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Full Length Research Paper

The prevalence of group A rotavirus infection and some risk factors in pediatric diarrhea in Zaria, North central Nigeria

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Group A rotavirus cause infectious, severe and dehydrating diarrhea which have great impact on childhood morbidity and mortality worldwide. This study was designed to investigate the disease burden and risk factors of rotavirus infection among children 1 - 5 years in Zaria, Nigeria. Stool samples were collected from 666 diarrheic children and 170 matched non -diarrheic controls and screened for rotavirus antigen by ELISA. Their socio-demographic information and clinical presentations were also noted. There was a 15.6 and 7.6% prevalence of rotavirus infections among the diarrheic and non-diarrheic children, respectively, with the peak of infection occurring between 1 – 6 months of age. The most common clinical features included dehydration (59.1%), fever and vomiting (41.3%), vomiting (34.6%) and fever (19.2%). Age, feeding regimen, and the presence of another person in the house with diarrhea were found to be risk factors for rotavirus diarrhea while gender and socioeconomic status were not. In view of the peak of infection in infants in the study area, rotavirus vaccine will be best administered in early infancy.

Key words: Rotavirus, prevalence, risk factors, pediatric, diarrhea.

INTRODUCTION

Rotavirus infection is the single most important cause of infectious, severe, dehydrating diarrhea and death globally in children aged 5 years and below (Ahmed et al., 2009; Mast et al., 2009; Dhama et al., 2009), and continues to have a great impact on childhood morbidity and mortality (Dennehy, 2008). Rotaviruses are classified into serogroups A through G but only groups A – C have been shown to infect humans with the severe disease mainly caused by members of group A (Nguyen et al., 2004). Rotavirus is highly transmissible and virtually all children will have experienced at least one rotavirus infection by the age of 5 years (White et al., 2008). Reinfection is also common (Fischer et al., 2002), although previous infections reduce the risk of severe disease (White et al., 2008). Adults are also known to experience rotavirus diarrhea (Paul et al., 2008).

Each year rotavirus infection leads to about 600000 deaths globally (Parashar et al., 2006; Mast et al., 2009) with more than 85% of these deaths occurring in Africa and Asia (CDC, 2008). In 2004, six countries, including Nigeria, accounted for more than half of all rotavirus diarrhea deaths in children under 5 years of age (Ahmed et al., 2009). Rotavirus disease is more severe than diarrhea caused by other enteric pathogens (Albano et al., 2007), with symptoms including an average of six stools per day (Castello et al., 2006), severe dehydration which is 14 times more frequent in children with rotavirus diarrhea than among those with the disease from other causes (Kapikian and Channock, 1996) and vomiting and fever (Nguyen et al., 2004; Aminu et al., 2008; Ahmed et al., 2009). The administration of oral rehydration is also hampered by the accompanying vomiting (Parashar et al., 2006).

The reported prevalence of rotavirus infection in children requiring hospitalization ranges from 17.7 - 69% in different countries and in different settings (Kazemi et al., 2006). Parashar et al. (2003, 2006) noted that while diarrheal disease incidence has reduced in recent years, due in part to improved hygiene practices and sanitation,

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the incidence of rotavirus infection continues to increase. They further opined that hygiene and water interventions are likely to be effective only on diarrhea caused by bacteria and parasitic agents. Conversely, Sergio and Ponce de Leon note that improvements in hygiene practices and access to clean water will reduce the incidence of rotavirus diarrhea (Sergio and Ponce de Leon, 2009).

In view of the seriousness of this disease burden worldwide, WHO has recommended the use of rotavirus vaccines in countries with an under five mortality rate of more than 10% (WHO, 2009) . Rotavirus vaccines do not protect against infection, but do protect against severe disease requiring hospitalization; a probable outcome for most children in African settings (White et al., 2008). In fact in the United States, rotavirus vaccine is now included as part of routine vaccine schedule for all infants (Bernstein, 2009).

The study was designed to investigate rotavirus disease burden, clinical symptoms and risk factors among children 5 years old reporting to eight hospitals in Zaria, Nigeria. The baseline data generated will contribution to the information required as for the introduction of rotavirus vaccine in Nigeria.

MATERIALS AND METHODS

Study design

The study was conducted in eight major hospitals in the Zaria metropolis and its environs. A diarrhea case was defined as a child passing 3 or more loose, liquid, watery or a bloody loose stool in a 24 h period (Baqui et al., 1992). The controls were age matched children with no history of diarrhea on the day of stool collection or in the 3 weeks preceding sample collection. Enrolment was for children 1 day to 5 years old and subject to informed consent from their parents/guardians. Children whose ages could not be ascertained were excluded from the study. A standardized questionnaire was used to obtain the socio-demographic information for each child and the state of dehydration was assessed by medical personnel.

This study did not interfere with the normal management of these children.

Specimen collection

Stool samples were collected over a period of 2 years. About 5 g or 5 ml of each fecal specimen was scooped with a spatula or decanted into a labeled screw cap polystyrene bottle and tightly screwed. These were transported to the laboratory in a cold box and stored at -20 $^{\circ}$C until ready for analyses. As much as possible samples were subjected to only one freeze, thaw procedure.

Viral detection

Group A rotavirus antigen was detected according to the manufacturer's instructions using the IDEIA^{TM} Rotavirus kit (DAKO Diagnostic Ltd, UK). The test is a qualitative enzyme immunoassay for the detection of group A rotavirus from fecal samples. It is capable of detecting group A rotavirus particle counts as low as 7.8 $\times 10^5$ /ml. The test plates were read at 450 nm by a Multiscan MIC II reader (Manufacturer?). Any sample well with an absorbance value greater than the cut off value was considered positive and samples with absorbance values less than the cut off value were considered negative.

Data analysis

Differences in proportions were assessed by chi square test. P values < 0.05 were considered statistically significant.

RESULTS

A total of 835 stool samples were screened for rotavirus antigen. Of these, 665 and 170 were diarrhea and non-diarrhea samples, respectively. Among the 665 children that were presented with diarrhea, 15.6% (104) were positive for rotavirus. Those with diarrhea were about two times more likely to be infected with rotavirus than those without diarrhea (OR = 2.21). The association between rotavirus infection and diarrhea was statistically significant ($p < 0.01$) as only 7.6% (13) of those without diarrhea were found to be rotavirus positive. The degree of dehydration among the children with diarrhea was found to be severe, mild, and absent in 14.5, 44.6, and 40.8% of children, respectively. Rotavirus frequency was 21.6, 62.7 and 15.7% among children displaying none, mild and severe dehydration, respectively.

There was no significant association between rotavirus infection and gender (Table 1) ($p > 0.05$) although age was found to be significantly associated with the infection ($p < 0.01$) (Table 1). The age group analysis of rotavirus positive children with diarrhea manifested the highest infection rate among those aged 1- 6 months with 25.3% prevalence. Among the risk factors examined (Table 2), rotavirus infection was not associated with attendance of a daycare , socioeconomic status and drinking water boiled or unboiled water ($p > 0.05$) but was marginally associated with the presence of another person in the household with diarrhea ($p = 0.05$) and significantly associated with the type of food the child was fed ($p < 0.01$).

DISCUSSION

In the present study, rotavirus infection occurred in 15.6% of children 0 - 60 months old that presented with diarrhea and 7.6% of age matched controls. There was a statistically significant association between diarrhea and rotavirus infection ($p = 0.01$) although it had no association with previous history of diarrhea ($p > 0.05$). There was also no statistically significant association between the start of the diarrheal episode and the detection of rotavirus in the stool ($p > 0.05$). The current report is in contrast to the previous report from Zaria ascribing 61% of diarrheal infections among children to

Table 1. Attributes of the 665 children with diarrhea.

No. of children by: Age (months)	Rotavirus detection	
	Rotavirus positive (n = 104)	Rotavirus negative (n = 561)
	No. (%)	No. (%)
<1 (n = 13)	0 (0)	13 (100)
1 - 6 (n = 79)	20 (25.3)	59 (74.7)
7 - 12 (n = 213)	42 (19.7)	171 (80.3)
13 - 24 (n = 146)	20 (13.7)	126 (86.3)
25 - 36 (n = 99)	9 (9.1)	90 (90.9)
37 - 48 (n = 74)	6 (8.1)	68 (91.9)
49 - 60 (n = 41)	7 (17.1)	34 (82.9)
Gender		
Male (n = 362)	62 (17.1)	300 (82.9)
Female (n = 303)	42 (13.9)	261 (86.1)

rotavirus (Dossetor et al., 1979). However, a similar rotavirus prevalence of 18% among diarrheic children and 7.2% among non- diarrheic children in a hospital setting was reported by Aminu et al. (2008) in northern Nigeria. A community based study in randomly selected districts in Zaria by Aminu et al. (2008) reported a rotavirus prevalence of 9% in children under five years of age. Although Dossetor et al. (1979) admitted the paucity of their samples (21 samples), the time of sample collection, the age of the children and the method of investigation could have contributed to the marked difference in prevalence observed. However, studies from southern Nigeria seem have higher rotavirus prevalence values than the reports from northern Nigeria (Abiodun et al., 1994; Omotade et al., 1995; Audu et al., 2002; Odimayo et al., 2008; Ogbu et al., 2008). Apart from differences in time of collection, method of collection and screening of samples, geographical location of the study, differences in prevalence might also reflect changing trends (CDC, 2008).

The outcome of rotavirus infection was significantly associated with the age of the child ($p < 0.01$) with a peak among children 1 - 6 months and decreasing with age. Earlier researchers have made similar observations (Odimayo et al., 2008). This might partly be explained by the fact that older children acquire protective immunity during repeated exposures to the virus and, therefore, subsequent infections are mild or asymptomatic (White et al., 2008). There was 20% asymptomatic neonatal infection in this study (data not shown). This gave credence to an observation that breastfeeding is protective in infants that are less than 6 months old (Saravanan et al., 2004; Dennehy, 2008). This observation had also been reported by Nguyen et al. in 2004. A rotavirus vaccine for this study area will therefore be best administered in early infancy before the peak of rotavirus infection.

There was no statistically significant difference in rotavirus prevalence between male (14.6%) and female (13.2%) children with diarrhea in this study ($p > 0.05$). This is probably because at that age there is no difference in life styles between the boy and girl child. Other studies have reported similar observations (Saravanan et al., 2004; Aminu et al., 2008).

Of the 104 rotavirus positive diarrheic children, the most frequent type of stools observed were watery stool (65.4%) and watery and mucoid stool (18.3%). The major clinical features among these children included vomiting and fever (41.3%), vomiting (34.6%), fever (19.2%), respiratory symptoms (1.9%) and others (2.9%). Similar observations had been made by other researchers (Nguyen et al., 2004; Parashar et al., 2006; WHO, 2009.). Both diarrhea and vomiting are means by which fluid is lost, thus, leading to dehydration commonly associated with rotavirus diarrhea. In this study, rotavirus infection was found to be highly associated with dehydration ($p < 0.001$). It was severe in 14.5%, mild in 44.6% and absent in 40.8% of the diarrheic children. Likewise, rotavirus prevalence was 21.6% among those not dehydrated and 78.4% among those that were dehydrated. Before coming to the hospital, 51% of the diarrheic children were given oral rehydration solution (ORS). These results are promising indicating that educations programs about oral rehydration may be partially succeeding in reduce the number deaths due to severe dehydration and diarrheal disease. Although some researchers advocate ORS as the first line of treatment in diarrheal cases (Odimayo et al., 2008), others noted the difficulty in administering this therapy in view of the associated vomiting in rotavirus diarrhea (Parashar et al., 2004).

Rotavirus was found to be significantly associated with the feeding regimen of the children ($p < 0.01$). The highest prevalence was among those that were exclusively breastfed (21.4%), followed by those fed on

Table 2. Relationship between some risk factors and rotavirus infection in children.

No. of respondents by risk factors	Rotavirus detection		P value
	Rotavirus positive No. (%)	Rotavirus negative No. (%)	
1. Socioeconomic status of parents			
High (n = 669)	94 (14.1)	557 (85.9)	p>0.05
Low (n = 159)	22 (13.8)	137 (86.2)	
2. Attendance of daycare			
Attend (n = 47)	6 (12.8)	41 (87.2)	p>0.05
Do not attend (n = 788)	111 (14.1)	677 (85.9)	
3. Feeding			
Exclusive breast feeding (n = 84)	18 (21.4)	66 (78.6)	
Breast + solid food (n = 250)	51 (20.4)	199 (79.6)	p<0.01
Solid food only (n = 331)	35 (10.6)	296 (89.4)	
4. Another person in the household with diarrhea			
Yes (n = 122)	26 (21.3)	96 (78.7)	p = 0.05
No (n = 510)	73 (14.3)	437 (85.7)	
5. Type of drinking water			
Boiled (n = 62)	11 (17.7)	51 (82.3)	p>0.05
Not boiled (n = 510)	73 (14.3)	437 (85.7)	
6. Previous history of diarrhea			
Yes (n = 352)	51 (14.5)	301 (85.5)	p>0.05
No (n = 184)	35 (19.0)	149 (81.0)	

breast milk and solid food (20.4%) and then in those that were fed on solid food only (10.6%). A similar observation was reported by Aminu et al. (2008). These results seem to suggest that breastfeeding may not protect the child against rotavirus infections and additional studies may be required to elucidate this phenomenon. The low prevalence of rotavirus in children fed solid food may reflect the age of the child and decreasing rotavirus prevalence in older children rather than a protective effect due to the solid food.

Rotavirus infection was marginally associated (p = 0.05) with the presence of another person in the household with diarrhea. This supports reports that the virus is highly infectious and can be transmitted from person to person (de Wit et al., 2003; Bucher and Aebi, 2006; Dennehy, 2008).

The socioeconomic status of the child's parents, attendance of a daycare facility, type of drinking water and previous history of diarrhea (Table 2) had no statistically significant association with rotavirus prevalence (p > 0.05). Researchers have noted that rotavirus is resilient and highly contagious and, therefore, improvements in water and sanitation are unlikely to be effective preventive measures of rotavirus disease, supporting the advocacy for mass vaccination programs (Huppertz et al., 2008).

The results generated in this study will be used to generate baseline rotavirus burden data and combined with data from other regions in Nigeria, used to provide evidence to support the introduction of rotavirus vaccine to Nigerian children.

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