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Changing Trends of Rotavirus and Enteric adenovirus in Children: Before and After the COVID-19 Pandemic

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ABSTRACT

Objectives: This study aimed to investigate changes in the incidence and seasonal distribution pattern of enteric viruses that are common in children during the COVID-19 pandemic.

Methods: The study included patients aged 0–9 years who were diagnosed with acute gastroenteritis (AGE) in the pediatric emergency department between September 2017 and August 2022.

Results: During the study, 4,244 patients who underwent rotavirus (RV)/enteric adenoviruses (eAV) antigen tests with a diagnosis of AGE were included. Compared with the pre-pandemic period, during the COVID-19 pandemic, RV positivity decreased (479 [16.6%] vs. 167 [12.3%], $p < 0.001$), whereas eAV positivity tended to increase (120 [4.1%] vs. 78 [5.8%], $p = 0.020$).

Conclusion: This surveillance study demonstrates the long-term effects of the COVID-19 outbreak on RV and eAV infections in children. In the early phase of the pandemic, both viruses had almost disappeared, but in the late phase, they returned to the pre-pandemic level.

Keywords: COVID-19, human enteric adenovirus, preventive measures, rotavirus



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INTRODUCTION

The COVID-19 virus can be transmitted through droplets and by touching the mouth, nose, and eyes after contact with contaminated surfaces.^[1-4] In the fight against the pandemic, strict non-pharmacological measures (NPIs) implemented in primary care have been effective in slowing down the epidemic.^[5] It has been reported that primary care measures, especially hand hygiene, social distancing, and mask use, reduce both viral respiratory diseases, such as influenza and respiratory syncytial virus, and the incidence of enteroviral infections.^[6-17] Acute gastroenteritis (AGE) is common worldwide, and it is an important cause of death in children <2 years of age, especially in developing countries. Rotavirus (RV) and enteric adenoviruses (eAV) are the most common causes of AGE in children.^[18] The incidence of enteroviral infections transmitted by the fecal-oral route was also reduced with the strict application of NPIs in the early phase of the pandemic, but data are limited in terms of the course of enteroviral infections in the late phase of the pandemic. The aim of this was to determine the seasonal frequency of RV and eAV infections in children in the early and late stages of the pandemic and to compare them with the pre-pandemic period.

METHOD

This study was conducted in the pediatric emergency department of a tertiary university hospital in Istanbul, Turkey, with approximately 130,000 patients admitted per year. Patients aged

between 0 and 9 years who were diagnosed with AGE in the pediatric emergency department and tested for RV and eAV antigen in the stool were analyzed retrospectively. The study period was from September 2017 to August 2022. Based on the start of the pandemic in Turkey, the pre-pandemic period was from September 2017 to February 2020, and the pandemic period from March 2020 to August 2022. The 1st year of the pandemic (from March 2020 to February 2021) was defined as the early pandemic period, and the 2nd year of the pandemic (from March 2021 to February 2022) was defined as the late pandemic period. An AGE diagnosis was made in children who had ≥ 3 watery stools or vomited ≥ 2 times in 24 h, and these symptoms persisted for a maximum of 7 days. Patients aged 5 years and younger were classified as preschool children, and patients aged 6–9 years were classified as school-age children.

A total of 4244 patients who met the inclusion criteria and whose records were fully accessible were included in the study. Scanning of the data was done using the hospital's software system for the following International Classification of Diseases 10th Revision codes: A08, Viral and other specified intestinal infections; A09, Diarrhea and gastroenteritis of presumed infectious origin. The decision to perform a fecal rota-adenovirus test was made by the examining physician. According to usual clinical practice, fresh stool samples are placed in clean, sealed boxes and transported to the laboratory within 30 min. The stool samples were investigated for rota-adenovirus antigen positivity using the Combo Rapid Test (Citest Diagnostics, Vancouver, Canada), applying the lateral immunochromatographic method.

Statistical Package for the Social Sciences (SPSS) software version 20.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical calculations and analyses. Descriptive statistical methods, such as frequencies and percentages, were used to analyze demographic data and diagnosis distributions. The Chi-square test was used to compare differences between groups. A $p < 0.05$ was considered statistically significant.

RESULTS

Of the 4,244 patients included in the study, 2891 (68.1%) were admitted in the pre-pandemic period and 1353 (31.8%) in the pandemic period. Compared with the pre-pandemic period, the number of patients decreased by 1538 (53.0%) during the pandemic. The demographic characteristics and frequency of virus positivity are summarized in Table 1.

The frequency of RV and enteric adenovirus was 24 (5.8%) versus 9 (2.2%) in the early pandemic period, respectively, and 60 (11.3%) versus 34 (6.4%) in the late pandemic period ($p = 0.003$ and $p = 0.002$, respectively).

During the entire study, 638 (75.6%) patients were followed up as outpatients, 110 (13.0%) were followed up in the emergency department, and 96 (11.4%) patients were followed up as hospitalization. Clinical courses of RV and eAV infections before and during the pandemic are summarized in Table 2.

Compared with the pre-pandemic period, it was observed that the typical seasonal distribution of RV infection between November and May in the early phase of the pan-

Table 1. The demographic characteristics and frequency of virus positivity

	Whole study period (n=4244)	Pre-pandemic period (n=2891)	Pandemic period (n=1353)	p
Gender				
Male	2373 (55.9)	1594 (55.1)	779 (57.6)	0.135
Female	1871 (44.1)	1297 (44.9)	574 (42.4)	
Age Groups				
0–5 years	3653 (86.1)	2442 (84.5)	1211 (89.5)	<0.001
6–10 years	591 (13.9)	449 (15.5)	142 (10.5)	
Virus positivity				
RV	646 (15.2)	479 (16.6)	167 (12.3)	<0.001
eAV	198 (4.7)	120 (4.1)	78 (5.8)	0.020
Total	844 (19.9)	599 (20.7)	245 (18.1)	0.019
Co-infection (RV and eAV)	37 (0.9)	20 (0.7)	17 (1.3)	0.065

The total period of the study is 60 months, consisting of 30 months in the pre-pandemic period and 30 months in the post-pandemic period. Data is presented as n (%), Chi-square test. eAV: Enteric adenovirus; RV: Rotavirus.

Table 2. Clinical courses of RV and eAV infections before and during the pandemic

	Pre-pandemic period	Pandemic period	Chi-square	p
Outpatient follow-up	461 (76.3)	177 (73.7)	1.151	0.562
Emergency follow-up	74 (12.2)	36 (15.0)		
Hospitalization	69 (11.4)	27 (11.2)		
Total	604 (100.0)	240 (100.0)		

The total period of the study is 60 months, consisting of 30 months in the pre-pandemic period and 30 months in the post-pandemic period. Data are presented as n (%). Chi-square test. eAV: Enteric adenovirus; RV: Rotavirus.

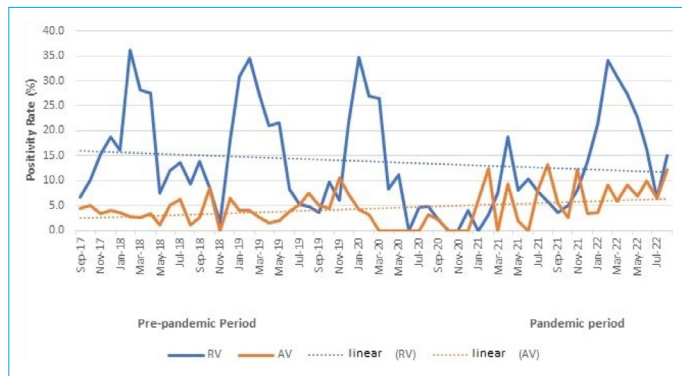


Figure 1. The seasonal distribution of rotavirus and enteric adenoviruses in pre-pandemic and pandemic period.

demic shifted to March–July. The seasonal distribution of RV and eAV in pre-pandemic and pandemic periods is shown in Figure 1.

DISCUSSION

Although COVID-19 spread rapidly, causing a worldwide pandemic, surprisingly, other viral infectious diseases common in children almost disappeared during the pandemic. The enteroviral load was reduced by strict administration of NPIs early in the pandemic. However, data showing the course of enteric viruses in the late phase of the pandemic, when NPIs were relaxed, are limited. In this study, it was found that the seasonality and the frequency of positivity of these viruses changed during the early and late stages of the pandemic.

RV or eAV-positive AGE cases admitted to the pediatric emergency department during the COVID-19 pandemic decreased by approximately 50% compared with the pre-pandemic period. Many studies conducted in different geographic regions of the world have shown that enteroviral infections decreased during the pandemic, similar to this study.^[10-17,19] There may be several explanations for this situation. The most valid explanation is that NPIs, which were strictly applied in the early phase to slow the COVID-19 pandemic, also prevented the transmission of enteric viruses.

[6,18,20] NPIs, which were strictly implemented, included no face-to-face education in schools, use of masks, compliance with hand hygiene, lockdown, and home-office working. In addition, the attention of health personnel in the pandemic was focused on the dominant virus, severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). Therefore, enteroviral infections, which usually follow a mild course, may have been underdiagnosed. In addition, the concern of parents that SARS-CoV-2 could be transmitted from health institutions played a role in the decrease in hospital admissions of children with AGE. Worried parents may have only brought children with severe AGE to the emergency room.^[15,21-23] However, in this study, the need for the frequencies intravenous fluids and hospitalization of patients who attended the pediatric emergency service were similar in pre-pandemic and pandemic. This may be related to the mostly mild-to-moderate clinical course of enterovirus infections.^[18]

In this study, the frequency of RV positivity decreased significantly throughout the pandemic compared to the pre-pandemic period. When evaluated according to age groups, RV positivity decreased more significantly in pre-school children during the pandemic period. This finding is due to the fact that RV infection is more common in children aged 0–5 years. It was surprising to find that eAV positivity increased and RV positivity decreased significantly during the pandemic compared to before the pandemic. Both enteric viruses are transmitted through the oral-fecal route. NPIs taken to control the COVID-19 epidemic would be expected to reduce positivity similarly for both viruses. To explain this paradox, we compared the early phase of the pandemic, when NPIs were strictly implemented in Turkey, and the late phase of pandemic fatigue, when adherence to NPIs decreased and restrictions were gradually lifted. In the early stages of the outbreak, both eAV and RV positivity rates were close to 0%, especially in the period March–July 2020. In the early period of the pandemic, positivity for both enteric viruses decreased as expected. On the other hand, both RV and eAV virus positivity increased in the late period of the pandemic. Moreover, the rapid increase in

eAV positivity in the late period was even higher than in the pre-pandemic period. The increase in eAV during the pandemic was a reflection of this rapid increase at the end of the pandemic. The most important variable affecting the results between the early and late periods of the pandemic is thought to be the strict or loose implementation of the NPI. Late in the pandemic, NPIs were relaxed, and school-aged children returned to school. Increased close contact at school, decreased compliance with hand washing and general hygiene rules, and an increase in enteric viruses. In a study similar to the results of this study, Liu et al. reported that eAV positivity increased rapidly when NPIs were relaxed.^[14] This may also be related to the structural feature of eAV. It suggests that eAV, which is resistant even to non-enveloped and alcohol-containing disinfectants, can only be controlled with strict NPIs.

Similar to this study, other studies have been published showing that RV infection decreased in the early phase of the pandemic and increased in the late phase.^[10,14,19] However, Knudsen et al. reported that there was no decrease in RV positivity during the pandemic period compared with the pre-pandemic period.^[24] This is related to the fact that the RV vaccine has been administered in the Norwegian national vaccination program since 2014, and has decreased RV gastroenteritis even before the pandemic. In addition, the detection of vaccine strains in stool samples in children who received the RV vaccine may have caused the RV test positivity to remain constant.^[24] The RV vaccine is not applied in the national vaccination program in Turkey. Therefore, in this study, RV positivity in the early phase of the pandemic may have decreased more significantly than in countries where vaccination occurs.

As determined in this study, differences in the administration of NPIs affected the incidence of enteroviral infections.^[10,14,19] However, in a new study conducted in China, it was reported that norovirus and RV infections increased and returned to pre-pandemic levels, despite the strict application of NPIs in the late phase of the pandemic, but it is thought that the strict NPIs applied during the pandemic are not sustainable in the long term.^[25] In contrast, Kuitunen et al. found that, in Finland, the incidence of RV infection, in particular, did not return to the pre-pandemic level and remained at a lower level, despite earlier relaxation of NPIs.^[26] This was associated with the low population density in Finland. The results of this study in Istanbul, the most populated city in Turkey in terms of population density, are in parallel with the results of the study conducted in China. The relaxation of NPIs may lead to different outcomes depending on various demographic characteristics, such as population density.

The normal seasonal distribution of RV is that it peaks in winter and spring eAV infections occur sporadically throughout the year.^[18] In this study, RV was distributed seasonally and adenovirus sporadically during the winter months, in accordance with the literature data before the pandemic. In the early phase of the pandemic, the seasonal distribution of RV shifted from winter to the spring–summer months and reached lower peak levels. This change was thought to be related to NPIs that were strictly applied in the early period. In the late phase of the pandemic, when NPIs were relaxed, RV returned to pre-pandemic levels in terms of seasonal distribution and peak levels. Liu et al. found that the peak levels of RV decreased during the pandemic, but its seasonal distribution did not change eAV infections were distributed sporadically during the pandemic as well.^[14]

There are some limitations of the study. First, it is a single-center and retrospective study. Second, because RV and eAV tests were not applied to every patient admitted to our emergency department with a diagnosis of AGE, not all cases of RV and eAV could be detected.

CONCLUSION

This study showed that although RV and eAV infections decreased significantly in the early phase of the COVID-19 pandemic, they quickly returned to pre-pandemic levels in the late phase of the pandemic. The most important variable that could cause this difference between the early and late phases of the pandemic was the way NPIs were implemented. In addition, the effectiveness of NPIs may differ with demographic characteristics, such as population density, and health practices, such as national RV vaccination.

Disclosures

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REFERENCES

1. Bai Y, Yao L, Wei T, Tian F, Jin DY, Chen L, et al. Presumed asymptomatic carrier transmission of COVID-19. *JAMA* 2020;323:1406–7.

2. Carlos WG, Cruz C, Cao B, Pasnick S, Jamil S. Novel Wuhan (2019-nCoV) coronavirus. *Am J Respir Crit Care Med* 2020;201:7–8.
3. Ather A, Patel B, Ruparel NB, Diogenes A, Hargreaves KM. Coronavirus disease 19 (COVID-19): Implications for clinical dental care. *J Endod* 2020;45:584–95.
4. Cai J, Sun W, Huang J, Gamber M, Wu J, He G. Indirect virus transmission in cluster of COVID-19 cases, Wenzhou, China, 2020. *Emerg Infect Dis* 2020;26:1343–5.
5. Pan A, Liu L, Wang C, Guo H, Hao X, Wang Q, et al. Association of public health interventions with the epidemiology of the COVID-19 outbreak in Wuhan, China. *JAMA* 2020;323:1915–23.
6. Cowling BJ, Ali ST, Ng TWY, Tsang TK, Li JCM, Fong MW, et al. Impact assessment of non-pharmaceutical interventions against coronavirus disease 2019 and influenza in Hong Kong: An observational study. *Lancet Public Health* 2020;5(5):e279–88.
7. Van Brusselen D, De Troeyer K, Ter Haar E, Vander Auwera A, Poschet K, Van Nuijs, et al. Bronchiolitis in COVID-19 times: A nearly absent disease? *Eur J Pediatr* 2021;180:1969–73.
8. Garg I, Shekhar R, Sheikh AB, Pal S. Impact of COVID-19 on the changing patterns of respiratory syncytial virus infections. *Infect Dis Rep* 2022;14:558–68.
9. Polcwiartek LB, Polcwiartek C, Andersen MP, Østergaard L, Broccia MD, Gislason GH, et al. Consequences of coronavirus disease-2019 (COVID-19) lockdown on infection-related hospitalizations among the pediatric population in Denmark. *Eur J Pediatr* 2021;180:1955–63.
10. Kraay ANM, Han P, Kambhampati AK, Wikswo ME, Mirza SA, Lopman BA. Impact of nonpharmaceutical interventions for severe acute respiratory syndrome coronavirus 2 on norovirus outbreaks: An analysis of outbreaks reported by 9 US states. *J Infect Dis* 2021;224:9–13.
11. Li W, Zhu Y, Lou J, Chen J, Xie X, Mao J. Rotavirus and adenovirus infections in children during COVID-19 outbreak in Hangzhou, China. *Transl Pediatr* 2021;10:2281–6.
12. Eigner U, Verstraeten T, Weil J. Decrease in norovirus infections in Germany following COVID-19 containment measures. *J Infect* 2021;82:276–316.
13. Bruggink LD, Garcia-Clapes A, Tran T, Druce JD, Thorley BR. Decreased incidence of enterovirus and norovirus infections during the COVID-19 pandemic, Victoria, Australia, 2020. *Commun Dis Intell* 2021;45:5/
14. Liu P, Xu M, Lu L, Ma A, Cao L, Su L, et al. The changing pattern of common respiratory and enteric viruses among outpatient children in Shanghai, China: Two years of the COVID-19 pandemic. *J Med Virol* 2022;94:4696–703.
15. Maldonado-Barrueco A, García-Rodríguez J, Yániz-Ramírez J, Serrano-Vaquero I, Parra-Alonso JC, Vega-Nieto C, et al. Impact of the SARS-CoV-2 pandemic on the prevalence and incidence of gastrointestinal viruses in children up to five years old: A retrospective cohort study. *Microbiol Spectr* 2022;10(3):e0266921.
16. Mack D, Gohl P, Kolbert M, Schui D, Küsters U, Harzer O, et al. Where have the enteric viruses gone? - Differential effects on frequent causes of infectious diarrhoea by SARS-CoV-2 pandemic lockdown measures. *Infect Prev Pract* 2021;3:100184.
17. Yang L, Shi S, Na C, Li B, Zhao Z, Yang T, et al. Rotavirus and norovirus infections in children under 5 years old with acute gastroenteritis in southwestern China, 2018–2020. *J Epidemiol Glob Health* 2022;12:292–303.
18. Bányai K, Estes MK, Martella V, Parashar UD. Viral gastroenteritis. *Lancet* 2018;392:175–86.
19. Wang LP, Han JY, Zhou SX, Yu LJ, Lu QB, Zhang XA, et al. Disease Control and Prevention (CDC) Etiology of Diarrhea Surveillance Study Team. The changing pattern of enteric pathogen infections in China during the COVID-19 pandemic: A nation-wide observational study. *Lancet Reg Health West Pac* 2021;16:100268.
20. Cowling BJ, Leung G. Epidemiological research priorities for public health control of the ongoing global novel coronavirus (2019-nCoV) outbreak. *Euro Surveill* 2020;25:2000110.
21. Rosenbaum L. The untold toll - the pandemic's effects on patients without Covid-19. *N Engl J Med* 2020;382:2368–71.
22. Choi DH, Jung JY, Suh D, Choi JY, Lee SU, Choi YJ, et al. Impact of the COVID-19 outbreak on trends in emergency department utilization in children: A multicenter retrospective observational study in Seoul metropolitan area, Korea. *J Korean Med Sci* 2021;36:e44.
23. Jeffery MM, D'Onofrio G, Paek H, Platts-Mills TF, Soares WE 3rd, Hoppe JA, et al. Trends in emergency department visits and hospital admissions in health care systems in 5 states in the first months of the COVID-19 pandemic in the US. *JAMA Intern Med* 2020;180:1328–33.
24. Knudsen PK, Lind A, Klundby I, Dudman S. The incidence of infectious diseases and viruses other than SARS-CoV-2 amongst hospitalised children in Oslo, Norway during the Covid-19 pandemic 2020–2021. *J Clin Virol Plus* 2022;2:100060.
25. Chan MC. Return of norovirus and rotavirus activity in winter 2020–21 in city with strict COVID-19 control strategy, China. *Emerg Infect Dis* 2022;28:713–6.
26. Kuitunen I, Artama M, Haapanen M, Renko M. Noro- and rotavirus detections in children during COVID-19 pandemic—a nationwide register study in Finland. *Acta Paediatr* 2022;111:1978–80.