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Epidemiology and risk factors associated with group a human rotavirus infection in Sokoto metropolis, Nigeria

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ABSTRACT

Rotavirus constitutes the major cause of severe gastroenteritis in young children worldwide. Despite its importance, little is known about the epidemiology of rotavirus in Sokoto State, Nigeria. The objectives of this study were to determine the occurrence and possible factors associated with human rotavirus infection in Sokoto metropolis, Nigeria. A total of 200 stool samples were collected from less than 5 years old patients at 5 different tertiary hospitals in Sokoto metropolis. Samples were tested and analysed for the presence of human group A rotavirus along with a questionnaires completed for each patient. Of the total number of samples collected, 51 were found to be positive for human group A rotavirus indicating 25.5% prevalence status of the population sampled. Factors associated with rotavirus infection were analysed using chi-square statistical method and discussed.

Key words: Group A human Rotavirus, Diarrhoea, Children, Sokoto metropolis, Nigeria.

INTRODUCTION

About three decades following the discovery of rotavirus in infants that died from severe diarrhoea in Melbourne, Australia (Bishop et al., 1973), rotavirus remains the single most important cause of severe diarrhoea in young children worldwide (Kapikian et al., 2001). The virus was later recognized in primates, horses, pigs, dogs, cats, sheep, rabbits, mice, cows and birds (Nakagomi and Nakagomi, 1993).

Compared to the developed countries where high morbidity and low morbidity rates are usually reported due to rotavirus infections (CDC, 1999), in developing countries, rotavirus has been the leading cause of life-threatening diarrhoea in infants and young children. In fact, the burden of rotavirus diarrheal disease in infants and children under 5 years of age in developing countries has been estimated to be 130 million cases out of which 873,000 die of rotavirus associated diarrheal each year (IOM, 1986; Cunliffe et al.1998).

In Nigeria, a high incidence of childhood diarrhea is estimated to account for over 160,000 of all deaths in children less than 5 years of age annually and of this number approximately 20% are associated with rotavirus infection (Parashar et al., 2003). Although, there is the need for understanding the epidemiology, disease burden and type of serotypes circulating in various geographical locations for effective control and preventions (Estes, 2001), these information are lacking in Sokoto state. Thus, the objective of this study is to determine the prevalence of human rotavirus gastroenteritis in Sokoto metropolis, Nigeria. The study will also identify the various risk factors associated with cases of rotavirus gastroenteritis.

MATERIALS AND METHODS

Study Area

Sokoto state lies between longitude 11°C 30´ to 13°C 50´ East and latitude 4°C to 6° North. The state falls within the savannah zone, and is located in the north western Nigeria where life expectancy for men and women is 51
years and 52 years respectively and the GNP per capita is 320 dollars (World Bank, 2003). The present study was conducted in three urban human hospitals located in Sokoto metropolis, namely: Usmanu Danfodiyo University Teaching Hospital, Sokoto (UDUTH), Specialist Hospital, Sokoto and Women and Children Hospital, Sokoto. These urban hospitals also service rural communities from all parts of the state, including neighbouring states.

Sampling Method

Sample size was calculated as described by Campbell (1997). At the end of the sample size estimation was 189 (N=189). However, to increase chances of detection of the infection, the numbers of samples were increased to 200. A validated questionnaire based on WHO generic protocol was administered to generate the primary data along with sample collection bottle where adequate information on every child was obtained. Patient information such as identification number, address, and admission diagnosis, date of admission, presenting symptoms, and socio-economic status of the patient’s parents were recorded.

Sample Collection

Diarrhoea samples were collected from all diarrheic children under 5 years of age that were presented at the identified hospitals after obtaining the parental consent. Diarrhoea in the study was defined as the passage of more than 3 looser than normal stools within 24 hours. The stool samples were collected aseptically in sterile commercial bijour bottles adequately labelled (patient ID and date of collection) and transported on ice to the Veterinary Microbiology Laboratory of Usmanu Danfodiyo University, Sokoto, where they were stored at -20°C until transported on ice to Noguchi Memorial Institute for Medical Research (NMIMR) in Accra, Ghana where they were stored at -20°C until tested.

Determination of Rotavirus Antigen by ELISA

A commercial DAKO Rotavirus ELISA kit was used to detect the presence of human Group A rotaviruses in stool samples. All test procedure and interpretation was carried out according to the manufacturer’s instructions (Multiskan Plus, Labsystems Oy. Helsinki, Finland).

Data Analysis

Statistical Programme for Social Sciences (SPSS17.0; SPSS Inc, Chicago USA) was used to analyse the data. Data was analysed by simple inferential statistics and Chi square analysis to identify the factors associated with rotavirus positivity.

RESULTS

Rotavirus Detection in Children in Sokoto Metropolis

Out of the 200 human diarrhoea stools examined by ELISA, rotavirus was detected in 51 of the samples indicating a prevalence of 25.5%.

Factors associated with rotavirus diarrhoea among children in Sokoto metropolis

Age and Rotavirus Diarrhoea in Children in Sokoto

The data on age distribution of rotavirus diarrhoea in humans indicates that the prevalence of rotavirus diarrhoea is high in children between 0-12 months of age (46.7%), followed by those between the age of 13-24 months (22.9%) However, the prevalence reduced as the children became older as indicated in Figure 1. For example, the lowest prevalence was seen in the age category of 49-60 months (10%). The Chi square analysis of age as a factor further indicated significant (P<0.05) association between the age and rotavirus diarrhoea.

Gender and Rotavirus Diarrhoea in Children in Sokoto

The results showed that male children were more presented to the hospital than the female children. Relatively higher numbers of children affected by rotavirus diarrhoea (53%) were male children compared to the female children (47%), however, no statistical significance was found between rotavirus diarrhoea gender (P>0.05).

Nature of Stool and detection of Rotavirus in Children in Sokoto

According to the nature of stools, the data showed that a high frequency of detection in watery stool tinged with blood (58.3%) indicating possible mixed infection with other parasites. The detection of the virus in stool mixed with mucus was 36.8% which further support the possibility of mixed infection. This result was depicted in figure 2.

Duration of Rotavirus Diarrhea in Children in Sokoto

The results showed that, for the 51 rotavirus positive children, diarrhoea lasted for 2 days in majority of cases (43.1%). However, the diarrhea could last for up to 7 days as observed in 27.5% of rotavirus positive children.
**Figure 1:** Age Prevalence of Rotavirus Diarrhoea in Children in Sokoto metropolis.

**Figure 2:** Distribution of Rotavirus Diarrhoea in Children Presented with different types of stool in Sokoto
Table 1: Duration of Rotavirus Diarrhoea in Children in Sokoto.

<table>
<thead>
<tr>
<th>Duration of diarrhoea in days</th>
<th>No. positive</th>
<th>% Positive</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>22</td>
<td>43.1</td>
<td>43.1</td>
</tr>
<tr>
<td>3-4</td>
<td>12</td>
<td>3.9</td>
<td>66.7</td>
</tr>
<tr>
<td>5-7</td>
<td>14</td>
<td>27.5</td>
<td>94.1</td>
</tr>
<tr>
<td>8-10</td>
<td>2</td>
<td>3.9</td>
<td>98</td>
</tr>
<tr>
<td>&gt;10 Days</td>
<td>1</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
<td><strong>100</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>

Table 2: Frequency of Vomiting in Rotavirus Diarrhoea in Children in Sokoto

<table>
<thead>
<tr>
<th>Vomiting</th>
<th>No. Positive</th>
<th>Percentage Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>40</td>
<td>78.4</td>
</tr>
<tr>
<td>No</td>
<td>11</td>
<td>21.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>51</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

Figure 3: Dehydration Status of Rotavirus Diarrhoea positive Children in Sokoto

Only in few cases (2%) did the duration of the diarrhoea reach 10 days (Table 1).

**Vomiting and Rotavirus Diarrhoea in Children in Sokoto metropolis**

The results showed that vomiting was present in over 78.4% of all rotavirus diarrhoea while vomiting was absent in 22.6% of the cases (Table 2). Chi square analysis indicated significant association between rotavirus diarrhoea and vomiting (P<0.05). The duration of vomiting in days observed in 51 rotavirus positive children showed that majority of cases occurred within 1-2 days (90%) with very few cases occurring up to seven days (7.5%)

**Dehydration level and Rotavirus Diarrhoea in Children in Sokoto metropolis**

The data on the level of dehydration in rotavirus diarrhoea positive children in Sokoto showed that none, mild or severe dehydration was present in 7.8%, 37.3% and 45.1% respectively as summarized in Figure.3. The results showed that the level of dehydration in majority of
children suffering from rotavirus diarrhoea was severe. Chi-square analysis also indicated statistically significant association between rotavirus diarrhoea and dehydration ($P<0.05$).

**Clinical Symptoms Present in Rotavirus Diarrhoea in Children in Sokoto**

Majority of the children suffering from rotavirus diarrhoea had either fever (72.5%) or fever with respiratory symptoms (11.8%). The prevalence of rotavirus diarrhoea in children showing respiratory symptoms without fever was 3.9% (Table 3). Chi square analysis did not indicate any significant association between rotavirus diarrhoea and the presence of these symptoms ($P>0.05$).

**Rotavirus Diarrhoea in Children in Sokoto According to Child’s type of Food**

The results showed a high prevalence among children fed with breast milk and solid foods (56.9%). A low prevalence was recorded among children fed exclusively with breast milk (7.8%). In contrast, high prevalence was observed among children fed on solid foods only (23.5%). A considerable percentage was observed among children fed on variety of foods (11.8%) as shown in Table 4. Chi square analysis indicated statistically significant relationship between rotavirus diarrhoea and type of food ($P<0.05$).

**Rotavirus Diarrhoea in Children in Sokoto According to the Persons that Prepare Children’s Food**

According to the person(s) that usually prepared the food of the child, the results showed that in majority of the cases (57%), nannies were responsible for the preparation of the child’s food followed by mother (33%) while in 10% of the cases the child’s food was usually prepared by anybody available (Figure 4). However, the association of rotavirus diarrhoea with the persons (s)
Table 5: Prevalence of Rotavirus Diarrhoea in Children in Sokoto According to Family Source of Water

<table>
<thead>
<tr>
<th>Source of water</th>
<th>No. positive</th>
<th>Percentage</th>
<th>Cumulative Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap</td>
<td>39</td>
<td>76.5</td>
<td>76.5</td>
</tr>
<tr>
<td>Well</td>
<td>7</td>
<td>13.7</td>
<td>90.2</td>
</tr>
<tr>
<td>River</td>
<td>2</td>
<td>3.9</td>
<td>94.1</td>
</tr>
<tr>
<td>Pond</td>
<td>3</td>
<td>5.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Prevalence of Rotavirus Diarrhoea in Children in Sokoto According to Drinking Water of the Child

<table>
<thead>
<tr>
<th>Drinking water of the child</th>
<th>No. positive</th>
<th>Percentage Positive</th>
<th>Cumulative Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiled</td>
<td>21</td>
<td>45.1</td>
<td>45.1</td>
</tr>
<tr>
<td>Not boil</td>
<td>30</td>
<td>54.9</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

that usually prepared child's food was not significant ($P > 0.05$).

**Rotavirus Diarrhoea in Children in Sokoto According to the Family Source of Water**

The rate of detection of human rotavirus in children according to the source of water is summarized in Table 5. The data showed that more than 76% of the cases were detected from children whose major source of water was tap water. The prevalence was 13.7% among children whose major source of water was well water. The rate of detection of rotavirus diarrhoea among children whose major source of water was River was 3.9% and 5.9% Pond.

**Rotavirus Diarrhoea in Children in Sokoto According to the Drinking Water of the Child**

The result on the prevalence of the human rotavirus diarrhoea according to the child’s drinking water was summarized in table 6. There was a prevalence of 45.1% and 54.9% of rotavirus diarrhoea among children whose drinking water were boiled and not boiled respectively. The difference in terms of association was however not significant ($P > 0.05$).

**Analysis of Rotavirus Diarrhoea in Children in Sokoto According to Child’s Contact with Animals**

The results on the prevalence of rotavirus diarrhoea in children in sokoto according to child’s contact with animals are summarized in Table 7. The results showed a high prevalence (49%) among children that often had contact with animals. A prevalence of 29.4%was also recorded among those that rarely had contact with animals. A low prevalence of 21.5% was recorded among those that never had any contact with animals. Chi square analysis indicated significant association of rotavirus diarrhoea and child’s contact with animals ($P < 0.05$).

**Rotavirus Diarrhoea in Children in Sokoto According Educational Level of the Father**

The results showed lower prevalence of rotavirus diarrhoea among children whose father’s educational level was above secondary school (45.1%), while the prevalence was high (54.9%) among children whose father’s educational level was below secondary school (Figure 5). However, there was no statistical significance between rotavirus diarrhoea and educational level of the father ($P > 0.05$).

**Rotavirus Diarrhoea in Children in Sokoto According Educational Level of the Mother**

The results showed the prevalence of rotavirus diarrhoea among children whose mother’s educational level was above secondary school to be 49%. While the prevalence was lower 51% among children whose mother’s educational level was below secondary school (Figure 6). Similarly, there was no statistically significant difference in terms of rotavirus diarrhoea and educational level of the mother ($P > 0.05$).

**Rotavirus Diarrhoea in Children According to Attendance of Day Care**

The results showed high prevalence of rotavirus diarrhoea among children that attended day care (76.4%). While the prevalence was lower (23.5%) among children that did not attend day care (Figure. 7). The chi
Table 7: Prevalence of Rotavirus Diarrhoea in Children in Sokoto According to Child’s Contact with Animals

<table>
<thead>
<tr>
<th>Contact with Animal</th>
<th>No. positive</th>
<th>% Positive</th>
<th>Cumulative percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Often</td>
<td>25</td>
<td>49.0</td>
<td>49.0</td>
</tr>
<tr>
<td>Rare</td>
<td>15</td>
<td>29.4</td>
<td>78.4</td>
</tr>
<tr>
<td>Never</td>
<td>11</td>
<td>21.5</td>
<td>99.9</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>25.5</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5: Prevalence of Rotavirus Diarrhoea in Children in Sokoto According to Educational Level of the Father.

Figure 6: Prevalence of Rotavirus Diarrhoea in Children in Sokoto According to Educational Level of the Mother.
square test analysis indicated statistical significant association between rotavirus diarrhoea and day care attendance (P<0.05).

**Rotavirus Diarrhoea in Children in Sokoto According to the Economic Status of the Parents**

The results showed a high prevalence (54.9%) of rotavirus diarrhoea among children of parents with low economic status. The prevalence among the children of parents with high economic status was 45.1% (Figure 8).

However, the difference between the two groups was not statistically significant (P>0.05).

**DISCUSSION**

The reported global prevalence of rotavirus diarrhea from global surveillance networks and hospital based studies ranges from 6% to 56%. But, the hospital-based WHO global networks for surveillance of rotavirus diarrhea report estimated the rotavirus rate to range from 39 - 52%

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**Figure 7**: Prevalence of Rotavirus Diarrhoea in Children in Sokoto According to Day Care Attendance.

**Figure 8**: Prevalence of Rotavirus associated diarrhoea in Children in Sokoto According to Economic Status of the Parents.
In this study, 51 (25.5%) out of the 200 diarrheic children tested were found to be positive for rotavirus while 149/200 (74.5%) tested negative for rotavirus. Thus, the prevalence of rotavirus diarrhea accounted for 25.5% of diarrhea cases among children younger than five years presented to hospitals in Sokoto Metropolis. The result of this study is consistent with the sentinel based rotavirus surveillance system and hospital based study results within the African region (WHO, 2008).

Interestingly, however, earlier studies carried out in different parts of the northern Nigeria reported low prevalence. Pennap and Umoh (2010) reported rotavirus infection prevalence of 15.6% among children 0 - 60 months old that were presented with diarrhea in northeastern Nigeria. Aminu et al., (2008) similarly reported rotavirus prevalence of 18% among diarrheic children and 7.2% among non-diarrheic children in a hospital setting in northern Nigeria and prevalence of 9% in children less than five years of age in a community based study in the same region. Other investigators reported lower prevalence of the infection in the northern region (Adah et al., 1997). The low prevalence reported in the community based study is expected as higher prevalence of rotavirus infection is more likely to be encountered in hospital based studies since rotavirus positive cases are often severe and likely represented in hospitals (Banerjee et al., 2006). However, generally, studies from southern Nigeria had shown higher rotavirus prevalence values than those from northern Nigeria (Abiodun et al., 1994; Omotade et al., 1995; Audu et al., 2002; Odimayo et al., 2008). The differences in the prevalence recorded by different investigators had been attributed to differences in time of sampling, method of screening samples, geographical location of the study or changing trends of the burden of the rotavirus disease over the years (CDC, 2008).

In terms of age, this study showed the prevalence of rotavirus diarrhoea to be higher in children between 0-12 months of age (46.7%), followed by those between the age of 13-24 months (22.9%). The study also revealed that about 70% of rotavirus diarrhea occurred in children under the age of two years. The lowest prevalence was seen in the age category of 49-60 months (10%) showing that, the prevalence reduced as the children became older. The chi square analysis of age as a factor in rotavirus diarrhoea further indicated significant association between the age and rotavirus diarrhoea (P<0.05). This age distribution is comparable to earlier reports (Morris et al., 1986; Zarnani et al., 2004). This observation had been attributed to the assumption that in under-developed areas, the early peak of rotavirus diarrhoea might result from early exposure to contaminated sources as well as over-crowded homes (Bernstein and Ward, 2004). Furthermore, several studies had shown that, rotavirus gastroenteritis severe enough to require hospitalization was most frequently encountered in infants and young children from approximately 6 months to 2 years of age (Bern and Glass, 1994; Bishop, 1996).

This study also showed that more diarrheic male children 110 (55%) were presented to the hospital than the female children 90 (45%). This is in agreement with prospective studies conducted in health facilities on outpatients (Gomwalk et al., 1993) and inpatients (Steele et al., 1998) which showed that boys are more likely than girls to be taken to the health facility because of diarrhea (boy-girl ratios are 2 to 1 and 4 to 1, respectively). However, the result showed that, majority of children affected by rotavirus diarrhoea (26.7%) were female children compared to the male children (24.5%). But, Chi square analysis indicated no significant difference in terms of association between rotavirus diarrhoea and sex (P>0.05). This finding is in congruence with Pennap and Umoh(2010) who had reported no statistical significance in rotavirus prevalence between male (14.6%) and female (13.2%) children with diarrhea. This is probably because at that age of five and below, there is no difference in life styles between the boy and girl child. Other researchers had also reported similar observations (Saravanan et al., 2004; Aminu et al., 2008). In contrast, the present finding differed with the report of Yap et al. (1992) and Naficy et al. (1999) who reported that, males were more frequently affected by rotavirus diarrhoea than females. However, no reason was advanced by the investigators for their observation. Kazemi et al. (2006) reported conflicting results in respect of sex susceptibility to rotavirus disease from a number of investigators implying that sex as a factor in rotavirus diarrhoea needs further investigation.

Earlier studies indicated that stools in rotavirus diarrhoea were non-blood and generally lack faecal leukocytes and mucus may be found in about 20% of cases (Huicho et al., 1993). Surprisingly the result in this study showed a high frequency of rotavirus detection in watery stool tinged with blood (58.3%). This is also in contrast with the recent observation that blood tinged diarrhea was rare in rotavirus infection (Pennap and Umoh, 2010). However, the observation of high prevalence of rotavirus in blood watery stool may likely be as a result of mixed infection with other pathogens such as Shigella because in developing areas like Sokoto, transmission of enteric pathogens and co-infection are high as a result of poor sanitation, low immunity, lack of access to treatment, imbalanced diet and poor nutrition. The detection rate of the virus in stool mixed with mucus in this study was 36.8% which further supports the possibility of mixed infection even though stool in rotavirus infection had been reported to often contain large amounts of mucus (Fredrick et al., 2002).

Vomiting was observed to be present in over 33% of all...
rotavirus positive children tested in the present study but absent in 13.8% of the cases. There was significant association between vomiting and rotavirus diarrhoea ($P<0.05$). Indeed, vomiting had always been a common occurrence in rotavirus diarrhoea and had been reported to precede the diarrhoea in approximately half of all rotavirus diarrhoea cases (Haffejee, 1991). The duration of vomiting in days observed in the rotavirus positive children showed that majority of cases occurred within 1-2 days (90%) with very few cases occurring up to seven days (7.5%). This is in agreement with the observation of Pennap and Umoh (2010). But, generally rotavirus disease is usually self-limiting, lasting four to eight days, and the overall duration of symptoms was reported to be between 2 and 22 days (Wyatt et al., 1979). Recent report showed that, in severe rotavirus cases, children may suffer from symptoms of gastroenteritis for up to 9 days before recovery (Bass and Dorsey, 2004).

Rotavirus had often been associated with severe dehydration which is actually responsible for death associated with the infection (Offit et al., 2000). In addition, children with dehydration had been found to be about two times more likely to be detected positive for rotavirus (Binka et al., 2003). In this study, the prevalence of rotavirus diarrhoea in children with none, mild or severe dehydration was found to be 15.9%, 17.8% and 42.4% respectively. The result showed that the level of dehydration in majority of children suffering from rotavirus diarrhoea was severe. Chi square analysis also indicated significant association between rotavirus diarrhoea and dehydration ($P<0.05$). Our finding is in conformity with the report of Pennap and Umoh et al. (2010). Indeed, rotavirus infection had been associated with severe diarrhoea episodes and vomiting which often led to severe dehydration in babies and young children (Offit and Clark, 2000).

The analysis of other symptoms observed with rotavirus diarrhoea in children in Sokoto showed that majority of the children suffering from rotavirus diarrhoea had either fever (26.8%) or fever and respiratory symptoms (25%). The prevalence of rotavirus diarrhoea in children showing respiratory symptoms without fever was 21.1%. Chi square analysis however, indicated no significant association between rotavirus diarrhoea and these symptoms ($P>0.05$). When the frequency of occurrence of fever was considered alone or in combination with respiratory symptoms, the result showed that fever was present in 51.8% of the cases. This is in consonance with many reports that indicated the presence of fever in about 45% - 84% of patients suffering from rotavirus diarrhoea (Kovacs et al., 1987; Aminu et al., 2008). The observation of the presence of respiratory symptoms in 25% of the cases is also in agreement with earlier reports that indicated presence of various upper and lower respiratory infections, including otitis media, laryngitis, pharyngitis, and pneumonia during rotavirus illness (Lewis et al., 1979; Santosham et al., 1983; Zheng et al., 1991).

On the type of child’s food at its relation with rotavirus diarrhoea, our findings showed a high prevalence of the virus among children fed with breast milk and solid foods (38.7%). A low prevalence was recorded among children fed exclusively with breast milk (14.3%). The highest prevalence was observed among children fed on a variety of food (40%). Chi square analysis indicated significant relationship between rotavirus diarrhoea and type of food ($P<0.05$). The result was not in agreement with what was reported by Pennap and Umoh (2010) and Aminu et al., (2008), who reported the highest prevalence among children exclusively fed with breast milk. Their result suggested that, breastfeeding may not protect the child against rotavirus infections. But exclusive breastfeeding particularly in infants had been shown to offer protection against severe rotavirus infections (Clemens et al., 1993). Also, some prospective studies found that breastfed infants manifested a milder rotavirus disease (Naficy et al., 1999). However, it is possible that breastfeeding may only be protective if it is practiced with an intensity and frequency that allows continuous high level protection of the intestinal mucosa rather than sporadic or low volume feeds (Glass et al., 1986). It is important to further investigate the role of feeding regimen in the occurrence of rotavirus diarrhoea especially among exclusively breast fed children.

The result on the prevalence of rotavirus diarrhoea in relation to the persons that usually prepared children’s food showed that in majority of the cases (35.3%), nannies were responsible for the preparation of the child’s food followed by the mothers (26.4%) while in 22.1% of the cases the child’s food was usually prepared by anybody available. However, the association of rotavirus diarrhoea with the persons (s) that usually prepared child’s food was not significant ($P>0.05$). It was already noted that rotavirus infection is often spread by childcare workers especially if they don’t wash their hands after changing diapers, or by infected food handlers who prepare salads, sandwiches, carrots and other foods that require no cooking (Dennehy, 2000). Although the relationship between the person(s) that did prepare child’s food and rotavirus diarrhoea was not significant, the result did indicate the need to further investigate the role of nannies and food handlers in the epidemiology of rotavirus diarrhoea in Sokoto State.

The result showed that more than 46.2% of the rotavirus diarrhoea cases were detected among children whose major source of water was neither tap nor well water. The prevalence was least (23.6%) among children whose major source of water was tap water. The rate of detection of the rotavirus among children whose major source of water was well water was 26.9%. The difference in the rate of detection of the virus according to the source of water was not significant ($P>0.05$). This is
in consonance with the already established fact that improvement in water supplies and excreta disposal may reduce the transmission of enteric bacteria and parasites but is not likely to reduce the incidence of rotavirus diarrhoea (Cunliffe et al., 1998). Furthermore, a number of researchers had recently noted that rotavirus is resilient and highly contagious and, therefore, improvements in water supply and sanitation are unlikely to be effective preventive measures of rotavirus disease, thus supporting the advocacy for mass vaccination programs (Huppertz et al., 2008).

The analysis of result on the nature of child’s drinking water as it relate to rotavirus detection rate indicated that majority of the parent did not boil water given to the children 156/200 (78%) and that only 44/200 (22%) indicated that water given to the children was boiled. There was a prevalence of 29.5% and 24.4% of rotavirus diarrhoea among children whose drinking water was boiled and among those whose drinking water was not boiled respectively. The difference in terms of association was, however, not significant (P>0.05). This result is in agreement with earlier findings by Pennap and Umoh (2010) who reported that type of drinking water of the child had no statistically significant association with rotavirus prevalence.

The result on the prevalence of rotavirus diarrhoea in children based on child’s contact with animals showed a high prevalence (44.6%) among children that often had contact with animals. In the present study, prevalence of 20.8% was recorded among those that never had contact with animals. A low prevalence (16.5%) was recorded among those that rarely had any contact with animals. Chi square analysis indicated a significant association between rotavirus diarrhoea and child’s contact with animals (P<0.05). Indeed, evidences of direct transmission of animal rotaviruses to humans or animal rotaviruses contributing one or several genes to make animal-human reassortant viruses had been reported (Adah et al., 2003; Malik et al., 2005; Muller and John, 2007). Furthermore, the surveillance of circulating rotaviruses in human population revealed the presence of uncommon serotypes that were commonly found in domestic animals (Cook et al., 2004; Malik et al., 2005).

In terms of the educational levels of parents and the rotavirus positivity, there was high prevalence of rotavirus diarrhoea among children whose fathers’ educational level was above secondary school (31.5%). The prevalence was lower (22%) among children whose fathers’ educational levels were below secondary school. Interestingly, however, the result of the educational levels of female parents of the rotavirus positive children showed high prevalence of rotavirus diarrhoea among children whose mothers’ educational levels were above secondary school (26.8%), while the prevalence was lower (11.8%) among children whose mothers’ educational levels were below secondary school. But, the Chi square test analysis indicated no significant difference in terms of rotavirus diarrhoea and educational level of either of the child’s parent (P>0.05). This observation was in agreement with the report of Nakawesi et al. (2010) that showed children of mothers with a secondary or higher education level were two times more likely to have rotavirus diarrhea. It is however in contrast to what was found by Dennehy et al. (2006) in USA where children of mothers with a lower education level were found to be more likely to have rotavirus diarrhea (Dennehy et al., 2006). Although the reason for this disparity is unclear, it could be speculated that, the high prevalence of rotavirus diarrhoea among children of female parents whose educational level was above secondary school noted in this study may be as a result of the possibility that such female parents were likely working class women whose children were often left under the care of nannies who often spread rotavirus infection as observed by Dennehy (2000). A comprehensive study need to be undertaken to investigate the relationship of the educational status of parents and rotavirus diarrhoea.

The result on the prevalence of rotavirus diarrhoea in children based on whether the child attended day care or not showed high prevalence of rotavirus diarrhoea among children that attended day care (59.1%). While the prevalence was lower (9%) among children that did not attend day care. The chi square test analysis indicated significant association between rotavirus diarrhoea and day care attendance (P<0.05). This result is in agreement with the general observation that rotavirus infections were often found predominantly within families and closed communities, day-care centers and paediatric wards (Lew et al., 1990). The reason for higher prevalence of rotavirus diarrhoea seen in children that attended day care centres can be attributed to higher risk of virus transmission at these centres due to more close contact in these environments or due to lower rate of breast feeding in these children as observed by earlier workers (Kazemi et al., 2006). Recently Surajudeen et al., (2011) had reported that attendance of day care/nursery school appeared to serve as major risk factor for rotavirus infection.

The result on the prevalence of rotavirus diarrhoea in children in Sokoto according to the economic status of their parents showed a high prevalence (28.8%) of rotavirus diarrhoea among children of parents with low economic status. The prevalence among the children of parents with high economic status was 21.9%. The high prevalence observed among children of parents of low economic status may be as a result of poverty which usually limits access to health care and restricts appropriate and balanced diets and care, making poor children more likely to become sick than the better-off children (Victora et al., 2003). However, the difference between the two groups was not significant (P>0.05) and
this is in consonance with the findings of Pennap and Umoh (2010) who reported no significant relationship between rotavirus diarrhea and economic status of the parents.

In conclusion, this study shows that rotavirus is an important pathogen associated with diarrhea in less than 5years old children presented at major tertiary hospitals in Sokoto State, Nigeria. There is need for continuous and intensive serotype-specific surveillance of rotaviruses in Sokoto to provide an accurate understanding of the circulating serotypes/genotypes in Sokoto State. Further studies on the roles of socio-economic risk factors associated with the disease will be useful in further elucidation the changes in the risk factors with change in time.

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