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Detection of fecal shedding of rotavirus and enteric adenovirus antigens in vaccinated Libyan infants following their three doses of RotaTeq® vaccine

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Abstract:

Background: Rotavirus and Adenoviruses were major public health challenge in viral gastroenteritis. The RotaTeq® vaccine offered protection against rotavirus disease. In Libya, there was a lack of studies on the shedding of rotavirus vaccine, enteric adenovirus, and its potential transmission within households, particularly among immunocompromised individuals. Aim: To examined fecal shedding of rotavirus antigens at day 7 post- RotaTeq® vaccination and investigate the prevalence of enteric adenovirus among infants aged 2, 4, and 6 months. Material and methods: 104 stool samples from Libyan infants who received the three doses of the RotaTeq® vaccine were obtained at day 7 post-vaccination. The study was conducted at Garyounis Clinic and New Benghazi Clinic from December, 2022, to February, 2023. Immunochromatographic testing was performed using the Rotavirus and Adenovirus Combo Rapid Test Kit. Results: 46 samples of 104 (44.2%) was rotavirus antigen-positive. Among the participants, 20 out of 49 (40.8%) tested positive after the first dose, 15 out of 32 (46.9%) after the second dose, and 11 out of 23 (47.8%) after the third dose. Stool samples from 47 (45.2%) of the samples tested positive for enteric adenovirus, while 57 (54.8%) tested negative. 32 (30.8 %) of the samples tested positive for co-rotavirus and enteric adenovirus antigens, while 72 (69.2%) were negative. Conclusion: The shedding of rotavirus antigen after RotaTeq® vaccine, as well as the presence of enteric

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adenoviruses, would contribute to our understanding of vaccine indirect effects and horizontal transmission of enteric viruses among immunocompromised individuals in households with vaccinated infants.

Keywords: Rotavirus; RotaTeq® vaccine; Shedding, Enteric adenovirus, Horizontal transmission

Introduction:

Rotaviruses and enteric adenoviruses are shed in stools and primarily transmitted through fecal-oral route, person-to-person contact and fomites. The human rotavirus vaccine strain, provides protection against future rotavirus infections in infants. The human rotavirus vaccine is shed in the stool of vaccinated infants. After undergoing significant clinical trials, RotaTeq® (Merck & Co., Whitehouse Station, NJ) a vaccine made up of human-bovine reassortant rotavirus was authorized in 2006 for use in the US. Its effectiveness in preventing rotavirus gastroenteritis was confirmed in these trials (1, 2). In October 2013, the vaccine has been given to all children in three doses in Libya (3).

Shedding of rotavirus vaccine was observed in vaccinated infants at the first dose in a large trial (1), and at the first and third dose in the Rotavirus Efficacy and Safety Trial (REST) (4). In 2011 study, fecal shedding of rotavirus vaccine virus was 21.4% after the first dose, and rotavirus antigen was detected as early as day 3 and as late as day 9 post- vaccination, with the highest shedding rate occurring on days 6 to 8 post-vaccination (5). Shedding of rotavirus vaccine was observed in vaccinated infants at all three doses, with the highest shedding observed on day 7 post-vaccination (6).

The Rotarix and RotaTeq fecal shedding can induce herd immunity against RV disease in unvaccinated children, and adults, as has been demonstrated in developed regions (7,8,9).

The dynamics of fecal rotavirus shedding in an unvaccinated population were studied in children with asymptomatic rotavirus infection and clinical rotavirus disease using electron microscopy, enzyme immunoassays, and polymerase chain reaction (PCR), there is a positive correlation between fecal viral load and disease severity (10). PCR-based assays have demonstrated that fecal shedding can continue for 24 days after the onset of symptoms (11).

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Shedding data from vaccinated infants and its contribution on transmission is insufficient in sub-Saharan Africa (12). Where rotavirus vaccines have been introduced, they have had a significant positive impact on the use of rotavirus-related healthcare interventions (13).

A study found that 80-90% of vaccinated subjects shed RotaTeq and Rotarix vaccine virus within 1-4 weeks post-vaccination using reverse transcription polymerase chain reaction (RT-PCR) (14). These studies highlighted the importance of examining the influence that vaccine strain shedding may have on clinical diagnoses and rotavirus surveillance data (15,16,17).

Horizontal transmission of vaccine viruses has been studied in sibling transmission of vaccine-derived rotavirus (RotaTeq®) associated with rotavirus gastroenteritis (18). Because infectious vaccine viruses are excreted in feces, there is a theoretical possibility that vaccine viruses can be transmitted horizontally to unvaccinated or naive infants (19).

Transmission of rotavirus vaccine strains to unvaccinated individuals are possibly expected from any live attenuated vaccines such as oral polio vaccine, which provide indirect protection in developing countries compared with developed countries (20). Antigen-based testing and PCR assay were used to distinguish vaccine from wild-type viruses. When these tests are not available, the detection of rotavirus RNA in infants is not necessarily an indication of infection may be due to vaccine shedding (21). It was also found that high fecal virus shedding may contribute to the continued high prevalence of asymptomatic infection in young children and the continued transmission of rotavirus (22), Notably, this faecal shedding occurred as early as post-vaccination day 2 and as late as post-vaccination day 13 and peaked on post vaccination day 5–10 (23). Shedding of RotaTeq® vaccine strains in asymptomatic children is generally not considered clinically significant (24).

Transmission of vaccine-derived rotavirus from vaccinated children to vaccinated siblings has been associated with symptomatic rotavirus gastroenteritis (25). Several studies have shown that transmission of human rotavirus vaccine strains has occurred; from vaccinated infants to close contacts; reported transmission rates range from 0% to 18.8% (26). Environmental transmission of rotaviruses and enteric adenoviruses occurs when the virus is present in the environment (e.g., on surfaces or water sources) and is then infected by a susceptible individual (27). A study

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conducted in Nigeria demonstrated that mono/co-infection with rotavirus and enteric adenovirus exist among apparently healthy school aged (28). Immunochromatographic tests (ICT) are widely used to detect rotavirus and enteric adenovirus antigens in stool samples, they are faster, cheaper, and require no additional equipment (29). Although ICT tests may be suitable for rotavirus detection, testing of stool samples with RT-PCR to identify vaccine strain still needed.

1. Material and methods

2.1. Study design and population

The study was conducted from December 2022 until February 2023 at the Garyounis Clinic and New Benghazi Clinic. One hundred and four (104) stool samples were collected from infants between 2, 4 and 6 months on day seven post- pentavalent rotavirus vaccine (RV5). 49 infants after the first dose, 32 infants after the second dose, and 23 infants after the third dose.

2.2. Sample Collection

After providing verbal consent, the sample was collected in universal sterile disposable plastic containers, each tube stored at -20ºC until processing and tested.

2.3. Immunochromatographic Test (ICT)

Immunochromatographic testing was performed using the Rotavirus and Adenovirus Combo Rapid Test Kit (Biopanda Reagents Ltd., Belfast, United Kingdom, Product Number: RAPG-RAV-001). The test was performed and interpreted according to the manufacturer's instructions and our previous study (29).

1.4. Statistical analysis

Data analysis was performed using the SPSS (Statistical Package for Social Sciences) software package (version 23) (IBM Corp., Armonk, N.Y., USA).

2. Results

3.1. Rotavirus detection rates

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Stool samples from 46 of 104 children contained rotavirus antigen positive on day 7 post-vaccine. The 58 of 104 were negative for rotavirus antigen. Rotavirus detection in 20 of 49 participants after the first dose, 15 of 32 after the second dose, and 11 of 23 after the third dose table 1.

Table 1. Relative Frequencies% (n), of Rotavirus antigens detection in stool on day 7 post administration of three doses of RotaTeq® Vaccine

Results of Combo Rapid Test [1]	1st Dose* (n= 49)	2nd Dose* (n=32)	3rd Dose* (n= 23)	Total (n= 104)
Positive test	40.8 % (20)	46.9% (15)	47.8% (11)	44.2% (46)
Negative test	59.2 % (29)	53.1% (17)	52.2% (12)	55.7% (58)

[1] Rotavirus and Adenovirus Combo Rapid Test Kit (Biopanda Reagents Ltd., Belfast, United Kingdom, Product Number: RAPG-RAV-001), (on day 7 post RotaTeq® Vaccine)
*1st dose (at two months of age), 2nd dose (at four months of age), and 3rd dose (at Six months of age)
n= number of samples

In addition, the distribution of positive rotavirus according to gender at two months (n=20) showed 35% (n=7) male, and 65% (n=13) female, at four months (n=15) it showed 53.3% (n=8) male, and 46.7% (n=7) female, and at six months (n=11) showed 63.3 % (n=7) male, and 36.4% (n=4) female.

3.2. Adenovirus detection rates

Stool samples from 47 (45.2%) of 104 children contained enteric adenovirus antigen-positive and 57 (54.8%) were negative for enteric adenovirus antigens Table 2.

Table 2. Relative Frequencies % (n), of adenovirus antigens detection in stool samples by Combo Rapid Test

Results of Combo Rapid Test [1]	at two months of age (n*= 49)	at four months of age (n*=32)	at six months of age (n*= 23)	Total (n*= 104)
Positive test	30.6 % (15)	٥٠ % (16)	69.6 % (16)	45.2 % (47)
Negative test	69.4 % (34)	٥٠ % (16)	30.4 % (7)	54.8 % (57)

[1] Rotavirus and Adenovirus Combo Rapid Test Kit (Biopanda Reagents Ltd., Belfast, United Kingdom, Product Number: RAPG-RAV-001).

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*****n= number of samples

The distribution of positive enteric adenovirus, according to gender were 53.2 % (n=25) male and 46.8 % (n=22) female, among them were at two months (n=15) showed 40 % (n=6) male and 60% (n=9) female, at four months (n=16) it showed 68.7% (n=11) male and 31.3% (n=5) female, and at six months (n=16) showed 50% (n=8) male and 50% (n=8) female.

3.3. Co- rotavirus and adenovirus detection rates

Stool samples from 32 (30.8 %) of 104 children were rotavirus and enteric adenovirus antigens-positive specimens and 72 (69.2%) were negative for rotavirus and enteric adenovirus antigens Table 2.

Table 3. Relative Frequencies % (n), of rotavirus and enteric adenovirus antigens detection in stool samples by Combo Rapid Test

Results of Combo Rapid Test [1]	at two months of age (n*= 49)	at four months of age (n*=32)	at six months of age (n*= 23)	Total (n*= 104)
Positive test	24.5% (12)	34.4 % (11)	39.1 % (9)	30.8 % (32)
Negative test	75.5% (37)	65.6 % (21)	60.9 % (14)	69.2% (72)

[1] Rotavirus and Adenovirus Combo Rapid Test Kit (Biopanda Reagents Ltd., Belfast, United Kingdom, Product Number: RAPG-RAV-001)

*n= number of samples

The distribution of positive rotavirus and adenovirus, according to gender were 53 % (n=17) male and 47% (n=15) female, among them were at two months (n=11) showed 36.4 % (n=4) male and 63.6% (n=7) female, at four months (n=11) it showed 63.6% (n=7) male and 36.4% (n=4) female, and at six months (n=10) showed 60% (n=6) male and 40% (n=4) female.

4. Discussion

Rotavirus and enteric adenovirus are the main causes of acute gastroenteritis, which leads to significant illness and death worldwide. These viruses primarily affect infants and young children, posing serious health risks, especially in developing nations.

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In this study, we detected the presence of rotavirus and enteric adenovirus antigens in fecal samples from vaccinated infants aged 2, 4, and 6 months, following the administration of RotaTeq® vaccine by using an ICT test.

The results of this study showed that fecal shedding of rotaviruses antigens was observed in vaccinated infants at all three doses, 40.8 % following the first dose, 46.9% following the second dose, and 47.8% following the third dose by an ICT test. A previous study also discovered that vaccinated infants shed the rotavirus vaccine at all three doses, with the highest shedding occurring on the day 7 post-vaccination (6). In contrast to 12.7% following the first dose, 0 following the second dose and following the third dose of fecal shedding of vaccine virus in a large trial by using PCR (1). In another study (REST), 8.9% following the first dose, 0 following the second dose, and 0.3% following the third dose (4). According to a study conducted in 2011, the presence of rotavirus vaccine virus in fecal samples was 21.4% after the first dose (5).

According to positive rotavirus and enteric adenovirus antigens samples among vaccinated and healthy infants between 2-6 months, they were similar 44.2% positive rotavirus samples, 45.2% positive enteric adenovirus samples and 30.8% positive co- rotavirus and enteric adenovirus samples. According to age and gender there was no different between them, except 69.6% detection rate in group of age 6 months among positive enteric adenovirus samples, which could be attributed to the decrease in protection provided by specific maternal antibodies acquired through full breastfeeding (30).

5. Conclusion

Rotavirus and enteric adenovirus antigens were shedding among vaccinated and healthy infants between 2-6 months. The shedding of rotavirus and enteric adenovirus in feces plays a crucial role in disease transmission, as it increases the risk of pathogens being released into the environment and subsequently infecting other susceptible individuals (e.g., immunocompromised individuals in households with vaccinated infants).

Furthermore, our study was limited by a small sample size, there were no plans to use sensitive RT-PCR to detect vaccine viruses, and we were unable to determine after what dose long-term

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shedding started. Further research, including results RT-PCR will help answer these important questions.

Conflict of Interests

The authors declare that there is no conflict of interest.

Data availability

All data generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Financial Disclosure

The author states that no funding was provided for this study.

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Ethics:

Permission for the study was obtained from faculty of public health management, allowing our students to carry out project work in partial fulfillment of the requirements for the Bachelor of Public Health degree. Verbal consent was obtained from participant's families after the purpose of the study was explained. All data obtained from participants was kept confidential and used only for the study.

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References:

1. Vesikari, Timo, David O. Matson, Penelope Dennehy, Pierre Van Damme, Mathuram Santosham, Zoe Rodriguez, Michael J. Dallas et al. "Safety and efficacy of a pentavalent human–bovine (WC3) reassortant rotavirus vaccine." *New England Journal of Medicine* 354, no. 1 (2006): 23-33.

2. Cortese, Margaret M., and Umesh D. Parashar. "Prevention of rotavirus gastroenteritis among infants and children: recommendations of the Advisory Committee on Immunization Practices (ACIP)." *Morbidity and Mortality Weekly Report: Recommendations and Reports* 58, no. 2 (2009): 1-25.

3. Miftah, Awadh, Salem IM Alkoshi, Kacey C. Ernst, and Smeo Mohamed Nagib. "Frequency of rota virus infection among children in North-Eastern Region of Libya: A hospital-based study from Almarj." *Libyan Journal of Medical Sciences* 1, no. 3 (2017): 76-79.

4. it Work, How Does. "Merck Updates Prescribing Information for ROTATEQ (R), the Company's Vaccine to Help Prevent Rotavirus Gastroenteritis in Infants and Children.".

5. Yen, Catherine, Kathleen Jakob, Mathew D. Esona, Ximara Peckham, John Rausch, Jennifer J. Hull, Susan Whittier, Jon R. Gentsch, and Philip LaRussa. "Detection of fecal shedding of rotavirus vaccine in infants following their first dose of pentavalent rotavirus vaccine." *Vaccine* 29, no. 24 (2011): 4151-4155.

6. Phua, Kong Boo, Seng Hock Quak, Bee Wah Lee, Shanta Christina Emmanuel, Paul Goh, Htay Htay Han, Beatrice De Vos, and Hans Ludwig Bock. "Evaluation of RIX4414, a live, attenuated rotavirus vaccine, in a randomized, double-blind, placebo-controlled phase 2 trial involving 2464 Singaporean infants." *Journal of Infectious Diseases* 192, no. Supplement_1 (2005): S6-S16.

7. Matthijnssens, Jelle, Mustafizur Rahman, Vito Martella, Yang Xuelei, Sofie De Vos, Karolien De Leener, Max Ciarlet, Canio Buonavoglia, and Marc Van Ranst. "Full genomic analysis of human rotavirus strain B4106 and lapine rotavirus strain 30/96 provides evidence for interspecies transmission." *Journal of virology* 80, no. 8 (2006): 3801-3810.

8. Lopman, Ben A., Aaron T. Curns, Catherine Yen, and Umesh D. Parashar. "Infant rotavirus vaccination may provide indirect protection to older children and adults in the United States." *Journal of infectious Diseases* 204, no. 7 (2011): 980-986.

9. Curns, Aaron T., Claudia A. Steiner, Marguerite Barrett, Katherine Hunter, Emily Wilson, and Umesh D. Parashar. "Reduction in acute gastroenteritis hospitalizations among US children after introduction of rotavirus vaccine: analysis of hospital discharge data from 18 US states." *The Journal of infectious diseases* 201, no. 11 (2010): 1617-1624.

10. Kang, Gagandeep, Miren Iturriza-Gomara, Jeremy G. Wheeler, Premila Crystal, Bindhu Monica, Sasirekha Ramani, Beryl Primrose et al. "Quantitation of group A rotavirus by real-time reverse-transcription-polymerase chain reaction: Correlation with clinical severity in children in South India." *Journal of medical virology* 73, no. 1 (2004): 118-122.

11. Mukhopadhya, Indrani, Rajiv Sarkar, Vipin Kumar Menon, Sudhir Babji, Anu Paul, Priya Rajendran, Thuppal V. Sowmyanarayanan et al. "Rotavirus shedding in symptomatic and asymptomatic children using reverse transcription-quantitative PCR." *Journal of medical virology* 85, no. 9 (2013): 1661-1668.

12. Bennett, Aisleen, Louisa Pollock, Khuzwayo C. Jere, Virginia E. Pitzer, Benjamin Lopman, Naor Bar-Zeev, Miren Iturriza-Gomara, and Nigel A. Cunliffe. "Duration and density of fecal rotavirus shedding in vaccinated Malawian children with rotavirus gastroenteritis." *The Journal of infectious diseases* 222, no. 12 (2020): 2035-2040.

13. Troeger, Christopher, Ibrahim A. Khalil, Puja C. Rao, Shujin Cao, Brigette F. Blacker, Tahmeed Ahmed, George Armah et al. "Rotavirus vaccination and the global burden of rotavirus diarrhea among children younger than 5 years." *JAMA pediatrics* 172, no. 10 (2018): 958-965.

14. Hsieh, Yu-Chia, Fang-Tzy Wu, Chao A. Hsiung, Ho-Sheng Wu, Kuang-Yi Chang, and Yhu-Chering Huang. "Comparison of virus shedding after lived attenuated and pentavalent reassortant rotavirus vaccine." *Vaccine* 32, no. 10 (2014): 1199-1204.

15. Vesikari, Timo, David O. Matson, Penelope Dennehy, Pierre Van Damme, Mathuram Santosham, Zoe Rodriguez, Michael J. Dallas et al. "Safety and efficacy of a pentavalent human–bovine (WC3) reassortant rotavirus vaccine." *New England Journal of Medicine* 354, no. 1 (2006): 23-33.

16. Hsieh, Yu-Chia, Fang-Tzy Wu, Chao A. Hsiung, Ho-Sheng Wu, Kuang-Yi Chang, and Yhu-Chering Huang. "Comparison of virus shedding after lived attenuated and pentavalent reassortant rotavirus vaccine." *Vaccine* 32, no. 10 (2014): 1199-1204.

17. Ye, Suifang, David M. Whiley, Robert S. Ware, Carl D. Kirkwood, Stephen B. Lambert, and Keith Grimwood. "Multivalent rotavirus vaccine and wild-type rotavirus strain shedding in Australian infants: a birth cohort study." *Clinical Infectious Diseases* 66, no. 9 (2018): 1411-1418.

18. Payne, Daniel C., Kathryn M. Edwards, Michael D. Bowen, Erin Keckley, Jody Peters, Mathew D. Esona, Elizabeth N. Teel, Diane Kent, Umesh D. Parashar, and Jon R. Gentsch. "Sibling transmission of vaccine-derived rotavirus (RotaTeq) associated with rotavirus gastroenteritis." *Pediatrics* 125, no. 2 (2010): e438-e441.

19. Anderson, Evan J. "Rotavirus vaccines: viral shedding and risk of transmission." *The Lancet infectious diseases* 8, no. 10 (2008): 642-649.

20. Perez-Schael, Irene, María J. Guntiñas, Mireya Pérez, Vito Pagone, Ana M. Rojas, Rosabel González, Walter Cunto, Yasutaka Hoshino, and Albert Z. Kapikian. "Efficacy of the rhesus rotavirus–based quadrivalent vaccine in infants and young children in enezuela." *New England Journal of Medicine* 337, no. 17 (1997): 1181-1187.

21. Whiley, David M., Suifang Ye, Sarah Tozer, Julia E. Clark, Cheryl Bletchly, Stephen B. Lambert, Keith Grimwood, and Graeme R. Nimmo. "Over-diagnosis of rotavirus infection in infants due to detection of vaccine virus." *Clinical Infectious Diseases* 71, no. 5 (2020): 1324-1326.

22. Bennett, Aisleen, Louisa Pollock, Khuzwayo C. Jere, Virginia E. Pitzer, Benjamin Lopman, Naor Bar-Zeev, Miren Iturriza-Gomara, and Nigel A. Cunliffe. "Duration and density of fecal rotavirus shedding in vaccinated Malawian children with rotavirus gastroenteritis." *The Journal of infectious diseases* 222, no. 12 (2020): 2035-2040.

23. Li, Jin-song, Bing Cao, Han-chun Gao, Dan-di Li, Lin Lin, Li-li Li, Na Liu, and Zhao-Jun Duan. "Faecal shedding of rotavirus vaccine in Chinese children after vaccination with Lanzhou lamb rotavirus vaccine." *Scientific Reports* 8, no. 1 (2018): 1001.

24.Markkula J, Hemming M, Vesikari T. Detection of vaccine-derived rotavirus strains in nonimmunocompromised children up to 3–6 months after RotaTeq® vaccination. The Pediatric infectious disease journal. 2015 Mar 1;34(3):296-8.

25.Payne DC, Edwards KM, Bowen MD, Keckley E, Peters J, Esona MD, Teel EN, Kent D, Parashar UD, Gentsch JR. Sibling transmission of vaccine-derived rotavirus (RotaTeq) associated with rotavirus gastroenteritis. Pediatrics. 2010 Feb 1;125(2):e438-41.

26. Bennett, Aisleen, Louisa Pollock, Khuzwayo C. Jere, Virginia E. Pitzer, Benjamin Lopman, Umesh Parashar, Dean Everett et al. "Infrequent transmission of monovalent human rotavirus vaccine virus to household contacts of vaccinated infants in Malawi." *The Journal of Infectious Diseases* 219, no. 11 (2019): 1730-1734.

27. Han, Sangha, Seok-Woo Hyun, Jeong Won Son, Min Su Song, Dong Jae Lim, Changsun Choi, Si Hong Park, and Sang-Do Ha. "Innovative nonthermal technologies for inactivation of emerging foodborne viruses." *Comprehensive Reviews in Food Science and Food Safety* (2023).

28.Samson Enitan, S., Ihongbe, J. C., Ochei, J. O., Oluremi, A. S., & Ajulibe, G. E. (2019). Detection of rotavirus and adenovirus Co-infection among apparently healthy school aged children in Ilishan-remo community of Ogun state, Nigeria. *Asian Journal of Pediatric Research*, *2*(4), 1-12.

29. Elfaitouri, Amal, Guma Abdeldaim, Asma Elshebani, and Suaad Abdallah. "Detection of Rotavirus and Enteric Adenovirus among children with Acute Gastroenteritis admitted to Benghazi Pediatric Hospital." Libyan J Med Res. 2023(-17-1)-19-29

30. do Nascimento, Lilian Gonçalves, Alexandre Madi Fialho, Juliana da Silva Ribeiro de Andrade, Rosane Maria Santos de Assis, and Tulio Machado Fumian. "Human enteric adenovirus F40/41 as a major cause of acute gastroenteritis in children in Brazil, 2018 to 2020." *Scientific Reports* 12, no. 1 (2022): 11220.