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ORIGINAL RESEARCH

Predictors of Abdominal Pain Duration in Henoch–Schönlein Purpura and Nomogram Model Development: A Retrospective Study of 220 Cases

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Objective: Our study aims to identify risk factors that predict an abnormally prolonged duration of abdominal pain relief (DAPR) in patients with abdominal Henoch–Schönlein purpura (A-HSP) and to construct a nomogram for early prediction.

Methods: We reviewed data of all patients (n = 375) with confirmed A-HSP from the Chongqing Medical University platform, from 22 January 2011 to 18 November 2022. After applying rigorous inclusion and exclusion criteria, 220 patients were ultimately enrolled. We split them into two groups by the DAPR: < 1 week and ≥ 1 week. Multivariate relogit regression was performed to select factors associated with DAPR lasting ≥ 1 week, including demographics, symptoms, laboratory results, and treatment. We then constructed a nomogram to estimate risk probability and internally validated its performance via bootstrapping using discrimination, calibration, and clinical utility.

Results: There were 220 patients in the training. Multivariate relogit regression analysis demonstrated that age, initial onset, neutrophil-to-lymphocyte ratio (NLR), and bowel wall thickening were independent risk factors for DAPR ≥ 1 week. The Area Under the Curve (AUC) of the nomogram constructed based on the above factors was 0.849. Both the Calibration curve and Decision Curve Analysis (DCA) of the nomogram showed that the model exhibited good fitness.

Conclusion: The nomogram can effectively predict the prolonged duration of abdominal pain (≥ 1 week) in A-HSP patients, helping clinicians distinguish high-risk patients at an early stage and optimize treatment plans. However, external validation remains essential before clinical implementation.

Plain Language Summary: What is already known about this topic?

- Abdominal Henoch–Schönlein purpura (A-HSP) typically presents with abdominal pain. Persistent pain raises the risk of dangerous digestive problems, severe illness, or death, resulting in poorer short-term outcomes, particularly in adults.
- Persistent abdominal pain also raises the risk of kidney involvement. Monitoring pain duration can help in the early detection of kidney damage.
- We currently lack reliable tools to predict cases of abnormally prolonged abdominal pain for A-HSP patients.

What does this study add?

- Our study found that age, initial onset, bowel wall thickening, and elevated NLR blood levels were linked to abdominal pain lasting ≥ 1 week in A-HSP patients.
- A scoring tool based on these four factors could help doctors make early treatment decisions. However, it must first be tested in other patient groups before being used in practice.

Keywords: IgA vasculitis, allergic purpura, gastrointestinal involvement, predictive model, prognostic factors

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Introduction

Henoch–Schönlein Purpura (HSP) —also known as immunoglobulin A vasculitis (IgAV) or Allergic Purpura—is an IgA-mediated hypersensitivity reaction affecting capillaries and small vessels.[1] The overall incidence is about 3–27/100,000 persons every year, and the disease occurs worldwide, with a relatively high incidence in Asian populations.[2] Skin is the most commonly involved area, with almost all patients presenting with palpable skin purpura. The incidence of joint involvement is around 60–74%, gastrointestinal involvement is about 50–65%, renal involvement is about 30–54%, and manifestations in other organs, such as the nervous system, the lungs, and the heart, are relatively rare.[3,4]

When HSP patients manifest predominant gastrointestinal symptoms, the condition is termed abdominal Henoch–Schönlein purpura (A-HSP). A-HSP typically presents concurrently with or following cutaneous purpura, though gastrointestinal symptoms may occasionally precede skin findings.[1] Although A-HSP is self-limiting in most patients, it varies greatly between individuals. If not managed in a timely manner, severe complications such as gastrointestinal bleeding, bowel ischemia or necrosis, and intestinal perforation may develop as the disease progresses.[5,6] Currently, several studies have focused on the early diagnosis of abdominal pain in HSP and the early detection of complications such as gastrointestinal bleeding or renal impairment.[7–9] However, there remains a lack of simple predictive models to predict cases of abnormally prolonged abdominal pain for A-HSP patients, particularly for patients unable to undergo timely gastroscopy. Our study differs from previous research in several ways: first, we conducted a multi-center study, which enabled us to investigate a wider array of potential predictors and cover a more diverse population. Second, our predictive nomogram was developed using data spanning a broad age range, thereby ensuring applicability across both pediatric and adult populations. This tool provides an intuitive and simple method for identifying high-risk individuals with abnormally prolonged abdominal pain duration. Third, unlike currently available models that are primarily reliant on inflammatory markers and clinical features,[10] this study incorporated radiological imaging findings into the prediction model, providing enhanced specificity for gastrointestinal symptoms. Finally, our study focuses on abnormally prolonged abdominal pain duration as a crucial indicator for early intervention in A-HSP patients. Unlike other severe complications, abdominal pain represents one of the most frequent gastrointestinal manifestations, with a significantly higher incidence. Monitoring its duration enables identification of high-risk patients before severe complications develop, offering a critical window for timely intervention.

Therefore, this study aims to identify independent risk factors for abnormally prolonged duration of abdominal pain relief (DAPR) in A-HSP patients and develop a nomogram to assist in clinical decision-making, thereby improving treatment efficacy and long-term prognosis.

Materials and Methods

Research Design

This study is a retrospective study, and the data were obtained from the Chongqing Medical University platform, which integrates multicenter clinical records from affiliated hospitals. A total of 375 hospitalized patients with a discharge diagnosis of "Henoch–Schönlein Purpura (abdominal type)" were identified across multiple departments (dermatology, gastroenterology, pediatrics, etc)., from 22 January 2011 to 18 November 2022. After predefined inclusion and exclusion criteria were applied, 220 patients were ultimately enrolled in analyses (Figure 1). Owing to the inherent rarity of A-HSP, which has constrained our sample size, all model evaluations and statistical analyses were performed using only the internal dataset; external validation was not conducted.[11]

This study was approved by the Ethics Committee of the First Affiliated Hospital of Chongqing Medical University (No: K2024-223-01).

Inclusion Criteria

(1) Confirmed diagnosis of A-HSP at discharge. (2) Age: 2 years and above.

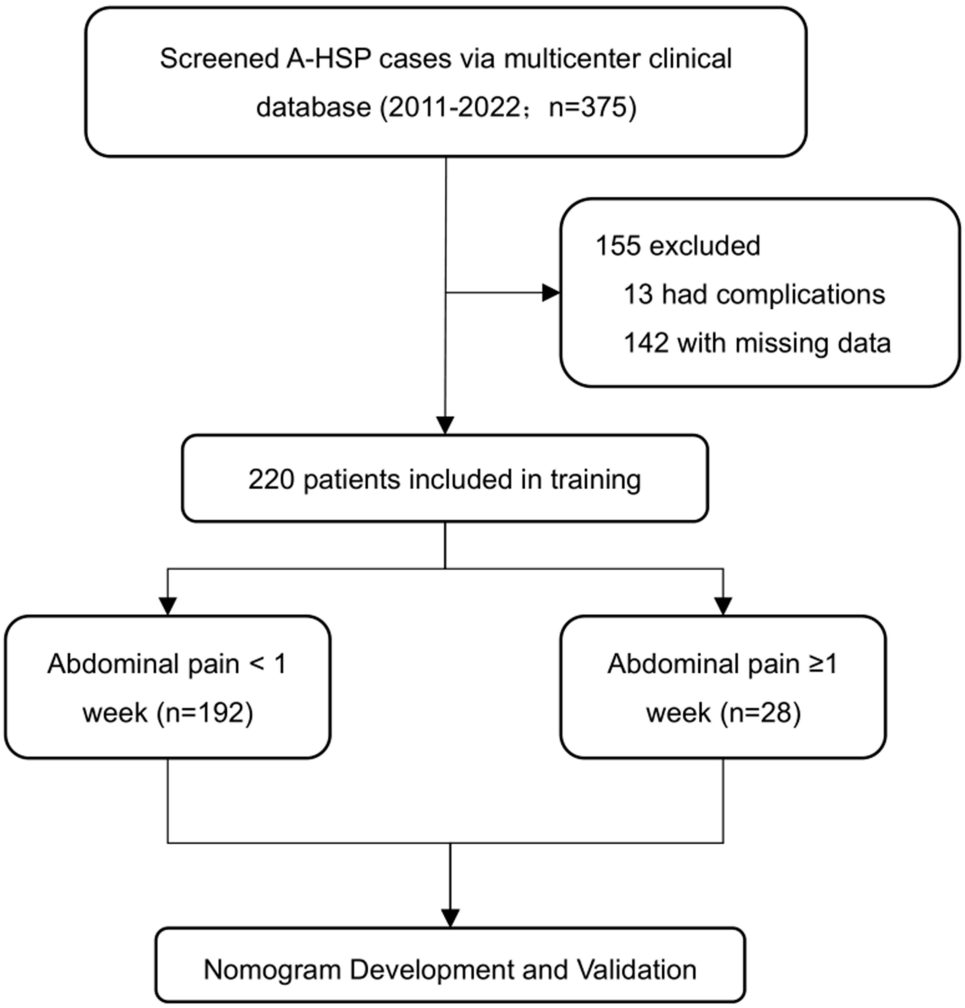

Figure 1 Flow chart of study subject inclusion.
Notes: Figure 1 illustrates the patient selection workflow for nomogram development. Initially, 375 A-HSP patients from Chongqing Medical University affiliated hospitals were screened. After excluding 155 patients (13 due to complications and 142 with missing data), 220 patients were included in the training cohort. These participants were stratified into two subgroups based on the duration of abdominal pain relief: 192 patients with Abdominal pain <1 week and 28 patients with Abdominal pain ≥1 week. The final phase details nomogram development and validation using these cohorts.
Abbreviation: A-HSP, Abdominal Henoch-Schönlein purpura.

Exclusion Criteria

(1) Comorbid other systemic vasculitides, severe infections, other gastrointestinal disorders, acute abdominal conditions, or immunodeficiency. (2) Incomplete medical records.

Data Collection and Definition

Baseline variables and potential risk factors were extracted from the data platform, including demographics (age, gender), clinical manifestations (initial onset, rash distribution, concomitant symptoms, systemic involvement, days from abdominal pain onset, etc)., laboratory indices (neutrophil-to-lymphocyte ratio [NLR], neutrophil-to-albumin ratio [NPAR]), medical imaging findings (ultrasonography, CT), and treatment approaches. Notably, upon reviewing the data, we found that joint-involvement records were missing for most of the 375 screened patients; the presence or absence of arthritis and arthralgia was documented in only 169 (45.1%). To minimize potential bias, we excluded this variable from statistical analyses.

The primary outcome was abdominal pain relief time, defined as the number of days from the initiation of inpatient treatment to the complete disappearance of abdominal pain. Patients were separated into two groups based on DAPR:

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"abdominal pain < 1 week" and "abdominal pain ≥ 1 week". In A-HSP, abdominal pain typically presents as an acute onset of diffuse abdominal cramps, and currently there is no validated, day-specific prognostic criterion for the duration of this symptom. In this study, patients were stratified according to the criterion of non-traumatic acute abdominal pain with symptom duration of less than one week.[12] This approach focuses on investigating prolonged abdominal pain duration (an abnormal condition) in A-HSP patients, thereby enabling clinicians to rapidly identify high-risk patients and initiate early intervention.

Imaging information was obtained from the patients' first either ultrasonography or CT examinations upon admission. The following abnormal imaging findings were recorded based on the examination reports: bowel wall thickening, ascites, abdominal lymphadenopathy, abnormal intestinal contents, and hyperactive bowel peristalsis. Each abnormal finding was assigned one point, and the total score of these abnormal imaging findings, termed the imaging score, ranged from 0 to 5. Renal involvement was defined as the presence of hematuria and/or proteinuria, or laboratory evidence of urine protein > 0.15 g/L, or serum creatinine > 110 μmol/L.[13,14] When analyzing medication dosage, the wide age distribution of patients may introduce considerable inter-individual bias. To minimize this bias, glucocorticoids (GCs) doses were calculated using age-adjusted standard body weight.[15–18] All GCs doses were converted to methylprednisolone equivalents. The initial GCs dose was calculated as follows:

$$D_{init} = \frac{D_{first}}{W_{std}} \tag{1}$$

D_{init}: the initial GCs dose (mg/kg), the first administered GCs dose normalized to the age- adjusted standard weight; D_{first} : the first administered GCs dose after admission (mg); W_{std}: the age- adjusted standard weight (kg).

Additionally, to evaluate total therapeutic exposure, the cumulative GCs dose was calculated as follows:

$$D_{cum} = \frac{D_{total}}{W_{std}} \tag{2}$$

D_{cum}: the cumulative GCs dose (mg/kg), the total administered GCs dose normalized to the age- adjusted standard weight; D_{total}: the total GCs dose used for the duration of hospitalization for each patient (mg).

Statistical Analysis

Statistical analyses were performed using R (version 4.4.3). Continuous variables are expressed as mean ± standard deviation (SD) and compared using Student's t-tests or Mann–Whitney *U*-tests; categorical variables are presented as counts (percentages) and analyzed with χ^2-tests. Variables with >30% missing data or containing obvious inexplicable mistakes were excluded. The missing values were imputed using random forest multiple imputation methods. Given the exceptionally low annual incidence of HSP (3–27/100,000) meeting WHO rare disease criteria (<50/100,000), the occurrence of DAPR ≥ 1 week—as a complication—is necessarily even lower. Consequently, multivariate rare-events logistic regression (relogit regression; brglm package) was employed to address bias in rare outcomes.[19,20] Variables with P < 0.2 in univariate analyses were included. Stepwise regression eliminated non-significant variables ($P \geq 0.05$) to derive the final model. Nomograms (rms package), calibration curves, and decision curve analysis (dcurves package) were constructed for risk prediction. $P < 0.05$ defined statistical significance.

Results

Baseline Demographics and Clinical Characteristics

The demographics and clinical characteristics of the 220 patients are shown in Table 1: The age distribution ranges from 2 to 73 years, with a mean age of 8.00 ± 6.00 years. Among the patients, 24 (10.9%) are adults, 133 (60.5%) are male.

Patients were separated into two groups based on DAPR: "abdominal pain < 1 week" and "abdominal pain ≥ 1 week". The differences between the two groups were considered to have potential statistical significance ($P < 0.2$) in the following 11 variables: age ($P = 0.04$), initial onset ($P = 0.03$), cumulative GCs dosage ($P = 0.06$), melena or/and hematochezia ($P = 0.03$), associated symptoms ($P = 0.05$), diarrhea ($P = 0.04$), bowel wall thickening ($P < 0.01$), ascites ($P = 0.16$), abdominal lymphadenopathy ($P = 0.17$), NLR (P < 0.01), and NPAR ($P < 0.01$).

Table 1 Baseline Demographic and Clinical Characteristics Between the Two Groups of Patients

Variables	Total (n=220)	Abdominal Pain ≥1 Week Group (n=28)	Abdominal Pain < 1 Week Group (n=192)	*P*-value
Age(years)	8.00±6.00	10.00±12.25	8.00±5.00	0.04*
Adult(n, %)	24(10.9)	9(4.1)	15(6.8)	<0.01*
Male Gender(n, %)	133(60.5)	18(8.2)	115(52.3)	0.66
Initial Onset(n, %)	166(76.1)	26(11.9)	140(64.2)	0.03*
Initial GCs Dose	3.17±6.32	2.73±5.47	3.17±6.33	0.71
Cumulative GCs Dose	18.87±46.52	34.95±50.50	17.87±44.03	0.06*
Rash Limited to Lower Limbs(n, %)	99(55.6)	12(6.7)	87(48.9)	0.88
Renal Involvement(n, %)	177(80.5)	23(10.5)	154(70.0)	0.81
Melena and / or Hematochezia(n, %)	106(48.1)	19(8.6)	87(39.5)	0.03*
Associated Symptoms(n, %)	126(57.5)	21(9.6)	105(47.9)	0.05*
Vomiting	109(52.2)	16(7.7)	93(44.5)	0.21
Diarrhea	24(11.5)	6(2.9)	18(8.6)	0.04*
Radiological Abnormalities(n, %)	139(70.2)	17(8.6)	122(61.6)	0.94
Bowel Wall Thickening	53(26.1)	13(6.4)	40(19.7)	<0.01*
Ascites	51(25.1)	10(4.9)	41(20.2)	0.16*
Abdominal Lymphadenopathy	27(13.3)	6(3.0)	21(10.3)	0.17*
Abnormal Intestinal Contents	103(52.1)	12(6.1)	91(46.0)	0.83
Hyperactive Bowel Peristalsis	46(23.0)	4(2.0)	42(21.0)	0.43
Imaging Score	1.00±2.00	2.00±1.25	1.00±2.00	0.28
NLR	3.56±5.30	9.67±6.35	3.22±4.90	<0.01*
NPAR	0.02±0.01	0.03±1.26	0.02±0.01	<0.01*

Note: **P*-value < 0.2 indicates potentially statistical significance.
Abbreviations: GCs, glucocorticoids; NLR, Neutrophil-to-Lymphocyte Ratio; NPAR, Neutrophil-to-Albumin Ratio.

Risk Factors Prediction

Afterward, the multivariate relogit regression for rare events enrolls 11 potential predictors above and gender, the results are shown in Table 2. The stepwise regression method was used to progressively exclude non-significant variables, and the final results demonstrated that 4 variables, which included age (OR: 1.09, 95% CI: 0.03–0.15), initial onset (OR:

Table 2 Multivariate Relogit Regression: Risk Factors for Outcome

Variables	OR	95% CI	*P*-value
Age	1.08	0.01–0.18	0.03 *
Gender	1.35	−0.85–1.64	0.60
Initial Onset	11.51	0.71–6.65	0.02 *
Cumulative GCs Dose	1.00	−0.00–0.00	0.27
Melena and / or Hematochezia	1.11	−1.10–1.36	0.86
Associated Symptoms	1.35	−0.99–1.73	0.62
Diarrhea	1.68	−1.02–2.07	0.48
Bowel Wall Thickening	2.12	−0.42–2.16	0.20
Ascites	0.65	−1.94–0.76	0.48
Abdominal Lymphadenopathy	2.40	−0.48–2.31	0.18
NLR	1.14	0.04–0.26	< 0.01 *
NPAR	0.87	−1.01–0.59	0.71

Note: **P*-value < 0.05 indicates statistical significance.
Abbreviations: GCs, glucocorticoids; NLR, Neutrophil-to-Lymphocyte Ratio; NPAR, Neutrophil-to-Albumin Ratio.

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Table 3 Multivariate Relogit Regression: Age, Initial Onset, Bowel Wall Thickening, and NLR

Variables	OR	95% CI	*P*-value
Age	1.09	0.03–0.15	<0.01 *
Initial Onset	8.26	0.63–4.73	0.01 *
Bowel Wall Thickening	3.12	0.15–2.23	0.02*
NLR	1.19	0.09–0.28	<0.01 *

Note: *P-value < 0.05 indicates statistical significance.
Abbreviation: NLR, Neutrophil-to-Lymphocyte Ratio.

8.26, 95% CI: 0.63–4.73), bowel wall thickening (OR: 3.12, 95% CI: 0.15–2.23), and NLR (OR: 1.19, 95% CI: 0.09–0.28), were independent risk factors for the DAPR ≥ 1 week (Table 3).

Construction of a Colored Risk Stratification Bands Predicting Nomogram

The nomogram model (Figure 2) integrates the weight contributions of each factor and calculates a total score to estimate the risk probability. For example, consider a 35-year-old patient with A-HSP who is experiencing his first onset of this disease, has radiologically confirmed bowel wall thickening, and an NLR of 8. According to the colored risk stratification bands nomogram, the patient's age of 35 corresponds to a score of 3.5, initial onset to 2.5, bowel wall thickening to 1, and NLR to 1.5. Summing these scores yields a total score = 3.5 + 2.5 + 1 + 1.5 = 8.5. Referring to the bottom band, a total score of 8.5 corresponds to a risk probability of 0.87, which means that this patient has a relatively high risk of 87% of experiencing DAPR lasting more than one week.

Validation of the Predicting Nomogram

The comparative ROC analyses demonstrated an AUC value of the nomogram was 0.849 (95% CI: 0.769–0.929), with a sensitivity of 73.08% and a specificity of 83.44%. Overall, the nomogram significantly improved the predictive ability, sensitivity, and specificity compared to individual factors (Figure 3). The regression model was internally validated using the bootstrap validation method (B = 1000 repetitions), the calibration curve was close to the ideal diagonal line, suggesting that the model is capable of providing reliable prediction results. Furthermore, the Decision Curve Analysis (DCA) showed a significant net benefit in the prediction model. However, these findings warrant cautious interpretation until external validation is completed.

Subgroup Analysis: The Effect of Glucocorticoids Dose on the Duration of Abdominal Pain Relief

The estimated marginal means plot was utilized to qualitatively assess the impact of different GCs doses on the risk of DAPR ≥ 1 week (Figure 4). The analysis revealed that higher initial GCs doses were negatively associated with DAPR ≥ 1 week, Conversely, higher cumulative GCs doses were associated with a longer duration of pain relief.

Discussion

Abdominal pain is the cardinal symptom of abdominal Henoch–Schönlein purpura (A-HSP), causing significant discomfort, psychological distress, and increased healthcare costs for patients.[1,21] Current evidence indicates that gastrointestinal involvement is a major contributor to morbidity and mortality in adults with A-HSP, with short-term prognosis closely linked to its severity.[22] Studies suggest that persistent abdominal pain correlates with renal involvement, and its duration may aid in early detection of renal complications.[23–25] Consequently, accurately predicting the duration of abdominal pain is critical for guiding clinical decision-making. Our study identified age, initial onset, bowel wall thickening, and NLR as independent risk factors for duration of abdominal pain relief (DAPR) ≥ 1 week. Patients with A-HSP who meet these criteria may be at higher risk of experiencing an abnormally prolonged duration of abdominal pain and may benefit from the early use of adequate doses of glucocorticoids (GCs).

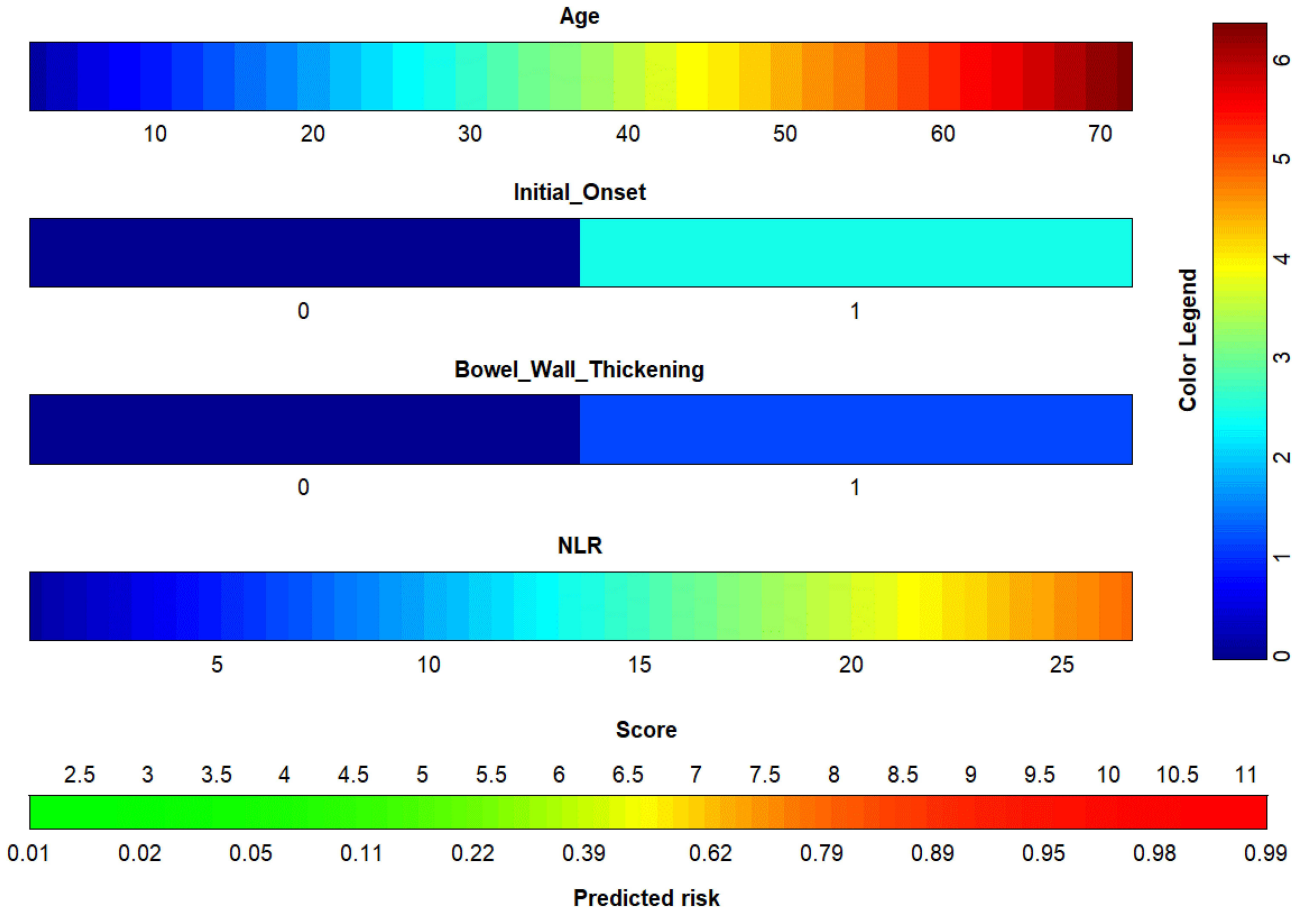

Figure 2 Colored risk stratification bands nomogram for predicting time of abdominal pain relief lasting more than one week.
Notes: Figure 2 shows a colored risk stratification bands nomogram for predicting the duration of abdominal pain relief lasting more than one week. The nomogram integrates the weight contributions of each factor and calculates a total score to estimate the risk probability. The "color legend" on the right indicates the scores assigned to each variable and its respective subgroups. The total score is obtained by summing the individual scores of the four variables and then matched to the corresponding risk probability labeled on the bottom band. Specifically, for every 10-year increase in age, approximately 1 point is assigned; for initial onset, approximately 2.5 points; for bowel wall thickening, approximately 1 point; and for every 5-point increase in NLR, approximately 1 point.
Abbreviation: NLR, Neutrophil-to-Lymphocyte Ratio.

In multivariate analysis, age was identified as an independent risk factor for DAPR ≥ 1 week. This aligns with previous studies indicating that adult A-HSP patients typically experience more severe symptoms and poorer prognoses than pediatric patients.[26,27] The increasing complexity of the immune system coupled with declining repair and regulatory capacity with age likely contributes to prolonged abdominal pain.[28] Symptom profiles also differ: children primarily present with skin purpura and arthralgia, whereas adults more frequently exhibit abdominal pain and renal involvement.[29,30]

In addition, NLR was also found to be an independent risk factor for DAPR ≥ 1 week. This is consistent with prior studies linking elevated NLR to increased disease severity and prolonged duration in A-HSP patients.[31,32] Given that HSP is an immune-mediated vasculitis, its core pathology involves IgA immune complex deposition in small vessel walls, triggering systemic immune activation.[33] The systemic inflammatory response drives significant neutrophil accumulation and activation at inflammatory sites. These neutrophils release a variety of inflammatory mediators and proteases that amplify the inflammatory cascade. Concurrently, lymphocytes remain relatively stable or suppressed, directly elevating the NLR.[34] Furthermore, additional mechanisms—including oxidative stress and cytokine network imbalances—may contribute to disease pathogenesis.[33]

Initial onset was an independent predictor for the prolonged duration of abdominal pain. During the first HSP episode, abdominal pain represents one of the most common symptoms,[35,36] with gastrointestinal manifestations occurring in

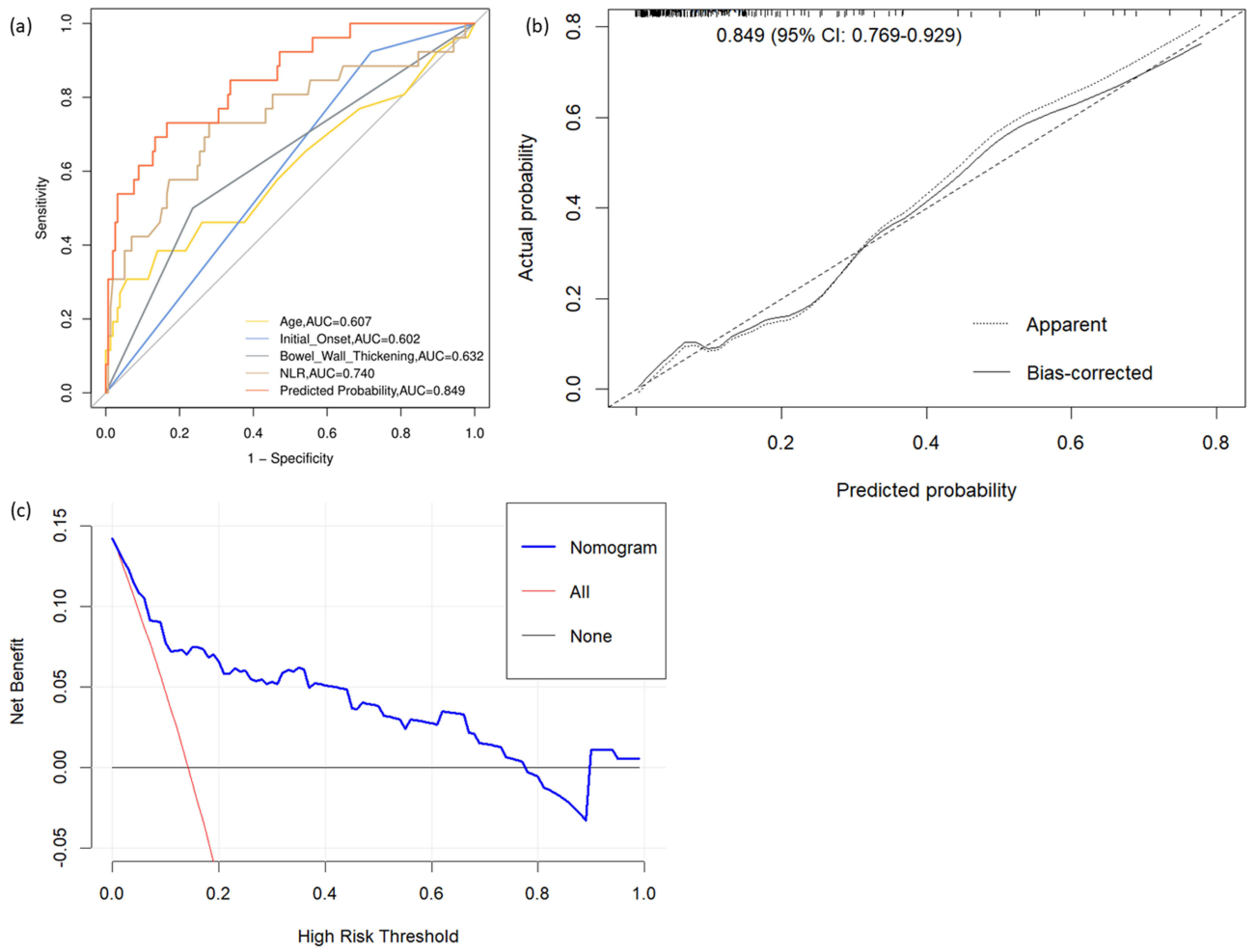

Figure 3 Comparative receiver operating curves, Calibration curves, and Decision curve analysis for predicting the probability of abdominal pain relief lasting more than one week.
Notes: Figure 3 contains three images. Panel (**a**) shows comparative receiver operating characteristic (ROC) curves for the age, initial onset, bowel wall thickening, NLR, and nomogram. The area under the curve (AUC) values are 0.607, 0.602, 0.632, 0.740, and 0.849, respectively. Panel (**b**) displays the calibration curves for predicting the probability of abdominal pain relief lasting more than one week. The calibration curves compare the predicted probabilities from the nomogram with the actual observed outcomes. The x-axis represents the predicted probability of abdominal pain relief, while the y-axis shows the actual observed probability. The calibration curve closely follows the ideal diagonal line (indicating perfect calibration), with a 95% confidence interval (CI) of 0.769–0.929. This suggests that the nomogram provides reliable and accurate prediction results. Panel (**c**) shows the Decision Curve Analysis (DCA) for predicting the probability of abdominal pain relief lasting more than one week. The DCA curve illustrates the net benefit of using the nomogram compared to the "treat all" or "treat none" strategies. The x-axis represents the threshold probability, while the y-axis shows the net benefit. The nomogram demonstrates a higher net benefit across a range of threshold probabilities, indicating its superior clinical utility in predicting abdominal pain relief.
Abbreviation: NLR, Neutrophil-to-Lymphocyte Ratio.

50–75% of patients. Crucially, these symptoms precede cutaneous purpura in 10–40% of cases, complicating diagnosis.[37] This atypical presentation often leads patients to seek care across multiple medical departments, delaying appropriate treatment. Consequently, severe gastrointestinal complications arising during the disease course may extend abdominal pain duration.[38]

The bowel wall thickening was also an independent predictor for the prolonged duration of abdominal pain in this study. This finding is frequently detected in gastrointestinal imaging reports. Its underlying pathogenesis involves the deposition of IgA immune complexes and the accumulation of inflammatory cells, damaging vascular walls and resulting in intestinal wall edema and hyperplasia.[8,39] Additionally, endothelial damage in small vessels increases vascular permeability, causing local ischemia that exacerbates intestinal wall thickening. This study utilized initial admission medical imaging to evaluate the temporal association between bowel wall thickening and abdominal pain duration. It demonstrated that early bowel wall thickening correlates with prolonged abdominal pain, underscoring its diagnostic and

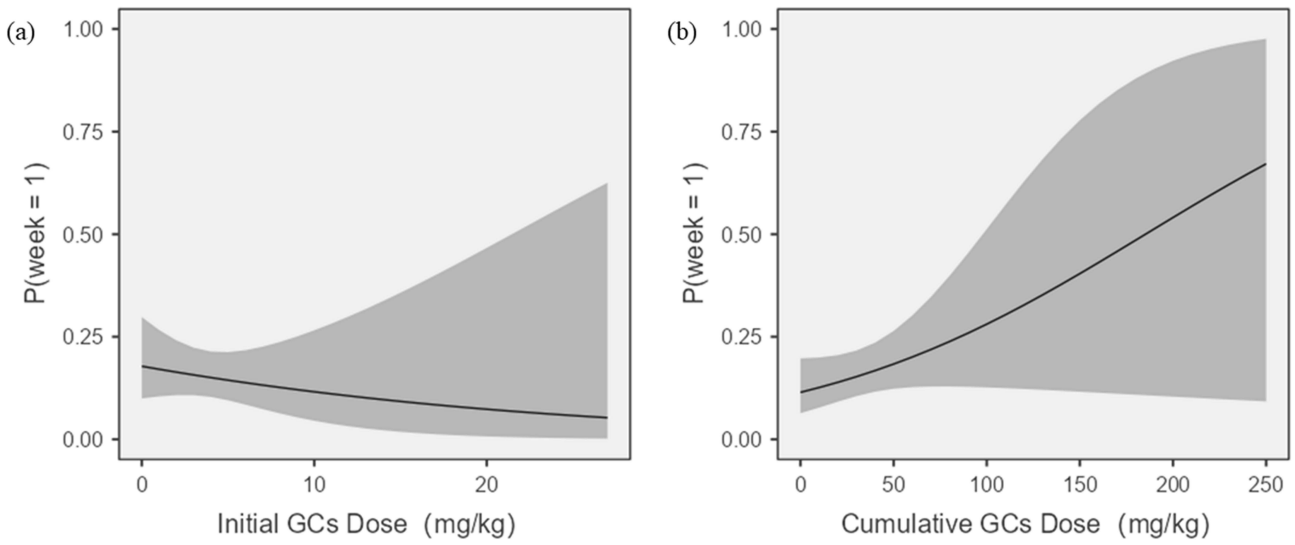

Figure 4 Estimated marginal means plot in assessing the impact of different glucocorticoids (GCs) doses on the risk of abdominal pain relief lasting more than one week.
Notes: Figure 4 shows an estimated marginal means plot assessing the impact of different glucocorticoids (GCs) doses on the risk of abdominal pain relief lasting more than one week. The x-axis represents the dose of glucocorticoids (mg/kg), and the y-axis shows the probability of abdominal pain relief lasting more than one week. Panel (**a**) illustrates that as the initial glucocorticoids dose increases, the probability of abdominal pain relief lasting more than one week gradually decreases. Panel (**b**) shows that as the cumulative glucocorticoids dose increases, the probability of abdominal pain relief lasting more than one week significantly increases.
Abbreviations: GCs, glucocorticoids; NLR, Neutrophil-to-Lymphocyte Ratio.

early-stage disease assessment value. For patients with significant bowel wall thickening, aggressive anti-inflammatory therapy may be required to control inflammation.[40,41] The latest guidelines for HSP state that medical imaging is non-essential for diagnosis but is crucial for differentiating severe gastrointestinal complications.[3] This study emphasizes imaging findings due to their superior specificity and visual clarity in assessing gastrointestinal involvement compared to blood tests. Furthermore, imaging is widely used clinically due to its cost-effectiveness and non-invasive nature. In the prior univariate analysis, ascites and abdominal lymphadenopathy demonstrated potential statistical significance, suggesting they may partially indicate prolonged abdominal pain risk in A-HSP patients. However, limited sample size reduced statistical power for accurately assessing the associations. Future studies with expanded cohorts are warranted to further investigate imaging's value in evaluating gastrointestinal involvement in HSP.

GCs are established as first-line therapy for gastrointestinal involvement in HSP, with efficacy demonstrated across numerous clinical studies.[8,42] For instance, a Finnish multicenter,[43] prospective, randomized, double-blind, placebo-controlled study demonstrated that prednisone (1 mg/kg/day for 2 weeks, followed by tapering) significantly reduced abdominal pain scores (2.5 vs. 4.8 points, P=0.029) and shortened pain duration (1.5 vs. 2.7 days, P=0.028). Early GCs initiation (eg, within 48 hours of symptom onset) significantly reduces symptom duration.[44] Our study demonstrated that higher initial GCs doses shortened the DAPR, whereas increased cumulative GCs doses did not mitigate prolonged abdominal pain risk. This likely reflects early suppression of inflammatory response, thereby minimizing tissue damage and preventing severe complications. While higher cumulative GCs doses may be needed for severe cases, they also increase the risk of side effects like osteoporosis, hypertension, and diabetes, which can further complicate patient health.[45–47] Therefore, it is advisable to use an initial higher GCs dose to quickly control the condition and reduce overall GCs exposure.

The nomogram developed in this study integrates four predictors including age, initial onset, bowel wall thickening, and NLR to quantify the probability of the DAPR ≥1 week in patients with A-HSP. This tool can provide objective and individualized assistance for clinical decision-making: (1) Initial evaluation stage: Aids clinicians to identify high-risk patients who need close monitoring. (2) Treatment decision stage: It provides objective guidance for active treatment decisions. This shifts practice from experience-based to data-driven decisions. For high-risk patients predicted to have prolonged duration of abdominal pain, start intensive interventions early. These include corticosteroid therapy or combination treatments, implement timely NPO (nothing by mouth) status with adequate nutritional support, arrange

targeted examinations like gastrointestinal endoscopy, and extend the hospital observation period. Conversely, low-risk patients can avoid unnecessary overtreatment, reducing healthcare costs and medication-related adverse effects. (3) Doctor-patient communication stage: Visual nomogram results help explain disease progression to families and improve treatment adherence. Clinicians should apply this tool flexibly while recognizing its limitations: it requires external validation before clinical implementation, ongoing validation across diverse populations remains essential, and it cannot replace clinical judgment regarding other complications.

There are still some limitations to our investigation: first, the significance of our findings is limited by the retrospective nature of this study and its sample size. Owing to the rarity of A-HSP, which has constrained our sample size, we prioritized statistical power for predictive model development over external validation to minimize design bias. We included only high-quality cases with relatively complete clinical profiles, excluding those with underlying conditions. The final model incorporated 4 predictors with an events-per-variable (EPV) ratio of 7.0 (28 outcome events/4 variables), which, while below the conservative EPV ≥10 threshold, aligns with the minimum EPV=5 standard for rare outcomes.[48] The model's robustness despite limited EPV is supported by: (1) application of rare-events logistic regression to mitigate overfitting; (2) internal validation via 1000 bootstrap repetitions demonstrating strong discrimination, excellent calibration (curve closely aligned with ideal), and significant net benefit on decision curve analysis. These consistent validation metrics indicate reliable performance, though external validation remains warranted. Second, joint involvement was not included in the statistical analysis of this study due to its high level of missing data. Current research does not clearly establish a direct cause-and-effect relationship between joint involvement and gastrointestinal symptoms. Instead, these manifestations are considered part of the disease's overall presentation. However, since joint involvement reflects systemic inflammation, future studies could further explore interactions between these two aspects. In addition, assessment of bowel wall thickening was limited to qualitative description; quantitative evaluation may enhance prediction accuracy for abdominal pain duration in HSP patients. Finally, a high percentage of children were enrolled in this study, consistent with the epidemiologic observation that the prevalence of HSP is significantly higher in children than in adults. However, the limited ability of children to describe subjective symptoms resulted in the inability to accurately record data on some symptoms about abdominal pain. Meanwhile, other factors that may affect the duration of abdominal pain in A-HSP, such as genetic testing, biomarkers, and immune indicators, should be further explored in conjunction with existing studies to enrich the connotation of the prediction model and improve the accuracy of prediction.

Conclusion

In summary, our study identified that age, initial onset, NLR, and bowel wall thickening were independent risk factors for DAPR lasting more than one week in patients with A-HSP. Based on these findings, we have developed a colored risk stratification bands nomogram that serves as a robust quantitative tool for predicting the likelihood of an abnormally prolonged duration of abdominal pain. The clinical utility of this nomogram is primarily manifested in the early identification of high-risk patients and the implementation of appropriate therapeutic management. However, external validation remains essential before clinical implementation. Future research should focus on expanding the sample size and conducting more external validation to optimize the performance of the model and verify its clinical applicability.

Abbreviations

AUC, Area Under the Curve; A-HSP, Abdominal Henoch-Schönlein purpura; CT, Computed Tomography; DCA, Decision Curve Analysis; DAPR, Duration of abdominal pain relief; EPV, Events-Per-Variable; GCs, Glucocorticoids; HSP, Henoch-Schönlein Purpura; IgAV, Immunoglobulin A vasculitis; NLR, Neutrophil-to-Lymphocyte Ratio; NPAR, Neutrophil-to-Albumin Ratio; NPO, nothing by mouth; ROC, Receiver Operating Characteristic curve; SD, standard deviation; SKD, severe kidney disease.

Data Sharing Statement

The data for this study are available from the corresponding author upon reasonable request and institutional approval. Some data, due to privacy concerns, have been deposited in the restricted-access data platform of Chongqing Medical

University; these files can be obtained only after completion of the university's internal application-and-approval procedure.

Ethics Approval

This study was conducted using anonymized data obtained from the hospital database. In accordance with the ethical principles of the Declaration of Helsinki, the requirement for informed consent was waived by the Institutional Review Board (IRB) of the First Affiliated Hospital of Chongqing Medical University due to the retrospective nature of the study and the use of de-identified data. This retrospective study was approved by the Ethics Committee of the First Affiliated Hospital of Chongqing Medical University (No: K2024-223-01).

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Disclosure

The authors declare that they have no conflicts of interest in this work.

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