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Evaluation of Rotavirus and Adenovirus Prevalence in Children Diagnosed with Acute Gastroenteritis in Baku Using Laboratory Parameters

Bakü'de Akut Gastroenterit Tanılı Çocuklarda Rotavirüs ve Adenovirüs Sıklığının Laboratuvar Parametreleri ile Değerlendirilmesi

Sema Nasibli[1] (İD), Rugiyya Samadzade[2] (İD), Ramin Bayramlı[3] (İD)

[1] *Azerbaijan Medical University Faculty of Medicine, Baku, Azerbaijan*
[2] *İnci Laboratories, Medical Microbiology, Baku, Azerbaijan*
[3] *Department of Medical Microbiology and İmmunology, Azerbaijan Medical University Faculty of Medicine, Baku, Azerbaijan*

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Abstract

Objective: Rotavirus and adenovirus are among the primary causative agents of acute gastroenteritis in children. As in other developing countries, these viral pathogens contribute significantly to morbidity and mortality in pediatric populations in Azerbaijan. This study aimed to investigate the prevalence of rotavirus and adenovirus and their association with laboratory parameters in children diagnosed with acute gastroenteritis in Baku.

Material and Methods: This retrospective study reviewed the medical records of pediatric patients who presented with gastroenteritis at a private hospital in Baku between January 2018 and January 2024. Immunochromatographic tests were used to detect rotavirus and adenovirus antigens in stool samples. Biochemical parameters of patients with viral antigen positivity were evaluated using the hospital automation system.

Results: Viral antigen positivity was detected in 170 of 789 (21.5%) patients. Rotavirus antigen was identified in 131 (77.1%) patients, adenovirus antigen in 26 (15.3%) patients, and co-infection with both viruses in 13 (7.6%) patients. The majority of patients (59.4%) were in the 0-4 years age group. Among co-infected patients, erythrocytes were observed in stool microscopy in 33.3%, and elevated leukocyte counts were observed in 55.6%. In rotavirus-positive patients, neutrophilia was

Öz

Giriş: Rotavirüs ve adenovirüs, çocuklarda akut gastroenteritin başlıca etkenleri arasında yer almaktadır. Diğer gelişmekte olan ülkelerde olduğu gibi Azerbaycan'da da bu viral etkenler, çocuklarda önemli morbidite ve mortaliteye neden olmaktadır. Bu çalışmanın amacı, Bakü'de akut gastroenterit tanısı alan çocuklarda rotavirüs ve adenovirüs prevalansını ve bu enfeksiyonların laboratuvar parametreleri ile ilişkisini araştırmaktır.

Gereç ve Yöntemler: Çalışmada, Ocak 2018-Ocak 2024 tarihleri arasında Bakü'de özel bir hastaneye gastroenterit şikayetiyle başvuran pediyatrik hastaların tıbbi kayıtları retrospektif olarak incelenmiştir. Dışkı örneklerinde rotavirüs ve adenovirüs antijenlerinin saptanmasında immünokromatografik testler kullanılmıştır. Viral antijen pozitifliği saptanan hastaların biyokimyasal parametreleri hastane otomasyon sistemi üzerinden değerlendirilmiştir.

Bulgular: Toplam 789 hastanın 170 (%21.5)'inde viral antijen pozitifliği saptanmıştır. Rotavirüs antijeni 131 (%77.1) hastada, adenovirüs antijeni 26 (%15.3) hastada ve her iki virüsle birlikte koenfeksiyon 13 (%7.6) hastada tespit edilmiştir. Hastaların çoğunluğunu (%59.4) 0-4 yaş grubundaki çocuklar oluşturmaktadır. Koenfekte olan hastaların %33.3'ünde dışkı mikroskobisinde eritrosit, %55.6'sında ise yüksek sayıda lökosit gözlenmiştir. Rotavirüs pozitif hastalarda nötrofil yüksekliği %35.5,

Correspondence Address/Yazışma Adresi

Rugiyya Samadzade

İnci Laboratories,
Medical Microbiology
Baku, Azerbaijan

E-mail: rukiyesamadzade@gmail.com

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observed in 35.5%, leukocytosis in 16.1%, lymphocytosis in 25.8%, and monocytosis in 16.1%. C-reactive protein levels were elevated in 51.6% of rotavirus-positive patients and 25% of adenovirus-positive patients.

Conclusion: This study provides the first pediatric data on rotavirus and adenovirus infections among children with acute gastroenteritis in Baku, Azerbaijan, addressing a significant gap in national epidemiological information. The findings highlight the importance of rapid diagnostic tests and the potential diagnostic value of commonly used laboratory parameters. In conclusion, the findings indicate that promoting hygiene practices in children and including the rotavirus vaccine in the national immunization program could reduce the burden of viral gastroenteritis and improve child health outcomes across the region.

Keywords: Adenovirus, acute gastroenteritis, Baku, C-reactive protein, rotavirus

lökosit yüksekliği %16.1, lenfosit yüksekliği %25.8 ve monosit yüksekliği %16.1 olarak belirlenmiştir. C-reaktif protein düzeyi, rotavirüs hastalarının %51.6'sında, adenovirüs hastalarının ise %25'inde yüksek bulunmuştur.

Sonuç: Bu çalışma, Azerbaycan'ın Bakü şehrinde akut gastroenterit tanısı alan çocuklarda rotavirüs ve adenovirüs enfeksiyonlarına ilişkin ilk pediyatrik verileri sunmakta ve ulusal epidemiyolojik bilgi eksikliğini gidermektedir. Bulgular, hızlı tanı testlerinin önemini ve yaygın laboratuvar parametrelerinin potansiyel tanısal değerini ortaya koymaktadır. Sonuç olarak, çocuklarda hijyen uygulamalarının teşvik edilmesi ve rotavirüs aşısının ulusal bağışıklama programına dahil edilmesinin, viral gastroenterit yükünü azaltarak bölge genelinde çocuk sağlığı sonuçlarını iyileştirebileceğini göstermektedir.

Anahtar Kelimeler: Adenovirüs, akut gastroenterit, Bakü, C-reaktif protein, rotavirüs

Introduction

Acute gastroenteritis (AGE) is a major cause of morbidity and mortality worldwide, particularly among children under five years of age. It is characterized by sudden-onset watery diarrhea, abdominal pain, nausea, and vomiting, which may lead to dehydration, malnutrition, impaired growth, and, in severe cases, death (1,2). According to the World Health Organization (WHO), rotavirus is a leading cause of severe diarrhea in young children, and vaccination has been shown to substantially reduce hospitalizations and mortality worldwide.

AGE can be caused by viruses, bacteria, or parasites, with viral agents accounting for approximately 70-80% of cases. Among these, rotavirus is the most frequently detected pathogen, responsible for the majority of diarrheal cases in children. Rotaviruses are endemic worldwide and occur more commonly during the winter months in temperate regions. Most children experience at least one rotavirus infection by the age of five, resulting in significant morbidity and, particularly in developing countries, high mortality rates (3-5).

Enteric adenoviruses, particularly serotypes 40 and 41, are the second most common viral agents causing AGE in children. Adenovirus infections are more prevalent in children under three years of age and can lead to dehydration, metabolic disturbances, and prolonged illness. The prevalence of adenovirus-related gastroenteritis varies geographically and seasonally, with higher rates reported in warm climates and during summer months (6,7).

Although antibiotics are frequently prescribed for AGE, most cases are viral or self-limiting, and unnecessary antibiotic use contributes to antimicrobial resistance, adverse effects, and increased healthcare costs. Accurate diagnosis based on patient history, physical examination, and laboratory testing is therefore essential for effective management (8,9).

This study addresses this critical gap by providing the first epidemiological analysis of rotavirus and adenovirus prevalence in pediatric gastroenteritis cases in Baku, Azerbaijan, over a five-year period. By evaluating associations between viral infection status and key laboratory markers such as C-reactive protein (CRP), leukocyte counts, and stool microscopy findings, this research not only enhances the understanding of the clinical profile of viral gastroenteritis in the region but also provides valuable insights for early diagnosis and management. The findings support the need for expanded public health initiatives, including the introduction of routine rotavirus vaccination and improved hygiene practices, which could significantly reduce the disease burden and healthcare costs associated with viral gastroenteritis in Azerbaijani children.

Materials and Methods

Study design and sample

All data used in this study have been anonymized and personal identifiers have been completely removed. An official petition regarding the nature of the data was submitted to the hospital chief physician in the private hospital where the study was conducted and institutional approval was obtained (date: 15.01.2025, number: 2025/10). This study included pediatric patients diagnosed with gastroenteritis who were admitted to a tertiary care hospital located in Baku, Azerbaijan, between January 1, 2018, and January 1, 2024. Children aged one month to 18 years who presented with AGE were included in the study. Only children without chronic medical conditions were included to avoid potential effects on laboratory parameters. Stool samples collected from these children were sent to the hospital's Medical Microbiology Laboratory for the investigation of rotavirus and adenovirus antigens. The presence of rotavirus and adenovirus antigens was determined using a qualitative immunochromatographic combo test [Adenovirus and rotavirus (AV-RV) combo test, Boson Biotech, China].

Procedure

According to the manufacturer's instructions, stool samples were collected using an applicator stick to obtain approximately 50-100 mg of sample (4-6 mm in diameter), which was then placed into the provided buffer and vortexed. From the homogenized mixture, five drops (80-100 µl) were added into

the sample well of the test card. The results were read after waiting for 10-15 minutes. The test card contains two sections: the A section's test line is coated with monoclonal antibodies specific to rotavirus, and the B section's test line is coated with monoclonal antibodies specific to adenovirus. If the patient's stool contains either rotavirus or adenovirus antigens, a pink-colored line appears due to the reaction with the conjugate complex.

To detect secondary changes caused by gastroenteritis, blood samples from the pediatric patients were analyzed for hemogram, CRP, serum electrolytes, and biochemical markers. The hemogram test was conducted using the Sysmex XN-550 (Copyright© Sysmex EuropeSE, Germany), a compact 5-part differential analyzer employing fluorescent flow cytometry. Biochemical markers were analyzed using the Roche cobas® c311 analyzer (Roche, Switzerland). CRP levels in patient serum were measured quantitatively with the CS-480 Auto-Chemistry Analyzer (Dirui, China), and values above 5 mg/dL were considered positive. Serum electrolytes (sodium, potassium, calcium) were also analyzed using the CS-480 Auto-Chemistry Analyzer. The reference ranges of the biochemical parameters evaluated in this study were as follows: leukocytes (WBC: 4.86-13.18 $\times 10^3$/μL), erythrocytes (3.84-4.92 $\times 10^6$/μL), neutrophils (1.60-8.29 $\times 10^3$/μL), monocytes (0.24-0.92 $\times 10^3$/μL), lymphocytes (1.25-5.77 $\times 10^3$/μL), CRP (0-5 mg/dL), erythrocyte sedimentation rate (ESR) (0-20 mm/h), calcium (8.8-10.8 mg/dL), potassium (3.4-4.7 mmol/L), and sodium (132-141 mmol/L). Measurements exceeding these reference values were considered elevated. While exact mean and median values were not recorded, the proportion of patients exceeding these reference ranges was reported for neutrophils, lymphocytes, CRP, and ESR, providing an overview of inflammatory and hematological responses in the study population.Additionally, direct microscopic examination of stool samples was performed to identify etiologic agents. The results were obtained retrospectively from the Hospital's automation system.

Results

A total of 789 pediatric patients were included in the study. Viral antigen positivity was detected in 170 patients (21.5%), with rotavirus identified in 131 (16.5%), adenovirus in 26 (3.3%), and co-infection in 13 (1.6%) cases. Among positive cases, 62.4% were male and 37.6% were female (Table 1).

Rotavirus positivity was most common in children aged 0-4 years (59.4%) and predominantly detected during winter, whereas adenovirus was more frequent in autumn. Co-infections were also observed mainly in winter months (Figure 1,2).

Table 1. Distribution of viral antigen positivity according to age groups

Antigen Type	0-4 Years of Age	5-9 Years of Age	>10 Years
Rotavirus infection	72 (71.3%)	52 (85.2%)	7 (87.5%)
Adenovirus infection	18 (17.8%)	7 (11.5%)	1 (12.5%)
Co-infection	11 (10.9%)	2 (3.3%)	0

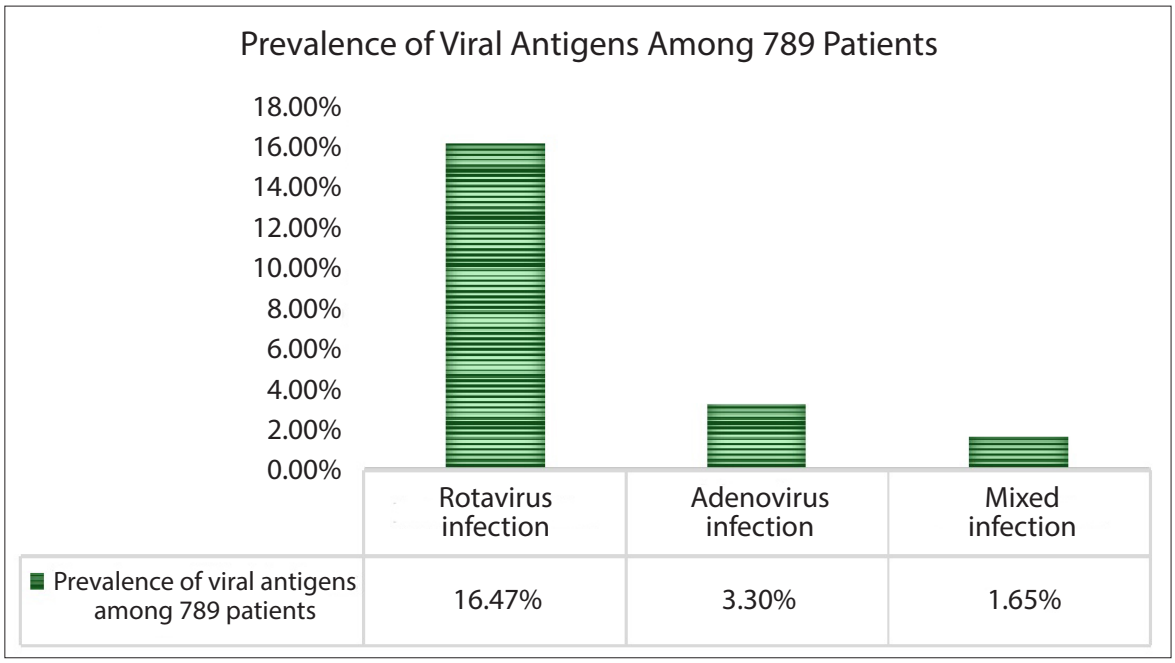

Figure 1. Distribution of viral antigens.

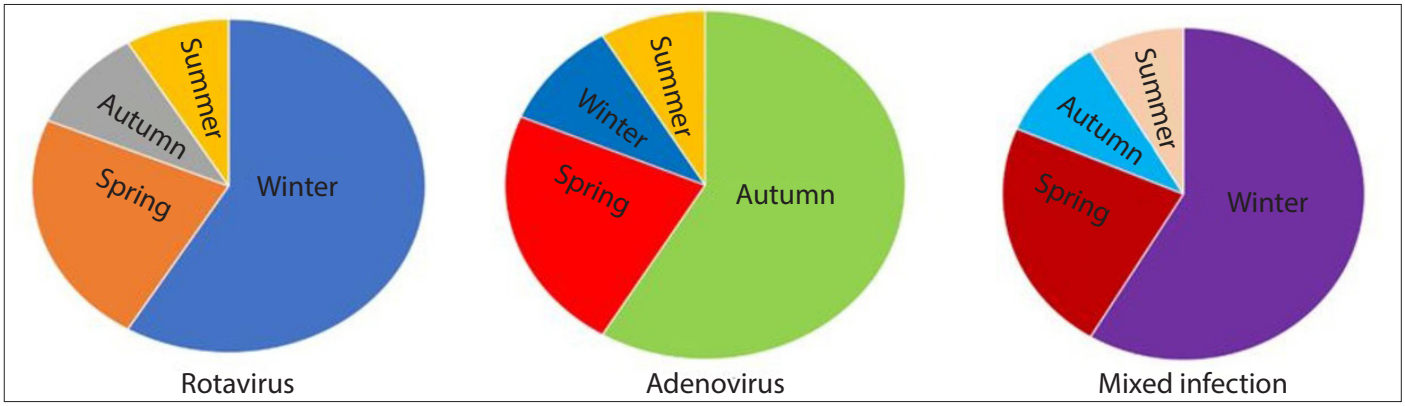

Figure 2. Seasonal distribution of viral antigen positivity.

Hematological analysis revealed that in rotavirus-positive patients, neutrophilia occurred in 35.5%, lymphocytosis in 25.8%, leukocytosis in 16.1%, and monocytosis in 16.1%. Among adenovirus-positive patients, only neutrophil and leukocyte counts were elevated (25% each), while co-infected patients primarily showed elevated monocyte levels (50%). Increased ESR was observed in 19.4% of rotavirus-positive patients (Table 2).

Gender-specific analysis demonstrated higher neutrophil elevations in females (58.3%) compared to males (20%), while lymphocyte counts were increased in 33.3% of females and 16% of males. Age-specific trends showed increased WBC and monocyte counts in 22.7% of patients aged 0-4 years, neutrophil increase in 57.1% of children aged 5-9 years, and lymphocytosis in 35.7% of the same age group. ESR elevations were similar in both age groups (13.6% and 14.3%, respectively) (Table 2).

CRP levels were elevated in 51.6% of rotavirus-positive and 25% of adenovirus-positive patients, with no significant changes in co-infected patients. Sodium levels were decreased in 6.5% of rotavirus-positive patients, while potassium and calcium levels remained within normal ranges across groups (Table 3). CRP elevations were higher in males (56%) than females (25%), and age-specific analysis showed comparable CRP levels in children aged 0-4 and 5-9 years (45.5% and 42.9%, respectively).

Microscopic stool analysis indicated that leukocytes were elevated in 41.7% of children aged 0-4 years, 40% aged 5-9 years, and 50% over 10 years. Erythrocytes were detected in 13.5%, 9.1%, and 25% of these age groups, respectively (Table 4). Among co-infected patients, leukocytes and erythrocytes were elevated in 55.6% and 33.3%, respectively. Gender-specific stool findings showed higher leukocyte counts in males (45%) compared to females (35.6%), with erythrocytes observed in 14% of male and 10.2% of female patients.

Table 2. Hemogram and sedimentation results of patients with detected viral antigen positivity

Antigen Type	WBC	Lymphocyte	Monocyte	Neutrophil	ESR
Rotavirus infection	16.1%↑	25.8% ↑	16.1% ↑	35.5% ↑	19.4% ↑
Adenovirus infection	25% ↑	Normal	Normal	25% ↑	Normal
Co-infection	Normal	Normal	50% ↑	Normal	Normal

WBC: White blood cell, ESR: Erythrocyte sedimentation rate.

Table 3. Laboratory parameter results of patients with detected viral antigen positivity

Antigen Type	CRP	Sodium	Potassium	Calcium
Rotavirus infection	51.6%↑	6.5% ↑	Normal	Normal
Adenovirus infection	25% ↑	Normal	Normal	Normal
Co-infection	Normal	Normal	Normal	Normal

CRP: C-reactive protein.

Table 4. Distribution of stool microscopy results by age groups in patients with detected viral antigen positivity

Age Groups	Fecal Leukocytes	Fecal Erythrocyte
0-4 years	41.7%↑	13.5%↑
5-9 years	40%↑	9.1%↑
>10 years	50%↑	25%↑

Discussion

AGE is one of the most common causes of hospital admissions in childhood and leads to the death of millions of children each year. Accurate identification of the causative pathogen is crucial for selecting appropriate treatment in AGE infections. Since the majority of AGE cases are of viral origin, determining the specific agent is essential to prevent unnecessary use of antibiotics. In addition to developing and underdeveloped countries, rotaviruses and adenoviruses are also the leading viral agents of AGE in children under five years of age in developed countries, causing annual epidemics and contributing to the deaths of millions of children worldwide (10).

In previous studies comparing the gender distribution of children with AGE, Asena et al. reported that 57.2% of the patients were male and 42.8% were female; Çelik et al. found 53.7% male and 46.3% female; Turna et al. reported 50.65% male and 49.35% female; Cankurt et al. found 61% male and 39% female; Aydın et al. reported 53.8% male and 46.2% female; and Mercan et al. reported 55.9% male and 44.1% female (11-16). In our study, consistent with the literature, viral antigen positivity was found to be higher in male patients (62.4%).

Rotavirus is the most common cause of viral gastroenteritis in children. According to the latest report published by the WHO in 2024, rotaviruses cause approximately 140 million cases of diarrhea annually, resulting in more than 600.000 deaths (2). In a multicenter study conducted by Malek et al. in the Eastern Mediterranean Region, the prevalence of rotavirus in children was reported to range between 16% and 61% (17). Recent studies in European countries have shown that rotavirus positivity in children varies between 27% and 52% (18).

In Türkiye, studies among children have reported rotavirus positivity rates ranging from 10.7% to 24%, with a meta-analysis of 99 studies, including 117.741 children and 26.566 cases of rotavirus gastroenteritis, reporting a median positivity of 31.8% (16,19). Various diagnostic methods were used, including immunochromatographic tests (64.5%), ELISA (16.7%), and latex agglutination (13.3%). In our study, the rotavirus positivity rate was 16.6%, comparable to prevalence values in neighboring countries and Europe. Before the introduction of rotavirus vaccination, nearly all children worldwide experienced at least one infection by the age of five. Following vaccine implementation, epidemiological studies have shown a significant decline in disease prevalence, with research in Brazil and Mexico indicating prevention of approximately 80.000 hospitalizations and 1.300 diarrhea-related deaths annually (20). Accordingly, the WHO recommends including rotavirus vaccination in national immunization programs, particularly in countries with high rotavirus-related mortality (21).

Enteric adenovirus is the second most common cause of acute viral gastroenteritis in children after rotavirus. Studies conducted in Türkiye have reported adenovirus prevalence rates ranging from 1.4% to 16.2%, while international studies have shown a broader range from 2.4% to 22.2% (22). In this study, conducted among children living in Baku, the adenovirus positivity rate was found to be 3.3%. Similar to global findings, the low rate of isolated adenovirus positivity in our study may be due to cross-reactivity in patients who tested positive for both viruses, where adenovirus infection might have triggered a false-positive result for rotavirus.

Rotavirus and adenovirus are major causes of gastroenteritis in children under the age of five, with a higher prevalence in those under two years old. The frequency of these viral agents tends to decline with increasing age. Diarrhea caused by rotavirus is more common and presents with a more severe clinical course in children under two years of age (23). In the study by Mercan et al., the rotavirus positivity rate was 21%, with the highest prevalence observed in children aged 0-5 years (16). Tokak et al. noted that 67.7% of rotavirus-positive and 66.4% of adenovirus-positive cases were in children under two years of age (24). In our study, consistent with the literature, the majority of cases (59.4%) were children aged 0-4 years.

In temperate regions, rotavirus gastroenteritis is most frequently observed during the winter months, whereas in tropical climates it can occur throughout the year. Rotavirus infections in children are typically seen during the winter season, particularly between December and February in countries such as Saudi Arabia and India, and between March and December in European and American countries (25). In studies conducted in Türkiye, rotavirus positivity has also been reported to be more common in the winter months (26). In our study, rotavirus positivity was detected predominantly in the winter season (90.5%), which aligns with findings from other studies conducted in Azerbaijan's geographic region.

Unlike rotaviruses, adenoviruses cause AGE throughout the year without significant seasonal variation across different geographic regions of the world. A study conducted in Australia reported adenovirus positivity predominantly during the winter and spring months, whereas in Brazil, the highest rates were observed in the summer and autumn seasons (27). In various cities across Türkiye, studies have shown that adenovirus antigen is most commonly detected in winter, followed by spring and autumn (19). In our study, adenovirus positivity was most frequently observed during the autumn months, which is consistent with findings from studies conducted in neighboring countries.

Research has shown that leukocytosis is more common than leukopenia in children with viral AGE. In a study by Aydın et al., leukocytosis was detected in 57.4% of rotavirus cases and 32.4% of adenovirus cases (15). In our study, among rotavirus-positive patients, increased levels of neutrophils (35.5%), leukocytes (16.1%), lymphocytes (25.8%), and monocytes

(16.1%) were observed. In adenovirus-positive patients, only neutrophil (25%) and leukocyte (25%) levels were found to be elevated. Additionally, ESR was assessed, and elevated ESR was observed in 19.4% of rotavirus-positive patients.

CRP is generally a marker that is significantly elevated in acute bacterial infections (28). It is usually lower in viral infections, although elevated CRP levels have been reported in certain viral infections. In a study conducted by Cankurt et al., CRP positivity was found to be significantly higher in children with rotavirus, adenovirus, and mixed infections (p= 0.02, p= 0.003, p= 0.0001) (14). Aydın et al. also reported that while no significant increase in CRP was observed in patients with parasitic infections, CRP levels were significantly elevated in those with rotavirus and/or adenovirus infections (15). In our study, CRP levels were significantly elevated in 51.6% of rotavirus cases and 25% of adenovirus cases. These findings suggest that CRP elevation should be considered not only in bacterial but also in viral AGE cases.

When evaluating electrolyte levels among viral agents, the literature indicates that hyperchloremia may accompany hypernatremia in cases of dehydration due to fluid loss. In a study conducted by Yorulmaz et al., hypernatremia (sodium >145 mEq/L) was detected in 4 (0.97%) patients and hyponatremia (sodium <132 mmol/L) in 47 (11.40%) patients with AGE (29). Özmen et al. reported that sodium and chloride levels were significantly higher in the viral AGE group (30). In a study by Aydın et al. involving children with AGE, it was reported that rotavirus was the causative agent in the majority (82%) of hyponatremia cases. Furthermore, among children with adenovirus infection, 3.63% had hypokalemia, while 1.81% had hyperkalemia. The study also found that rotavirus was the causative agent in 86.6% of AGE cases presenting with hypokalemia (15). In our study, no significant differences were observed in potassium and calcium levels among patients with viral antigen positivity. However, sodium levels were found to be decreased in 6.5% of rotavirus-positive patients. In addition, subgroup analyses in our study revealed that elevated CRP and stool leukocyte levels were more frequently observed in male patients, whereas lymphocytosis was more common in females. The presence of erythrocytes in stool samples was also more frequently detected in older children. Although these findings may suggest age- and sex-related differences in immune and inflammatory responses, the limited sample size requires cautious interpretation.

This study represents one of the first original investigations into the prevalence and epidemiological characteristics of rotavirus and adenovirus infections among children with AGE in Baku, Azerbaijan. Given the geographic proximity and similar sociodemographic features shared by Azerbaijan and neighboring countries such as Türkiye, our findings provide a valuable point of comparison for understanding regional patterns of viral gastroenteritis. The data confirm that rotavirus and adenovirus are significant etiological agents in pediatric gastroenteritis cases in Baku, underscoring their public health relevance.

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The widespread implementation of rapid immunochromatographic testing in clinical practice can facilitate timely diagnosis, reduce unnecessary antibiotic prescriptions, and support effective case management. Importantly, the inclusion of rotavirus vaccines in Azerbaijan's national immunization schedule could significantly reduce disease burden, prevent avoidable hospitalizations, and lower both mortality and morbidity rates among young children.

Moreover, the study highlights that routinely measured laboratory parameters such as CRP, leukocyte differentials, and electrolyte levels can also provide supportive diagnostic value in viral infections. Recognizing the patterns associated with viral gastroenteritis may contribute to more rational antibiotic prescribing practices, which is critical in the ongoing effort to combat antimicrobial resistance. These findings have direct implications for shaping national child health strategies, optimizing diagnostic protocols, and informing future epidemiological surveillance efforts across the region.

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Ethics Committe Approval: This study has been approved by İnci Laboratories (Decision no: 2025/10, date: 15.01.2025).

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