



Frequency and Seasonal Distribution of Adenovirus and Rotavirus in Children Diagnosed with Acute Gastroenteritis: A Single Centre Experience

Akut Gastroenterit Tanısı Konulan Çocuklarda Adenovirüs Ve Rota Virüs Sıklığı Ve Mevsimsel Dağılımı: Tek Merkez Deneyimi

Sadiye Sert¹, Berna Erayman²

¹Department of Pediatrics, Konya Beyhekim Training and Research Hospital, Konya, Turkey
²Department of Microbiology, Konya Beyhekim Training and Research Hospital, Konya, Turkey

Abstract

Aim: We aimed to investigate the relationship between age, gender, and season with respect to the frequency of rotavirus and adenovirus antigens in stool specimens obtained from children one month to 18 years of age who were diagnosed with acute gastroenteritis.

Material and Method: The records of stool specimen analyses for 1960 patients with diagnosis of acute gastroenteritis at our hospital from January 2017 to August 2022 were retrospectively examined. The patient's admission year, season, gender, age, and stool viral antigen test results were retrospectively analysed from the file records.

Results: Viral antigen was detected in stool specimen in 272 (13.8%) of the patients included in the study, while 92 (4.7%) of them were rotavirus and 180 (9.1%) were adenoviruses. In our study, it was determined that both rotavirus and adenovirus were most common in the one month-2 years of age group. Rotavirus was detected most frequently in the winter months and adenovirus in the spring months. Twenty-six (28.2%) patients with rotavirus gastroenteritis and 68 (37.7%) patients with adenovirus gastroenteritis were hospitalized and treated.

Conclusion: In our study, rotavirus and adenovirus, which are viral gastroenteritis agents, were detected at high rates in acute gastroenteritis in children. Enteric adenovirus and rotavirus were detected more frequently in winter and spring. The frequency of viral agents should be considered in the clinical evaluation and treatment planning of children with acute gastroenteritis. Demonstrating viral antigens in stool will prevent unnecessary antibiotic use.

Keywords: Adenovirus, children, gastroenteritis, prevalence, rotavirus

Öz

Amaç: Akut gastroenterit tanısı konulan 1 aylık-18 yaş arası çocuklardan alınan dışkı örneklerinde rota virüs ve adeno virüs antijenlerinin yaş, cinsiyet ve mevsim ile ilişkisini araştırmayı amaçladık.

Gereç ve Yöntem: Hastanemize Ocak 2017-Ağustos 2022 tarihleri arasında akut gastroenterit tanısı konulan 1960 hastanın dışkı örneği analiz kayıtları retrospektif olarak incelendi. Hastanın başvuru yılı, mevsimi, cinsiyeti, yaşı ve gaitada viral antijen testi sonuçları dosya kayıtlarından retrospektif olarak incelendi.

Bulgular: Çalışmaya alınan hastaların 272'sinde (%13.8) dışkı örneğinde viral antijen saptanırken, bunların 92'sinde (%4.7) rotavirüs ve 180'ninde (%9.1) adenovirüs saptandı. Çalışmamızda hem rota virüs hem de adenovirüsün bir ay-2 yaş grubunda en yaygın olduğu saptandı. Rota virüs en sık kış aylarında, adenovirüs ise ilkbahar aylarında tespit edilmiştir. Yirmi altı (%28.2) hasta rota virüs gastroenteritiyle ve 68 (%37.7) hasta adenovirüs gastroenteritiyle hastaneye yatırılarak tedavi edildi.

Sonuç: Çalışmamızda viral gastroenterit etkenleri olan rota virüs ve adeno virüs çocuklarda, özellikle iki yaşın altındaki çocuklarda akut gastroenteritlerde yüksek oranda saptanmıştır. Enterik adeno virüsler ilkbaharda rota virüsler kış ayında daha sık saptanmıştır. Akut gastroenteritli çocukların klinik değerlendirme ve tedavi planlamasında viral etkenlerin sıklığı göz önünde bulundurulmalıdır. Gaitada viral antijenlerin gösterilmesi gereksiz antibiyotik kullanımını önleyecektir.

Anahtar Kelimeler: Adeno virüs, çocuklar, gastroenterit, prevalans, rota virüs

Corresponding (İletişim): Sadiye Sert, Beyhekim, Devlethane Sokak No:2/C, 42060, Konya, Turkey.

E-mail (E-posta): sadiyesert@yahoo.com.tr

Received (Geliş Tarihi): 02.03.2023 **Accepted (Kabul Tarihi):** 12.03.2023



INTRODUCTION

The American Academy of Pediatrics (AAP) defines acute gastroenteritis as a diarrheal disease of rapid onset, with or without additional symptoms and signs, such as nausea, vomiting, fever, or abdominal pain.^[1] Viruses are the most important etiology and are responsible for approximately 70% of the episodes of acute gastroenteritis in children. There are over 20 different types of viruses that have been identified as etiological agents. In the United States, rotavirus and noroviruses are the most common viral agent that causes diarrhea, followed by enteric adenoviruses, sapovirus, calicivirus and astroviruses.^[2] Bacterial infection accounts for 10% to 20% of all the acute gastroenteritis. The most common bacterial reasons are, *Salmonella* species, *Campylobacter* species, *Shigella* species and *Yersinia* species. *Giardia lamblia* is the most common protozoal infection that causes gastroenteritis. Other protozoa include *Entamoeba histolytica* and *Cryptosporidium* species.^[3]

Viral gastroenteritis displays abruptly with vomiting and watery diarrhoea, often accompanied by low-grade fever and abdominal cramps. Clinical appearance of viral gastroenteritis ranges from an asymptomatic infection to severe dehydrating diarrhoea. Dehydration is a severe complication that can lead to hypovolaemic shock, coma, and death.^[4] Treatment of viral gastroenteritis is based primarily on replacement of fluid and electrolytes. The AAP, Centers for Disease Control and Prevention, European Society for Pediatric Gastroenterology and Nutrition, and the World Health Organization all strongly support the use of oral rehydration therapy as the first-line therapy for the treatment of acute gastroenteritis, except in cases of severe dehydration.^[3] Abundant vomiting, worsening dehydration with altered consciousness, or severe acidosis, hypovolaemic shock, abdominal distension, and ileus are indications for intravenous rehydration.^[5] Rotaviruses primarily affect young children, are responsible for 200,000 deaths worldwide, with most deaths occurring in developing countries. The proportion of rotavirus infections range from 8–10% of diarrhoea episodes of all severity to almost 35–40% of diarrhoea episodes requiring hospital admission worldwide.^[4] In developing countries, especially in the pediatric age group, acute gastroenteritis morbidity and mortality is quite high.^[6] Rotaviruses worldwide endemic, especially in countries with a temperate climate, mostly in winter and under 2 years old seen in children.^[7] However, highly effective rotavirus vaccine has prevented severe gastroenteritis cases as well as reduced the attributable mortalities.^[8] Acute gastroenteritis due to adenoviruses is most common in countries with a hot climate.^[9] The rate of enteric adenovirus 40 and 41 varies from 1–8% in developed countries to 2–31% in developing countries.^[10] Adenovirus infected patients normally present clinical symptoms such as diarrhea, vomiting and complications of the respiratory system.^[11] Using mathematical modeling, the Global Burden of Diseases study estimated that in 2016, enteric adenovirus infections caused 75 million episodes of diarrhea globally among children <5 years of age, with an associated attributable fraction for mortality of 11.8%.^[12]

In adenovirus and rotavirus gastroenteritis, leucocytosis, neutrophilia, and high C-reactive protein can be detected without secondary bacterial infection.^[13,14] Therefore, detection of viral antigens in stool will prevent unnecessary antibiotic use. The distribution of viral agents may differ according to age and season. Different results have been obtained in previous studies on this subject. In this study, we aimed to investigate the relationship between age, gender, and season with respect to the frequency of rotavirus and adenovirus antigens in stool specimens obtained from children one month to 18 years of age who were diagnosed with acute gastroenteritis.

MATERIAL AND METHOD

Rotavirus and adenovirus antigen results in stool specimen were obtained retrospectively in the hospital automation system, with a diagnosis of gastroenteritis in children one month to 18 years of age who were admitted to our hospital's Pediatrics Clinic between January 2017 and August 2022. The 2026 patients were diagnosed with acute gastroenteritis. In 1960 patients, stool adenovirus and rotavirus were examined. In the absence of the kit, 66 patients whose stool examination could not be performed and whose information could not be reached were excluded from the study. The patient's admission year, season, gender, age, and stool viral antigen test results were retrospectively analysed from the file records. The patients were divided into five age groups: one month to 2, 2-4, 4-6, 6-10 and 10-18 years of age. Application dates of patients were classified according to the seasons.

Detection of the presence of adenovirus and rotavirus antigen in stool samples taken from patients was made using the LJ 2000 Automatic Stool Parasite Analyzer (Jinan Lanjie Biotechnology Co., Ltd, China) with high resolution CCD camera support. Ethics committee approval for our study was obtained from the ethics committee of Karatay University Medical Faculty Hospital (approval number 2023/008).

Statistical analysis

Statistical analyzes in our study were performed using the Statistical Package for Social Sciences (SPSS) version 22 (IBM Corp. Armonk, NY, USA) program. Kolmogorov Smirnov and Shapiro Wilk tests were used to check whether the numerical measurements in the study group provided the assumption of normal distribution. In descriptive statistics, mean±standard deviation was used for parametric data if it fit the normal distribution, or median (minimum-maximum) if it did not fit the normal distribution, and frequency and percentage values were used for categorical data. Pearson chi-square test was used to compare categorical measures between groups. In the comparison of parametric measurements between the groups, the independent groups T test was used for the variables conforming to the normal distribution, and the Mann Whitney U test was used for the variables not conforming to the normal distribution of the groups. Significance level was accepted as $p < 0.05$.

RESULTS

Evaluation of the Demographic Data, Frequency and Seasonal Distribution of Rotavirus Gastroenteritis in Children

The 92 of the 1960 patients (4.7%) who were examined for rotavirus were positive, and 180 (9.1%) of the 1960 patients who were tested for adenovirus were positive. In total, 272 (13.8%) of all patients were positive for rotavirus or adenovirus viral antigen in stool examination. While the mean age of the 272 patients was 3.15 ± 2.94 years (median, 2.1 years, minimum-maximum 0.1-17.9 years).

Of the patients diagnosed with acute gastroenteritis included in the study, 1123 (57.2%) were boy and 837 (42.8%) were girl. While the mean age of the patients was 5.01 ± 4.50 years (median, 3.4 years, minimum-maximum 0.1-17.9 years), the mean age of the boys was 5.01 ± 4.63 years and the mean age of the girls was 5.02 ± 4.32 years. Of the patients who were positive for rotavirus antigen, 66.3% (n=61) were boy. The mean age of the patients with rotavirus was 3.62 ± 3.12 years (median, 2.55 years, minimum-maximum 0.5-17.4 years).

Co-infection of adenovirus with rota virus was not detected in any of our patients. When the mean age of the patients participating in the study was compared in terms of gender, no statistically significant difference was found (p:0.38). The seasonal distribution of rotavirus positive patients was 25 (1.3%) in spring, 8 (0.4%) in summer, 19 (1%) in autumn and 41 (2%) in winter, respectively. When the frequency of rotavirus in the stool specimen of the participants was examined according to months and seasonal distribution, the most common month was December, while the most common season was winter (Table 1, Figure 1,2).

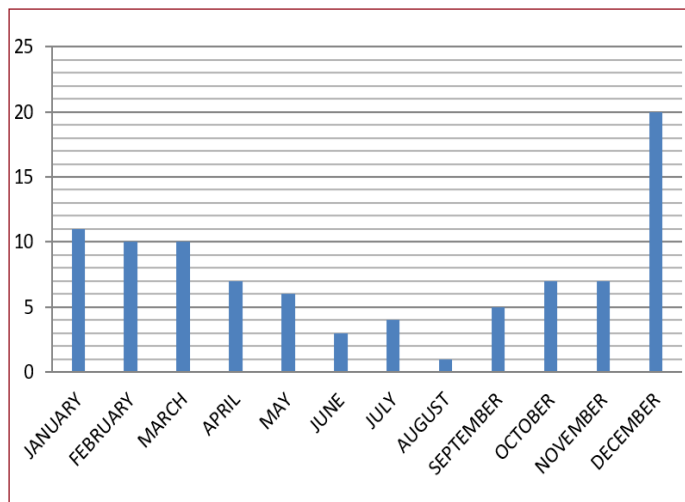


Figure 1. Distribution of patients with positive rotavirus antigen in stool specimen by months

Table 1: Distribution of patients with 92 positive rotavirus antigens in stool specimen by months

Months	n	%
January	11	0,54%
February	10	0,49%
March	10	0,49%
April	7	0,35%
May	6	0,30%
June	3	0,15%
July	4	0,20%
August	1	0,05%
September	5	0,25%
October	7	0,35%
November	7	0,35%
December	20	0,99%

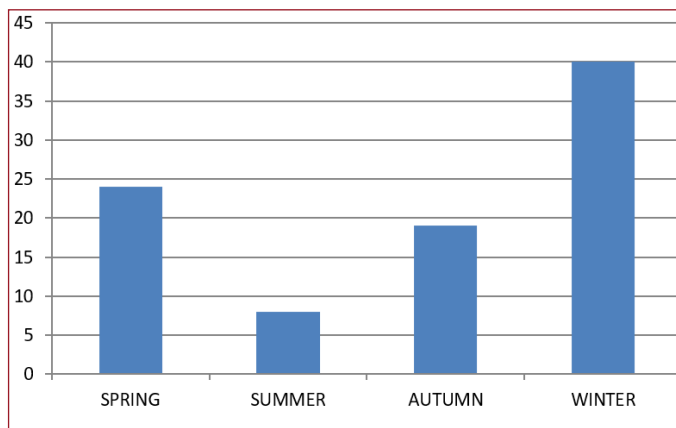


Figure 2. Seasonal distribution of patients with positive rotavirus antigen in stool specimen

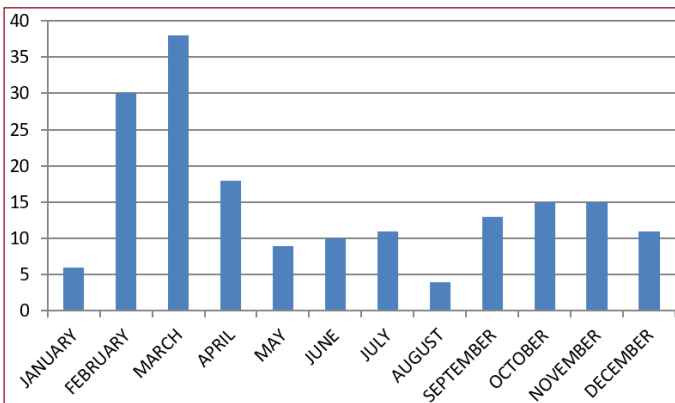
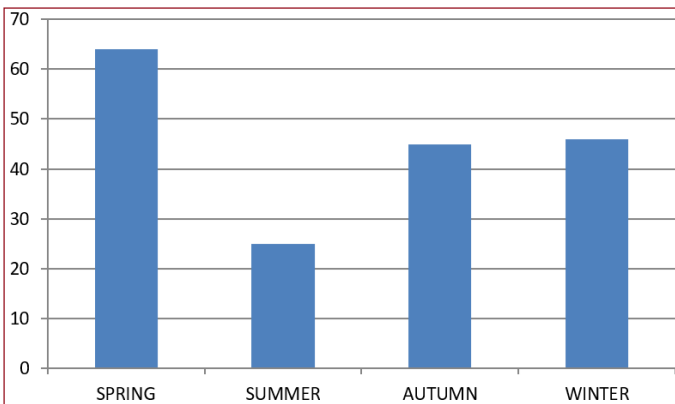
Evaluation of the Demographic Data, Frequency and Seasonal Distribution of Adenovirus Gastroenteritis in Children

The frequency of rotavirus was found to be statistically significantly higher in December and winter season when compared to other months and seasons (p<0.0001). Twenty-six (28.2%) of the patients with rotavirus gastroenteritis were hospitalized and treated.

Enteric adenovirus antigen in stool specimen was positive in 180 (9.1%). Enteric adenovirus antigen in stool specimen was positive in 88 (4.4%) boys and 92 (4.7%) girls. While the mean age of the patients with adenovirus was 2.88 ± 2.77 years (median, 1.9 years, minimum-maximum 0.1-17.9 years). When compared in terms of gender, there was no statistically significant difference in the frequency of detecting enteric adenovirus in stool specimen (p:0.295). When the frequency of adenovirus in the stool specimen of the participants was examined according to months and seasonal distribution, the most common month was March, while the most common season was spring (Table 2, Figure 3,4). The frequency of adenovirus was found to be statistically significantly higher in March and spring season when compared to other months and seasons (p<0.0001 for both). Of the patients with adenovirus gastroenteritis, 68 (37.7%) were hospitalized and treated.

Table 2: Distribution of patients with 180 positive adenovirus antigens in stool specimen by months

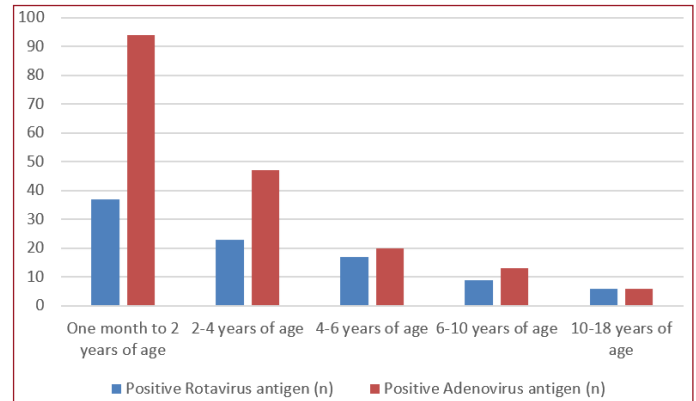
Months	n	%
January	6	0,30%
February	30	1,48%
March	38	1,88%
April	18	0,89%
May	9	0,44%
June	10	0,49%
July	11	0,54%
August	4	0,20%
September	13	0,64%
October	15	0,74%
November	15	0,74%
December	11	0,54%

**Figure 3.** Distribution of patients with positive adenovirus antigen in stool specimen by months**Figure 4.** Seasonal distribution of patients with positive adenovirus antigen in stool specimen

Frequency of Adenovirus And Rotavirus in Children with Acute Gastroenteritis by Age Groups

The patients one month to 2 years of age were the most common age group. A statistically significant difference was found when the patients were compared with age groups in terms of gender ($p:0.024$). The rotavirus positivity rate by age groups was 1.9% in the group one month to 2 years of age, 1.2% in the group 2-4 years of age, 0.9% in the group 4-6 years of age, 0.5% in the group 6-10 years of age, and 0.3% in the group 10-18 years of age, respectively. Rotavirus antigen positivity rates in stool were found to be statistically

significantly higher in the group one month to 2 years of age when compared with other age groups ($p:0.001$). Distribution of patients with positive stool rotavirus and adenovirus antigen was showed in **Figure 5**.

**Figure 5.** Distribution of patients with positive stool rotavirus and adenovirus antigen by age groups

According to age groups, adenovirus positivity rate was 4.8% in the group one month to 2 years of age, 2.4% in the group 2-4 years of age, 1.1% in the group 4-6 years of age, 0.7% in the group 6-10 years of age, and 0.3% in the group 10-18 years of age, respectively. Adenovirus antigen positivity rates in stool were found to be statistically significantly higher in the group one month to 2 years of age when compared with other age groups ($p<0.0001$).

DISCUSSION

Viruses, including rotaviruses, enteric adenovirus, norovirus, astrovirus, and calicivirus, are known to be the most important etiological agents responsible for about 70.0% of cases of gastroenteritis infection in children.^[15] In both developing and developed countries, viral gastroenteritis is the most common cause of hospitalization for infants and older children with severe dehydration resulting from diarrhea; it is also a cause of infant mortality. Rotavirus infections are the most common reasons in these patients.^[16] Nowadays, studies show that the frequency of rotavirus and adenovirus varies between countries, and in different geographic regions of the same country, according to years and age groups. In a study conducted across many countries with different socioeconomic development levels, rotavirus and adenovirus prevalence varied 4.8%-45% and 1.5%-17.6%, respectively.

In developed countries, the prevalence of viruses in patients with enteric infections is reported to be 3.1-5.0%.^[17-19] However, it has been reported that enteric adenovirus is highly variable in developing countries. In a study conducted in Iraq, the prevalence of adenovirus was reported to be approximately 15%.^[20]

In Turkey, the prevalence of rotavirus is reported to vary between 6.7% and 20.2% and the prevalence of adenovirus between 0.96% and 7.6%.^[21] According to studies conducted in Turkey, rotavirus infections constituted 9.8-39.8% of viral

gastroenteritis infections, and adenovirus infections 7.8-10.0%.^[22-25] In the study conducted by Öner et al.^[21], which included a 4-year period published in 2022, on children and adults, rotavirus antigen was found to be 8.2%, adenovirus antigen was 2.2% in stool samples. In a recent study conducted in our country, while rotavirus antigen screening was performed in 1,359 children younger than 5 years, adenovirus antigens was done in 1,270 children younger than 5 years. In this study, rotavirus antigen was detected in 194 (14.3%) of all stool specimen tested, and adenovirus antigen was detected in 39 (3.1%).^[6] Viral antigens were detected in 884 (17.1%) of a total of 5156 stool specimens examined with the diagnosis of acute gastroenteritis in a previous study conducted in children in Konya. Of those who were found positive, 764 (14.8%) were determined as rotavirus and 120 (2.3%) as adenovirus.^[26] In a previous study in children under 5 year of age, viral antigen was detected in 53 of 96 stool specimens. Rotavirus was detected in 39.6%, adenovirus 10.4%, and norovirus 5.2%.^[27] In our study, we detected rotavirus and adenovirus most frequently in children younger than two years old.

In another study, viral antigens were observed in 348 (25%) of 1358 stool specimens in children. Among the positive results, the incidence of rotavirus was 23.7%, adenovirus 1.5%, and the incidence of co-existence of both viruses was found to be 0.4%.^[28] In a study in the South eastern Anatolia region of our country, 597 of 3607 patients diagnosed with acute gastroenteritis were found to be positive for rotavirus antigen.^[29] In another study, rotavirus was detected in 14 (12.5%) children and adenovirus was detected in 5 (4.5%) children in a total of 112 children under 6 years of age with diarrhea, and dual infection was detected in one case (0.9%).^[30] Some studies have reported on co-infection of adenovirus with other viruses, including rotavirus, which can be associated with more severe symptoms.^[31] Rotavirus-adenovirus co-infection was determined in 21.7% of cases in the study by Shams in Iran.^[15] In our study, co-infection of adenovirus with rota virus was not detected.

The records of stool specimens of 772 patients under 4 years of age who were followed up with the diagnosis of acute gastroenteritis in Ankara were reviewed retrospectively, and rotavirus antigen was found positive in 174 (22.5%).^[32] In a study in Istanbul, rotavirus antigen was investigated by immunochromatographic method in 3618 stool specimens taken from children with pre-diagnosis of acute gastroenteritis and sent for rotavirus search, and rotavirus antigen was found in 745 (20.6%) of the samples.^[33] In another study, viral antigen was detected in 988 (14.04%) out of 7037 patients. Rotavirus was detected in 750 (10.7%) patients, and adenovirus in 238 (3.3%) patients.^[9] In our study, we detected viral antigen including rotavirus and adenovirus in the stool specimen of 13.5% of the 1960 children examined. Adenovirus antigen positivity was detected in 9.1% of the patients and rotavirus positivity in 4.7% of the children.

In study by Turkdagi et al. viral antigen was detected in 338 (12.1%) of 2795 patients. Rotavirus was found to be positive in 273 (9.8%) of these samples, adenovirus in 36 (1.3%) and rotavirus and adenovirus in 29 (1.0%) samples. It was determined that 154 (45.6%) of the patients with viral antigen were girl, 184 (54.4%) were boy, and 198 (58.6%) were in the under 2 years of age.^[34] In the study conducted in Çorum, viral antigen was detected in 706 (22.1%) of 3189 children. Rotavirus was detected in 17.5% of stool specimens, adenovirus in 3.3%, and rotavirus and adenovirus in 1.3%. It was observed that there was no statistical difference between the genders in terms of the frequency of detection of rotavirus and adenovirus.^[35] In our study, we also did not find a significant difference when the prevalence of rotavirus and adenovirus was compared in terms of gender.

Rotavirus and adenovirus infections are seen throughout the year. Rotavirus infection is common in many countries in winter and spring. Öner et al. found that the rotavirus infections increased from December to April and then decreased until September. The adenovirus infection was observed in January with the highest positive rate. The seasonal pattern of the rotavirus varies according to the climate zone and is also associated with local weather.^[21] In study in China revealed that adenovirus was detected throughout the year and there was no seasonal pattern or any peak in frequency of adenovirus through the year.^[36] Furthermore, enteric adenoviral gastroenteritis in most parts of the world was documented throughout the entire year and does not display seasonal distribution.^[37] However, another study showed an increase in rotaviruses infections in autumn-winter season.^[38] In the study in Van, viral antigens were determined in 205 (21%) of 955 patients; rotavirus was positive in 124 (13%), adenovirus in 81 (8.5%), and rotavirus and adenovirus together in 43 (4.5%). Viral antigen-positive cases were most frequently seen in autumn and winter months.^[39] In our study, rotavirus was most commonly detected in December and winter, while adenovirus was detected in March and spring.

It is known that rotavirus gastroenteritis has a more severe clinical course and requires more hospitalization and intravenous fluid therapy.^[40] In our study, approximately one third of the children diagnosed with rotavirus gastroenteritis were hospitalized and treated while approximately 38% of the children diagnosed with adenovirus gastroenteritis were hospitalized.

Limitations of the Study

Since it is a retrospective study, detailed data on the clinical signs and symptoms of the patients could not be reached. The reason why the frequency of enteric adenovirus was higher than the frequency of rotavirus in our study may be due to rotavirus vaccination in children. However, as this is a retrospective study, we could not learn about the vaccination status.

CONCLUSION

Our study showed that rotavirus and adenovirus, which are the agents of viral gastroenteritis, are seen at a substantial rate. Especially in children less than the two years of age, viral agents are more likely to be detected. Enteric adenovirus and rotavirus were detected more frequently in winter and spring. We suggest that viral gastroenteritis agents should be considered and examined in children with suspected gastroenteritis. Demonstration of viral antigens in stool samples will prevent unnecessary antibiotic use, as it can mimic bacterial infection clinically and laboratory.

ETHICAL DECLARATIONS

Ethics Committee Approval: Ethics committee approval for our study was obtained from the Ethics Committee of Karatay University Medical Faculty Hospital (approval number 2023/008).

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

REFERENCES

- American Academy of Pediatrics; Subcommittee on Acute Gastroenteritis; Provisional Committee on Quality Improvement. Practice parameter: the management of acute gastroenteritis in young children. *Pediatrics* 1996;97(3):424-35.
- Rivera-Dominguez G, Castano G, Ekanayake LS, Goyal A. "Pediatric gastroenteritis," in *StatPearls*, StatPearls Publishing, 2019.
- Chow CM, Leung AK, Hon KL. Acute gastroenteritis: from guidelines to real life. *Clin Exp Gastroenterol* 2010;3:97-112.
- Bányai K, Estes MK, Martella V, Parashar UD. Viral gastroenteritis. *Lancet* 2018;392(10142):175-86.
- Guarino A, Albano F, Ashkenazi S, et al. European Society for Paediatric Gastroenterology, Hepatology, and Nutrition/European Society for Paediatric Infectious Diseases evidence-based guidelines for the management of acute gastroenteritis in children in Europe. *J Pediatr Gastroenterol Nutr* 2008;46 (suppl 2):S81-122.
- Diñç HÖ, Taner Z, Özbey D, Gareayaghi N, Sirekbasan S, Kocazeybek BS. The Prevalence of Rotavirus and Adenovirus Childhood Gastroenteritis: data of the University Hospital of Cerrah paşa Medical Faculty Between January 2013 and December 2018. *Türk Mikrobiyol Cemiy Derg* 2019;49(4):206-11.
- Bayırlı Turan D, Karaaslan F, Kuruoğlu T, Şerefhanoğlu K. An Evaluation in Terms of Rotavirus and Enteric Adenovirus Infection in Children With Acute Diarrhea Requiring in Patient Treatment. *Turkish J Pediatr Dis* 2020;14(3):220-24.
- de Cal Wilhelm I, del Pozo Mohedano RB, Sánchez-Fauquier A. Rotavirus and other viruses causing acute childhood gastroenteritis. *Enferm Infecc Microbiol Clin* 2008;26:61-5.
- Tokak S, Doğaç U, Güzeş Atılğan E. Investigation of Adenovirus and Rotavirus Frequency and Seasonal Distribution in Children with Acute Gastroenteritis. *KÜ Tıp Fak Derg* 2022;24(1):163-70.
- Sanaei Dashti A, Ghahremani P, Hashempoor T, Karimi A. Molecular Epidemiology of Enteric Adenovirus Gastroenteritis in under-Five-Year-Old Children in Iran. *Gastroenterol Res Pract* 2016;2016:2045697.
- Kumthip K, Khamrin P, Ushijima H, Maneekarn N. Enteric and non-enteric adenoviruses associated with acute gastroenteritis in pediatric patients in Thailand, 2011 to 2017. *PLoS One* 2019;14(8):e0220263.
- Lee B, Damon CF, Platts-Mills JA. Pediatric acute gastroenteritis associated with adenovirus 40/41 in low-income and middle-income countries. *Curr Opin Infect Dis* 2020;33(5):398-403.
- Aydın E, Aydın N, Perçin Renders D. Evaluation of the Effect of Acute Gastroenteritis Factors on Laboratory Parameters in Pediatric Patients. *Flora Infeksiyon Hastalıkları Ve Klinik Mikrobiyoloji Derg* 2022;27(1):125-34.
- Appenzeller C, Ammann RA, Duppenhaler A, Gorgievski-Hrisoho M, Aebi C. Serum C-reactive protein in children with adenovirus infection. *Swiss Med Wkly* 2002;132(25-26):345-50.
- Shams S, Tafaraji J, Aghaali M, et al. Prevalence of enteric adenovirus and co-infection with rotavirus in children under 15 years of age with gastroenteritis in Qom, Iran. *Gastroenterol Hepatol Bed Bench* 2022;15(3):256-62.
- World Health O. Rotavirus vaccines. *Wkly Epidemiol Rec* 2007;82(32):285-95.
- Grimwood K, Carzino R, Barnes GL, Bishop RF. Patients with enteric adenovirus gastroenteritis admitted to an Australian pediatric teaching hospital from 1981 to 1992. *J Clin Microbiol* 1995;33:131-6.
- Bon F, Fascia P, Dauvergne M, Tenenbaum D, Planson H, Petion A, et al. Prevalence of group A rotavirus, human calicivirus, astrovirus, and adenovirus type 40 and 41 infections among children with acute gastroenteritis in Dijon, France. *J Clin Microbiol* 1999;37:3055-8.
- Li L, Phan TG, Nguyen TA, Kim KS, Seo JK, Shimizu H, et al. Molecular epidemiology of adenovirus infection among pediatric population with diarrhea in Asia. *Microbiol Immunol* 2005;49:121-8.
- Yassin BAG, Ali SHM, Abu Al-ess HQM, et al. A trend of seasonality of enteric adenoviral gastroenteritis in pediatric patients less than five years from Baghdad. *J Res Med Dent Sci* 2018;6:18-23.
- Öner SZ, Kaleli İ, Demi R M, Mete E, Çalışkan A. Rotavirus and adenovirus prevalence in patients with acute viral gastroenteritis in Denizli, Turkey, 2017-2021. *J Med Virol* 2022;94(8):3857-62.
- Akinci N, Ercan T E, Yalman N, Eren A, Severge B, Ercan G. The Frequency of Rotavirus in Children with Acute Gastroenteritis. *J Clin Anal Med* 2015;6(4):449-51.
- Bicer S, Sahin GT, Koncay B, et al. Frequency of gastroenteritis in pediatric emergency department. *J Pediatr Inf* 2008;3(2):96-9.
- Palanduz A. Infectious gastroenteritis: etiologic agents and clinical assessment. *J Pediatr Inf* 2009;3(2):116-8.
- Kurugöl Z, Geylani S, Karaca Y, et al. Rotavirus gastroenteritis among children under five years of age in Izmir, Turkey. *Türk J Pediatr* 2003;45(4):290-4.
- Tüzüner U, Gülçen BS, Özdemir M, Feyzioğlu B. Frequency of Adenovirus and Rotavirus and Their Seasonal Distribution in Children With Gastroenteritis. *Klimik Dergisi* 2016;29(3):121-4.
- Çelik AY, Emiroğlu M, Kurtoğlu MG, İnci A, Odabaş D. Investigation of the Frequency of Viral Agents in Children with Acute Gastroenteritis in the 0-5 Years Age Group. *Turkish J Pediatr Dis* 2016;2:101-6.
- Bayraktar B, Toksoy B, Bulut E. Detection of Rotavirus and Adenovirus in Children with Acute Gastroenteritis. *Klimik Dergisi* 2010;23(1):15-7.
- Konca C, Tekin M, Akgun S, et al. Prevalence of rotavirus in children with acute gastroenteritis, seasonal distribution, and laboratory findings in the southeast of Turkey. *J Pediatr Infect* 2014;8(1):7-11.
- Altındış M, Beştepe G, Çeri A, Yavru S, Kalaycı R. Frequency of rotavirus and enteric adenovirus infection in children with acute gastroenteritis. *SDÜ Tıp Fak Derg* 2008;15:17-20.

31. Romo-Saenz CI, Medina-Soltero MR, Delgado-Gardea M, et al. Human enteric circulating viruses and co-infections among hospitalized children with severe acute gastroenteritis in Chihuahua, Mexico, during 2010-2011. *Jundishapur J Microbiol* 2020;13:e95010.
32. Koçak M, Çalışkan E, Köksal AO. Rotavirus Frequency in Children With Acute Gastroenteritis Who Were Hospitalized in Keçiören Education and Research Hospital Pediatric Clinic. *Ankem Derg* 2014;28(4):134-7.
33. Nazik H, İlktaç M, Öngen B. Evaluation of incidence of rotavirus gastroenteritis in pediatric age group. *Ankem Derg* 2006;20(4):233-5.
34. Dağı HT, Findık D. Investigation of rotavirus and adenovirus antigens in patients with acute gastroenteritis. *J Clin Exp Invest* 2014;5:256-60.
35. Güreşer A, Karasartova D, Taşçı L, Boyacıoğlu Z, Taylan ÖH. Rotavirus and Adenovirus Frequency in Children with Acute Gastroenteritis in Corum. *Flora* 2017;22(2):58-66.
36. Qiao H, Nilsson M, Abreu ER, et al. Viral diarrhea in children in Beijing, China. *J Med Virol* 1999;57:390-6.
37. Modarres S, Modarres FJ. Enteric adenovirus infection in infants and young children with acute gastroenteritis in Tehran. *Acta Medica Iranica* 2006;44:349-53.
38. Basu G, Rossouw J, Sebunya TK, et al. Prevalence of rotavirus, adenovirus and astrovirus infection in young children with gastroenteritis in Gaborone, Botswana. *East Afr Med J* 2003;80:652-5.
39. Gültepe B, Gündüçoğlu H, Çıkman A, Parlak M, Berktaş M. Prevalence of rotavirus and adenovirus gastroenteritis observed around the Van. *Sakarya Tıp Derg* 2013;3(3):131-4.
40. Akan H, Izbirak G, Gürol Y, et al. Rotavirus and adenovirus frequency among patients with acute gastroenteritis and their relationship to clinical parameters: A retrospective study in Turkey. *Asia Pac Fam Med* 2009;8:8.