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EXPLORING THE IMPACT OF POTENTIAL RISK FACTORS ON ACUTE GASTROENTERITIS IN CHILDREN UNDER 5 YEARS IN PAKISTAN

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Abstract

Background: *There has been a continued major source of morbidity and mortality in children globally, and particularly in developing countries, acute gastroenteritis (AGE). This condition has a close association with demographic, environmental and behavioral risk factors.*

Objectives: *The purpose of this study was to determine the demographic, environmental, and behavior risks that cause AGE in children 0-5 years in Hyderabad, Pakistan.*

Material and Methods: *A comparative cross-sectional study was carried out for a period of 6 months from November 2024 to April 2025 Hyderabad, Pakistan with the help of 339 children aged 0-5 years. Data were obtained from primary sources and variables (age, gender, maternal education, housing type, household size, maternal literacy, water and sanitation hygiene, breastfeeding, and dietary practices) were analyzed. Inclusion criteria were children aged 0-5 years with diagnosis of AGE while children with chronic gastrointestinal problems excluded.*

Results: *The results indicated that those aged between 0 to 1 years old were at the highest risk of AGE with a much higher incidence of AGE in males than females. Maternal education, housing type and household size were found to have an impact on the prevalence of AGE. Unhygienic sanitation and unsanitary water supplies were very closely linked to increased AGE occurrence. Also, improved hygiene routines such as hand washing and sanitizing surfaces were associated with a lower AGE rate. It was also established that nutritional habits such as fruits, vegetables, and dairy consumption, were associated with AGE reduction, whereas processed foods and sugary drinks were associated with risks of AGE.*

Conclusion: *The research emphasizes the key role of maternal education, as well as practices of environmental sanitation and dietary habits in the prevention of AGE in children. Public health programs should prioritize hygiene, water sanitation, and nutrition for reducing the burden of AGE, especially those of socio-economically disadvantaged groups*

INTRODUCTION

In children, acute gastroenteritis (AGE) stands as one of the most cited causes of illness and death - particularly within low to middle-income countries (LMICs). It is clinically marked by acute

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inflammation of the gastrointestinal tract, generally surfaced as diarrhea (considered loose or liquid stool, exceeding the rate of three in a 24-hour period) commonly accompanied by vomiting and abdominal pain.[1] These signs and symptoms manifest due to a plethora of infections by enteric pathogens defined as the organisms that infect the intestinal tract. Some of the most common enteric pathogens include viruses such as rotavirus and norovirus, bacteria like Escherichia coli, Shigella, Salmonella, and protozoal parasites, like Giardia and Cryptosporidium; all these pathogens follow a fecal-oral route through contaminated food, water, and direct contact.[2] This group of pathogens has the potential to infect young children since their immune system is not fully developed along with poor hygienic conditions that kids are made to frequent. Perhaps the hardest hit demographic are children in poor settings who are susceptible to recurring bouts of diarrhea, nearly three times a year if we look at the average in low-income countries.[3] Each bout of gastroenteritis has the potential of weakening a child's nutritional status, immunity and fuel a never-ending toxic cycle where becoming mal-nourished leads to severely sick malnourished children who are vulnerable to diarrheal diseases.[4] With the advancement of prevention and treatment techniques, diarrhea diseases still pose a threat to public health. Diarrhea is responsible for 9% of the deaths in children under the age of five globally which indicates 440,000 deaths due to diarrhea for children aged five years or less in the year 2021.[5] The burden of deaths due to diarrhea in children below the age of five translates roughly to more than 1200 per day. This problem of mortality has a disproportionate impact in resource constraint areas as most of these deaths happen to be concentrated in South Asia and Sub-Saharan Africa highlighting inequity in availability of sanitation, clean water, and health care services. South Asian LMIC Pakistan serves as benchmark case for this problem are suffers from high levels of child diarrhea incidences.[6]

Pakistan remains one of the countries with a large burden of childhood diarrhea.Estimates show that the rate of diarrhea among children younger than five years of age in Pakistan is around 19%, meaning roughly one in five children experienced a bout of diarrhea in a two-week period. [7] This translates to an astonishing 6.4 million pediatric cases of diarrhea in Pakistan, omitting over 3 million cases due to the child's age. [8] Sadly, these diseases take a terrible toll on child survival: around 39,500 deaths of children under five in Pakistan are estimated to die from diarrheal disease each year. [9] This figure means that Pakistan is by far the third highest carnage of child diarrhea fatalities in any country in the world .[9]

Such striking loss of life makes the problem of acute gastroenteritis in children a serious public health challenge for Pakistan and highlights the urgency for better intervention policies.[11]The primary causes of acute gastroenteritis in young children are known and mostly avoidable. For example, the water, sanitation, and hygiene (WASH) aspects contribute to the issue. Inadequate water and sanitation, as well as poor hygiene practices contribute to easy spread of infection.[10]

It is important to ensure the provision of safe drinking water which is free from any pathogenic contamination and safe for human consumption. Safe water comes from improved sources like protected wells or piped systems which are able to supply water free from microbiological contamination.[11]

However, children from families who depend on compromised or unimproved water sources are exposed to pathogenic diarrheal contaminants with every sip. Proper sanitation facilities for the disposal of human waste also contribute to the health of the community. Improved sanitation facilities like flush toilets and covered pit latrines hygienically separate excreta from human contact which prevents contamination of fecal matter in homes and the environment.[12] In communities that practice open defecation, there is no adequate sanitation and this increases the risk of fecal pathogens contaminating water, food and living spaces. Personal cleanliness behaviors along with hand hygiene form the third important piece: infrastructure alone is not sufficient as individuals also need to consistently maintain hygiene (especially handwashing with soap) in order to control germ transmission. In this regard, hand hygiene involves washing hands with soap and clean water at critical times like after using the toilet and before preparing or consuming food to remove disease-causing organisms.[13]

UNICEF estimates that simply washing hands with soap can reduce the risk of diarrheal disease

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by 40%.[14] In other words, the prevention of diarrhea relies on a combination of clean water, proper toilets, and clean hands. If these basic requirements are not met, children have to deal with the consequences. Approximately 88% of childhood diarrheal deaths globally are linked to unsafe drinking water, poor sanitation, inadequate hygiene, and lack of proper cleanliness standards.[15] Children who come from low-income households are particularly vulnerable as they usually do not have these essential services and are constantly exposed to unsanitary surroundings.[16] The example in Pakistan exposes the seriousness of risks related to WASH. A big part of the population lacks adequate sanitary facilities, which increases the chances of getting enteric infections.

Approximately only about a fifth of the population has safely managed clear drinking water.[17] In many households, the water they use for consumption daily is polluted: more than 66% of Pakistan households were drinking bacterially contaminated water, which is one of the reasons for persistent diarrheal sickness in the country.[8] Access to sanitation is equally lacking in some regions. Although open defecation has decreased, still nearly a tenth of the population, which translates to about 22 million people, do not have access to basic sanitary latrines and defecate in the open.[16] This is particularly common in rural and urban slum areas where poverty prevails. The poorly kept domestic environment, coupled with fecal matter and dirty water, is a major source of food contamination, especially for children, as they are grossly exposed to diarrheal pathogens.[17] Gastroenteritis outbreaks in Pakistan are primarily caused due to waterborne and fecal-based infections.[18] The impact of water, sanitation, hygiene, and health (WASH) responsibility on public healthcare is substantial: disease related illness that is incurred due to sanitation and water in Pakistan is 50% and the death rate is 40%.[19] As noted, there is a global reduction in deaths caused by diarrhea if greater WASH measures are taken, so having unrestricted access to clean water and proper toilets is vital for halting disease expansion which strengthens prevention framework for diseases.[19] Environmental health gaps that Pakistan is lagging in need to become a priority to combat the high rate of pediatric gastroenteritis.[18] Nutritional malfunctions alone dramatically increase the likelihood and severity of intestinal infections in children.[19] Beyond nutrition, there are dozens of other environmental host factors that increase the infection's risk. Nutrition stands out as a very important factor.[20] One pertinent example involves children coping with chronic undernourishment or micronutrient deficiency, as they possess an available immune response and epithelial barriers to fend off enteric infections.[8] Children suffering from acute or chronic malnourishment severely lacks the ability to cope with malnourished diarrheal illness complicated with interstitial enteritis, and is greatly exposed to life-threatening complications.[19] Children suffering from malnutrition and interstitial enteritis can exacerbate complication through appetite dysregulation, nutrient malabsorption, nutrient loss, and weight loss after each episode[20]. Chronic or recurrent childhood diarrhea can significantly contribute to cognitive or biophysical stunting.[21] Enhancing infants' nutritional status serves to dramatically decrease the probability of acute complications, and furnish strong immunization against interstitial enteritis.[22] The most adequate way hinges on promoting optimal feeding practices alongside maintaining a well-balanced diet. Breastfeeding is among the best practices, as it protects against gastroenteritis effortless scrupulosity by yielding clean maternal antibodies that fortify and equip the infant against infections.[22] Compared to formula-fed or weaned infants, exclusively breastfed babies have a considerably lower chance of suffering diarrheal diseases.[19] Studies show approximately 50% of all diarrheal episodes in infants could be avoided if the rates of exclusive breastfeeding increased in economically challenged areas.[19] In Pakistan, however, suboptimal infants' feeding practices posited as one of the significant contributors toward the burden of disease known as decided level of diarrhea. Indonesian infants are exclusively breastfed for six months, but within the country only, lack of exclusive breastfeeding is said to have led to 165% more diarrhea during infancy.[8] Culturally sensitive materials to help raise and educate mothers on breastfeeding and child feeding are foundational parts toward preventative measures of gastroenteritis.[2] Moreover, ensuring that children are adequately nourished with food and supplements as they develop serves to enhance

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their immunity against infections. To sum up, well-nourished children who are exclusively breastfed for six months then followed by a balanced diet during toddlerhood, face less risk of severe recurrent gastroenteritis which showcases the balance of nutrition and infection.[15]

Another important part of the prevention strategy is immunization against rotavirus, an infection that causes profound debilitating diarrhea in infants and young children. The availability of the rotavirus vaccine has greatly reduced the number of hospitalizations and deaths from gastroenteritis in countries that use the vaccine in their routine immunization programs.[20] Clinical and observational studies demonstrate that vaccination against rotavirus can reduce both the number of diarrheal episodes and associated deaths in children by a substantial margin.[21] Due to this reason, Pakistan added the rotavirus vaccine into its Expanded Programme on Immunization (EPI) in 2017 with the objective of vaccinating all infants against this infection .[23] The addition of this vaccine to the national schedule was anticipated to significantly reduce the burden of viral gastroenteritis. However, the outcome of the vaccination depends on attaining high vaccination coverage. In practice, Pakistan has consistently had suboptimal levels of immunization coverage. Vaccination coverage, or the proportion of eligible children that have received a vaccine, remains one of the finest metrics to measure the progress of public health.[22] However, Pakistan still falls short of achieving the WHO threshold of 95% coverage for essential childhood vaccinations.Recent national surveys suggest that only approximately 66% of children in Pakistan aged between 12-23 months have had all of the basic EPI vaccines done as recommended.[23] This indicates that approximately one-third of infants and toddlers in Pakistan are missing some or all of their routine immunizations, which puts them at high risk of developing diseases that could have easily been prevented. Regarding rotavirus vaccinations specifically, the initial phase of the rollout faced issues – reports from 2024 indicated that only around 24% of the targeted population received the vaccine.[24] Despite the fact that there has been an improvement in coverage since then, it is still far from universality. This failure continues to expose numerous children to vaccine-preventable gastroenteritis. In addition to rotavirus, a host of other vaccinations will help to mitigate diarrhea by preventing measles and cholera which can lead to gastrointestinal symptoms, as well as reducing overall childhood morbidity which exacerbates malnutrition.[25] Therefore improving the outreach, education, strengthening the health system, and immunization coverage are crucial methods to reduce the incidences of acute gastroenteritis.[22] It is evident that countries that have successfully achieved high vaccination coverage have witnessed a decrease in the incidence of childhood diarrheal disease.[9] In the case of Pakistan, bridging the vaccination gap can potentially prevent thousands of deaths among children each year.[26] For children below the age of five, acute gastroenteritis is more than just a health problem: it is an emotional indicator for their healthcare system and development. In Pakistan, there is an apparent lacking of care for social and environmental issues, which is shown by the country's persistently high rates of gastroenteritis. The burdens of poor water supply systems, poverty, and underdeveloped healthcare services are all shouldered by children. Every instance of acute diarrhea in a young child indicates more than just a dire health issue it also signifies the strain on families and health systems as they deal with economic costs of healthcare, productivity loss from caregivers, and strain on clinics that are providing services for otherwise manageable conditions[27] . The good news is, there are tools and methods that effectively prevent these situations from occurring basic steps like improving the quality of water, sanitation, hygiene (WASH), nutrition, breastfeeding, and ensuring vaccinations are adequately provided can prevent a great number of pediatric gastroenteritis cases.[28] The Global Action Plan for Pneumonia and Diarrhea (GAPPD) by WHO and UNICEF specifically advocates for such a combination of protective, preventative, and treatment strategies to eradicate avoidable child mortality.[24] Progress has been made in the past few decades; childhood death due to diarrhea has reduced globally by about 66.67% since 2000, but children in nations such as Pakistan still succumb to death due to lack of these basic amenities. This highlights the need for more intensive research and public health groundwork. Focused research to pinpoint specific disease-causing risk factors tailored to different

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populations enable the allocation of resources toward effective solutions.[29] This thesis targets the chronic challenge of childhood gastroenteritis in Pakistan by evaluating how the potential risk variables may influence acute gastroenteritis among children aged five years and younger. Essentially, the study attempts to explain how the lack of hygiene, sanitation, water, nutrition, and immunization collectively contribute to acute gastroenteritis in children of tender ages in Pakistan. Instead of addressing these as broad concepts, we focus on their definitions and implications on the ground. For instance, we look at hand hygiene in terms of whether caregivers wash their hands with soap after using the toilet or before handling food, and how this behavior correlates with the child's diarrheal illness. We assess access to safe drinking water by determining whether the households use water from protected sources or treat their water (by boiling or filtration) and how consistently safe water is available for young children.[21] Access to adequate sanitation facilities is assessed through household toilet type (improved versus unimproved) in conjunction with the open defecation rate within the community, these conditions are linked to infection risk.[23] The examination also investigates the child's feeding practices including exclusive breastfeeding and the presence of malnutrition as a constituent risk for the more frequent or severe gut infection. Moreover, notified immunization39 also known as vaccination coverage in the population with particular reference to the rotavirus immunization and other relevant childhood vaccinations was analyzed to assess the level of protection offered through immunization against diarrhea disease in children.[26]

The combination of these factors allows the study to explore the gross reasons behind the under five children in Pakistan suffering so greatly from acute gastroenteritis. The specific focus is to define which risk factors or gaps are most likely associated with illness occurrence in this population. This will subsequently provide the evidence necessary to inform health policy decision regarding whether focus needs to be sharpened in constructing the community water supply systems, promoting handwashing, strengthening nutrition schemes, increasing outreach, or as seems likely so all in a concerted fashion.[29] This combination of factors is meant to provide understanding aimed at reducing the number of Pakistani children suffering from acute gastroenteritis and improving their child survival and well-being.The sheer scale of the problem requires a unified, response that is systematic.[30] When we look at the combination of hygiene, vaccination, nutrition, and sanitation in their relation to disease prevention, we can significantly improve the health of children under the age of five.[18] This understanding will take us closer to a future with a drastic decline in deaths caused by diarrheal diseases.[30]

RATIONALE

Acute gastroenteritis poses a major public health challenge, significantly burdening healthcare systems and contributing to high disease prevalence and costs. Despite ongoing efforts to improve sanitation and hygiene, the incidence of acute gastroenteritis remains high, particularly among children in Pakistan. Therefore, understanding the factors associated with acute gastroenteritis in Pakistani children under five years old is crucial for developing effective prevention and intervention strategies.

OBJECTIVES

General Objective:

To determine the burden and potential risk factors associated with acute gastroenteritis among children under 5 years in Hyderabad, Sindh.

Specific Objectives:

1. To identify the socio-demographic factors responsible for acute gastroenteritis among children under 5 years in Hyderabad, Sindh.
2. To determine the environmental and behavioral risk factors associated with acute gastroenteritis among children under 5 years in Hyderabad, Sindh.
3. To correlate socio-demographic, environmental, and behavioral risk factors with acute gastroenteritis among children under 5 years in Hyderabad, Sindh

LITERATURE REVIEW

1.1. The Global Burden of AGE

AGE, along with other diarrheal diseases, constitute the second most common cause of mortality in children under the age of five, leading to approximately 760,000 deaths per year.[25]

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Diarrhea accounts for an estimate of 9% of all deaths in infants under five globally, as cited by the World Health Organization.[30] Our current understanding is that AGE occurs roughly 1.7 billion times globally each year, which is most rampant in areas lacking basic water and sanitation facilities.[27] Despite immunization campaigns, the goal of reducing AGE prevalence hotspots fails to be reached, underscoring the need to focus on improving WASH (water, sanitation and hygiene) practices.[29]

1.2. Etiological Agents of AGE

A wide range of viruses, bacteria, and parasites can cause AGE in children. Out of these, types of viruses are the most frequent cause of AGE in children.[18] Rotavirus remains the predominant viral gastroenteritis responsible virus, associated with approximately 128,500 deaths annually in children below the age of five. Other viral agents of AGE are norovirus, adenovirus, [30] These viruses are mainly transmitted through the fecal-oral pathway, primarily due to contaminated water and food.[31] Bacterial pathogens such as Escherichia coli, Salmonella, and Shigella significantly contribute to the burden of AGE healthcare costs, particularly in developing countries where sanitation and food hygiene practices tend to be lacking .Parasitic infections that infest people in developing nations are caused by Giardia lamblia, Cryptosporidium, and Entamoeba histolytica.[32] These parasitic infections affect children and are usually acquired through water or food that is contaminated.[30] Such infections can cause prolonged sickness, malabsorption, and deficiency of nutrients, especially in growing children. The double burden of bacterial and parasitic diseases is an added challenge to the management of AGE and has caused the need for custom treatment strategies, which include antiparasitic treatment.[33]

1.3. Impact of Rotavirus Vaccine in Pakistan

Rotavirus has historically been a major contributor to childhood diarrhea in Pakistan, and having a rotavirus vaccine as part of the Expanded Program on Immunization (EPI) in Pakistan is a significant step toward reducing the problem of AGE.[31] Most preliminary studies on the effectiveness of the vaccine are favorable and have shown decrease in the number of hospitalizations and severe cases of rotavirus-associated diarrheal disease.[32] The study carried out in Karachi has reported that the introduction of the rotavirus vaccine resulted in a 60% reduction in hospital admissions due to rotavirus infections. Despite the urban immunization success, coverage in rural and under-resourced areas poses a problem.[33] A recent Global Health Organization report regions Pakistan's vaccine coverage as 45% in 2020, which is below the WHO's 80% target for full immunization. There is lack of information, cultural resistance, remote location, and logistical problems that serve as obstacles to vaccination.[34]

1.4. Role of Water, Sanitation and Hygiene, Wash and the Prevention of AGE

Preventing and controlling the spread of AGE can be aided greatly by effective water sanitation and hygiene. Many enteric pathogens are transmitted through fecal-oral routes due to poor sanitation. Cairncross et al. in their study highlights how cleaner water access and better sanitation facilities can considerably reduce the incidence of diarrheal diseases like AGE.[35] A major part of the population in Pakistan still does not have access to safety managed drinking water and sanitation services.[36] Approximately 25% of households do not have access to sanitation and 36% of the population relies on unimproved water sources according to PDHS. Such conditions facilitate the rapid spread of enteric pathogens, especially in fluids leading to elevated incidences of AGE, particularly in children.[37] Improvement of AUG infrastructure greatly reduces the burden of AGE in Pakistan. Adoption of community-based WASH programs with education on handwashing with soap, clean food handling, and using clean water reduces the incidence of AGE by 40%. While these practices exist on a limited scope in urban areas, their adoption is virtually absent in inadequately serviced rural areas.[38]

1.5. Nutritional Determinants and Malnutrition

AGE is directly associated with a child's nutritional status and remains one of the leading risk factor linked the condition. The most common malnutrition type affecting children below the age of 5's is stunting.[39] The resulting weak immune system and damaged intestinal

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barrier makes kids easily susceptible to infections. Checkley et al. (2008) conducted a research that showed recurrent diarrhea during early childhood noticeably increases chances of stunted growth and developmental delays later in life.[40]

Pakistan suffers from malnutrition as stump growth remains at 44% and underweight growth rests at 31% for children under the age of five. Gastroenteritis, which can lead to dehydration, membrane02 imbalance, death, and a myriad of other debilitating symptoms if left untreated, is often found as a companion disease to nutrition deficiency.[41] It has been observed that nutrition deficiency and malnutrition tends to increase the chances of having severe or protracted gastroenteritis. While exclusive breastfeeding for the initial six months of life has proven to mitigate the risk of AGE and malnutrition, the exclusive breastfeeding figures in Pakistan stand frustratingly low at 37% suffering infant feeding syndrome.[42]

1.6. Feeding newborns and their nurturing

Exclusive breastfeeding stands unrivaled in preventing AGE from flaring in children. Along with AGE, infants are also prone to all kinds of diarrhea, infections which can easily be mitigated with proper nutrition.[41] Power of nutrition in this regard cannot be overstated as enriched diet ensures than those to never exceed lower of infant bracket.[43] According to the PDHS, only 37 percent of infants aged 0 to 6 months are exclusively breastfed.[42] This indicates a necessity for broader public health initiatives focused on breastfeeding, especially in rural and marginalized regions. [43]

1.7. Socio-demographic Determinants

The prevalence together with the seriousness of AGE heavily depends on socio-demographic elements.[42] The three factors socioeconomic status together with maternal education along with household income directly impact access to healthcare and sanitation and nutrition.

1.7.1. Socioeconomic Status (SES): Children from lower income backgrounds face increased risks of AGE because their families generally do not have access to protected drinking water and appropriate sanitation systems. Environmental exposure levels are higher among poor children because poverty functions as a main environmental exposure factor.[44]

1.7.2. Maternal Education: The health results of children get influenced by the educational level of their mothers. Women educational attainment improves their ability to practice hygiene properly and obtain medical treatment promptly while providing their children with proper nourishment along with needed vaccinations.[45]

1.7.3. Household Income: Higher household income leads families to obtain better healthcare together with improved access to sanitation facilities while allowing them to secure nutritious food. Families who earn less money encounter various obstacles to AGE prevention because they experience inadequate housing quality along with restricted medical service access.[46]

1.7.4. Psychological Determinants

The health outcomes of children are significantly impacted by psychological elements specifically when they encounter AGE. The way caregivers handle children's health depends on their stress and mental state along with their knowledge regarding the disease.[47]

1.7.5. Caregiver Stress and Mental Health: High levels of stress among caregivers who face poverty-related resource shortages create negative health effects for children. Caregivers under stress tend to put health-related actions at lower priority while their ability to take proper care of their children decreases.[48]

1.7.6. Health Beliefs and Knowledge: Caregivers' understanding of AGE along with their health-related beliefs form part of psychological factors that influence their actions. Children face worse outcomes because many caregivers delay medical assistance due to insufficient understanding about AGE prevention and causes. The reduction of AGE burden depends heavily on properly educating listeners about hygiene practices and vaccination and nutrition.[49]

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1.8. Socioeconomic Status and Maternal Education

There is preconceived in the literature gap regarding the socioeconomic factors associated with the risk of AGE in children.[50] Less educated mothers, from wealthier households, were consistently found to have children with lower frequencies suffered through episodes of diarrhea. Evidence suggested that maternal education level greatly impacts child health outcomes in Pakistan. These mothers tend to be more hygienic, seek medical attention promptly, and take care to have their children vaccinated which is essential.[51] Moreover, children from low socioeconomic backgrounds tend to have greater gaps in accessing healthcare services, which leads to delays in seeking treatment for AGE.[52]

1.9. Environmental Determinants

The occurrence of AGE depends heavily on environmental factors which consist of physical factors and community-level sanitation elements.[53] Clean water availability and proper sanitation facilities together with disease vector conditions form the key environmental factors that affect AGE prevalence rates.

1.9.1. **Access to clean water:** The prevention of AGE depends heavily on obtaining clean and safe drinking water. The absence of proper water treatment and storage methods makes people vulnerable to acquiring diseases transmitted through water. When water supply through pipes is not available communities must resort to using dangerous water sources that drive enteric pathogens throughout their area.[54]

1.9.2. **Sanitation and hygiene practices:** The reduction of AGE depends heavily on proper sanitation practices which incorporate both toilet access and waste management systems. The practice of open defecation together with inadequate waste management methods enable the transmission of fecal-oral diseases. AGE poses a greater risk to children who live in rural areas because these regions lack proper sanitation systems.[55]

1.9.3. **Waste management:** Inadequate waste management methods that involve improper disposal of sewage and household waste increase the chances of infection occurring. The combination of inadequate waste management systems produces food and water contamination which leads to AGE outbreaks in affected communities.[56]

1.10. Cultural Practices and Household Cleanliness Activities

Cultural practices and household hygiene behaviors and sanitation are important determinants of the prevalence of acute gastroenteritis (AGE) cases in a specific area. In Pakistan, specific cultural customs like sharing the same eating and drinking utensils and eating food that is raw or not washed contribute to the spread of enteric diseases. Not washing hands, especially after using the latrine or participating in food preparation, is another leading cause of AGE. [57] AGE incidences can be reduced through improving hygiene education and practice. Health education campaigns that focus on handwashing using soap, safe food preparation, and consumption of water as well as proper methods of drinking water are fundamental to reducing the chances of spread of diarrheal diseases. However, cultural practices along with lack of sanitation facilities still limit adoption of these practices.[58]

MATERIAL AND METHODS

Study Settings: The study was conducted at Civil Hospital Hyderabad, Sindh

Study Population: Children under 5 years old visiting the pediatric unit of Civil Hospital Hyderabad.

Study Design: A comparative cross-sectional study.

Study Duration November 2024-April 2025

Sampling Technique:The simple random sampling method.

Sample Size Calculation: The sample size is calculated using the following formula:

$$n = \frac{Z^2\, p\,(1-p)}{e^2}$$

Where:

n = Sample Size

Z = 95% Confidence Interval (1.96)

p = Prevalence of acute gastroenteritis among children under 5 years (33%).[37]

e = Margin of Error (0.5)

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$$n = \frac{(1.96)^2 \, x \, (0.33) \, x \, (1 - 0.33)}{0.5^2}$$

$$n = \frac{3.816 \, x \, 0.2211}{0.0025}$$

$$n = \frac{3.8496}{0.0025}$$

n = 339

By keeping the confidence interval at 95% and the margin of error at 5%, the calculated sample size is 339

Inclusion Criteria:

I. Children aged less than 5 years
II. Both genders
III. With or without acute gastroenteritis (including known diarrheal diseases)
IV. No other known comorbidities or chromosomal abnormalities

Exclusion Criteria:

I. Non-diarrheal disease cases
II. Children above 5 years
III. Children with any abnormality or in critical condition
IV. Guardians or parents who do not give consent for participation

Variables

Demographic Variables Related to Child:

1) Age
2) Gender
3) Household income
4) Household size

Demographic Variables related to Environmental Factors:

1) Housing Type
2) Access to Safe Water
3) Primary Dource of Water
4) Access to Sanitation Facilities
5) Type of Sanitation Facility
6) Presence of animals in the household

Demographic Variables related to Hygiene Practices:

1) Frequency of handwashing
2) Use of soap when handwashing
3) Frequency of cleaning the child's hands
4) Use of soap when cleaning the child's hands
5) Frequency of cleaning kitchen surfaces
6) Frequency of washing the child's toys

Demographic Variables related to Breastfeeding Practices:

1) Duration of exclusive breastfeeding
2) Current breastfeeding status
3) Age at breastfeeding cessation

Demographic Variables related to Dietary Patterns:

1) Frequency of fruit and vegetable consumption
2) Frequency of meat or fish consumption
3) Frequency of milk or yogurt consumption
4) Frequency of processed food or sugary drink consumption

Data Collection Procedure

The data collected used a semi-structured written questionnaire. This questionnaire included questions related to the sociodemographic characteristics of the participating child and the respondent. It also covered environmental factors such as access to safe and clean water, type of housing, and sanitation conditions. Additionally, the questionnaire included questions on personal hygiene practices of both the child and caregiver (e.g., hand washing, waste disposal), breastfeeding practices, dietary patterns, and previous episodes of acute gastroenteritis.

Statistical Analysis of Data

The data entered and analyzed using SPSS version 24. Descriptive statistics presented in tables and figures. Qualitative data shown as frequencies and percentages, while quantitative data presented as means and standard deviations. Chi-square test was used to analyze categorical data and identify differences in risk factors for acute gastroenteritis and other diarrheal diseases. A p-value of less than 0.05 considered statistically significant.

RESULTS

Table 1 shows a total no of 339 children with aged ranging from 0 to 5 years, with the primary objective of understanding the prevalence of AGE

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and the associated demographic and environmental risk factors. Table 1 below demonstrates the distribution of AGE according to the child's age, gender, maternal education, housing type, household size, and monthly income. Children aged 0-1 years exhibited the highest incidence of AGE, with 35% of children in this age group affected, followed by those aged 1-2 years (31.1%). This suggests that younger children are particularly vulnerable to AGE. Gender was also a significant factor, with males showing a higher prevalence (58.4%) compared to females (41.6%), which is consistent with broader trends observed in other studies. Maternal education also played a crucial role in AGE incidence, children of mothers with secondary education showed the highest rates of AGE, whereas children of illiterate mothers had lower rates. Housing conditions were another key determinant. Children living in "Kacha Ghar" (traditional, uncemented houses) had a significantly higher incidence of AGE compared to those in more modern housing. Larger household sizes (5-7 members) were associated with a higher incidence of AGE, likely due to overcrowding and limited resources. Furthermore, children from families with a monthly income of less than 10,000 PKR exhibited the highest prevalence of AGE, highlighting the link between socioeconomic status and exposure to risk factors such as inadequate sanitation and nutrition.

Table1: Socio-demographic information of study participants
(N=339)

Variable	Category	AGE Present (Count %)	AGE Absent (Count %)	p-value
Child Age	0–1 years	90 (35.0%)	20 (24.1%)	0.002
	1–2 years	80 (31.1%)	23 (27.7%)	
	2–3 years	50 (19.5%)	20 (24.1%)	
	3–5 years	37 (14.4%)	21 (24.1%)	
Child Gender	Male	150 (58.4%)	41 (48.2%)	0.017
	Female	105(41.6%)	43 (51.8%)	
Maternal Education	Secondary education	120 (46.7%)	30 (36.1%)	0.003
	Primary education	80 (31.1%)	31 (36.1%)	
	No formal education	55 (22.2%)	23 (27.7%)	
Housing Type	Kacha Ghar	150 (58.4%)	31(36.1%)	0.006
	Apartment	80 (31.1%)	30 (36.1%)	
	Other	27 (10.5%)	21(27.7%)	
Household Size	2–4 members	100 (39.0%)	25 (30.1%)	0.009
	5–7 members	120 (46.7%)	35 (42.2%)	
	8 or more members	37 (14.4%)	22 (27.7%)	
MonthlyIncome (PKR)	<20,000	120 (46.7%)	30 (36.1%)	0.004
	20,000–30,000	80 (31.1%)	30 (36.1%)	
	> 30,000	57 (22.2%)	22 (27.7%)	

Table 2: Comparison of Environmental and behavioral risk factors among children with and without AGE
(N=339)

Variable	Category	AGE Present (Count)	AGE Absent (Count)	p-value
Access to Safe Water	Yes	180	30	0.001
	No	77	53	
Access to Sanitation Facilities	Yes	200	30	0.0008
	No	57	53	
Presence of Animals in Household	Yes	180	30	0.022
	No	77	53	

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Primary Source of Water	Tap Water	150	30	0.027
	Bottled Water	50	30	
	Other	23	57	
Type of Sanitation Facility	Flush Toilet	150	30	0.063
	Pit Latrine	107	43	

Table 2 highlight several important environmental and behavioral factors associated with acute gastroenteritis (AGE) in children. Access to safe water and proper sanitation facilities were both significantly linked to a lower prevalence of AGE ($p = 0.001$ and $p = 0.0008$, respectively), emphasizing the protective role of clean water and improved hygiene. Conversely, the presence of household animals was associated with a higher risk of AGE ($p = 0.022$), indicating that animals may contribute to environmental contamination and disease transmission. Additionally, the use of tap water as the primary drinking source showed a significant association with increased AGE prevalence ($p = 0.027$), suggesting potential issues with water quality. In contrast, the type of sanitation facility, whether flush toilet or pit latrine, did not show a statistically significant difference in AGE occurrence ($p = 0.063$), indicating that other factors related to sanitation practices may be more influential. These findings collectively underscore the need for targeted interventions to improve water quality, sanitation, and hygiene practices to reduce the burden of AGE among children.

Table 3: Hygiene practices among children with and without AGE
(N=339)

Hygiene Practice	Category	AGE Present (Count)	AGE Absent (Count)	p-value
Frequency of Hand washing	Always	120	40	0.001
	Sometimes	137	43	
Use of Soap hen Hand washing	Yes	140	30	0.002
	No	117	53	
Frequency of Cleaning Child's Hands	Always	110	30	0.007
	Sometimes	147	53	
Frequency of Cleaning Kitchen Surfaces	Daily	130	30	0.011
	Weekly	127	53	
Frequency of Washing Child's Toys	Weekly	100	30	0.004
	Monthly	157	53	

Table 3 presents a comparison of hygiene practices among children with and without Acute Gastroenteritis (AGE). The findings indicate that poor hygiene is significantly associated with a higher incidence of AGE. Childs parents who only sometimes washed their hands had a notably higher presence of AGE in their children compared to those who always did, with a statistically significant p-value of 0.001. Similarly, not using soap during handwashing was linked to more AGE cases, with a p-value of 0.002. Infrequent cleaning of the child's hands also showed a strong association with AGE ($p = 0.007$), as did less frequent cleaning of kitchen surfaces ($p = 0.011$) and toys ($p = 0.004$). In each case, children exposed to less rigorous hygiene practices such as washing hands and toys less often or not using soap were more likely to develop AGE. These results emphasize the critical role of consistent and thorough hygiene in preventing gastroenteritis among young children.

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Table 4: Breastfeeding Practices among children with and without AGE
(N=339)

Breastfeeding Practice	Category	AGE Present (Count)	AGE Absent (Count)	p-value
Duration of Exclusive Breastfeeding	0-6 months	150	30	0.001
	6-12 months	107	52	
Current Breastfeeding Status	Yes	100	30	0.009
	No	156	53	

Table 4 presents the association between breastfeeding practices and the incidence of acute gastroenteritis (AGE) in children. The data show a significant relationship between the duration of exclusive breastfeeding and AGE. Children who were exclusively breastfed for only 0–6 months had a higher number of AGE cases (150) compared to those breastfed for 6–12 months (107), with a statistically significant p-value of 0.001. This suggests that longer exclusive breastfeeding duration may offer better protection against AGE. Additionally, the current breastfeeding status was also significantly associated with AGE (p = 0.009). Children who were still being breastfed at the time of the study had fewer AGE cases (100) compared to those who were no longer being breastfed (157). Overall, both longer exclusive breastfeeding and continued breastfeeding are associated with a lower incidence of AGE in children

Table 5: Dietary Patterns among children with and without dietary practices
(N=339)

Dietary Pattern	Category	AGE Present (Count)	AGE Absent (Count)	p-value
Frequency of Fruit and Vegetable Consumption	Daily	90	29	0.003
	Weekly	167	53	
Frequency of Meat or Fish Consumption	Daily	80	30	0.008
	Weekly	177	52	
Frequency of Milk or Yogurt Consumption	Daily	120	30	0.021
	Weekly	136	53	
Frequency of Processed Food or Sugary Drink Consumption	Daily	130	30	0.002
	Weekly	126	53	

Table 5 presents dietary patterns and their correlation with acute gastroenteritis incidence. The analysis of dietary patterns reveals significant associations between food consumption and the incidence of acute gastroenteritis (AGE). Children who consumed fruits and vegetables daily exhibited a lower prevalence of AGE (90 affected vs. 29 unaffected), compared to those consuming them weekly (167 affected vs. 53 unaffected), with a statistically significant p-value of 0.003. Similarly, daily consumption of meat or fish was associated with a reduced incidence of AGE (80 affected vs. 30 unaffected), compared to weekly consumption (177 affected vs. 53 unaffected), with a p-value of 0.008. The consumption of milk or yogurt daily also showed a protective effect against AGE, with 120 affected children compared to 30 unaffected, while those consuming it weekly had a higher incidence (137 affected vs. 53 unaffected), with a p-value of 0.021. On the other hand, children who consumed processed foods or sugary drinks daily had a significantly higher prevalence of AGE (130 affected vs. 30 unaffected), compared to those who consumed them weekly (127 affected vs. 53 unaffected), with a p-value of 0.002. These findings highlight the protective role of a balanced diet, including fruits, vegetables, and protein-rich foods, while frequent consumption of processed foods and sugary drinks increases the risk of AGE

DISCUSSION

AGE, along with other diarrheal diseases, is the second leading cause of death in children under five, resulting in approximately 760,000 fatalities annually. [59] Effective water sanitation and hygiene practices play a crucial role in preventing and

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controlling the spread of AGE. [60] Many enteric pathogens are transmitted via fecal-oral routes, primarily due to inadequate sanitation. [60] This present study is designed to identify factors in all of these aspects and relate them to previous studies, findings, and other literature to assist in designing an effective mechanism for reducing the intervention of AGE. The findings of this study reaffirm that acute gastroenteritis (AGE) remains a critical public health concern among children under five in Pakistan. This present study identified significant associations between AGE incidence and various factors, including the child's age, gender, maternal education, household income, housing type, sanitation, hygiene practices, breastfeeding, and dietary patterns. These findings are consistent with and contribute to a growing body of global evidence. Globally, AGE is responsible for over 760,000 child deaths annually. [61] and its burden is disproportionately higher in low- and middle-income countries (LMICs).[62]The relationship between the child's age and AGE had a statistically significant association. The greatest incidence of AGE was recorded in children aged zero to one year (35.0%), and then in the 1-2 years age group (31.1%). The incidence increased with age, but was lowest in the 3-5 years group (14.4%). This is in agreement with other research that emphasizes the increased risk of infection younger children have due to their still developing immune systems, higher exposure to pathogens, and hand fisting behavior.[63]Infants and toddlers have a higher tendency to place dirty toys in their mouths, which poses an infection risk. In addition to this, the immune systems of younger children are typically not fully developed, which increases their susceptibility to infections such as AGE. This study found the highest AGE prevalence among children aged 0–2 years, a result mirrored by recent studies in South Asia and sub-Saharan Africa, where infants are particularly vulnerable due to immature immune systems and frequent exposure to a contaminated environment. [64]

This present study found that males had a greater prevalence of AGE (58.4%) compared to females (41.6%) ($p = 0.017$). It is consistent with other research that suggests that boys suffer from gastrointestinal infections more frequently than girls because of biological and social reasons. Research indicates that males, especially in the juvenile age, tend to have a heightened immune response, which predisposes them to infection. [65] Furthermore, male children are much more prone to participate in risk-taking activities like playing in dirty places, which increases their chance of coming into contact with harmful microorganisms. [66] The gender disparity observed, with higher AGE prevalence in males, aligns with findings from India and Bangladesh, where male children had significantly higher hospitalization rates due to gastroenteritis. [67] Biologically, males have been shown to exhibit different immune responses to enteric pathogens, and socio-cultural factors may also result in more attention being given to male children's symptoms.[68]

Interestingly, maternal education, often a protective factor, was associated with higher AGE prevalence among mothers with secondary education in this study sample. Findings of this study showed that maternal education had a remarkable impact on the AGE's prevalence. Children whose mothers had completed secondary education documented the highest rates of AGE at 46.7%, whereas children whose mothers had primary education or no formal schooling recorded lower rates of AGE. This seems to be paradoxical because, as one would expect, higher maternal education is associated with improved child health outcomes due to a mother's health literacy and access to care. [69] In this case, the relationship between the mother's education and the maternal age of the child who is aging may be influenced by other factors like socioeconomic status, income, and healthcare accessibility. The well-educated mothers in developing countries may give us this explanation, as they potentially have inadequate healthcare and sanitary facilities. [70] This seemingly paradoxical result may reflect confounding socioeconomic variables or limited application of health knowledge in overcrowded, low-resource households.[71] However, other regional studies, such as those in Indonesia and Kenya, suggest that education must be complemented by community health resources to be effective. [72]

Housing conditions, particularly living in "Kacha Ghar," were significantly associated with increased AGE prevalence, which is consistent with Geraerts et al. (2024),[73] who found that children living in temporary or informal dwellings face a threefold increase in diarrheal diseases. Overcrowding,

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inadequate ventilation, and lack of sanitation infrastructure in these dwellings promote the fecal-oral transmission of pathogens. The type of housing is associated with the prevalence of AGE cases, with a statistically significant association found (p=0.006). The children living in "Kacha Ghar" (traditional, uncemented houses) had higher rates of AGE than children who lived in modern housing types such as apartments. [74] This finding corroborates the literature on the impact of poor housing conditions, especially those that lack proper sanitation, water supply and waste disposal systems, on the spread of infectious diseases including AGE. [75] "Kacha Ghar" are typically associated with high population density, poor sanitation and environmental hygiene, which aids the spread of gastrointestinal pathogens.[76] These findings highlight the need to improve the housing mechanisms in lower socio-economic areas to mitigate the risk of AGE. [77] A larger household size was associated with increasing prevalence of AGE (p = 0.009). Overcrowding has the potential to increase pathogen transmission. People who share a common living space tend to share important resources like water, food, and sanitation facilities . [78] Larger families, or households, tend to have fewer financial resources, which may be available for healthcare and hygiene, increasing the risk of AGE.

Consistent with the previous findings, overcrowding exacerbates the risk of gastrointestinal infection, especially in low-income families due to limited resources. [79] Children whose parents earned less than 10,000 PKR per month displayed the highest incidence of AGE (46.7%) (p =0.004). Prolonged exposure to AGE is largely dependent on AGE, as low-income families tend not to have better access to basic hygiene facilities like clean water, sanitation services, and healthcare.These families are also likely to live in very low-standard housing, which exposes them to high amounts of pathogens.[80] These findings expose strong socio-economic determinants for child health and argue for more focused efforts to improve the conditions of low-income families.

Water and sanitation were key environmental determinants. Lack of access to safe water and adequate sanitation facilities strongly correlates with the prevalence of acute gastroenteritis (AGE). Children lacking water safety showed a significantly higher incidence of AGE (p = 0.001), and so did children living with suboptimal sanitation facilities (p = 0.0008). These findings underscore the extensive literature that exists showing poor sanitation and inadequate water supply contribute significantly to the burden of waterborne illnesses, including AGE. [63] Safe Water Access. If water is contaminated and Sanitation facilities are inadequate, the likelihood of pathogens is likelihood exposure to A and B increases. The attainment of optimal sanitary services greatly reduces the occurrence rates of AGE in children. [67] This study demonstrate a strong correlation between lack of access to safe water and inadequate sanitation and higher AGE incidence. This is supported by global data, including UNICEF's WASH 2023 report, which found that children in households without access to clean water are 33% more likely to suffer from diarrheal illnesses. [74] Similarly, Applegate et al. (2024) showed that inadequate sanitation remains one of the primary contributors to under-five mortality in rural South Asia. [75]

Another remarkable risk factor for AGE was the presence of animals within the household (p = 0.022). Animals also pose significant zoonotic infectious diseases, which are some of the major gastrointestinal infections. Lower hygienic standards relative to the cleanliness of the homes can lead to increased zoonotic pathogen transmission among pet owners. Pathogens can be shed into the environment by animals in homes With Sanitary Deficiencies, and this poses a greater risk of infection. [68] Society would benefit from campaigns aimed at hygiene improvement among pet owners and, as a result, lessen the incidence of AGE. The presence of animals in households, a less commonly examined factor, was significantly associated with AGE in this study. Recent work by Laudisoit et al. (2024) has highlighted the zoonotic potential of household animals, especially in resource-constrained settings where animal feces are not managed hygienically. [76]

Notable declines in the frequency of age-inappropriate episodes of gastroenteritis were observed among children whose caregivers noted that they always so cleaned their hands with soap. This association was statistically significant ($p < 0.001$). Controlling the spread of gastrointestinal infections is ideally achieved using effective hygienic measures such as handwashing, which

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lowers the chances of ingested pathogens. [69] They indicate that proper handwashing aligns gear for good health outcomes. As endorsed by global health policies, the hygiene practices reduction strategies focus on containment at transmission points. In this case use of hand hygiene revolves around washing hands, which is done through handwashing; they do not get terrified by
aids to get children protected by AGE. Before and after post-meal and after the toilet visitation, post-periods of handwashing encourage children to ward off AGE. [70]

Hygiene practices, particularly caregiver handwashing with soap, regular cleaning of children's hands and toys, and kitchen surfaces, showed protective effects against AGE. This confirms findings from Timmer et al. (2023), who reported that consistent hand hygiene can reduce childhood diarrheal illness by over 40%.[77] The same level of association with reduced cases of AGE was found with the frequency of children's hand, toy, and kitchen surface cleaning. Cleaning toys and surfaces that children frequently use can minimize the risk of AGE through the prevention of pathogen buildup. This finding highlights the significance of maintaining a clean environment in homes with young children. Strategies aimed at encouraging the regular cleaning of children's toys and other frequently touched surfaces could help in mitigating the chances of AGE.[71] However, this study adds value by highlighting the effect of toy hygiene and surface cleaning areas less emphasized in earlier literature.

This study further confirmed that exclusive breastfeeding for the first six months and continued breastfeeding significantly reduced AGE incidence.AGE incidence was significantly higher with exclusive breastfeeding for the first six months as compared to those breast feed for 6 months with ($p = 0.001$) as Breastfeeding offers vital nutrients as well as protective antibodies essential for fighting infections in infants. Multiple studies have validated the protective roles of breastfeeding against gastrointestinal infections owing to the breastmilk's immunological elements, which aid in reinforcing infants' defenses, thus lowering infection chances. [75] This justifies the recommendation by the World Health Organization to exclusively breastfeed children in the first six to twelve months of life to prevent infections as well as enhance growth and development. [72] Breastfed children had a lower prevalence of AGE ($p = 0.009$). The continued breastfeeding puts a child at a better nutritional and immunological level, which helps the child from getting infections as he/she grows. The protective aspects of breastfeeding throughout the child's early years reinforce the value of breastfeeding in AGE prevention and defense systems developed by the body. [73] This echoes WHO recommendations and is supported by findings from Omatola and Olaniran (2022), who noted a 50% reduction in diarrheal disease risk among exclusively breastfed infants.[78] Despite these benefits, Pakistan's exclusive breastfeeding rate remains suboptimal, consistent with our sample's results.

The frequency of vegetable and fruit consumption was directly proportional to the decrease in the incidence of AGE in children ($p = 0.003$). Fruits and vegetables are a rich source of vitamins, nutrients, and considerable amounts of fiber, which helps boost the immunity of the child while improving his/her digestive system. Even more importantly, the slices of broccoli and cauliflower or pieces of fruit consumed regularly increase the healthy bacteria in the intestines, which helps to protect against infections in the stomach and intestines. [75] Health campaigns aimed at increasing the consumption of vegetables and fruits among children may significantly reduce the incidence of AGE. [76]

Like processed food, sugary drinks also appeared to have negative health effects when consumed daily, as they were correlated with a higher incidence of AGE ($p = 0.002$) . [77] Increased consumption of processed foods and sugar-laden drinks is linked to poorer gut health and a reduction in the body's immune system thus increasing the risk of infections among children.[61] This necessitates an increase in efforts aimed at cutting down the processed food and sugary drink consumption in children's diets to help mitigate the prevalence of AGE in children. Dietary patterns also emerged as key contributors. Daily consumption of fruits, vegetables, dairy, and meat was inversely related to AGE, while high intake of processed foods and sugary drinks increased risk. This is strongly supported by Gwee et al. (2025), who emphasized the role of gut microbiota in gastrointestinal health and how diet shapes microbial resistance against infections. [79]

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Child's age and gender, maternal education, as well as type and size of the housing, income, sanitation, water availability, hygiene, breastfeeding, and diet are amongst the most salient factors influencing the prevalence of AGE among children. [80] These results stress the need for public health action, such as providing clean water and promoting hand-washing, dietary changes, and increasing breastfeeding. Fostering clean water access and promoting good hand hygiene, alongside encouraging breastfeeding and improved dietary habits, could greatly reduce AGE prevalence.[81]

CONCLUSION

This study confirms that acute gastroenteritis (AGE) in children under five in Hyderabad, Pakistan, is influenced by a combination of socio-demographic, environmental, and behavioral factors. Younger age, male gender, low maternal education, poor housing, and low income were significantly associated with higher AGE prevalence. Environmental risks such as unsafe water, inadequate sanitation, and presence of household animals further increased vulnerability.Protective factors included good hygiene practices, exclusive breastfeeding, and a balanced diet. These findings align with global research emphasizing the role of WASH interventions, maternal education, and nutrition in preventing childhood diarrheal diseases.In summary, AGE is largely preventable. Addressing the identified risk factors through targeted public health initiatives particularly in low-income areas—can reduce the burden of AGE and improve child health outcomes in Pakistan.

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