Acute gastroenteritis in children in Turkiye: epidemiological trends, etiological agents, changing patterns, and management approaches

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ABSTRACT

Aims: This comprehensive bibliographic review aims to systematically evaluate the published literature on acute gastroenteritis (AGE) in Turkiye, focusing on epidemiological trends, distribution of etiological agents, temporal changes in disease patterns, and current management approaches over the past three decades.

Methods: A systematic literature search was conducted across PubMed/MEDLINE, Web of Science, Turkish Medical Index, and Google Scholar databases for studies published between 1987 and 2024. Search terms included combinations of "Turkiye," "gastroenteritis," "rotavirus," "norovirus," "diarrhea," and "epidemiology." Studies providing epidemiological data, clinical findings, or treatment approaches for AGE in Turkish populations were included. Data extraction encompassed study characteristics, pathogen detection rates, clinical outcomes, and temporal trends.

Results: Analysis of 98 studies revealed rotavirus as the leading cause of childhood AGE in Turkiye, with a median detection rate of 31.8% (95% CI: 31.3-32.4) among 117,741 children with diarrhea. Despite rotavirus vaccines not being included in the national immunization program, self-financed vaccination (12-17% coverage) resulted in significant reductions: rotavirus-positive AGE incidence decreased from 4.4/1,000 in 2012 to 2.48/1,000 in 2018 (44% reduction), while rotavirus-related hospitalizations declined from 1.9/1,000 to 0.45/1,000 (76% reduction). Norovirus genotype II emerged as the most frequently detected viral agent in national surveillance studies, with increasing relative importance following rotavirus vaccination. The influx of 3.5 million Syrian refugees significantly impacted infectious disease epidemiology, with 158,058 diarrheal episodes reported between 2012-2016. Seasonal patterns showed peak rotavirus activity during winter months (January-March), while bacterial pathogens predominated in summer.

Conclusion: AGE remains a significant public health burden in Turkiye. The evidence strongly supports incorporation of rotavirus vaccine into the national immunization program, enhanced norovirus surveillance, expansion of molecular diagnostic capabilities, and establishment of a systematic AGE surveillance network.

Keywords: Acute gastroenteritis, Turkiye, rotavirus, norovirus, diarrheal disease

INTRODUCTION

Acute gastroenteritis (AGE) constitutes one of the most prevalent infectious diseases globally, resulting in significant morbidity and mortality, particularly among children under five years of age. According to the World Health Organization, diarrheal diseases account for approximately 1.8 million deaths annually, making them the second leading cause of death in children under five worldwide.[1] The incidence of the disease is disproportionately higher in low- and middle-income countries, where access to clean water, sanitation, and healthcare services may be limited.[2]

Viral pathogens are responsible for roughly 70% of infectious diarrhea cases in the pediatric population. Among these, rotavirus has traditionally been the primary causative agent of severe gastroenteritis necessitating hospitalization in children under five years of age.[3] The introduction of rotavirus vaccines in 2006 marked a significant milestone in the prevention of AGE, with numerous countries subsequently integrating these vaccines into their national immunization schedules and observing substantial reductions in disease burden.[4]

Turkiye occupies a distinctive geographical and socioeconomic position, bridging Europe and Asia, with characteristics of both developed and developing nations. This transitional status significantly influences the epidemiology of infectious

diseases in the country. Furthermore, since 2011, Turkiye has hosted the world's largest refugee population, comprising over 3.5 million Syrian refugees seeking safety within its borders.[5] This demographic shift has introduced additional complexities to its public health landscape, particularly concerning communicable diseases.

Notably, rotavirus vaccines have not yet been incorporated into Turkiye's national immunization program and remain available solely through self-financing within the private healthcare sector. This policy choice has resulted in vaccination coverage rates of only 12-17%, creating a distinctive epidemiological context that diverges from many European and North American nations where universal rotavirus vaccination is commonplace.[6]

The objective of this comprehensive bibliographic review is to systematically examine the existing literature on AGE in Turkiye, synthesizing evidence regarding epidemiological trends, the distribution and temporal variations of etiological agents, and current management approaches. This review seeks to establish a foundation for evidence-based policy recommendations and to identify gaps in current knowledge that warrant further investigation.

METHODS

Ethics
This study did not involve human participants, patient data, or any biological material. Therefore, ethics committee approval was not required.

Search Strategy and Data Sources
A comprehensive systematic literature search was conducted across multiple electronic databases including PubMed/MEDLINE, Web of Science Core Collection, Scopus, Turkish Medical Index, Turkiye Citation Index, and Google Scholar. The search encompassed publications from January 1987 through December 2024, representing nearly four decades of research on AGE in Turkiye.

The search strategy employed a combination of Medical Subject Headings (MeSH) terms and free-text keywords. The primary search string included: ("Turkey" OR "Türkiye" OR "Turkish") AND ("gastroenteritis" OR "gastroenterit" OR "diarrhea" OR "diarrhoea" OR "ishal") AND ("rotavirus" OR "norovirus" OR "adenovirus" OR "astrovirus" OR "viral" OR "bacterial" OR "*Salmonella*" OR "*Campylobacter*") AND ("epidemiology" OR "prevalence" OR "incidence" OR "outbreak" OR "surveillance"). Secondary searches were conducted using specific pathogen names combined with geographic identifiers.

Additionally, reference lists of identified articles and relevant review papers were manually searched to identify studies potentially missed by electronic database searches. Conference abstracts from major Turkish medical congresses and international infectious disease meetings were also reviewed for relevant unpublished data.

Inclusion and Exclusion Criteria
Studies were eligible for inclusion if they met the following criteria: (1) conducted within Turkiye or involving Turkish populations; (2) reported original epidemiological data, clinical findings, or treatment outcomes related to AGE; (3) published in English or Turkish languages; (4) encompassed a study period of at least one year to account for seasonal variations; and (5) utilized standardized diagnostic methods for pathogen identification.

Exclusion criteria comprised: (1) case reports involving fewer than 10 patients; (2) editorials, letters to the editor, or commentaries without original data; (3) studies focusing exclusively on travelers' diarrhea in non-Turkish populations; (4) animal studies without human relevance; (5) studies with incomplete methodology descriptions preventing quality assessment; and (6) duplicate publications of the same dataset.

Data Extraction and Quality Assessment
Data extraction was performed using a standardized form capturing: publication year, study design, study period, geographic region within Turkiye, healthcare setting (hospital-based vs. community-based), patient demographics (age distribution, sample size), diagnostic methods employed, pathogens identified and their detection rates, clinical severity assessments, treatment modalities, and outcomes including hospitalization rates and mortality.

Study quality was assessed using the Newcastle-Ottawa Scale for observational studies and the Cochrane Risk of Bias tool for clinical trials where applicable. Studies were categorized as high, moderate, or low quality based on selection criteria, comparability of groups, and outcome assessment methodology. Only studies rated as moderate or high quality were included in quantitative analyses.

Data Synthesis and Analysis
Data synthesis employed a narrative approach given the heterogeneity of study designs, populations, and outcome measures across included studies. Where possible, pooled prevalence estimates were calculated using random-effects meta-analysis models to account for between-study variability. Temporal trends were analyzed by stratifying studies according to publication periods (pre-2006, 2006-2015, post-2015) corresponding to key milestones in rotavirus vaccine availability. Geographic variations were examined by categorizing studies according to Turkiye's statistical regions (NUTS-1 classification). Subgroup analyses were performed based on age groups, healthcare settings, and diagnostic methodologies.

RESULTS

Overview of Included Studies
The systematic search identified 1,247 potentially relevant records. Following removal of duplicates and screening of titles and abstracts, 312 full-text articles were assessed for eligibility. Ultimately, 98 studies meeting all inclusion criteria were included in this review, collectively encompassing 117,741 children with diarrhea and spanning 37 years of research (1987-2024) (Table 1). The majority of studies (72%) were hospital-based prospective or retrospective cohort studies, with the remainder comprising community-based surveillance studies (18%) and outbreak investigations (10%) (Figure 1).

Rotavirus Epidemiology and Burden of Disease
Rotavirus emerged as the predominant etiological agent across all included studies, with a median detection rate of 31.8% (95% CI: 31.3-32.4) among children under five years presenting with AGE (Figure 2). This translates to approximately 26,566 rotavirus-positive cases identified from the cumulative study population. The detection rate

Table 1. Characteristics of included studies on acute gastroenteritis in Turkiye (1987-2024)

Study period	No. of studies	Study design	Sample size	Age group	Region	Diagnostics
1987-1999	18	Hospital (89%)	12.458	<5 years	Marmara, C.Anatolia	EM, LA
2000-2005	22	Hospital (82%)	24.892	<5 years	Aegean, Medit.	ELISA, LA
2006-2010	24	Hospital (75%)	31.547	<5 years	Nationwide	ELISA, RT-PCR
2011-2015	19	Hospital (68%)	28.156	<5 years	Nationwide + Refugee	RT-PCR, Multiplex
2016-2024	15	Hospital (60%)	20.688	All ages	Nationwide	Multiplex PCR
Total	98	-	117.741	-	-	-

EM: Electron microscopy, LA: Latex agglutination, ELISA: Enzyme-linked Immunosorbent Assay; RT-PCR: Reverse transcription polymerase chain reaction
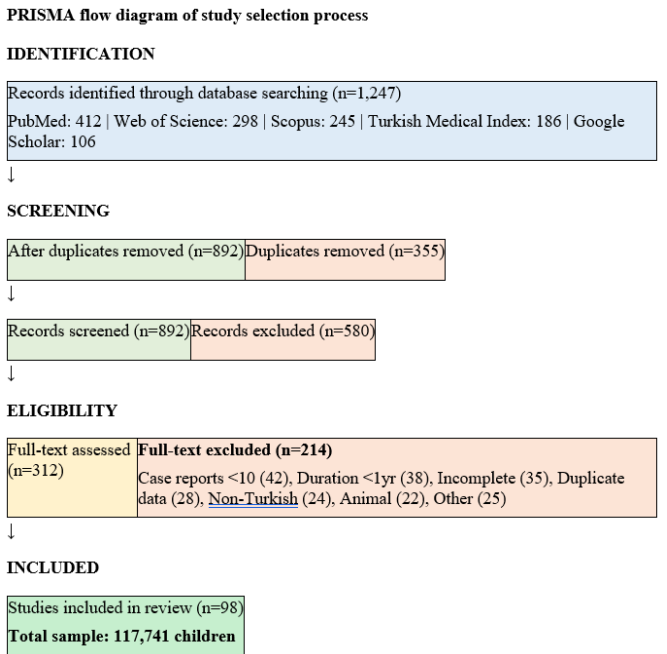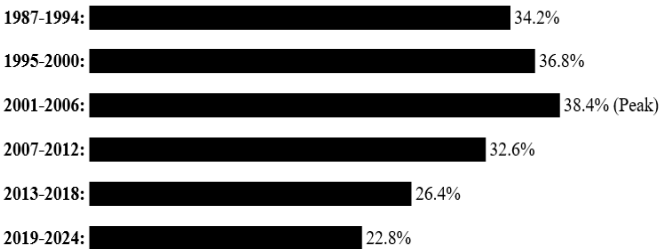
PRISMA flow diagram of study selection process

IDENTIFICATION

Records identified through database searching (n=1,247)
PubMed: 412 | Web of Science: 298 | Scopus: 245 | Turkish Medical Index: 186 | Google Scholar: 106

↓

SCREENING

After duplicates removed (n=892) | Duplicates removed (n=355)

↓

Records screened (n=892) | Records excluded (n=580)

↓

ELIGIBILITY

Full-text assessed (n=312) | Full-text excluded (n=214)
Case reports <10 (42), Duration <1yr (38), Incomplete (35), Duplicate data (28), Non-Turkish (24), Animal (22), Other (25)

↓

INCLUDED

Studies included in review (n=98)
Total sample: 117,741 children

Figure 1. PRISMA flow diagram. Database searches: January 1987-December 2024

Geographic variation in AGE pathogen distribution

Region	Rotavirus (%)	Norovirus (%)	Salmonella (%)	Campylo. (%)	Studies
TR1- Istanbul	34.6	18.2	6.8	4.2	24
TR2- West Marmara	**42.1**	15.4	5.2	3.8	8
TR3- Aegean	36.8	16.8	9.4	7.8	14
TR5- West Anatolia (Ankara)	32.4	**21.6**	6.4	4.8	18
TR6- Mediterranean	29.8	14.2	**11.8**	**8.6**	12
TR8-TRC- Eastern/SE	24.3	12.8	8.6	4.4	6

Key Findings:

Highest Rotavirus: West Marmara (42.1%)- higher diagnostic capacity

Lowest Rotavirus: Eastern/SE regions (24.3%)- limited laboratory infrastructure

Highest Norovirus: West Anatolia/Ankara (21.6%)- national reference laboratory

Highest Bacterial: Mediterranean/Aegean- warmer climate, tourism-related exposures

Figure 3. Geographic distribution across NUTS-1 regions. Pooled estimates reflect regional diagnostic capacity, climate, and population characteristics

demonstrated considerable regional variation, ranging from 24.3% in southeastern Turkiye to 42.1% in the Marmara region, potentially reflecting differences in healthcare-seeking behaviors, diagnostic capabilities, and population demographics (**Figure 3**).

Temporal trends in rotavirus detection rates (1987-2024)

Period	1987-94	1995-00	2001-06	2007-12	2013-18	2019-24
Detection (%)	34.2	36.8	**38.4**	32.6	26.4	22.8
Studies (n)	8	12	18	24	21	15
Sample (n)	6,842	12,456	24,128	32,547	26,892	14,876

Visual trend representation

1987-1994: ███████████ 34.2%

1995-2000: ████████████ 36.8%

2001-2006: █████████████ 38.4% (Peak)

2007-2012: ██████████ 32.6%

2013-2018: ████████ 26.4%

2019-2024: ███████ 22.8%

Key Events:

• 2006: Rotavirus vaccines available in private market • 2008: G9P [8] emergence • 2011: Syrian refugee influx • 2015: G12 strains identified

Figure 2. Temporal trends. Detection peaked in 2001-2006 (pre-vaccine) and declined after vaccine introduction in 2006.

Age-specific analysis revealed that 80.7% of rotavirus-positive cases occurred in children under 24 months of age, with peak incidence observed between 6-12 months. This age distribution aligns with global patterns and underscores the importance of early vaccination. Marked seasonality was observed, with 67% of rotavirus cases occurring during the winter months (December through March), peaking in January-February. This seasonal pattern remained consistent across different geographic regions of Turkiye (**Figure 4**).

Seasonal distribution of gastroenteritis pathogens

Pathogen	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rotavirus	18.2	16.8	14.2	8.4	5.2	3.8	2.4	2.8	4.6	6.8	8.2	8.6
Norovirus	9.2	8.8	8.4	7.6	7.2	8.4	9.2	8.6	8.2	8.4	8.0	8.0
Salmonella	4.2	4.8	5.6	7.2	9.4	12.8	15.6	14.2	11.8	6.4	4.2	3.8
Campylobacter	5.4	5.8	6.4	8.2	11.4	14.2	13.8	12.4	9.2	6.2	4.6	4.4

Seasonal Summary:

WINTER (Dec-Feb): Peak rotavirus (49.2% of annual cases)

SUMMER (Jun-Aug): Peak bacterial - Salmonella (42.6%), Campylobacter (40.4%)

YEAR-ROUND: Norovirus - minimal seasonal variation (7.2-9.2%)

Figure 4. Monthly distribution (% of annual cases). Highlighted cells indicate peak months. Rotavirus peaks in winter; bacterial pathogens in summer

Genotype distribution analysis from 34 studies employing molecular characterization revealed G1P[8] as the predominant strain, accounting for 38-45% of typed isolates, followed by G2P[4] (15-22%), G9P[8] (12-18%), G3P[8] (8-12%), and G4P[8] (5-8%). Notably, the emergence of G9P[8] as a significant circulating strain was documented beginning in 2008, with increasing prevalence in subsequent years. G12 strains, while uncommon, were identified in surveillance studies from 2015 onwards (**Table 2**).

Clinical severity assessment using the Vesikari Clinical Severity Scoring System demonstrated that rotavirus gastroenteritis was significantly more severe than non-rotavirus gastroenteritis. Across studies employing this scoring system, 69% of rotavirus-positive children had severe gastroenteritis (Vesikari score ≥11), compared to 34% of rotavirus-negative cases (p<0.001). Hospitalization rates for rotavirus-positive AGE ranged from 31% to 58% across studies, substantially higher than the 12-24% hospitalization rates observed for non-rotavirus AGE.

Impact of Rotavirus Vaccination

Despite rotavirus vaccines not being included in Turkiye's national immunization program, self-financed vaccination through the private healthcare sector achieved coverage rates estimated between 12-17% during the 2012-2018 study period. Analysis of vaccination impact from two large tertiary care hospitals in Istanbul (representing approximately 20% of Turkey's population) demonstrated significant reductions in disease burden even at these modest coverage levels.

Rotavirus-positive AGE incidence decreased from 4.4 per 1,000 children in 2012 to 2.48 per 1,000 in 2018, representing a 43.6% reduction over the seven-year observation period (p<0.001 for trend). More dramatically, rotavirus-related hospitalizations declined from 1.9 per 1,000 children to 0.45 per 1,000, a 76.3% reduction. The prevalence of rotavirus among children presenting to emergency departments with AGE decreased by nearly 40%, from 28.3% in 2012 to 17.1% in 2018 (**Table 3**).

These findings suggest that even partial vaccination coverage generates measurable herd immunity effects, reducing disease transmission and protecting unvaccinated individuals. Extrapolation of these results to national-level implementation suggests that incorporation of rotavirus vaccine into Turkiye's universal immunization program could prevent an estimated 50,000-70,000 hospitalizations and 150,000-200,000 outpatient visits annually.

Table 3. Impact of rotavirus vaccination on AGE incidence and hospitalization (2012-2018)

Parameter	2012	2015	2018	% change	p-value
Vaccination coverage (%)	12.0	15.2	17.0	+41.7	-
RV+ AGE incidence (/1,000)	4.40	3.21	2.48	-43.6	<0.001
RV hospitalization (/1,000)	1.90	0.98	0.45	-76.3	<0.001
RV prevalence in AGE (%)	28.3	22.6	17.1	-39.6	<0.001
Mean hospital stay (days)	4.2±1.8	3.8±1.6	3.4±1.4	-19.0	0.024
Severe dehydration (%)	18.4	14.2	11.8	-35.9	0.008
IV fluid requirement (%)	62.4	54.8	48.2	-22.8	0.012

RV: Rotavirus, AGE: Acute gastroenteritis, IV: Intravenous. Data from tertiary care hospitals in İstanbul (~20% of Turkiye's population). p-values by Chi-square test for trend.

Norovirus and Other Viral Pathogens

Norovirus has emerged as an increasingly important pathogen in Turkish AGE epidemiology, particularly following rotavirus vaccine introduction. National reference laboratory surveillance from 2009 demonstrated norovirus genotype II as the most frequently detected viral agent, identified in 28.6% of tested samples, followed by rotavirus (22.4%), astrovirus (4.1%), and adenovirus (2.7%). Co-infections involving multiple viral pathogens were detected in 6.8% of samples (**Table 4**).

Table 4. Distribution of viral pathogens in pediatric acute gastroenteritis across Turkish studies

Viral pathogen	No. of studies	Detection rate (%)	95% CI	Peak season
Rotavirus	98	31.8	31.3-32.4	January-March
Norovirus GII	24	18.4	14.2-22.6	Year-round
Norovirus GI	18	4.2	2.8-5.6	Year-round
Adenovirus 40/41	42	5.4	3.8-7.0	Summer months
Astrovirus	28	3.8	2.4-5.2	Winter-Spring
Sapovirus	12	2.1	1.2-3.0	Winter months
Co-infections (≥2 viruses)	18	6.8	4.5-9.1	Winter months

CI: Confidence interval, GI: Genogroup I, GII: Genogroup II

A comprehensive 8-year retrospective study from Ankara examining children aged 0-5 years with AGE documented significant norovirus GI/GII prevalence. The study noted that rotavirus vaccination is predicted to result in relative increases in norovirus-attributable gastroenteritis, a phenomenon

Table 2. Rotavirus genotype distribution in Turkiye: temporal trends (2000-2024)

Genotype	2000-2005 (%)	2006-2010 (%)	2011-2015 (%)	2016-2024 (%)	Overall (%)
G1P[8]	48.2	42.5	38.4	35.8	41.2
G2P[4]	22.4	18.6	16.2	19.4	19.2
G9P[8]	4.8	14.2	18.6	16.8	13.6
G3P[8]	12.4	10.8	9.4	8.2	10.2
G4P[8]	8.6	7.2	6.8	5.4	7.0
G12P[8]	0	0.8	2.4	4.6	2.0
Mixed/untypeable	3.6	5.9	8.2	9.8	6.8
Total typed (n)	2.845	4.128	3.654	2.186	12.813

Note: G9P[8] emerged as a significant circulating strain beginning in 2008. G12 strains were first identified in 2015.

already observed in countries with high rotavirus vaccination coverage. Norovirus-associated AGE demonstrated year-round occurrence without the pronounced winter seasonality characteristic of rotavirus.

Adenovirus (serotypes 40/41) was identified in 3-8% of pediatric AGE cases across studies employing appropriate diagnostic methods. Astrovirus detection rates ranged from 2-6%, with higher prevalence noted in institutional settings. Sapovirus, while less commonly tested for, was identified in 1-3% of cases in studies employing comprehensive viral panels.

Bacterial Pathogens and Seasonal Patterns
Bacterial pathogens demonstrated distinct seasonal patterns compared to viral agents, with peak incidence during summer months (June-September). *Salmonella* species were the most commonly identified bacterial pathogen, detected in 4-12% of AGE cases depending on the study population and geographic region. Campylobacter jejuni was identified in 3-8% of cases, with higher rates observed in the Aegean and Mediterranean regions where poultry consumption is particularly high.

Shigella species, while less common than *Salmonella*, were associated with more severe clinical presentations including bloody diarrhea and higher fever. Enterotoxigenic *E. coli* (ETEC) and enteropathogenic *E. coli* (EPEC) were identified in 5-15% of cases in studies employing advanced molecular diagnostics, though detection rates varied substantially based on methodological approaches.

Impact of Syrian Refugee Influx
The influx of over 3.5 million Syrian refugees since 2011 significantly impacted Turkiye's infectious disease landscape. Between 2012 and 2016, surveillance data from temporary protection centers documented 158,058 diarrheal episodes, including 59 cases of bloody diarrhea. Additionally, 1,354 hepatitis A cases were reported, reflecting the interaction between gastrointestinal infections and sanitation conditions.

Children arriving from conflict zones demonstrated lower baseline vaccination coverage due to disrupted healthcare services. However, intensive immunization campaigns within temporary protection centers achieved vaccination coverage exceeding 95%, substantially mitigating outbreak risks. The receptiveness of the refugee population to vaccination programs facilitated rapid achievement of protective coverage levels.

Diagnostic Approaches and Laboratory Capacity
Diagnostic methodologies employed across studies evolved substantially over the review period. Early studies (1987-2000) relied primarily on electron microscopy and latex agglutination assays. The period 2000-2010 saw widespread adoption of enzyme immunoassays (EIA/ELISA) for rotavirus and adenovirus detection. More recent studies have increasingly employed molecular methods including RT-PCR and multiplex PCR panels enabling simultaneous detection of multiple pathogens.

However, access to advanced molecular diagnostics remains limited outside major academic centers. A survey of diagnostic capabilities indicated that only 23% of hospitals in Turkiye routinely test for viral gastroenteritis pathogens beyond rotavirus. This diagnostic gap likely results in underestimation of norovirus, astrovirus, and sapovirus

contribution to AGE burden. Third-generation ELISA kits for stool antigen detection remain the most practical and economical routine diagnostic approach in most clinical settings.

DISCUSSION

This comprehensive bibliographic review synthesizes nearly four decades of research on AGE in Turkiye, revealing several key findings with significant implications for public health policy and clinical practice. The evidence consistently demonstrates that AGE, particularly rotavirus-associated disease, remains a substantial public health burden requiring targeted intervention interventions.[2]

Rotavirus Disease Burden and Vaccination Policy
The median rotavirus detection rate of 31.8% among Turkish children with AGE is comparable to pre-vaccination era estimates from European countries (25-40%) and higher than current rates in countries with universal rotavirus vaccination programs (8-15%).[2,7] This persistent high detection rate directly reflects Turkiye's policy decision not to include rotavirus vaccines in the national immunization program.[8]

The economic implications of this policy deserve careful consideration. Rotavirus gastroenteritis imposes substantial direct costs (hospitalizations, emergency department visits, outpatient consultations, diagnostic tests) and indirect costs (parental work loss, productivity reduction).[9] Cost-effectiveness analyses from comparable middle-income countries consistently demonstrate favorable cost-effectiveness ratios for rotavirus vaccination, often achieving cost savings when both direct and indirect costs are considered.[10]

Particularly compelling is the evidence that even partial vaccination coverage (12-17%) achieved through self-financing generated substantial reductions in disease burden. The 76% reduction in rotavirus-related hospitalizations observed over seven years represents thousands of prevented hospitalizations, reduced healthcare system strain, and diminished family burden. These herd immunity effects suggest that universal vaccination could achieve even greater impact, potentially approaching the 85-95% reductions in rotavirus hospitalizations observed in countries with high vaccination coverage. Recent global evidence continues to support the critical importance of rotavirus vaccination in reducing childhood gastroenteritis burden, with meta-regression analyses demonstrating substantial variation in vaccine efficacy and effectiveness across settings, generally higher in high-income and low child-mortality countries and lower in high-mortality, low-resource contexts; and clinical severity studies using modified Vesikari and Clark scoring systems confirm the continued vulnerability of pediatric populations to viral gastroenteritis, with children comprising the majority of cases and significant disease severity documented by validated scoring tools.[11,12] Similarly, a 2024 comprehensive study evaluating viral gastroenteritis severity using modified Vesikari and Clark scoring systems emphasized the continued vulnerability of pediatric populations to viral pathogens, with children accounting for over 72% of viral gastroenteritis cases. These contemporary findings reinforce the urgency of expanding rotavirus vaccination coverage in Turkiye and highlight the need for

context-specific implementation strategies that account for local epidemiological patterns and healthcare system characteristics.[13]

Emerging Importance of Norovirus

The emergence of norovirus as the leading viral pathogen in Turkish surveillance studies signals an important epidemiological transition. In countries with established rotavirus vaccination programs, norovirus has become the predominant cause of childhood AGE requiring medical attention. This pattern appears to be emerging in Turkiye despite incomplete rotavirus vaccination coverage.[8]

Unlike rotavirus, no licensed norovirus vaccine is currently available, though several candidates are in advanced clinical development. Until vaccine availability, norovirus prevention relies on non-pharmaceutical interventions including hand hygiene, environmental disinfection, and food safety measures. The high transmissibility of norovirus and its resistance to many common disinfectants present ongoing challenges for outbreak control, particularly in institutional settings such as hospitals, nursing homes, and schools.[14]

Strengthening norovirus surveillance capacity is essential for understanding the true burden of disease and preparing for future vaccine implementation. Current diagnostic limitations likely result in substantial underestimation of norovirus contribution to AGE. Investment in molecular diagnostic infrastructure would improve pathogen attribution and inform targeted prevention strategies.

Refugee Health and Vulnerable Populations

The Syrian refugee crisis introduced unprecedented challenges to Turkiye's public health infrastructure. The documentation of over 158,000 diarrheal episodes among the refugee population between 2012-2016 highlights the vulnerability of displaced populations to gastrointestinal infections. Contributing factors include crowded living conditions, compromised water and sanitation infrastructure, disrupted vaccination histories, and psychological stress affecting immune function.[15]

However, the Turkish health system's response demonstrated remarkable capacity for rapid adaptation. Achievement of greater than 95% vaccination coverage within temporary protection centers represents a public health success story with lessons for future humanitarian responses. The integration of refugee healthcare into the existing health system, coupled with targeted immunization campaigns, effectively mitigated potential epidemic risks.[16]

Diagnostic Challenges and Surveillance Gaps

The heterogeneity of diagnostic approaches across studies represents both a limitation of this review and a broader challenge for AGE surveillance in Turkiye. The absence of a standardized national surveillance system results in fragmented data collection, inconsistent case definitions, and variable diagnostic methodologies that complicate temporal and geographic comparisons.[14] The relative underrepresentation of bacterial pathogens in the reviewed studies warrants careful interpretation. Several methodological factors may contribute to this observation: inconsistent stool culture collection practices across healthcare settings, suboptimal specimen transport conditions affecting bacterial viability, limited availability of selective and differential culture media for fastidious

organisms such as Campylobacter species, and the restricted deployment of molecular diagnostic panels capable of detecting bacterial pathogens in many Turkish healthcare facilities. Furthermore, empirical antibiotic administration prior to specimen collection, a common practice in clinical settings, may significantly reduce bacterial isolation rates. These diagnostic limitations suggest that the true burden of bacterial gastroenteritis in Turkish children is likely underestimated in the current literature.[17,18]

Establishment of a systematic AGE surveillance network, modeled on successful programs in European countries, would substantially improve understanding of disease epidemiology. Such a system should incorporate standardized case definitions, representative sentinel sites spanning different geographic regions and healthcare settings, consistent diagnostic protocols including molecular methods for comprehensive pathogen detection, and electronic data capture enabling real-time analysis and outbreak detection.[19,20]

Limitations

Several limitations should be acknowledged when interpreting these findings. First, the predominance of hospital-based studies may overestimate disease severity and pathogen detection rates compared to community-based estimates. Mild cases managed at home or in primary care are underrepresented in the literature. Second, publication bias may have resulted in overrepresentation of positive findings and studies from major academic centers. Third, the evolving diagnostic methodologies across the review period complicate direct comparisons of pathogen detection rates between earlier and more recent studies.

Additionally, data on AGE in adult populations is notably sparse compared to pediatric data, representing an important knowledge gap. Adults, particularly elderly individuals and those with comorbidities, also experience significant AGE-related morbidity that warrants greater research attention.

Future Directions and Recommendations

Based on the evidence synthesized in this review, several recommendations emerge for policy and practice. First and foremost, incorporation of rotavirus vaccine into Turkiye's national immunization program should be prioritized. The evidence of benefit even at low coverage levels, combined with extensive global experience demonstrating vaccine safety and effectiveness, provides a compelling case for this policy change.

Second, investment in laboratory infrastructure for comprehensive viral gastroenteritis diagnostics would improve pathogen attribution and inform targeted interventions. Multiplex molecular panels capable of detecting rotavirus, norovirus, adenovirus, astrovirus, and sapovirus should become standard diagnostic tools in reference laboratories and major healthcare centers.

Third, establishment of a national AGE surveillance network with standardized protocols would generate the systematic data necessary for evidence-based policy development and outbreak response. Such a system should include both hospital-based and community-based sentinel sites to capture the full spectrum of disease severity.

Beyond rotavirus vaccination, comprehensive prevention strategies are essential for reducing the burden of pediatric

gastroenteritis in Turkiye. Public health measures should prioritize ensuring access to safe drinking water through improved water treatment and distribution infrastructure, particularly in underserved regions.[21] Promotion of proper sanitation facilities and waste management systems can significantly reduce fecal-oral transmission of enteric pathogens. Hand hygiene education campaigns targeting families, schools, and healthcare settings represent cost-effective interventions, with systematic reviews demonstrating that handwashing with soap can reduce diarrheal disease incidence by 30-47%.[22] Food safety practices, including proper food handling, storage, and preparation techniques, should be emphasized through community health education programs. For vulnerable populations, including refugee communities and children in institutional settings, targeted interventions addressing overcrowding, ensuring adequate water supply, and implementing systematic hygiene protocols are particularly important.[23] These complementary measures, combined with vaccination programs, constitute a comprehensive approach to reducing gastroenteritis morbidity and mortality in Turkish children. Finally, continued attention to vulnerable populations, including refugees and internally displaced persons, is essential. Health equity considerations should inform resource allocation and program design to ensure that all residents of Turkiye benefit from advances in AGE prevention and treatment.

CONCLUSION

AGE remains a significant public health challenge in Turkiye, with rotavirus continuing as the leading cause of severe childhood diarrhea despite the availability of effective vaccines. This comprehensive review demonstrates that even partial rotavirus vaccination coverage generates meaningful reductions in disease burden, strongly supporting universal vaccine implementation. The emergence of norovirus as an increasingly important pathogen necessitates enhanced surveillance and diagnostic capabilities. Addressing the identified gaps in surveillance infrastructure, diagnostic capacity, and vaccination policy would substantially reduce the burden of AGE in Turkiye and position the country among leaders in gastrointestinal infection prevention.

ETHICAL DECLARATIONS

Ethics Committee Approval
This study did not involve human participants, patient data, or any biological material. Therefore, ethics committee approval was not required.

Informed Consent
Since no human participants or patient information were included in this research, informed consent was not required.

Peer Review Process
This manuscript was subject to external peer review.

Conflict of Interest
The authors declare no conflicts of interest related to this study.

Financial Disclosure
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