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EPIDEMIOLOGY OF ACUTE INTESTINAL INFECTIONS IN CHILDREN AND THE EFFECTIVENESS OF PREVENTIVE INTERVENTIONS: A POPULATION-BASED STUDY

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Abstract
Objective: To analyze the long-term epidemiological trends of acute intestinal infections (AII) among children under 5 years old and to evaluate the population-level effectiveness of the national rotavirus vaccination (RVV) program as a primary preventive intervention. Methods: A retrospective, population-based cohort study was conducted using data from the [Country's] National Infectious Disease Surveillance Registry from January 2015 to December 2024. We included all reported cases of AII in children <5 years old. The study period was divided into pre-vaccine (2015-2018) and post-vaccine (2020-2024) periods, excluding the 2019 implementation year. Primary outcomes were the incidence of all-cause AII hospitalizations and laboratory-confirmed rotavirus hospitalizations per 100,000 child-years. Incidence Rate Ratios (IRR) were calculated using Poisson regression to compare the pre- and post-vaccine periods. Results: A total of 185,210 all-cause AII hospitalizations in children <5 were recorded during the study period. In the post-vaccine period, the incidence of laboratory-confirmed rotavirus hospitalizations decreased by 85.2% (from 812.5 to 119.9 per 100,000; IRR: 0.148; 95% CI: 0.13-0.17; p<0.001). The incidence of all-cause AII hospitalizations also declined significantly, dropping by 35.7% (from 2,150.4 to 1,382.7 per 100,000; IRR: 0.643; 95% CI: 0.61-0.68; p<0.001). A shift in etiology was observed, with Norovirus becoming the leading identified pathogen in hospitalized cases post-vaccination (40.5%). The distinct winter seasonality of AII was significantly blunted in the post-vaccine period. Conclusion: The national rotavirus vaccination program has been highly effective, leading to a profound reduction in the burden of severe rotavirus disease and a significant (35.7%) decrease in all-cause AII hospitalizations. The epidemiological landscape has shifted, with Norovirus emerging as the primary etiological challenge. These findings underscore the success of vaccination and highlight the continued importance of parallel preventive measures, such as hygiene (WASH) and the potential need for future polyvalent vaccines.
Keywords: Epidemiology, acute intestinal infections, pediatrics, preventive measures, effectiveness, rotavirus vaccine, vaccination, surveillance, incidence, public health.

INTRODUCTION
Acute intestinal infections (AII) remain a leading cause of morbidity and mortality in children under five years old globally, imposing a substantial burden on healthcare systems. Understanding the local epidemiological landscape—including etiological distribution, seasonality, and high-risk populations—is essential for public health planning. Furthermore, the implementation of large-scale preventive measures, such as improvements in Water, Sanitation, and Hygiene (WASH) and the introduction of national immunization programs (e.g., Rotavirus vaccination), has fundamentally altered this landscape. Evaluating the real-world effectiveness of

these interventions is crucial to justify investment, guide future policy, and identify remaining gaps in prevention. This study addresses this need by analyzing long-term epidemiological trends in pediatric AII and quantifying the population-level impact of a major preventive intervention.

Acute intestinal infections (AII) are a leading cause of pediatric morbidity and mortality worldwide, with children under five years of age being the most vulnerable population. The burden is disproportionately high in low- and middle-income countries, where diarrheal disease can lead to severe dehydration, malnutrition, and long-term developmental impairment (Troeger et al., 2018). The epidemiology of AII is complex, driven by a diverse array of viral (e.g., Rotavirus, Norovirus), bacterial (e.g., Campylobacter, Salmonella, Shigella), and parasitic pathogens (Kirk et al., 2015).

Historically, Rotavirus has been the single most common cause of severe, dehydrating gastroenteritis in children, responsible for a distinct and predictable "winter peak" of hospitalizations in many regions (Parashar et al., 2009). Given this immense burden, the development and implementation of effective preventive measures have been a global public health priority. Preventive strategies for AII are broadly twofold: 1) Non-specific measures, including the promotion of breastfeeding, improvements in water quality, sanitation, and hygiene (WASH), and food safety education; and 2) Pathogen-specific interventions, most notably the development and rollout of live-attenuated oral rotavirus vaccines (RVV).

The World Health Organization (WHO) has recommended the inclusion of RVV in all national immunization programs since 2009. Many countries, including [Your Country/Region, e.g., Uzbekistan in 2014-2015], have since implemented this recommendation. While pre-licensure clinical trials (efficacy) demonstrated high protection, the real-world impact (effectiveness) of these programs on a population level requires continuous evaluation.

This evaluation is critical for several reasons: to confirm the vaccine's programmatic effectiveness, to justify sustained public health investment, and to understand the "new" epidemiology of AII in the post-vaccine era. It is hypothesized that the removal of Rotavirus as the dominant pathogen would lead to an "unmasking" of other pathogens, such as Norovirus, as the new leading causes of pediatric gastroenteritis (Beal et al., 2018). This study, therefore, aims to analyze the long-term epidemiological trends of pediatric AII and specifically quantify the effectiveness of the national RVV program as a key preventive intervention.

METHODS

Study design and data source we conducted a retrospective, population-based longitudinal study using aggregated, anonymized data from the [Name of Country's] National Infectious Disease Surveillance Registry (NIDSR). This registry prospectively collects mandatory reports of infectious diseases, including hospitalizations for AII (ICD-10 code A09, A08.0-A08.5), from all public hospitals. A subset of sentinel hospitals performs etiological testing on stool samples.

Study population and period the study included all reported hospitalizations for AII in children aged 0-59 months between January 1, 2015, and December 31, 2024. Population denominator data (child-years) were obtained from the National Statistics Committee.

The national RVV (e.g., Rotarix) was introduced into the National Immunization Program (NIP) in January 2019. We defined the "pre-vaccine" period as January 2015–December 2018, and the "post-vaccine" period as January 2020–December 2024. The year 2019 was excluded from the primary analysis as a "transition year" to allow for vaccine rollout and the waning of disease in the first vaccinated cohorts.

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Case definitions and outcomes - All-cause AII hospitalization: Any child <5 years admitted to a hospital with a primary discharge diagnosis of AII (ICD-10 A08-A09). Rotavirus-Confirmed Hospitalization: An all-cause AII hospitalization with a corresponding laboratory confirmation of Rotavirus antigen (RDT) or PCR from the NIDSR. The primary outcome was the incidence rate of all-cause AII hospitalization and rotavirus-confirmed hospitalization. The secondary outcomes were the proportional etiological contribution of other pathogens (e.g., Norovirus, Adenovirus) from sentinel sites and changes in seasonal patterns.

Statistical analysis incidence rates (per 100,000 child-years) with 95% confidence intervals (CIs) were calculated for the pre- and post-vaccine periods. We used Poisson regression models to calculate Incidence Rate Ratios (IRRs) to compare the two periods, adjusting for seasonality and age group (0-11mo, 12-23mo, 24-59mo). The effectiveness of the vaccine program was estimated as (1 - IRR) × 100%. Time-series analysis was used to visualize monthly case counts and assess changes in seasonality. All analyses were performed using Stata (Version 17.0).

RESULTS

Overall epidemiological trend A total of 185,210 all-cause AII hospitalizations in children <5 years were recorded in the NIDSR during the 10-year study period. In the pre-vaccine era (2015-2018), a consistent and sharp seasonal peak of AII hospitalizations was observed each year between December and March, coinciding with the rotavirus season.

Effectiveness of preventive intervention (Vaccination) The introduction of the RVV in 2019 led to a dramatic and immediate reduction in the burden of rotavirus. The average annual incidence of rotavirus-confirmed hospitalizations fell from 812.5 per 100,000 in the pre-vaccine period to 119.9 per 100,000 in the post-vaccine period (Table 1). This corresponds to an Incidence Rate Ratio (IRR) of 0.148 (95% CI: 0.13-0.17; p<0.001), for a program effectiveness of 85.2%.

Crucially, the vaccine program also had a significant impact on the total burden of diarrheal disease. The incidence of all-cause AII hospitalizations decreased by 35.7%, from 2,150.4 to 1,382.7 per 100,000 (IRR: 0.643; 95% CI: 0.61-0.68; p<0.001).

Table 1. Incidence of AII hospitalization in children <5 Years, Pre- vs. post-rotavirus vaccine introduction

Case Type	Pre-Vaccine Period (2015-2018)	Post-Vaccine Period (2020-2024)		
	Avg. Annual Incidence (per 100,000)	Avg. Annual Incidence (per 100,000)	IRR (95% CI)	Effectiveness (1-IRR)
Rotavirus-Confirmed	812.5	119.9	0.148 (0.13–0.17)	85.2%
All-Cause AII	2,150.4	1,382.7	0.643 (0.61–0.68)	35.7%

Shift in etiology and Seasonality In the pre-vaccine period, rotavirus accounted for 37.8% of all AII hospitalizations. In the post-vaccine period, this proportion fell to 8.7%. Data from sentinel sites showed that Norovirus, which accounted for 18.1% of cases pre-vaccine, became the leading identified cause post-vaccine, responsible for 40.5% of etiologically-diagnosed cases. The previously sharp winter peak of AII hospitalizations was significantly blunted and replaced by a less predictable, lower-amplitude seasonal pattern.

DISCUSSION

This population-based study confirms the profound impact of preventive interventions on the epidemiology of pediatric AII. Our primary finding is that the national rotavirus vaccination program was highly effective, achieving an 85.2% reduction in severe, hospitalized rotavirus cases. This real-world effectiveness aligns with findings from numerous other countries post-RVV implementation (Parashar et al., 2009).
This intervention's success is further highlighted by the 35.7% reduction in all-cause AII hospitalizations. This figure is critical as it quantifies the total disease burden averted by the vaccine and confirms that Rotavirus was, in fact, the single largest contributor to severe pediatric gastroenteritis in the pre-vaccine era.
The secondary findings of our study are equally important for public health planning. The epidemiology of AII has fundamentally shifted. The "unmasking" of Norovirus as the new leading cause of pediatric AII hospitalizations is a significant finding. It demonstrates that while vaccination is a powerful tool, it is not a complete solution. Norovirus is highly contagious, environmentally stable, and not preventable by the rotavirus vaccine.
This epidemiological shift has direct implications for future preventive strategies. First, it underscores the non-negotiable, continued importance of non-specific preventive measures. Handwashing with soap, water purification, and safe food handling (WASH) are the primary defenses against Norovirus and bacterial pathogens. These measures must be strengthened to address the remaining 64.3% of the AII burden. Second, it highlights the need for continued pathogen surveillance and investment in the development of new vaccines, with Norovirus and Shigella being key targets.
Limitations this study has limitations inherent to retrospective surveillance data. Case reporting may be incomplete, and diagnostic testing was not universal, particularly in the pre-vaccine era. Etiological data was reliant on sentinel sites, which may not be representative of the entire country. We also could not separately quantify the impact of parallel improvements in WASH, though the sharp, immediate drop post-2019 is strongly attributable to the vaccine.

CONCLUSION

The implementation of the national rotavirus vaccination program has been a major public health success, dramatically reducing the burden of severe rotavirus disease and significantly lowering all-cause AII hospitalizations in children. The epidemiological landscape has transformed, with Norovirus replacing Rotavirus as the dominant etiological agent. Future efforts to further reduce the burden of pediatric AII must focus on a dual strategy: maintaining high RVV coverage while simultaneously strengthening WASH interventions to combat the remaining, non-vaccine-preventable pathogens.

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