



Prevalence of Rotavirus in Children with Diarrhea Attending Hospitals in Nasarawa State as a Case Study

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Authors' contributions

This work was carried out in collaboration among all authors. Author BAA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author AAS managed the analyses of the study. Author OIK managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study is aimed to determine the prevalence of Rotavirus among infants and young children that have gastroenteritis attending two Hospitals in Nasarawa State as a case study.

Study Design: A Hospital-based Cross-sectional Study was used in this study, and demographic data was obtained using questionnaire.

Place and Duration of Study: Department of Biological Science, Bingham University Karu, Nasarawa State, between May 2019 and July 2019.

Methodology: 200 children of age 0-10 with gastroenteritis were included in the study. Stool samples were collected aseptically in a lick proof universal container and samples were screened for Rotavirus using faecal antigen Rotavirus EIA cassette kit according to the manufacture's manual. The statistical analysis was done using the chi-square test (X^2) to determine the relationship between prevalence of Rotavirus and possible risk factors at 95% confident interval.

Results: The prevalence rate of 8.5% was recorded. Children within the age group 0-3 had the highest frequency of 10.7% than other age groups. It was also observed that the infection was

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more predominant in males than in females, with an incidence of 8.5% and 8.4% respectively, although this was not statistically significant since P-value >0.05. Also children of parents with informal education had a higher frequency of 14.5% than children of parents with formal education (4.8%) and this was statistically significant with P-value <0.05 showing a relation with the prevalence of Rotavirus. The infection was observed to have a high prevalence of 12.3% in children that were still breastfeeding. Incidence of the infection in children that use toys was 11.3% with the P-value <0.05 and was statistically significant with the infection. A prevalence of 12.5% was recorded in children that use potty as against other toilet types. A frequency of 9.2% was observed in children that used antibiotics, although this was not statistically significant with P-value >0.05. Children that had not been vaccinated for the infection had the highest frequency of 8.9% with P-value >0.05.

Conclusion: The detection of Rotavirus in children stool samples within the selected study location is a wakeup call and a fact that gastroenteritis is not only caused by bacteria.

Keywords: Prevalence; gastroenteritis; rotavirus; infection; children; incidence.

1. INTRODUCTION

Almost every child in the world has had diarrhoea caused by Rotavirus at least once by the age of five [1]. Diarrhoea has frequently ranked as one of the six causes of death, and the top three causes of death for infectious disease, also top two causes of death considering years of life lost according to reports [2]. Rotavirus infection which infects the bowels of humans and some animals is contagious and Rotavirus been its etiological agent, it is the most common cause of inflammation of the stomach and intestines that leads to severe diarrhoea in infants and young children across the globe, but older children and adults can get it too [3]. Rotaviruses were first identified in animals in the 1960s and then were subsequently found in humans by electron microscopic examination of the duodenum of children who had severe diarrhoea [4]. Rotaviruses are transmitted from person to person through direct contact with infected stool or the fecal-oral route [5]. Participation of children in day care activities or schools is a risk factor to Rotavirus infection, especially the likely spreads through faecal-oral route, contact from other children and day care workers [6]. The virus can be transmitted through respiratory droplets from sneezes, cough and catarrh [7]. Acute gastroenteritis induced by Rotavirus has been a major disease burden in Nigeria, since it was first reported in 1985. Although, Rotavirus vaccine is commercially accessible in Nigeria but routine vaccination have not been introduced to the National Immunization Program [8]. There have been increased prevalence rate with severe public health consequences mostly among children. Six countries: Nigeria, Congo, Ethiopia, India, China, Pakistan account for more than half of the global mortality burden of Rotavirus

diarrhoea [9]. The aim of this study was to establish the prevalence rate of Rotavirus among children attending Hospitals in Nasarawa State.

2. METHODOLOGY

2.1 Study Location

This study was carried out among children attending some Hospitals in Nasarawa state Nigeria. Nasarawa state was created on 1 October 1996 by the Abacha government from Plateau state. The capital of Nasarawa state is Lafia. Nasarawa state is bounded at the north by Kaduna state, in the west by Abuja, in the south by Kogi and Benue state and in the east by Taraba and Plateau state. The state lies between latitude 7° 45' and 9° 25'N of the equator and between longitude 7° and 9° 37'E of the Greenwich Meridian. There are 13 local governments in Nasarawa state. Nasarawa state has a total land mass of approximately 27,137.8 sq km. Nasarawa state lies within the guinea savannah region and has tropical climate with moderate rainfall. Population of Nasarawa state is 1,869,377 as at the last census in 2006 [10].

2.2 Study Population

The study involves the participation of 200 consented children below eleven years of age with gastroenteritis both in and outpatients attending some Hospitals in Nasarawa State.

2.3 Study Design

A Hospital-based Cross-sectional Study was used in this study, and demographic data was obtained using questionnaire. The participation of the children was randomized and their consent

was sought for before they were enrolled in the study. Confirmation of gastroenteritis based on signs and symptoms was done by the attending clinicians. The samples were screened for Rotavirus antibodies using faecal antigen Rotavirus EIA cassette kit [11].

2.3.1 Inclusion criteria

Includes children within ten years of age who were in and out patients of some Hospitals in Nasarawa State, who had been confirmed to have gastroenteritis, and their parents gave informed consent.

2.4 Sample Collection

Stool samples were collected aseptically under the supervision of the Head of Laboratory in the Hospital, using a sterile universal container with a leak-proof tight cover to keep the specimen. The stool samples collected were transported in a well-covered flask containing ice-pack, samples were transported immediately back to Bingham university laboratory for processing in the school. The color of the stool specimen, and its texture were part of the criteria used in the collection of the samples. Hospital number, age, sex was written on the stool containers for identification [12].

2.5 Sample Processing

Stool samples collected were refrigerated until the required sample size was obtained and then samples were screened for Rotavirus using faecal antigen Rotavirus EIA cassette kit according to the manufacture's manual. The Rotavirus test cassette works on the principle of qualitative lateral flow immunoassay for the detection of Rotavirus in human faeces specimen. In this assay Rotavirus is detected with the aid of specific antibody against the virus. After the addition of the sample diluent in buffer a color labelled antibody specifically binds to the virus if present in the sample. When this complex migrates upward on the membrane by capillary action, it is captured with the aid of another specific antibody at the test result line region of the test. If the virus is present a red test result line is generated if no result is present the color labelled antibody cannot bind at the test result line region [13].

2.6 Statistical Analysis

The statistical analysis was done using the chi-square test (χ^2) to determine the relationship

between prevalence of Rotavirus and possible risk factors. Percentage prevalence (%) was also calculated. Level of significance were determined by 95% confident interval. Tables were also used to represent various results in this study [14].

3. RESULTS

This study was carried out to examine the prevalence of Rotavirus in children between 0-10 years attending some hospitals in Nasarawa State which are Mararaba Medical Centre and Lunvo Primary Health Care Centre where an overall prevalence of 8.5% was recorded. The results gotten shows difference and variation in prevalence rate among age groups with highest prevalence recorded by age group 0-3 years (10.7%) while there was no record for age group 7-10 years (0.0%). Age group 4-6 recorded prevalence rate of 7.0% respectively. Statistical analysis showed that there was no significant association between the ages of children and prevalence of Rotavirus since $P>0.05$. Prevalence of Rotavirus in terms of sex was higher among males (8.5%) than in females (8.4%) with slight significant difference ($P>0.05$) in Table 1. Table 2 shows the prevalence of Rotavirus in relation to demographic characteristics. In terms of Guardians level of education, those who had formal level of education had a prevalence of 4.8% while those who had informal level of education had a prevalence rate of 14.5% respectively, there was significant relationship between Guardians level of education and the prevalence of Rotavirus in children with $P\text{-value}<0.05$.

Table 3 shows the prevalence of Rotavirus in relation to its associated risk factors. The prevalence rate was higher in children that attended daycare/school (8.6%) and in children that do not attend daycare/school was 8.4%. Also, in terms of the use of toys, children that use or play with toys had a prevalence rate of 11.4% and children that don't use or play with toys had a prevalence of 1.7%. It showed there is a significant association between the use of toys and prevalence of Rotavirus since $P\text{-value}<0.05$. Prevalence rate differs between the sources of water consumed with sachet water having a prevalence of 13.6%, while tap water 7.4%, borehole water 8.3%, bottled water 0.0% and well water 6.7% and it shows there is no significant association between the source of water and prevalence of Rotavirus since $P\text{-value}>0.05$.

Table 4 shows the prevalence of Rotavirus in association to its clinical manifestation. In terms of the signs and symptoms, children that had diarrhea had a prevalence rate recorded at 12.1%, vomiting 6.7% and fever 3.6% respectively with P-value > 0.05. The prevalence rate of Rotavirus was high in children that had not been vaccinated for the virus with a prevalence of 8.9%.

Table 1. Prevalence of rotavirus in children based on age and sex

Age	Number Examined	Number Infected	Prevalence (%)	χ^2	P-value
0-3	121	13	10.7	2.988	0.224
4-6	57	4	7.0		
7-10	22	0	0.0		
Sex					
Male	117	10	8.5	0.001	0.977
Female	83	7	8.4		
Total	200	17	8.5		

At 95% confident level of interval

Table 2. Prevalence rate of rotavirus in relation to demographic and other characteristics

Variable	Number Examined	Number Infected	Prevalence (%)	χ^2	P-Value
Place of Residence					
Rented house	148	11	7.4	0.834	0.361
Personal house	52	6	11.5		
Guardians Education					
Formal	125	6	4.8	5.867	0.015
Informal	75	11	14.5		
Guardian's Hand wash					
Not often	146	13	8.9	0.114	0.0736
Often	54	4	7.4		
Child's Hand wash					
Not often	129	10	7.8	0.261	0.609
Often	71	7	9.9		
Breastfeeding Status (BF)					
Stopped BF	139	10	7.2	1.724	0.422
Breast feeding	57	7	12.3		
Never BF	4	0	0.0		
Type of food Consumed					
Others	137	12	8.8	2.793	0.425
Formula	24	2	8.3		
Pap	3	1	33.3		
Formula/Pap	36	2	5.6		
Total	200	17	8.5		

*At 95% confidence level of interval ; *KEY: Breastfeeding (BF)*

Table 3. Prevalence of rotavirus in relation to its associated risk factors

Variable	Number Examined	Number Infected	Prevalence (%)	χ^2	P-value
Attendance to Daycare/school					
Yes	151	13	8.6	0.009	0.923
No	49	4	8.4		
Use of Toys					
Yes	141	16	11.3	4.983	0.026
No	59	1	1.7		
Attendance/eat At occasions					
Yes	131	11	8.4	0.005	0.943
No	69	6	8.7		
Source of Drinking water					
Sachet	44	6	13.6	2.668	0.615
Tap	68	5	7.4		
Borehole	48	4	8.3		
Well	30	2	6.7		
Bottled	10	0	0.0		
Use of Feeding Bottle					
Yes	85	8	9.4	0.158	0.691
No	115	9	7.8		
Contact with pets/ Animals					
None	125	9	7.2	4.189	0.004
Dog	47	5	10.6		
Cat	11	1	9.1		
Cow	9	0	0.0		
Chicken	8	2	25.0		
Toilet used					
Water closet	61	4	6.6	3.108	0.540
Potty	48	6	12.5		
Pit latrine	43	2	4.7		
Diaper	43	5	11.6		
Others	5	0	0.0		
Total	200	17	8.5		

At 95% confident level of interval

4. DISCUSSION

Almost every child in the world has had diarrhoea caused by Rotavirus at least once by the age of five [1]. Induced acute gastroenteritis caused by Rotavirus has been a major disease burden in Nigeria, since it was first reported in 1985 with serious clinical manifestations mostly among children under five years of age [15]. According to World Health Organization (WHO), over 70% of diarrhoea-related deaths among children less than 5 years old occur in Africa and South-East Asia. Also The prevalence rates of Rotavirus have increased with serious public health consequences especially among children [16].

This research was conducted to determine the prevalence of Rotavirus among 200 children between the 0-10 years of age who met the inclusion criteria, had gastroenteritis and were in and out patients attending two hospitals in Nasarawa state which are Maraba Medical Centre and Lunvo Primary Health Care Centre. The result of this study revealed that the prevalence rate of Rotavirus among the children who participated in this study is 8.5% (17 infected children). This result is slightly similar to the report of a study, with a low prevalence of Rotavirus and Norovirus in hospital and community wastewater after introduction of Rotavirus vaccine in Nicaragua, which had a

prevalence of 11% [17]. The result in this study is lower compare to those obtained in other studies such as a study conducted among diarrheic children in Jos which gave a prevalence of 13.8% [18]. Also a study by lyoha and others, that reported a prevalence rate of Rotavirus in children induced severe diarrhea of 19.2% in Benin City [19], results of a study conducted in 2018 on the prevalence and genotype of Rotavirus infection among children with Gastroenteritis in Abuja, Nigeria reported a total of 25% [20], and in a recent report from Northern Nigeria Kaduna recorded a prevalence rate 32.2% of Rotavirus induced gastroenteritis in children [21] shows a higher prevalence compared to this study. The result from this study is also lower than those gotten from other african countries, this could be due to the fast spread of Rotavirus within those countries hence, the prevalence rates. It is estimated that 27% of all of diarrhoea disease hospitalization in Kenya of children under five is caused by Rotavirus infection [22]. This could probably be due to the larger sample size, study duration might be

longer or was conducted during an outbreak in those countries.

The low prevalence rate in this study could also be related to the sesonality, studies have shown that Rotavirus is predominantly seen in Nigeria during the dry season, In sub-Saharan Africa (Central African Republic, Ethopia, Ghana, Kenya, Nigeria and Somali), Rotavirus detections were 6 times more likely to have peaks during the dry season but the sesonality of the virus detection was not clearly defined in the onset or end of the dry season alone [23]. Also according to a study conducted by Tagbo and his collegues, peak season for Rotavirus occurred during the cold dry months of December to April during which 95% of all the cases occurred [24]. The low prevalence rate conducted in this study could also be linked to the time duration of the study, most studies done that had high prevalence rate were done within one, two and also four years duration such as a study carried out from october 2013-September 2014 involving 144 children below the age of five [25].

Table 4. Prevalence rate of rotavirus in relation to clinical manifestation

Variable	Number Examined	Number Infected	Prevalence (%)	X ²	P-value
Signs/Symptoms					
Diarrhoea	99	12	12.1	3.613	0.164
Vomiting	45	3	6.7		
Fever	56	2	3.6		
Duration of Signs/symptoms					
Short	104	11	10.6	1.202	0.273
Long	96	6	6.3		
Stool Texture/ Appearance					
Watery	54	2	3.7	2.338	0.505
Loose	71	7	9.9		
Green	43	5	11.6		
Formed	32	3	9.4		
Use of ORT					
Yes	66	6	9.1	0.044	0.833
No	134	11	8.2		
Vaccination For Rotavirus					
Yes	1	0	0.0	0.774	0.679
No	192	17	8.9		
Unknown	7	0	0.0		
Use of Antibiotics					
Yes	109	10	9.2	0.140	0.780
No	99	7	7.7		
Total	200	17	8.5		

At 95% confident level of interval * KEY: Oral Re-hydration Therapy (ORT)

The result of this study based on three age groups which were 0-3, 4-6, 7-10 showed the prevalence of Rotavirus being predominant among children between the age group 0-3 years, children less than three years of age were highly susceptible to Rotavirus infection which suggests that, almost all unvaccinated children within age 3-35 months get infected with the virus before they are five years old [26]. However older age groups 4-6 years had a lower prevalence rate of the virus compared to those from 0-3 years of age, which agrees with similar findings by Nyango *et al* that close to 90% of all children are infected with Rotavirus by two years of + age. However other ages manifested the infection too [27]. Age group 7-10 had no prevalence recorded, this could probably be due to their matured and stronger immune system compared to those of lower age groups, although by 3 years of age some children would have developed Rotavirus antibodies. Previous studies have demonstrated that children infected with Rotavirus develop systemic and local immune responses and are protected from severe disease upon reinfection [28].

Findings in this study showed the predominance of Rotavirus was detected more in males (8.5%) than in females (8.4%). This is similar to a previous study on gender predominance of Rotavirus infection [29]. This is also in agreement with another finding in which males have been found to be twice susceptible and likely to be admitted in hospitals than females [30]. The higher frequency of Rotavirus infection in male compare to female could probably be because male are likely to be active than females and are involved in vigorous activities.

The guardian's level of education also influences the prevalence of Rotavirus in this study where guardians with informal education recorded the highest level of frequency. These are guardians that have not had any form of education either primary, secondary or tertiary education, having an incidence of 14.5% detection in children, whereas guardians with formal education had 4.8% prevalence which was statistically significant. This may also reflect in the guardian's level of education as regarding sanitation practices/hygiene and exposure of the children to the infection [31]. This is in agreement with a study carried out in Sudan which shows that children of informal/illiterate parents are more infected with Rotavirus [30]. The high prevalence in children whose parents have informal level of

education probably could be due to the lack of knowledge on good hygiene practices to prevent the occurrence of the disease and do not take immense caution in their activities. Also there was a higher incidence of 8.9% in children that the guardians do not observe frequent hand wash, while those that observe frequent hand wash had an incidence of 7.4%, however there was no statistical significance to Rotavirus infection ($p>0.05$), this study agrees with a research stating that Rotavirus spreads from child to child through the contamination of caregivers hands from infected fomites or surfaces [4]. High incidence in children that guardians do not wash hands frequently is probably due to the use of ordinary soaps and not disinfectant in washing their hands, and poor hygiene practices.

Rotavirus infection reported a higher frequency of 11.5% in children that live in their personal houses, and children that live in rented houses a frequency of 7.4%. This study agrees with findings of the type of house resided as a risk factor for transmission of the infection [32]. Transmission of Rotavirus in personal houses could also be through respiratory droplets from sneezes, also the use of mild disinfectants that can't remove the virus during cleaning.

In terms of Breastfeeding status, Rotavirus had a high prevalence of 12.3% in children that were still breastfeeding, these were children within the age group 0-3 years. And children that were not and have stopped breastfeeding with a prevalence of 7.2%, this study agrees with a previous study that the highest prevalence of Rotavirus infection was observed in children between age 7-12 month, which is the period that coincides with the weaning period from breastfeeding of most infants, this shows the protective effect of breast milk against Rotavirus [33]. The rate of occurrence of Rotavirus in children that are still breastfeeding could also be due to the introduction of other types of food to the children during the weaning period, also the utensils used during feeding could serve as a vehicle for the virus. Also high frequency was observed in children that consume other types of food and not breast milk, with frequency of 33.3% in children that takes pap(sorghum) than other types of food. Although this was not statistically significant with $P>0.05$, and has no association with Rotavirus infection, but could be due to fecal contamination during the preparation process of the pap, and poor sanitation practices.

Prevalence of Rotavirus with its associated risk factors, it was observed that children that attend schools or daycares had higher prevalence of the infection (8.6%), than children that do not attend with a prevalence of 8.4%. This showed that the associated risk factors were not statistically significant since $P > 0.005$. Rotavirus transmission is facilitated in child day-care centres and schools, including homes by frequent and intimate exposure among susceptible hosts, with diaper changing as the highest risk factor for such mode of transmission [34]. Prevalence in children that attends schools or daycares could be due to inadequate disinfection of the areas to prevent the occurrence of communicable diseases and could also be due to the poor hygiene practices by the personnels and staff of the schools as a result of limited time to take care or attend to a large proportion of children under their care, whereas parents give optimum attention and care to their children naturally.

Childrens use of toys was found to be associated with the possible risk factors of Rotavirus, as its $P < 0.05$ and was statistically significant. A prevalence of 11.3% was observed in infected children that use toys, which was higher than children that do not use toys with prevalence of 1.7%. Rotavirus can be contracted from contaminated fomites and surfaces e.g toys, children can be seen to put objects into their mouths while scratching their gum during teething or when playing, such contaminated objects serve as a source of contamination for them [35]. An incidence of 8.7% was observed in children that do not attend/eats at occasions, these were children within the age group 0-3 years, while those that do attend/eat at occasion an incidence of 8.4%. It was not statistically significant as an association to the infection since $P > 0.05$. This study also agrees with findings that the virus passes easily through the fecal oral-route, which includes the ingestion of fecal contaminated water or food, person-to-person transmission and through contact with contaminated hands or objects such as, toys and surfaces [36]. There was also an incidence of Rotavirus detected in children that come in contact with pets/animals, there was a higher prevalence of 10.6% in children who had come in contact with dogs in their homes compared to those without. Most domestic animal species can play a role in the spread of the virus by acting as natural reservoirs of the virus or as intermediate or end host, due to the ability of the virus to overcome the barriers between species [37]. The 10.6% outcome in this study could be due to the

fact that most children had dogs in their homes, which serves as humans companions, best friend and guards. Although human Rotavirus strains that have a high degree of genetic homology with animal strains that have been identified [38].

Other risk factors such as the source of drinking water, type of toilet used and the use of feeding bottles were also observed in this study as a probable risk factors. Sachet water as the source of drinking water had the highest prevalence of 13.6% as against other source of water such as well, borehole, tap and bottled water, the source of drinking water could be a source of infection especially when it is faecally contaminated and used in preparation of foods. Also in terms of the type of toilet used, children that use potty had a higher prevalence as against other toilet types. Also children that uses feeding bottles had a high prevalence of 9.4% than non user of feeding bottle a prevalence of 7.8%, this was similar to a study done in Basrah [39]. The risk factors were not statistically significant with $P > 0.05$, these are environmental risk factors that are highly related to poor hygiene and lack of care [40]. The high incidence in feeding bottle users could be linked to poor sterilization, and handling of the feeder.

Children enrolled in this study had a clinical manifestation of diarrhoea as it's sign and symptom of the infection with 12.1% prevalence projection compared to the other clinical manifestations such as vomiting and fever. Fever had the lowest prevalence of 3.6%, though it was not statistically significant. It is postulated that vomiting in younger children tend to be at an increased risk of developing severe dehydration due to their small body size, as they lose a greater portion of their total fluid volume during the illness [41].

In terms of duration of the clinical manifestation there was high prevalence in children that had short duration of the signs and symptoms i.e the manifestation of the infection did not last long, with a prevalence of 10.3% and 6.3% in children with long duration of clinical manifestation respectively, this was not statistically significant with the association of Rotavirus infection to clinical manifestation with $P > 0.05$. In older children, Rotavirus infection can be asymptomatic; probably because they have some degree of protection from previous infection with this virus [42]. The Prevalence of Rotavirus in relation to stool texture and appearance shows that there was a high prevalence of 11.6% in children with green

appearance of stool than other stool texture and appearance observed in this study, chi-square showed there is no statistical association between the prevalence of Rotavirus and the stool texture and appearance. This could be due to the excessive loss of fluid that made the colour of the stool to turn green during the course of the diarrhoea.

This study also observed that about 9.1% incidence of infected children were treated with the use of Oral Re-hydration Therapy (ORT) as a rehydration therapy with loss of fluid due to diarrhoea, this supports a research carried out in 2018 where a prevalence of 66.7% positive children took ORS [43]. This shows that ORT had been used to stabilize the infected children during the manifestation of diarrhoea. Also a prevalence of 9.2% in children that use antibiotics was observed, as against 7.7% in children that did not take antibiotics, this showed that most of the Rotavirus infected children were treated with antibiotics for bacteria or other enteropathogens, this agrees with a research work on the apparent use of antibiotics in the management of watery diarrheic children in Abakiliki [39]. In terms of vaccination for Rotavirus there was a high prevalence of 8.9% in children that had not been vaccinated, although this was not statistically significant at $P > 0.05$, this may be due to the fact that Rotavirus is not one of the free routine vaccine given to children, or high cost of purchasing the vaccine.

5. CONCLUSION

The prevalence of Rotavirus infection in this study showed that Rotavirus was detected as a causative agent of gastroenteritis in children, with high incidence in children between age group 0-3, and males more susceptible to the infection. The detection of Rotavirus in children's stool samples within these selected study locations is a wake up call and a fact that gastroenteritis is not only caused by bacteria but also by the virus which can lead to death when untreated, therefore it is imperative that the health sector should pay more attention to the effect of these organism in children especially infants.

6. RECOMMENDATIONS

The routine check and screening of Rotavirus should be emphasized regularly to detect it in order to bring childhood death due to Rotavirus infections to the barest minimum. Rotavirus vaccines should be widely distributed across the

country at an affordable rate or should be one of the free routine vaccines administered to children in order to reduce the incidence. Children with gastroenteritis should be properly diagnosed of its causative agent to avoid indiscriminate prescription of antibiotics, development of drug resistant strain to antibiotics and other drugs in order to ensure proper treatment of infection caused by the agent.

7. STUDY LIMITATION

Children who currently did not show symptoms of gastroenteritis at the time of the study did not participate. The refusal of some of the children to participate in the study and high cost of analysis using modern efficient techniques were part of the limitations that were encountered in the study.

CONSENT AND ETHICAL APPROVAL

Ethical approval was sought from the Research Ethics Committee of the Ministry of Health Lafia and the selected hospital management board in Nasarawa State. Also consent of the patient was obtained through their parents.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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