.002	9.981
>6	108(16.59)	20(30.30)	88(15.04)		
≤6	543(83.41)	46(69.70)	497(84.96)		
Surgical Approach [n(%)]				<0.001	17.441
EMR	259(39.78)	42(63.64)	217(27.09)		
Others	392(60.22)	24(36.36)	368(62.91)		
Blood Type [n(%)]				0.476	2.497
O	214(32.87)	20(30.30)	194(33.16)		
A	204(31.34)	25(37.88)	179(30.60)		
AB	46(7.07)	6(9.09)	40(6.84)		
B	187(28.73)	15(22.73)	172(29.40)		
Number of Titanium Clips [pieces, $M(P_{25},P_{75})$]	1.00 (0.00,2.00)	2.50 (1.00,5..50)	0.00 (0.00,1.00)	<0.001	-8.330
Number of Polyps [pieces, $M(P_{25},P_{75})$]	5.00 (2.00,8.00)	7.00 (4.75,10.00)	4.00 (2.00,8.00)	<0.001	-4.182
Alanine Aminotransferase [U/L, $M(P_{25},P_{75})$]	17.00 (12.00,26.00)	16.00 (12.75,26.00)	17.00 (12.00,25.50)	0.809	-0.241
Fructosamine [μmol/L, $M(P_{25},P_{75})$]	255.00 (237.00,278.00)	277.50 (247.50,320.00)	254.00 (237.00,273.00)	<0.001	-4.692
Tota lCholesterol [mmol/L,$X\pm S$]	4.36±0.938	4.29±0.892	4.36±0.944	0.563	0.335
Glucose [mmol/L,$M(P_{25},P_{75})$]	4.63 (4.32,5.09)	4.50 (4.27,5.03)	4.63 (4.32,5.10)	0.341	-0.952

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Table 2. Variable Assignment Methods

Variable	Assignment
Diabetes History	No=0, Yes=1
Polyp Treatment History	No=0, Yes=1
Diabetes Duration	<10years=0, ≥10years=1
Withdrawal Time	<15min=0, ≥15min=1
AIS	≤6=0,>6=1
Surgical Approach	Others=0, EMR=1
Postoperative Fasting Duration	≤24h=0,>24h=1
Preoperative Dietary Restriction Duration	<3d=0, ≥3d=1
Number of Titanium Clips	Entered as a continuous variable
Fructosamine	Entered as a continuous variable
Number of Polyps	Entered as a continuous variable

Table 3. Logistic Regression Analysis Results of Hypoglycemia after Endoscopic Colorectal Polypectomy

Independent Variable	β	SE	Walds χ^2	*P*	*OR*	95%*CI*
Constant	-6.867	1.054	42.410	<0.001	0.001	--
Diabetes History	0.126	0.556	0.051	0.821	1.134	0.381~3.374
Polyp Treatment History	-1.088	0.416	6.838	0.009	0.337	0.149~0.761
Diabetes Duration	0.689	0.711	0.939	0.333	1.992	0.494~8.024
Withdrawal Time	0.230	0.429	0.286	0.593	1.258	0.542~2.919
Fructosamine	0.012	0.003	11.492	0.001	1.012	1.005~1.018
Number of Polyps	0.040	0.030	1.791	0.181	1.041	0.982~1.104
Number of Titanium Clips	0.710	0.128	30.545	0.000	2.034	1.581~2.616
Surgical Approach	-0.908	0.474	3.676	0.055	0.403	0.159~1.020
AIS	0.922	0.401	5.298	0.021	2.515	1.147~5.518
Postoperative Fasting Duration	2.117	0.972	4.747	0.029	8.305	1.237~55.765
Preoperative Dietary Restriction	1.776	0.390	20.685	<0.001	5.906	2.747~12.696

3.5 Construction and Evaluation of the Predictive Model for Hypoglycemia Risk after Endoscopic Colorectal Polypectomy

3.5.1 Construction and internal validation

In the development group, the AUC of the ROC curve for the constructed model was 0.885 (95% CI: 0.837-0.933), see Figure 2. At the maximum Youden index of 0.655, the model's sensitivity and specificity were 78.8% and 86.7%, respectively. The Hosmer- Lemeshow goodness-of-fit test result was χ^2=3.719, P=0.854. Bootstrap resampling analysis of the modeling group with 1000 replicates showed an AUC of 0.876 (95% CI: 0.829-0.920), indicating good discrimination ability of the prediction model. In the calibration plot, the calibration curve showed high overlap with the ideal curve, and the Hosmer- Lemeshow test χ^2=15.445, P=0.051, indicating good cali.

4. Discussion

4.1 Influencing Factors for Hypoglycemia Following Endoscopic Resection of Colorectal polyps

4.1.1 Fructosamine

This study found that elevated serum fructosamine concentration was an influencing factor for hypoglycemia following endoscopic resection of colorectal polyps. In 2021, the number of diabetic patients in China increased by 155% compared to 2011, reaching 140 million, of whom 51.7% were undiagnosed [14]. Fructosamine is a substance formed during the non-enzymatic glycation of plasma proteins by glucose, which can effectively reflect the average blood glucose level over the recent 1-3 weeks. Studies have shown [15] that its short-term response sensitivity is superior to glycated hemoglobin. Patients with long-term hyperglycemia have elevated insulin secretion levels. Due to postoperative fasting requirements, blood glucose levels decrease, while insulin secretion lags and is not synchronized with blood glucose levels, leading to hypoglycemia. This suggests that nursing staff should closely monitor preoperative serum fructosamine concentration, inquire about diabetes history and blood glucose control status, and reasonably monitor blood glucose changes to reduce the occurrence of hypoglycemia.

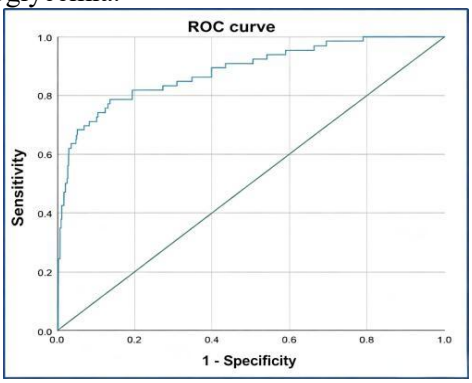


Figure 2. Receiver Operating Characteristic Curve of the Predictive Model

4.1.2 AIS score

This study found that an AIS score >6 points was an influencing factor for hypoglycemia following endoscopic resection of colorectal polyps. The AIS subjectively evaluates patients' perioperative sleep quality from a micro perspective [16]; higher scores indicate more severe insomnia. Poor perioperative sleep quality activates the body's stress system, excites the sympathetic nervous system, and increases secretion of cortisol, adrenaline, and other hormones, leading to increased oxygen consumption and vigorous energy metabolism, causing disturbed glucose metabolism and thereby leading to hypoglycemia

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[17]. Therefore, nursing staff should formulate more careful and comprehensive medication guidance and surgical schedule arrangements based on patient condition and sleep quality, provide better ward sleep environments for patients, improve patient care experience, and reduce the risk of hypoglycemia.

4.1.3 Postoperative fasting duration

This study found that postoperative fasting duration >24 hours was an influencing factor for hypoglycemia following endoscopic resection of colorectal polyps. That is, patients with fasting duration >24 hours had a 1.48-fold increased risk of postoperative hypoglycemia compared to those with ≤24 hours. Studies have pointed out that oral intake within 12 hours after surgery in colorectal cancer patients helps accelerate postoperative intestinal function recovery and is safe and effective[18]; early feeding after painless colonoscopic polypectomy can also reduce patient discomfort and lower the risk of postoperative complications[19], which is consistent with the results of this study. Nursing staff should reasonably select fasting duration and individualized fluid replacement plans based on intraoperative and postoperative conditions in consultation with physicians to reduce the risk of hypoglycemia.

4.1.4 Preoperative dietary restriction duration

This study found that preoperative dietary restriction duration ≥3 days was an influencing factor for hypoglycemia following endoscopic resection of colorectal polyps. That is, patients with duration ≥3 days had a 1.69-fold increased risk of postoperative hypoglycemia compared to those with <3 days. According to the "Expert Consensus Opinion on Bowel Preparation for Colonoscopy" [20], restricting diet for more than 24 hours before colonoscopy does not improve bowel preparation quality; 3 days of dietary restriction does not improve bowel preparation results compared to 1 day; it is recommended that patients stop consuming high-residue/high-fiber foods within 24 hours before colonoscopy. Therefore, nursing staff should formulate individualized bowel preparation dietary plans for patients before examination and change patients' inherent traditional thinking to reduce hypoglycemia caused by prolonged dietary restriction.

4.1.5 Number of titanium clips

This study found that the number of titanium clips used during surgery was an influencing factor for hypoglycemia following endoscopic resection of colorectal polyps; the more titanium clips used, the higher the risk of hypoglycemia. Metal titanium clips are a hemostatic device. Prior research [21] has demonstrated that adjunctive application of titanium clips during the procedure can markedly decrease delayed wound hemorrhage and enhance operative safety. To prevent titanium clip dislodgement, nursing staff should formulate diet and exercise plans for patients, instruct patients to strictly remain in bed within 24 hours after surgery and increase the duration of postoperative liquid diet, and reasonably monitor blood glucose to prevent postoperative hypoglycemia.

4.1.6 Polyp treatment history

This study found that polyp treatment history was an influencing factor for hypoglycemia following endoscopic resection of colorectal polyps. Studies have shown that the local recurrence rate after EMR is as high as 50% [22]. The "Chinese Expert Consensus on Early Diagnosis and Treatment of Colorectal Cancer" [23] proposes individualized screening models for different risk factors to reduce the recurrence risk after colorectal polypectomy. High compliance with follow-up examinations is positively correlated with disease knowledge mastery and comfort during initial colonoscopy [24]. Patients undergoing repeat polypectomy are more familiar with the process and can better tolerate the hunger caused by preoperative and postoperative dietary restrictions, increasing perioperative comfort. Consequently, nursing personnel ought to deliver more intensive educational interventions to individuals scheduled for first-time polypectomy, relieve their psychological distress, and enhance treatment adherence, thereby lowering the likelihood of low blood glucose following the procedure.

4.2 Predictive Model for Hypoglycemia Risk after Endoscopic Colorectal Polypectomy

This study used 651 patients from January 2025 to July 2026 as the training set for model development. The Hosmer-Lemeshow test and calibration curve indicated good model fit with high calibration. The AUC was 0.885 (95% CI: 0.837-0.933), indicating high discrimination. Bootstrap resampling was used for internal validation, with good Hosmer-Lemeshow test fit and high overlap between the calibration curve and ideal curve, indicating high calibration. The AUC was 0.876 (95% CI: 0.829-0.920), indicating good predictive performance in

internal validation. The prediction variables included in the model are simple, and the visualized nomogram can intuitively calculate individual hypoglycemia probability, with good operability.

5. Conclusion

The results of this study showed that polyp treatment history, fructosamine, AIS, duration of postoperative fasting, number of titanium clips, and duration of preoperative dietary restriction were influencing factors for hypoglycemia following endoscopic resection of colorectal polyps ($P<0.05$). The risk prediction model for hypoglycemia after endoscopic colorectal polypectomy constructed based on the above influencing factors demonstrated good predictive performance and can serve as a screening tool for identifying individuals at high risk of hypoglycemia. However, this study also had certain limitations: all samples were from a single tertiary Grade a hospital, and the data source was relatively homogeneous, which may limit representativeness. In addition, only Bootstrap resampling was used for internal validation, and external validation has not yet been performed; therefore, the generalizability of the model remains to be further confirmed. Consequently, subsequent research ought to broaden both sample sizes and recruitment sources, perform prospective multicenter investigations, and incorporate additional pertinent variables, with the aim of further optimizing the present risk prediction model. This would help mitigate hypoglycemia risk following endoscopic removal of colorectal polyps and improve the patient care experience.

Acknowledgments

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