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Epidemiology and clinical characteristics of acute viral gastroenteritis in 350 paediatric patients hospitalised between 2019 and 2022 in the Military Institute of Medicine – National Research Institute in Warsaw, Poland: a single-centre retrospective analysis

Epidemiologia i charakterystyka kliniczna ostrego wirusowego nieżytu żołądkowo-jelitowego u 350 dzieci hospitalizowanych w Wojskowym Instytucie Medycznym – Państwowym Instytucie Badawczym w latach 2019–2022: jednoośrodkowa analiza retrospektywna

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Abstract

Introduction and objective: Acute gastroenteritis, a common childhood illness worldwide, manifests with symptoms including fever, abdominal pain, vomiting, and diarrhoea. It is highly contagious, with transmission occurring through contaminated water, food, or poor hygiene. Globally, 1.7 billion cases of diarrhoeal diseases are diagnosed annually, causing approximately 525,000 deaths among children under the age of five. Dehydration caused by diarrhoea is a primary cause of hospitalisation, particularly in developing countries. **Aim:** Analysis of the aetiology, frequency, and seasonal distribution of viral pathogens responsible for acute gastroenteritis in children hospitalised between 2019 and 2022 at the Military Institute of Medicine – National Research Institute in Warsaw, Poland. **Materials and methods:** Medical records of patients aged 0 to 18 diagnosed with rotavirus, norovirus, and adenovirus-induced acute gastroenteritis were analysed. The pathogens had been identified with reliable immunochromatographic tests. Exclusion criteria encompassed bacterial infections, dietary errors, and inflammatory conditions. Data examined included age, gender, aetiology of gastroenteritis, seasonality, duration of hospitalisation, and clinical symptoms (diarrhoea, vomiting, fever, abdominal pain, and dehydration). Laboratory results such as white blood cell count, C-reactive protein, electrolyte levels, and organ function markers were also evaluated. **Results:** Data from 350 children hospitalised between 2019 and 2022 were analysed. The highest number of hospitalisations occurred in 2019 and 2022, with fewer cases in 2020–2021, likely reflecting the impact of the COVID-19 pandemic. Most patients were between 6 and 12 months old. Rotavirus infection commonly presented with fever, vomiting, diarrhoea, and dehydration. Adenovirus and mixed infections were associated with slightly higher C-reactive protein levels, while rotavirus infections showed mildly elevated aspartate aminotransferase levels. Haematocrit, blood urea nitrogen, creatinine, and electrolyte levels were similar across all cases. **Conclusions:** Our analysis showed that rotavirus was the most frequent cause of acute viral diarrhoea in children, followed by norovirus and adenovirus, with mixed infections being the least common. The peak incidence occurred in autumn and winter, except in 2021, reflecting changes in the dynamics of infections related to the coronavirus pandemic. Biochemical findings were not sufficiently characteristic to infer the aetiology of the disease.

Keywords: gastroenteritis, rotavirus, adenoviral infections, norovirus

Streszczenie

Wprowadzenie i cel: Ostry nieżyt żołądkowo-jelitowy, powszechnie występująca choroba wieku dziecięcego na całym świecie, objawia się gorączką, bólami brzucha, wymiotami i biegunką. Jest silnie zaraźliwa i może być przenoszona przez skażoną wodę, jedzenie lub wynikać ze złych nawyków higienicznych. Rocznie na świecie rozpoznaje się 1,7 mld przypadków chorób biegunkowych, które powodują około 525 tys. zgonów dzieci poniżej 5. roku życia. Odwodnienie spowodowane biegunką jest główną przyczyną hospitalizacji, zwłaszcza w krajach rozwijających się. Celem pracy jest analiza przyczyn etiologicznych, częstości występowania oraz sezonowego rozkładu patogenów wirusowych powodujących ostry nieżyt żołądkowo-jelitowy u dzieci hospitalizowanych w latach 2019–2022 w Wojskowym Instytucie Medycznym – Państwowym Instytucie Badawczym w Warszawie. **Materiał i metody:** Analizowano dokumentację medyczną pacjentów w wieku 0–18 lat z ostrym nieżytem żołądkowo-jelitowym wywołanym rotawirusem, norowirusem i adenowirusem. Patogeny zidentyfikowano za pomocą wiarygodnych testów immunochromatograficznych. Kryteria wykluczenia obejmowały zakażenia bakteryjne, błędy żywieniowe i stany zapalne. Analizowane dane obejmowały wiek, płeć, etiologię zapalenia żołądka, sezonowość, czas hospitalizacji i objawy kliniczne (biegunka, wymioty, gorączka, ból brzucha i odwodnienie). Przeanalizowano także wyniki badań laboratoryjnych, takie jak liczba białych krwinek, białko C-reaktywne, stężenia elektrolitów i wskaźniki czynności narządów. **Wyniki:** Analizowano dane 350 dzieci hospitalizowanych w latach 2019–2022. Najwięcej hospitalizacji odnotowano w 2019 i 2022 roku, najmniej – w latach 2020–2021, co odpowiada pandemii COVID-19. Większość pacjentów była w wieku 6–12 miesięcy. Zakażenie rotawirusem najczęściej manifestowało się gorączką, wymiotami, biegunką oraz odwodnieniem. W zakażeniach adenowirusem i zakażeniach mieszanych obserwowano nieznacznie podwyższone stężenia białka C-reaktywnego, natomiast w zakażeniach rotawirusem – nieco podwyższone wartości aminotransferazy asparaginianowej. Wartości hematokrytu, azotu mocznikowego we krwi, kreatyniny i elektrolitów były podobne we wszystkich przypadkach. **Wnioski:** W analizowanym okresie najczęstszym czynnikiem etiologicznym ostrych wirusowych biegunek u dzieci był rotawirus, następnie norowirus i adenowirus, a najrzadsze były zakażenia mieszane. Szczyt przypadków wystąpił jesienią i zimą, z wyjątkiem roku 2021, co odzwierciedla zmianę dynamiki zakażeń związanych z pandemią koronawirusa. Zmiany w badaniach biochemicznych nie były wystarczająco charakterystyczne do wnioskowania o etiologii choroby.

Słowa kluczowe: nieżyt żołądkowo-jelitowy, rotawirus, zakażenia adenowirusowe, norowirus

INTRODUCTION

Acute gastroenteritis, commonly known as infectious diarrhoea, is a prevalent childhood illness and a leading cause of hospitalisation, especially among infants and children under the age of five worldwide. Clinically, the disease presents with acute symptoms such as fever, abdominal pain, vomiting, and diarrhoea[1]. The disease is transmitted via the faecal-oral route and spreads quickly in the patient's surroundings. It is highly contagious, and a trace amount of infectious material containing 10–100 virus particles is enough to cause infection. Transmission can occur through contaminated water, food, unclean hands, or poor hygiene practices. Sources of infection include an ill person, a convalescent individual who continues to shed viruses in their faeces, or an asymptomatic carrier.

Worldwide, approximately 1.7 billion cases of childhood diarrhoeal disease are diagnosed annually, accounting for about 525,000 deaths in children under the age of five[2]. Dehydration caused by diarrhoea and vomiting is the primary cause of hospitalisation in industrialised countries and a significant contributor to mortality in developing countries[3,4]. Approximately 90% of diarrhoea-related deaths occur in Sub-Saharan Africa and South Asia[5].

Infectious acute diarrhoea is diagnosed when a child has three or more liquid or semi-liquid stools per day or when pathological components such as mucus, pus, or blood are present in the stool. The duration of acute diarrhoea does not exceed 14 days[6,7]. A broad spectrum of intestinal pathogens can cause infectious acute diarrhoea. In children, intestinal viruses are the most important aetiological factors of the disease. Clinically significant pathogens include group A rotavirus (*Reoviridae* family), norovirus (*Caliciviridae* family), and adenovirus 40/41 (group F). The aetiology of infectious acute diarrhoea depends on environmental, geographic, and socio-economic factors[8]. As a result, infectious acute diarrhoea disrupts the balance of the intestinal microbiome.

The aim of this study was to analyse the aetiology, frequency, and seasonal distribution of viral pathogens responsible for acute gastroenteritis in children hospitalised at the Department of Paediatrics, Paediatric Nephrology, and Allergology of the Military Institute of Medicine – National Research Institute between 2019 and 2022.

MATERIALS AND METHODS

The study was conducted in accordance with the Declaration of Helsinki and its later amendments. The protocol was reviewed and approved by the Ethics Committee: Komisja Bioetyczna przy Wojskowej Izbie Lekarskiej w Warszawie (Approval No: KB 102/2023).

The objective of the study was to analyse the medical documentation of patients who suffered from acute viral gastroenteritis caused by rotavirus, norovirus, adenovirus (ICD-10 codes A08.0, A08.1, A08.2) and were hospitalised at the Department of Paediatrics, Paediatric Nephrology, and Allergology at the Military Institute of Medicine – National Research Institute in Warsaw between 2019 and 2022.

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Inclusion criteria were patients aged 0 to 18 years and diagnosed acute gastroenteritis caused by rotaviruses, noroviruses, and adenoviruses, confirmed by rapid immunochromatographic tests of stool samples. Rotavirus and adenovirus infections were diagnosed using the NADAL® Rota-Adenovirus Test (nal von minden GmbH, Germany), and norovirus infections were identified using the NADAL® Norovirus GI + GII test (nal von minden GmbH, Germany). The declared sensitivity and specificity of both tests were >99%. Patients with symptoms of gastroenteritis caused by bacterial pathogens (e.g. *Salmonella* spp., *Yersinia* spp.), dietary errors, or inflammatory diseases such as cow's milk protein allergy were excluded from the analysis.

The analysis considered factors such as age, gender, aetiology of acute gastroenteritis, seasonality of illness, length of hospitalisation, and clinical symptoms including diarrhoea, vomiting, fever, abdominal irritability/pain, and dehydration. Diarrhoea was defined as more than three episodes of sudden, watery stools within 24 hours. Fever was determined as a core body temperature ≥38.0°C. Dehydration was diagnosed based on decreased skin turgor, reduced urination frequency to less than one-third of normal, or weight loss exceeding 5% of body weight.

Moreover, laboratory test results, including white blood cell count and C-reactive protein, sodium, potassium levels, aminotransferases, creatinine, and urea levels, were analysed.

Statistical analysis

Statistical analysis was performed using R statistical software[1]. Descriptive statistics were applied to analyse the characteristics of the collected data, with median, minimum, and maximum values, as well as interquartile ranges, used to understand the distribution and variability of the variables. Additionally, tables and graphs were employed to visualise and better interpret the data structure. The chi-square test was used to determine whether the occurrence of viruses differed across the analysed years.

Data modelling was conducted using linear regression analysis of aetiological variables (type of viral pathogen) and calendar-related variables (month of infection) as predictors for the outcome variable: the number of infections. The model formula was defined as "cases ~ virus * month of infection" (cases as the dependent variable, interaction between virus type and month of infection).

Statistical significance was set at $p < 0.05$.

RESULTS

The data from 350 children were analysed. The highest number of patients were hospitalised in 2019 and 2022, while a lower number of cases was noted between 2020 and 2021, corresponding with the COVID-19 pandemic. In all analysed years, most patients were aged between 6 and 12 months. The most frequent etiological factor was rotavirus. Rotavirus infections in most children manifest with fever, vomiting, diarrhoea, and signs of dehydration. The detailed demographic and clinical characteristics of the patients are presented in Tabs. 1 and 2. Fig. 1 shows the number of positive samples for noroviruses and their subtypes in relation to all isolated viral pathogens. The decrease in positive samples during the pandemic is visible.

The blood biochemical parameters of the analysed patients are shown in Tab. 3. Slightly higher C-reactive protein values were observed in cases of adenovirus and mixed infections (adenovirus and rotavirus). Additionally, rotavirus infections were associated with mildly elevated aspartate aminotransferase levels. Haematocrit, blood urea nitrogen, creatinine, and electrolyte values were similar across all cases.

Children with viral infections were most frequently hospitalised in March (18.6%), January (12.6%), and April (10.9%). The detailed contributions of individual aetiological factors to all viral infections are presented in Tab. 4, with graphical representations in Figs. 2 and 3. These data cover the entire study period. However, the data in these figures represent the frequency of virological diagnoses categorised by the types of pathogens, not their combined total.

The linear regression analysis of the model formula, as described in the Statistical analysis section, revealed a residual standard error of 7.911 with 60 degrees of freedom (DF). The multiple R-squared value was 0.08961, while the adjusted R-squared value was −0.07729. The F-statistic was 0.5369 with 11 and 60 DF, and a p-value of 0.8703.

DISCUSSION

In our material, the most common cause of gastroenteritis was rotavirus infection, followed by norovirus and adenovirus infections. These findings are consistent with the literature, which identifies rotavirus as the leading cause of infectious diarrhoea in children worldwide[9]. Also, Wawrzyniak et al. found a similar distribution of viral aetiological factors of acute gastroenteritis at our centre in 2018[10]. The incidence rates of individual types of viruses in our study corresponds to the results reported by Amodio et al.: 64%, 25.5%, 9.6% vs. 61.1%, 27.4%, 9.2%, respectively[11].

In a temperate climates, rotavirus infections exhibit a seasonal pattern, with a peak incidence in autumn and winter. Our data for 2019 and 2021, but not for 2021, support this relationship. The statistics from the National Institute of Public Health – National Institute of Hygiene (NIPH–NIH) are identical. In 2019, a total of 34,019 cases of rotavirus infections were reported[12], in 2020 – 5,967[13], in 2021 – 7,417[14], and 2022 – 34,211[15]. These variations may result from a significantly increased sanitation and hand disinfection regimen during the COVID-19 pandemic. Similar trends were observed in Germany[16]. However, our results indicate a lack of

* R Core Team: R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria 2023. https://www.R-project.org/.

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Characteristic	Statistics	Range
Sex, *n* (%): • female • male	 60 (36.6) 104 (63.4)	
Age [months], median (Q1;Q3)	2.54 (1.54;4.40)	0.33–24.0
Hbd [weeks], median (Q1;Q3)	39.00 (38.00;40.00)	26–41
Preterm, *n* (%)	24 (14.6)	
Feeding method, *n* (%): • breastfeeding only • breastfeeding + infant formula • infant formula only	 99 (60.4) 18 (11.0) 40 (24.4)	
Number of persons in household, median (Q1;Q3)	4.00 (4.00;4.00)	0–8
Number of rooms in household, median (Q1;Q3)	3.00 (2.00;3.00)	1–6
Number of persons in household/number of rooms, mean ± SD	1.59 ± 0.67	0–5
Number of siblings, *n* (%): • 0 • 1 • 2 • 3 • median (Q1;Q3)	 39 (24.1) 101 (62.3) 17 (10.5) 5 (3.1) 1.00 (1.00;1.00)	 0–3
Rhinitis, *n* (%)	127 (77.4)	
Cough, *n* (%)	162 (98.8)	
Dyspnoea, *n* (%)	90 (54.9)	
Apnoea, *n* (%)	6 (3.7)	
Foamy mucus, *n* (%)	58 (35.4)	
Time of symptoms [days]	4.04 ± 2.10	0–10
Fever [°C], *n* (%): • no fever • 37.7 < 38 • 38 < 39 • 39 < 40 • mean ± SD	 98 (60.1) 32 (19.6) 26 (16.0) 7 (4.3) 37.25 ± 0.89	 36.6–39.8
Time of fever before hospitalisation [days], median (Q1;Q3)	0.00 (0.00;1.00)	0–7
Time of fever in hospital [days], median (Q1;Q3)	0.00 (0.00;0.00)	0–3
Time of fever (total) [days], median (Q1;Q3)	0.00 (0.00;1.00)	0–7
Respiratory rate on admission to the hospital [/min], mean ± *SD*	51.21 ± 9.97	24–72
Saturation on admission to the hospital [%], mean ± *SD*	95.84 ± 2.07	88–99
Heart rate on admission to the hospital [/min], mean ± *SD*	140.37 ± 16.06	100–190
pH in capillary blood, mean ± *SD*	7.42 ± 0.04	7.12–7.53
pCO_2 in capillary blood [mm Hg], mean ± *SD*	36.22 ± 6.31	20.50–70.90
Saturation in capillary blood [%], mean ± *SD*	90.70 ± 5.15	63.60–99.60
Procalcitonin (PCT) [ng/mL], median (Q1;Q3)	0.09 (0.07;0.13)	0.02–3.10
C-reactive protein (CRP) [mg/L], median (Q1;Q3)	1.70 (0.72;6.33)	0.10–69.17
White blood cells (WBC) [1×10^3/μL], mean ± *SD*	11.25 ± 3.63	4.21–25.79
Neutrophil [%], mean ± *SD*	25.56 ± 14.58	4.60–88.30
Absolute neutrophil count (ANC) [1×10^3/μL], median (Q1;Q3)	2.40 (1.25;3.99)	0.37–15.20
°C – Celsius degrees; **Hbd** – weeks of pregnancy; **pCO_2** – partial pressure of carbon dioxide.		

Tab. 1. Baseline characteristics of the study group

		PCR method		
		Positive	**Negative**	**Total**
Rapid RSV test	**Positive**	114 (69.5)	0 (0.0)	114 (69.5)
	Negative	38 (23.2)	12 (7.3)	50 (30.5)
	Total	152 (92.7)	12 (7.3)	164 (100.0)
Data presented as *n* (%) of total group.				

Tab. 2. Comparison of results of rapid RSV tests vs. PCR method

connection between the type of pathogen causing the infection and the month of occurrence. The multiple *R*-squared value suggests that approximately 8.96% of the variability in the dependent variable (number of cases) can be explained by the independent variables (virus type, month of infection). Other calculations also justify the conclusion that the model does not define the dependent variable significantly, nor does at least one independent variable significantly impact the dependent variable. However, the fact remains that the

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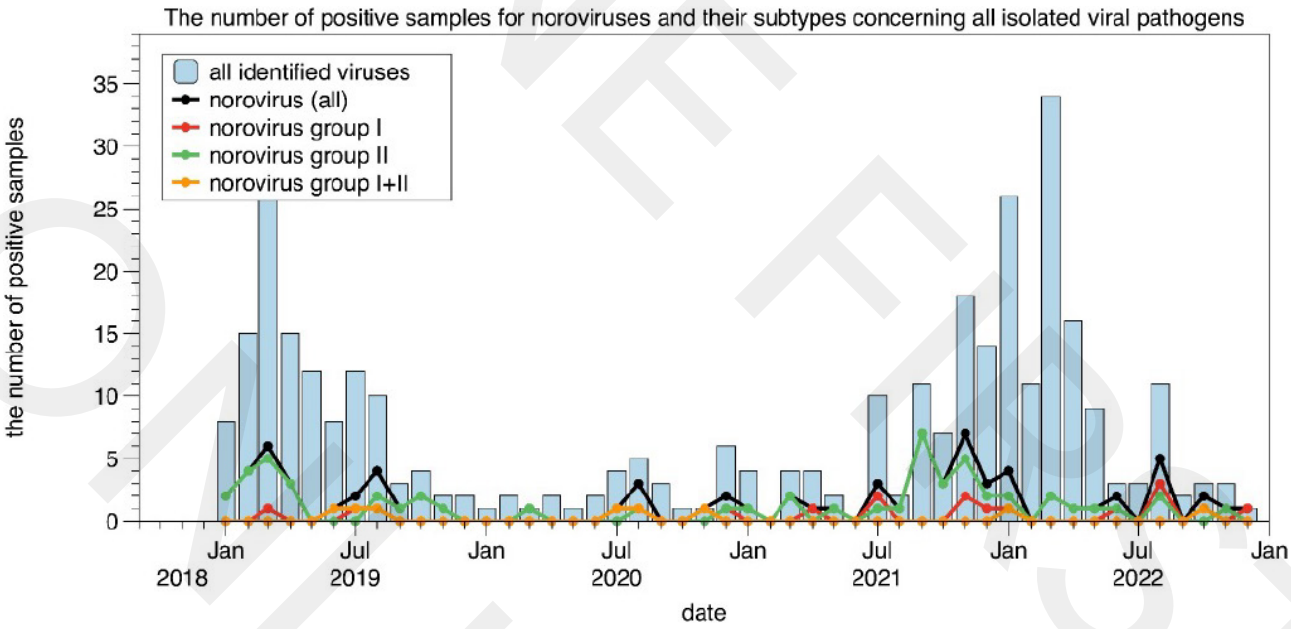

Fig. 1. The number of positive samples for noroviruses and their subtypes concerning all isolated viral pathogens

	Result				Sensitivity		Specificity	PPV	NPV	
	TP	**TN**	**FP**	**FN**	**(95% CI)**	***p***	**(95% CI)**	**(95% CI)**	**(95% CI)**	***p***
Total group	114	12	0	38	75.0 (67.3–81.7)		100.0 (73.5–100.0)	100.0	24.0 (19.3–29.4)	
Age [months]										
0–1	29	2	0	8	78.4 (61.8–90.2)	0.6881	100.0 (15.8–100.0)	100.0	20.0 (11.9–31.6)	0.929
2–3	43	6	0	16	72.9 (59.5–83.6)		100.0 (54.1–100.0)	100.0	27.3 (19.8–36.3)	
4–6	29	3	0	7	80.6 (63.9–91.8)		100.0 (29.2–100.0)	100.0	30.0 (18.1–45.5)	
7–12	7	0	0	4	63.6 (30.8–89.1)		–	–	–	
13–24	6	1	0	3	66.7 (29.9–92.5)		100.0 (2.50–100.0)	100.0	25.0 (11.7–45.6)	
Up to 3 months	72	8	0	24	75.0 (65.1–83.3)	>0.999	100.0 (63.1–100.0)	100.0	25.0 (19.1–32.0)	>0.999
Above 3 months	42	4	0	14	75.0 (61.6–85.6)		100.0 (39.8–100.0)	100.0	22.2 (15.4–31.0)	
Feeding method										
Breastfeeding only	75	5	0	19	79.8 (70.3–87.4)	0.123	100.0 (47.8–100.0)	100.0	20.8 (14.9–28.2)	0.8631
Breastfeeding + infant milk	10	4	0	4	71.4 (41.9–91.6)	0.7501	100.0 (39.8–100.0)	100.0	50.0 (30.4–69.6)	0.082
Infant milk only	26	2	0	12	68.4 (51.4–82.5)	0.387	100.0 (15.8–100.0)	100.0	14.3 (9.45–21.0)	0.468
Persons/rooms in household										
0–1	16	2	0	4	80.0 (56.3–94.3)	0.7101	100.0 (15.8–100.0)	100.0	33.3 (17.2–54.6)	0.167
2	42	4	0	16	72.4 (59.1–83.3)		100.0 (39.8–100.0)	100.0	20.0 (14.2–27.5)	
>2	4	3	0	2	66.8 (22.3–95.7)		100.0 (29.2–100.0)	100.0	60.0 (32.6–82.3)	
Siblings										
No	28	3	0	8	77.8 (60.9–89.9)	0.806	100.0 (29.2–100.0)	100.0	27.3 (16.9–40.9)	0.692
Yes	85	8	0	30	73.9 (64.9–81.7)		100.0 (63.6–100.0)	100.0	21.1 (16.4–26.6)	

95% CI – confidence interval; **FN** – false-negative; **FP** – false-positive; **NPV** – negative predictive value; ***p*** – *p*-value; **PPV** – positive predictive value; **TN** – true-negative; **TP** – true-positive.
Sensitivity and NPV % values compared between groups with Fisher exact test[1] or chi-square test.

Tab. 3. Validity analysis of RSV RADT vs. PCR method

frequency of infections was higher in autumn and winter in absolute numbers. The lack of association between the type of pathogen and the month of infection occurrence does not rule out other factors that may contribute to increased susceptibility to infections. Sung et al. found that low ambient temperatures increased the risk of viral gastroenteritis, while high temperatures increased the risk of bacterial gastroenteritis[17].

According to the NIPH–NIH data, between 2019 and 2022, the highest incidence of rotavirus infection was observed in children under five years of age[12–15]. Similar patterns are evident in our study material, reflecting the overall profile of paediatric hospitalisations at our centre.

The analysis of serum biochemical parameters showed that the median activity of aspartate aminotransferase was

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	Result				Sensitivity		Specificity	PPV	NPV	
	TP	TN	FP	FN	(95% CI)	*p*	(95% CI)	(95% CI)	(95% CI)	*p*
Duration of symptoms [days]										
0–1	5	1	0	2	71.4 (29.0–96.3)	**0.031[1]***	100.0 (2.50–100.0)	100.0	33.3 (13.4–61.7)	0.4181
2–3	50	3	0	10	83.3 (71.5–91.7)		100.0 (29.2–100.0)	100.0	23.1 (72.7–92.1)	
4–5	39	5	0	10	79.6 (65.7–89.8)		100.0 (47.8–100.0)	100.0	33.3 (22.3–46.5)	
6–7	9	1	0	10	47.4 (24.5–71.1)		100.0 (2.5–100.0)	100.0	9.1 (6.1–13.2)	
≥8	6	2	0	2	75.0 (34.9–96.8)		100.0 (15.8–100.0)	100.0	50.0 (23.1–76.9)	
0–3	55	4	0	12	82.1 (70.8–90.4)	0.177	100.0 (39.8–100.0)	100.0	25.0 (16.6–35.8)	>0.999
≥4	54	8	0	22	71.1 (59.5–80.9)		100.0 (63.1–100.0)	100.0	26.7 (20.4–34.1)	
Fever [°C]										
37.7 < 38	94	8	0	28	77.1 (68.6–84.2)	0.335[1]	100.0 (63.1–100.0)	100.0	22.2 (17.1–28.3)	0.469
38 < 39	16	2	0	8	66.7 (44.7–84.4)		100.0 (15.8–100.0)	100.0	20.0 (12.4–30.6)	
39 < 40	3	2	0	2	60.0 (14.7–94.7)		100.0 (15.8–100.0)	100.0	50.0 (25.5–74.5)	
<38	94	8	0	28	77.1 (68.6–84.2)	0.295	100.0 (63.1–100.0)	100.0	22.2 (17.1–28.3)	0.718
≥38	19	4	0	10	65.5 (45.7–82.1)		100.0 (39.8–100.0)	100.0	28.6 (19.5–39.8)	
Duration of fever before hospitalisation [days]										
0	87	5	0	26	77.0 (68.1–84.4)	0.315[1]	100.0 (47.8–100.0)	100.0	16.1 (12.1–21.2)	0.144
1	12	4	0	8	60.0 (36.1–80.9)		100.0 (39.8–100.0)	100.0	33.3 (22.6–46.1)	
2	7	1	0	3	70.0 (34.8–93.3)		100.0 (2.5–100.0)	100.0	25.0 (11.5–46.2)	
≥3	8	2	0	1	98.7 (93.2–99.9)		100.0 (15.8–100.0)	100.0	66.7 (22.2–93.3)	
0	87	5	0	26	77.0 (68.1–84.4)	0.453	100.0 (47.8–100.0)	100.0	16.1 (12.1–21.2)	0.1711
≥1	27	7	0	12	69.2 (52.4–82.9)		100.0 (59.0–100.0)	100.0	36.8 (26.7–48.3)	
Duration of fever during hospitalisation [days]										
0	89	9	0	34	72.4 (63.6–80.0)	0.416[1]	100.0 (66.4–100.0)	100.0	20.9 (16.6–26.0)	0.258
1	14	2	0	2	87.5 (61.7–98.5)		100.0 (15.8–100.0)	100.0	50.0 (21.5–78.5)	
2–3	9	1	0	2	81.8 (48.2–97.7)		100.0 (2.5–100.0)	100.0	33.3 (12.5–63.7)	
0	89	9	0	34	72.4 (63.6–80.0)	0.223[1]	100.0 (66.4–100.0)	100.0	20.9 (16.6–26.0)	0.337
≥1	23	3	0	4	85.2 (66.3–95.8)		100.0 (29.2–100.0)	100.0	42.9 (23.3–64.9)	
Total duration of fever [days]										
0	74	6	0	25	74.8 (65.0–82.9)	0.899[1]	100.0 (54.1–100.0)	100.0	19.4 (14.6–25.2)	0.659
1	14	2	0	5	73.7 (48.8–90.9)		100.0 (15.8–100.0)	100.0	28.6 (15.9–45.9)	
2–3	14	3	0	6	70.0 (45.7–88.1)		100.0 (29.2–100.0)	100.0	33.3 (20.4–49.4)	
≥4	10	1	0	2	83.3 (51.6–97.9)		100.0 (2.5–100.0)	100.0	33.3 (12.4–63.9)	
0	74	6	0	25	74.8 (65.0–82.9)	>0.999	100.0 (54.1–100.0)	100.0	19.4 (14.6–25.2)	0.4961
≥1	38	6	0	13	74.5 (60.4–85.7)		100.0 (54.1–100.0)	100.0	31.6 (22.4–42.5)	

95% CI – confidence interval; **°C** – Celsius degrees; **FN** – false-negative; **FP** – false-positive; **NPV** – negative predictive value; ***p*** – *p*-value; **PPV** – positive predictive value; **TN** – true-negative; **TP** – true-positive.
Sensitivity and NPV % values compared between groups with Fisher exact test[1] or chi-square test.
* In direct comparison the sensitivity in a 6–7 days group was significantly different from 2–3 days group ($p = 0.005$) and from 4–5 days ($p = 0.016$), while after Bonferroni correction the values reached 0.047 and $p = 0.162$, respectively.

Tab. 4. Validity analysis of RSV RADT vs. PCR method with regard to duration of symptoms, fever, duration of fever (prior to, during hospitalisation and total)

higher in rotavirus infections than in norovirus and adenovirus infections. These observations are consistent with the results reported by Biçer et al.[18]. However, inferring the aetiology of gastroenteritis based solely on changes in serum biochemical results can be challenging; dedicated virological tests remain the gold standard for diagnosis.

This study has some limitations. The primary focus was on the aetiological aspect of the disease, with slightly less emphasis on a detailed clinical analysis, including the assessment of patients' immunological status. Also, a comprehensive genetic analysis of the isolated pathogens was not conducted. However, these limitations do not diminish the relevance of the findings presented in this analysis for clinicians managing acute infectious diarrhoea in children or for those interested in this topic.

CONCLUSIONS

This analysis showed that between 2019 and 2022, the most common aetiological factor of acute viral diarrhoea in children was rotavirus, followed by norovirus and adenovirus, with mixed infections being the least frequent. The peak of cases occurred in autumn and winter, except in 2021,

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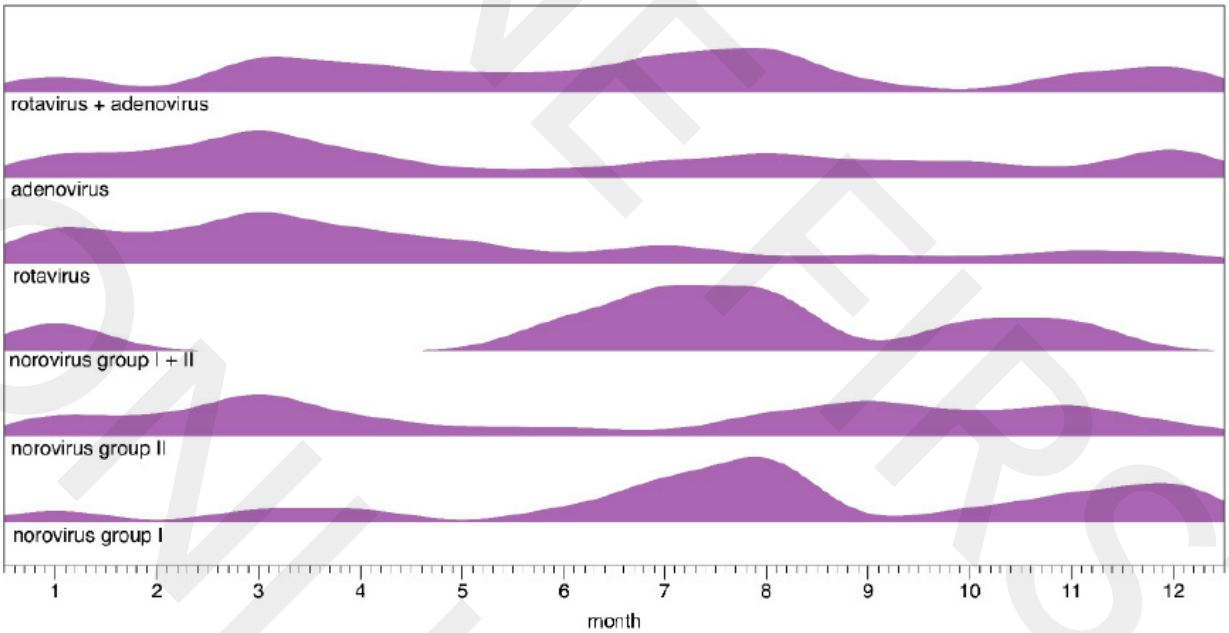

Fig. 2. The number of positive samples for noroviruses and their subtypes concerning all isolated viral pathogens

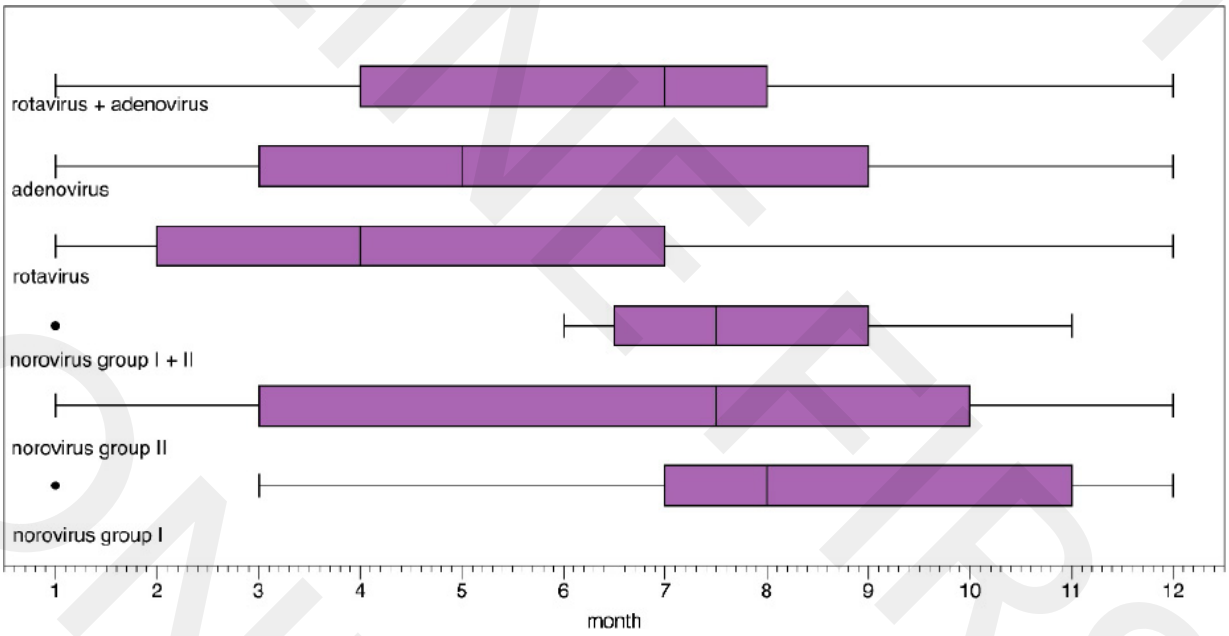

Fig. 3. The aetiology of viral infections between 2019 and 2022, and the incidence of pathogens in consecutive months

reflecting changes in the dynamics of infections related to the coronavirus pandemic. Biochemical study results were not sufficiently distinctive to determine the aetiology of the disease.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organisations which might negatively affect the content of this publication and/or claim authorship rights to this publication.

Author contribution

Original concept of study: AG, WP, ZR, BK. Collection, recording and/or compilation of data: AG, KM, MLP. Analysis and interpretation of data: AG, DT, WP, APO, ZR. Writing of manuscript: AG, DT, MLP. Critical review of manuscript: AG, DT, WP, KM, APO, ZR, BK. Final approval of manuscript: AG, DT, WP, KM, APO, MLP, ZR, BK.

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References

1. Walker CLF, Rudan I, Liu L et al.: Global burden of childhood pneumonia and diarrhoea. Lancet 2013; 381: 1405–1416.
2. World Health Organization: Diarrhoeal disease. Available from: https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease.
3. Ferreira CE, Raboni SM, Pereira LA et al.: Viral acute gastroenteritis: clinical and epidemiological features of co-infected patients. Braz J Infect Dis 2012; 16: 267–272.
4. Colletti JE, Brown KM, Sharieff GQ et al.: The management of children with gastroenteritis and dehydration in the emergency department. J Emerg Med 2010; 38: 686–698.
5. Kotloff KL, Platts-Mills JA, Nasrin D et al.: Global burden of diarrheal diseases among children in developing countries: incidence, etiology, and insights from new molecular diagnostic techniques. Vaccine 2017; 35: 6783–6789.
6. World Health Organization: The Treatment of Diarrhoea. A Manual for Physicians and Other Senior Health Workers. 4th revision. WHO/FCH/CAH/05.1. World Health Organization, Geneva 2005. Available from: https://www.who.int/publications/i/item/9241593180.
7. Guarino A, Lo Vecchio A, Dias JA et al.: Universal recommendations for the management of acute diarrhea in nonmalnourished children. J Pediatr Gastroenterol Nutr 2018; 67: 586–593.
8. Adams NL, Rose TC, Hawker J et al.: Relationship between socio-economic status and gastrointestinal infections in developed countries: a systematic review and meta-analysis. PLoS One 2018; 13: e0191633.
9. GBD 2016 Causes of Death Collaborators: Global, regional, and national age-sex specific mortality for 264 causes of death, 1980–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 2017; 390: 1151–1210.
10. Wawrzyniak A, Lipińska-Opałka A, Będzichowska A et al.: Epidemiology and clinical course of acute gastroenteritis in the Department of Paediatrics, Paediatric Nephrology and Allergology in 2018. Pediatr Med Rodz 2020; 16: 77–82.
11. Amodio E, De Grazia S, Genovese D et al.: Clinical and epidemiologic features of viral gastroenteritis in hospitalized children: an 11-year surveillance in Palermo (Sicily). Viruses 2022; 15: 41.
12. Czarkowski MP, Niewęgłowska A, Szmulik-Misiurek K et al.: Choroby zakaźne i zatrucia w Polsce w 2019 roku. Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny, Warszawa 2020. Available from: https://wwwold.pzh.gov.pl/oldpage/epimeld/2019/Ch_2019.pdf.
13. Czarkowski MP, Staszewska-Jakubik E, Wielgosz U: Choroby zakaźne i zatrucia w Polsce w 2020 roku. Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny, Warszawa 2021. Available from: https://wwwold.pzh.gov.pl/oldpage/epimeld/2020/Ch_2020.pdf.
14. Czarkowski MP, Staszewska-Jakubik E, Wielgosz U: Choroby zakaźne i zatrucia w Polsce w 2021 roku. Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny, Warszawa 2021. Available from: https://wwwold.pzh.gov.pl/oldpage/epimeld/2021/Ch_2021.pdf.
15. Czarkowski MP, Wielgosz U: Choroby zakaźne i zatrucia w Polsce w 2022 roku. Narodowy Instytut Zdrowia Publicznego – Państwowy Zakład Higieny, Warszawa 2023. Available from: https://wwwold.pzh.gov.pl/oldpage/epimeld/2022/Ch_2022.pdf.
16. Panteli D, Mauer N, Tille F et al.: How did the COVID-19 pandemic affect inpatient care for children in Germany? An exploratory analysis based on national hospital discharge data. BMC Health Serv Res 2023; 23: 938.
17. Sung J, Cheong HK, Kwon HJ et al.: Pathogen-specific response of infectious gastroenteritis to ambient temperature: national surveillance data in the Republic of Korea, 2015–2019. Int J Hyg Environ Health 2022; 240: 113924.
18. Biçer S, Çöl D, Küçük Ö et al.: Is there any difference between the symptomatology and clinical findings of viral agents causing dehydration. Minerva Pediatr 2018; 70: 165–174.

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