ORIGINAL ARTICLE ÖZGÜN ARAŞTIRMA

Factors Affecting Glomerular Filtration Rate and Length of Hospitalization in Pediatric Acute Poststreptococcal Glomerulonephritis: A Decade-Long Observational Study

Pediatrik Akut Poststreptoksik Glomerülonefritte Glomerüler Filtrasyon Hızı ve Hastanede Yatış Süresini Etkileyen Faktörler: On Yıllık Gözlemsel bir Çalışma

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Abstract

Introduction: Acute poststreptococcal glomerulonephritis (APSGN) remains a significant public health concern, especially in pediatric populations. This decade-long observational study aims to provide a comprehensive exploration of pediatric APSGN, emphasizing on factors those influencing glomerular filtration rate (GFR) and also contributing to prolonged hospitalization.

Materials and Methods: The single-center, observational, retrospective study was conducted from January 2010 to December 2020 and included children aged 3-18 years diagnosed with APSGN. Diagnostic criteria included hematuria, decreased serum complement-3 levels, and evidence of recent streptococcal infection. Data extracted from medical records encompassed demographic details, clinical features, and a range of laboratory parameters.

Results: Forty-four patients with APSGN were included (mean age: 8.65±3.31 years), 54.55% of whom were male. Hematuria was present in all cases (macroscopic hematuria in 77.27% of patients), edema in 63.64% of cases, and hypertension in 50.00% of cases. There was a negative correlation between inflammatory markers (C-reactive protein, neutrophil count, and neutrophil-to-lymphocyte ratio) and GFR (r: -0.511, r: -0.302, r: -0.380; p :< 0.05 respectively). Decreased GFR, albumin, and complement-3 levels (r: -0.361, r: -0.442, r: -0.315; p :< 0.05, respectively), and increased urine density and urinary protein excretion, correlated significantly with prolonged hospitalization r: 0.413, r: 0.362; p:< 0.05, respectively).

Conclusion: Despite the generally favorable prognosis of pediatric APSGN, this study highlights the potential for severe complications. Elevated inflammatory markers signal severe renal involvement, while decreased GFR, albumin, and complement-3 levels, as well as increased urine density and protein excretion, lead to extended hospital stays. These findings may be used for anticipating patient outcomes and optimizing resource utilization in pediatric APSGN care.

Keywords
Acute post-streptococcal glomerulonephritis, glomerular filtration rate, hematuria, nephritic syndrome, pediatric nephrology

Anahtar kelimeler
Akut poststreptokoksik glomerülonefrit, glomerüler filtrasyon hızı, hematüri, nefritik sendrom, pediatrik nefroloji

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Öz

Giriş: Akut poststreptoksik glomerülonefrit (APSGN), özellikle pediatrik popülasyonlarda önemli bir halk sağlığı sorunu olmaya devam etmektedir. On yıl süren bu gözlemsel çalışma, glomerüler filtrasyon hızını (GFH) etkileyen ve uzun süreli hastane yatışına neden olan faktörleri vurgulayarak pediatrik APSGN'nin kapsamlı bir incelemesini sunmayı amaçlamaktadır.

Gereç ve Yöntem: Ocak 2010'dan Aralık 2020'ye kadar tek merkezli, gözlemsel ve retrospektif bir çalışma olarak yürütülen araştırmaya APSGN tanısı konan 3-18 yaş arası çocuklar dahil edilmiştir. Tanı kriterleri arasında hematüri, serum kompleman-3 seviyelerinde azalma ve yakın zamanda streptokok enfeksiyonu geçirildiğine dair kanıtlar yer almıştır. Tıbbi kayıtlardan elde edilen veriler demografik ayrıntılar, klinik özellikler ve bir dizi laboratuvar parametresini kapsamaktadır.

Bulgular: Çalışmaya %54.55'i erkek olan 44 APSGN hastası (ortalama yaş: 8.65±3.31 yıl) dahil edildi. Tüm olgularda hematüri (hastaların %77,27'sinde makroskopik hematüri), %63,64'ünde ödem ve %50,00'sinde hipertansiyon mevcuttu. İnflamatuvar belirteçlerin (C-reaktif protein, nötrofil sayısı ve nötrofil/lenfosit oranı) GFH ile negatif korelasyonu vardı (sırasıyla r: -0,511, r: -0,302, r: -0,380; p:<0,05). Azalmış GFH, albümin ve kompleman-3 düzeylerinin (sırasıyla r: -0,361, r: -0,442, r: -0,315; p:<0,05) yanı sıra artmış idrar yoğunluğu ve idrarla protein atılımı, hastanede kalış süresinin uzamasıyla anlamlı şekilde ilişkiliydi (sırasıyla r:0,413, r:0,362; p:<0,05).

Sonuç: Pediatrik APSGN'nin genel olarak olumlu prognozuna rağmen, bu çalışma ciddi komplikasyon potansiyelini vurgulamaktadır. Yüksek inflamatuar belirteçler ciddi böbrek tutulumuna işaret ederken, azalmış GFH, albümin ve kompleman-3 seviyeleri ile birlikte artan idrar yoğunluğu ve protein atılımı hastanede kalış süresinin uzamasına neden olmaktadır. Bu bulgular, hasta sonuçlarının öngörülmesi ve pediatrik APSGN bakımında kaynak kullanımının optimize edilmesi için kullanılabilir.

Introduction

Acute poststreptococcal glomerulonephritis (APSGN) is a common inflammatory disease of the glomeruli that develops through immunological mechanisms following streptococcal infection, making it one of the most common causes of childhood glomerulonephritis (1,2).

The major clinical findings include macroscopic or microscopic hematuria, decreased urine output, hypertension, edema, and renal failure. APSGN usually develops after a beta-hemolytic streptococcal infection of the throat or skin. It usually appears 1-2 weeks after a throat infection and 3-5 weeks after a skin infection. Evidence of a previous beta-hemolytic streptococcal infection supports the diagnosis (1). As with other diseases caused by beta-hemolytic streptococcal infections, it is more common in societies with lower socioeconomic status and remains a serious public health issue in these countries (3).

Investigating the determinants of glomerular filtration rate (GFR) and length of hospitalization in pediatric APSGN cases is crucial for a more nuanced comprehension of the disease's progression. By exploring factors influencing GFR, such as specific patient demographics, clinical characteristics, and treatment modalities, we aim to identify variables that affect renal function in these cases.

Additionally, examining the duration of hospitalization will provide insights into the overall burden of APSGN on healthcare resources and patient well-being. Understanding the factors contributing to prolonged hospital stays can inform targeted interventions, potentially improving patient outcomes and optimizing resource utilization.

Our study seeks to fill gaps at existing knowledge, by leveraging a decade-long data from a tertiary hospital, presenting a comprehensive analysis that goes beyond previous researches. Through this study, we aim to contribute to pediatric APSGN for better management and new tailored care strategies.

Materials and Methods

Study Design and Participants

This single-center, observational, and retrospective study was conducted at the Division of Pediatric Nephrology, Necmettin Erbakan University Meram Faculty of Medicine from January 2010 to December 2020. The study focused on hospitalized children aged 3-18 years diagnosed with APSGN. The diagnostic criteria for enrollment in the study included the presence of either microscopic or macroscopic hematuria, decreased serum complement 3 (C3) levels, and evidence of a recent streptococcal infection (1). Confirmation of a preceding streptococcal infection was established through a positive throat culture or elevated anti-streptolysin O (ASO) titers (>200 IU/ml). Patients meeting these criteria were enrolled in the study.

Data Collection

A thorough retrospective review of patients' medical records was carried out, excluding records with missing data. Demographic information, clinical characteristics, and laboratory results were carefully extracted. The dataset included various medical parameters, including complete blood count, erythrocyte sedimentation rate, C-reactive protein (CRP), neutrophil count, neutrophil-to-lymphocyte ratio (NLR), ASO titer, C3, complement 4 (C4), creatinine, electrolytes, albumin, GFR, urinary protein excretion, urine density, treatments administered, duration of hematuria, and hospitalization. For certain data points where information was not readily available in the medical records, patients' parents were contacted by phone to ensure a comprehensive dataset.

Laboratory Assessments

Various laboratory parameters were measured, and reference values for our laboratory were as follows: C3 (0.9-1.8 g/L), C4 (0.1-0.5 g/L), albumin (3.5-5.4 g/dL), erythrocyte sedimentation rate (0-20 mm/h), and CRP (0-5 mg/dL). The NLR, an index of systemic inflammation, was assessed. Regarding urinary protein excretion, nephritic-level proteinuria was indicated by a spot urine protein-to-creatinine ratio of 0.2-2 and/or a 24-hour urine protein excretion of 4-40 mg/m^2/h. A urine protein-to-creatinine ratio greater than 2 and/or a 24-hour urine protein excretion greater than 40 mg/m^2/h indicated nephrotic-level proteinuria (1). GFR was calculated using the Schwartz formula (4), which incorporates patients' height and serum creatinine levels, with a GFR below 90 ml/min/1.73m^2 considered "decreased."

Renal Biopsy

Renal biopsy was performed on patients who exhibited severe renal impairment necessitating or progressing towards dialysis, those with rapidly progressing clinical manifestations, or delayed recovery of renal function within 2-3 weeks after onset. This was a crucial component of the study to further understand the histopathological aspects of APSGN in the pediatric population.

Blood Pressure Measurement

Blood pressure measurements were obtained following a minimum 10-minute rest, with hypertension defined as blood pressure exceeding the 95th percentile adjusted for age, gender, and height (5).

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) statistics, version 26 (IBM Corp., Armonk, NY, USA). The normality of the data was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Normally distributed data were presented as "mean ± SD (range)," while non-normally distributed data were presented as "median [interquartile range (IQR)]." The student's t-test and the Mann-Whitney U-test were used to compare normally and non-normally distributed continuous variables, respectively. Categorical variables were compared using the Chi-square test. The Pearson correlation coefficient and Spearman correlation coefficient assessed associations between length of hospitalization, GFR value, and other parametrically distributed continuous variables. When both variables are normally distributed use Pearson's correlation coefficient, otherwise use Spearman's correlation coefficient. During correlation examinations, the r-value was rated as: negligible between 0.00-0.29; weak between 0.30-0.49; moderate between 0.50-0.69; strong between 0.70-0.89; and very strong between 0.90-1.0 (6). A significance level of $P<0.05$ was applied.

Ethics Approval

All procedures performed in the current study were in accordance with the 1964 Helsinki Declaration and approved by our local ethical committee with a decision no. 2021/3146 dated 05.03.2021.

Results

Forty-four pediatric patients diagnosed with APSGN were included in our decade-long observational study, with a mean age of 8.65±3.31 years, and a gender distribution of 54.55% male (male/female ratio: 1.2). 15 cases were excluded due to insufficient data. Clinical manifestations were variable as hematuria was observed in all cases, macroscopic hematuria in 77.27%, edema in 63.64%, hypertension in 50.00%, fever in 36.36%, abdominal pain in 25.00%, oliguria in 18.18%, and anuria in 2.23% (Table 1). Clinical manifestations were variable as hematuria was observed in all cases, macroscopic hematuria in

Table 1. Clinical and laboratory characteristics		
Parameters	**Patients (n=44)**	**Normal Range**
Gender, n (%)		
Male	24 (54.55)	
Female	20 (45.45)	
Age, (years), mean ± SD (range)	8.65±3.31 (3.10-17.72)	
Prior antibiotic use, n (%)	14 (31.82)	
Hematuria, n (%)	44 (100.00)	
Macroscopic	34 (77.27)	
Proteinuria, n (%)	43 (97.73)	
Nephrotic-level proteinuria	22 (50.00)	
Urine PCR, (mg/mg), median (IQR)	1.7 (0.8-5.5)	<0.2 mg/mg
Edema, n (%)	28 (63.64)	
Hypertension, n (%)	22 (50.00)	
Fever, n (%)	16 (36.36)	
Abdominal pain, n (%)	11 (25.00)	
Decreased GFR, n (%)	17 (38.64)	
GFR, (mL/min/1.73 m^2) mean ± SD (range)	93.31±35.27 (10.60-152.90)	≥ 90 mL/min/1.73 m^2
Increased ASO, n (%)	42 (95.45)	
ASO (IU/mL), median (IQR)	655 (462-805)	< 200 IU/mL
Decreased C3, n (%)	44 (100.00)	
C3 (g/L), median (IQR)	0.19 (0.18-0.47)	0.9-1.8 g/L
Decreased C4, n (%)	15 (34.09)	
C4 (g/L), median (IQR	0.20±0.10 (0.04-0.44)	0.1-0.5 g/L
Increased CRP, n (%)	30 (68.18)	
CRP (mg/dL), median (IQR)	8.9 (3.1-307.5)	0-5 mg/dL
Increased ESR, n (%)	26 (59.09)	
ESR (mm/h), median (IQR)	22.50 (14.30-50.30)	0-20 mm/h
Hyperkalemia, n (%)	30 (68.18)	
Potassium (mmol/L), median (IQR)	4.7 (4.5-5)	3.5-5.1 mmol/L
Hypoalbuminemia, n (%)	19 (43.18)	
Albumin (g/dL), mean ± SD (range)	3.55±0.52 (2.50-4.66)	3.5-5.4 g/dL
WBC count (×10^3/µL), median (IQR)	11.31 (8.49-14.08)	4-10 x 10^3/µL
Neutrophil count (×10^3/µL), median (IQR)	7.51 (4.66-9.24)	1.5-7.3 x 10^3/µL
Lymphocyte count (×10^3/µL), mean±SD (range)	2.71±13.64 (0.90-6.90)	0.8-5.5 x 10^3/µL
NLR, median (IQR)	2.6 (1.6-3.8)	
Hemoglobin (g/dL), mean ± SD (range)	11.5±1.3 (8.9-15.1)	12.1-17.2 g/dL
Platelet count (×10^3/µL), median (IQR)	281.5 (237-360.75)	150-400 x 10^3/µL

ASO: Anti-streptolysin O, C: Complement, CRP: C-reactive protein, ESR: Erythrocyte sedimentation rate, GFR: Glomerular filtration rate, IQR: Inter quartile range, SD: Standard deviation, PRC: Protein-to-creatinine ratio, WBC: White blood cell

77.27%, edema in 63.64%, hypertension in 50.00%, fever in 36.36%, abdominal pain in 25.00%, oliguria in 18.18%, and anuria in 2.23%

Inflammatory markers exhibited significant correlations with GFR. The results indicated that CRP levels had a moderate negative correlation (r: -0.511, p: 0.001), and neutrophil count, and NLR had a weak negative correlation (r: -0.302, p: 0.046; r: -0.380, p: 0.011, respectively) with severe renal involvement in pediatric APSGN. The GFR showed a positive correlation with hemoglobin (r:0.306, p:0.043) and sodium levels (r:0.402, p:0.007) (Table 2).

Forty-two of our cases (95.45%) of our patients required hospitalization. The median duration of hospitalization was 7 days (IQR, 4.34-13.88). Prolonged hospitalization had statistically significant weak correlation with decreased GFR, albumin, and C3 levels (r: -0.361; p:0.016, r: -0.442; p:0.003, r: -0.315; p:0.037, respectively), as well as increased urine density and urinary protein excretion (r:0.413; p:0.005; r:0.362; p:0.016, respectively) (Table 2).

Subgroup analyses showed that 90.91% of the patients who had a preceding upper respiratory tract infection developed APSGN symptoms on average 10.15±4.71 days after the infection. None of the patients had a prior history of skin infection. In addition, 14 patients (31.82%) had a history of antibiotic treatment within one month before presentation (Table 1). However, antibiotic treatment did not have a significant effect on the duration of microscopic hematuria, glomerular filtration rate (GFR) upon admission, or length of hospitalization (p: 0.078, p: 0.917, p: 0.212, respectively).

High ASO titer was detected in 95.45% of the study participants. The C3 level was low in all cases, while the C4 level was reduced in 34.09% of patients (Table 1). The mean time of normalization of C3 and C4 levels were 40.07±20.11 and 17.13±12.21 days, respectively.

Table 2. Correlation analysis of clinical and laboratory findings with duration of hospitalization and glomerular filtration rate

Parameters	Duration of hospitalization		Glomerular filtration rate	
	r	p-value	r	p-value
Age	-0.078	0.613	0.035	0.822
Duration of hospitalization	1.000	.	-0.361	**0.016***
WBC count	0.260	0.088	-0.291	0.055
Neutrophil count	0.166	0.282	-0.302	**0.046***
Lymphocyte count	0.038	0.808	0.230	0.133
NLR	0.087	0.574	-0.380	**0.011***
Platelet count	-0.036	0.818	0.057	0.712
Hemoglobin	-0.135	0.382	0.306	**0.043***
Glomerular filtration rate	-0.361	**0.016***	1.000	.
Erythrocyte sedimentation rate	0.004	0.981	-0.164	0.288
C-reactive protein	0.150	0.330	-0.511	**0.001***
Sodium	-0.256	0094	0.402	**0.007***
Potassium	0.069	0.657	0.083	0.593
Albumin	-0.442	**0.003***	0.199	0.195
Anti-streptolysin O	-0.177	0.249	-0.173	0.261
Complement 3	-0.315	**0.037***	-0.079	0.612
Complement 4	-0.277	0.072	-0.070	0.657
Microscopic hematuria recovery time	0.259	0.090	-0.185	0.230
Urine PCR	0.413	**0.005***	-0.250	0.101
Urine density	0.362	**0.016***	-0.288	0.058

*Correlation analysis of variables; level of significance p<0.05
NLR: Neutrophil-to-Lymphocyte ratio, PCR: Protein-to-creatinine ratio, r: correlation coefficient, WBC: White blood cell

Proteinuria was present in 97.73% of patients. The median duration of recovery from proteinuria was 39.52 days (IQR, 16.53-89.57). Nephrotic-level proteinuria was present in 50.00% of cases, and there was no significant difference between at admission GFR and presence of nephrotic-level proteinuria (p:0.752) (Table 1). The median recovery time for microscopic hematuria was 83 days (IQR, 40-129.8), with only 6.83% of patients experiencing recovery after one year.

Renal biopsy was performed on 12 patients, revealing crescent formation in 16.67% of cases, C3 deposition in 75.00%, and IgG deposition in 50.00%. Hypercellular glomeruli were observed in all biopsies of patients.

Treatment strategies included fluid restriction in 86.64% of cases, with 72.73% of cases requiring antihypertensive therapies such as furosemide and enalapril. Methylprednisolone, azathioprine, or cyclophosphamide were administered in cases of crescentic glomerulonephritis or refractory nephrotic proteinuria. Hemodialysis was necessary in 6.82% of patients.

The patients were followed up for a median period of 6 months. Although recurrence was rare (2.27%), the study identified one case of recurrence, occurring 18 months after the initial attack. This highlights the importance of long-term follow-up in APSGN cases.

Discussion

The clinical manifestations observed in pediatric APSGN align with the typical characteristics reported in the literature. The prevalence of macroscopic hematuria, proteinuria, edema, and hypertension in our cohort mirrors previous findings, emphasizing the reliability of clinical presentation for diagnosing APSGN in children (7,8). The age distribution and gender predominance in our study align with the established epidemiological patterns (1).

APSGN is an inflammatory disease in which immune complex deposition, complement activation, and cellular mechanisms play important roles. Due to inflammatory pathogenesis, markers indicating an inflammatory process, including white blood cell count, neutrophil count, NLR, erythrocyte sedimentation rate, and CRP level, may predict the severity of the disease (1). In the study of Demircioglu et al. (8) elevated white blood cell count, neutrophil count, NLR, and CRP levels were found to be associated with lower GFR. On the other hand, Becquet et al. (9) found no correlation between CRP levels and disease severity or renal failure. In our study, there were statistically significant negative correlations of neutrophil counts, NLR, and CRP levels with GFR. Our results demonstrate a significant negative correlation between inflammatory markers (CRP, neutrophil count, and NLR) and GFR. This study suggests that increased systemic inflammation, as indicated by these markers, is associated with more severe renal involvement in pediatric APSGN. Monitoring these inflammatory indicators may provide clinicians with a useful tool for early identification of patients at risk of renal impairment.

Reducing the length of hospitalization due to APSGN is crucial for healthcare professionals and patients due to the economic burden. Therefore, it is important to determine certain factors affecting the length of hospitalization. To the best of our knowledge, few studies have investigated the factors affecting the length of hospitalization in pediatric patients with APSGN. Limm-Chan et al. (10) found that longer hospitalization was associated with increased serum creatinine and decreased admission bicarbonate levels. However, they did not find any significant correlation between the length of hospitalization and the level of ASO titer, severity of hypertension, or fluid overload. Our findings also indicate that antibiotic use prior to APSGN, serum potassium, ASO, and C4 levels were not correlated with the length of hospitalization. Notably, diminished GFR, albumin, and C3 levels, along with increased urine density and protein excretion, significantly correlated with extended hospital stays. These findings highlight the complexity of the disease and the interplay between renal function and duration of hospitalization. Patients presenting with these risk factors may require closer monitoring and more intensive management to optimize outcomes and reduce hospitalization duration.

Nephrotic-range proteinuria is observed in 10.0% of cases in APSGN, whereas the manifestation of nephrotic syndrome is considered rare (1). Previous research suggests that nephrotic-range proteinuria does not have a direct correlation with the severity of the disease (8,9,11). In consonance with prior research, our present investigation found no significant association between nephrotic-range proteinuria and the disease's

severity, despite a prevalence higher than reported in extant literature. Elevated titers of antibodies targeting streptococcal products serve as indicative evidence of recent group A beta-hemolytic streptococcus infections (GABHS). The ASO titer is one of the most commonly employed tests for APSGN due to the inaccessibility of primary serological markers such as Nephritis-associated Plasmin Receptor (NAPlr) or serum antibody levels to Streptococcal Pyrogenic Exotoxin B (SPEB) in many clinical settings (12,13). Notably, the ASO titer in the current study exceeded values reported in previous studies (10,14,15). This disparity is likely due to the fact that 90.91% of our cohort had recently experienced upper respiratory tract infections, with none reporting recent skin infections. Similar to former studies, we could not identify any significant association between ASO titers, GFR, and length of hospitalization (8,10).

Activation of the complement system is a characteristic feature in APSGN, leading to decreased levels of C3 and, occasionally, C4. Demircioglu et al. (8) found that 98.7% of patients had low C3 levels and 16% had low C4 levels, which were associated with decreased GFR (8). In contrast, a study in New Zealand examining 27 APSGN patients with severe renal involvement found no instances of low C4 levels, unlike our results (11). Becquet et al. (9) observed in their study that C3 levels were not significantly diminished in patients experiencing renal failure at the disease's onset, although C4 levels were not evaluated. Additionally, their research indicated that CRP levels, proteinuria, and macroscopic hematuria did not correlate with a severe clinical course (congestive heart failure, severe hypertension, and encephalopathy) or renal failure in APSGN. In the current study, all patients exhibited low C3 levels, and 34.09% manifested low C4 levels, indicating a higher prevalence of reduced C3 and C4 levels than expected in APSGN. Importantly, no significant correlation was identified between C3 and C4 levels, and GFR.

APSGN is a well-known kidney disease kidney disease that typically resolves without complications (7). Treatment is often supportive (1). The treatment of APSGN patients with poor prognostic factors is controversial and randomized controlled trials are needed (16). Antibiotic therapy during the initial GABHS infection, may help preventing the spread of the infection and, therefore, the development of APSGN (17). However, antibiotic prophylaxis is generally not necessary in APSGN, as it may occur even after the eradication of GABHS (18). The role of antibiotics in preventing APSGN is insignificant in most studies (19-21).

In our study, in consistence with the literature, no significant difference was found in terms of duration of hematuria, GFR on admission and length of hospitalization between cases with and without antibiotic use within 1 month before APSGN. The treatments administered for APSGN, including fluid restriction, antihypertensive therapies, and immunosuppressive agents in selected cases, align with the current management strategies (1). Hemodialysis, required in a small percentage of patients, highlights the potential severity and variability in clinical courses.

Recurrence is rare in APSGN (18). It is believed that the antigenic properties of nephritogenic streptococci are similar, and the antibodies formed, provide long-term immunity (17). The low recurrence rate observed in our study supports existing literature but emphasizes the importance of vigilant long-term follow-up to detect any potential relapses.

Study Limitations

It is essential to acknowledge the limitations of our study, including its retrospective nature and the relatively small sample size. Additionally, the absence of SPEB and NAPlr due to technical constraints may limit the comprehensiveness of our analysis. Despite these limitations, the study provides valuable insights into the multifaceted nature of pediatric APSGN.

Conclusion

In conclusion, our retrospective analysis elucidates key determinants influencing GFR and length of hospitalization in pediatric APSGN. Elevated inflammatory markers indicate severe renal involvement, while reduced GFR, albumin, and C3 levels, along with increased urine density and protein excretion, cause prolonged hospitalization duration. Elevated levels of these inflammatory markers may serve as early indicators of severe renal involvement, allowing for prompt intervention and potentially improved outcomes. Factors affecting length of hospitalization can assist in optimizing resource allocation, including personnel and facilities, to efficiently manage pediatric APSGN cases. This can

potentially reduce the economic burden associated with prolonged hospitalizations. Prospective, multi-center studies with larger numbers are necessary to confirm and expand upon these findings.

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Ethics

Ethics Committee Approval: All procedures performed in the current study were in accordance with the 1964 Helsinki Declaration and approved by our local ethical committee with a decision no. 2021/3146 dated 05.03.2021.

Conflict of Interest: No conflict of interest was declared by the authors.

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