Detection of Rotavirus and Adenovirus Co-infection among Apparently Healthy School Aged Children in Ilishan-remo Community of Ogun State, Nigeria

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Authors’ contributions

This work was carried out in collaboration among all authors. Author SSE designed the study, wrote the protocol and the first draft of the manuscript. Author JCI managed the analyses of the study. Authors JOO and ASO managed the literature searches. Author GEA performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Background: Viral gastroenteritis is still a major public health challenge in the Sub-Saharan Africa, with Rotavirus and Adenovirus as the leading causes of acute gastroenteritis among children.

Aim: The aim of this study was to investigate the prevalence of Rotavirus and Adenovirus co-infection and associated risk factors among apparently healthy school aged children with history of diarrhea in Ilishan-Remo community of Ogun State, Nigeria.

Study Design: This is a descriptive-epidemiological survey.

Place and Duration of Study: Department of Medical Laboratory Science, Babcock University, Ilishan-Remo, Ogun State, Nigeria, between March and May, 2019.

Methodology: A total of 60 children (24 males and 36 females) were recruited and their stool samples were examined using the SD Bioline Rota/Adeno virus antigen rapid test kits (Standard Diagnostics, INC., South-Korea) according to the manufacturer’s instruction. The demographic and clinical information of the participants were collected using structured questionnaires.

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3. INTRODUCTION

Acute gastroenteritis is one of the major causes of morbidity and mortality in children around the world. Although acute gastroenteritis could be caused by bacterial and parasitic agents, epidemiological evidence has shown that viral agents, particularly enteric viruses like the Rotavirus and Adenoviruses are the most implicated where this infection is concerned [1].

Rotavirus, a double-stranded RNA virus is one of the leading causes of acute gastroenteritis in children. Transmission of the virus occurs primarily through faecaloral route, person to person contact, contact with contaminated surfaces in the environment and also through respiratory droplets. Once the virus gets established within the small intestine, it usually replicates in the villous epithelium, which then leads to a reduction in the absorption of sodium, glucose and water in the intestine and a reduction in the levels of intestinal lactase, alkaline phosphatase and sucrose activity which then causes isotonic diarrhea [2]. Clinically, rotavirus infection is characterized by symptoms that range from mild or watery diarrhea of short or limited duration to serious and more frequent diarrhea which could be accompanied by vomiting and fever that usually results in dehydration with shock, electrolyte imbalance and possibly death [3].

Annually, rotavirus is responsible for 25 million visits to the hospital, 2 million admissions and about 180,000-450,000 deaths in children who are under 5 years of age around the world. Even though rotavirus infection occurs all over the world, majority of the deaths caused by this virus occur in developing countries [4]. In developed countries, the infection does not usually cause death, but still remains the most common cause of hospitalization for acute gastroenteritis in children and it could also lead to severe costs both medically and socially [5]. The burden caused by this disease has stimulated the efforts to develop vaccines, some of which are now licensed and are being used.

Adenovirus, a double-stranded DNA virus on the other hand, have been associated with respiratory, ocular and gastrointestinal disease mostly in children. There are at least 7 human adenovirus species and about 52 serotypes of Adenoviruses have been described. These different species and serotypes of adenoviruses affect various organs of the body. Hence; adenoviruses have been associated with a wide variety of clinical manifestations [6]. Common manifestations of Adenoviruses are pneumonia, cystitis, conjunctivitis, myocarditis and hepatitis. Although most times adenoviruses have been associated with respiratory disease, some serotypes (12, 18, 31, 40 and 41) called the Enteric Adenoviruses (Eads) cause diarrheal diseases. Serotypes 40 and 41 in particular, usually infect the gut wall and so are usually responsible for about 5-20% of cases of hospitalization due to diarrhea in children. Infections most often occur in children who are less than 2 years but have also been found in children of all ages. Adenoviruses have an incubation period of about 8 to 10 days with symptoms such as diarrhea, vomiting and fever occurring in most cases of the infection [7-9]. Diarrhea caused by adenoviruses typically last longer than those caused by rotaviruses, usually lasting for about 7 to 8 days. Transmission of the virus is usually through faecal oral route and the gastroenteritis is usually self-limiting [4].

No doubt, Rotavirus and Adenovirus are among the causes of pediatric gastroenteritis recognized by the World Health Organization (WHO).
However, there is limited information regarding the epidemiology of these enteric viruses in many developing countries including Nigeria. This is because many hospitals do not investigate for viral diarrhea. Most diarrhea cases that present in hospitals are investigated based on bacterial and parasitic agents. And as a result of the lack of performance of viral investigations, information about the causative agents of viral diarrhea is lost and so control and preventive strategies are not put in place to help combat the infections or limit the spread of the viral agents. And due to the limited information about the actual burden of these viruses in the study area, this epidemiological survey was therefore conducted to determine the prevalence of Rotavirus and Adenovirus mono/co-infection and associated risk factors among apparently healthy School aged children with history of diarrhea in Ilishan Remo community of Ogun State, Nigeria with the hope that the investigation will provide epidemiological evidence that will give a better understanding of the role of these viruses in childhood gastroenteritis.

2. MATERIALS AND METHODS

2.1 Study Design

This was a descriptive-prospective study.

2.2 Study Area

This cross-sectional community based study was carried out among apparently healthy school aged children with history of diarrhea in Ilishan Remo community of Ogun State. Ilishan Remo is a community located in the south-western region of Nigeria, coordinates 6.8932°N, 3.7105°E.

2.3 Duration of Study

This study was carried out between the months of March and May, 2019.

2.4 Study Population

Apparently healthy male and female School aged children between the ages of 1-12 years in Ilishan-Rermo community of Ogun State were the target population. They were randomly recruited from three (3) selected Primary schools in the community.

2.5 Sample Size Calculation

The sample size was estimated using the formula.

\[ N = \frac{Z^2 PQ}{d^2} \]

Where:

- \( N \) = required sample size
- \( Z^2 \) = Standard normal variant at 5% (p<0.05) error or 95% confidence interval is 1.96.
- \( P \) = Proportion of children with Rotavirus and Adenovirus co-infection from a previous study (estimated as 4%) [1].
- \( Q \) = Proportion of children without Rotavirus and Adenovirus co-infection from a previous study.
- \( d \) = Absolute error margin is 0.05.

\[ N = (1.96)^2 \times (0.04) \times 0.96/52 = 59 \]

For the calculation, a 95% confidence interval, a \( P \) value of 0.04 i.e., a proportion from a previous study by Karim et al. [1] and a margin error (d) set at 0.05 was used to determine the minimum sample size required.

2.6 Sample Size

A total of 60 stool samples were collected randomly from 60 (24 males and 36 females) school aged children recruited from three (3) selected Primary Schools (Twenty students per school, \( n=20 \)) in Ilishan-Rermo community of Ogun State.

2.7 Eligibility of Subjects

2.7.1 Inclusion Criteria

Consenting male and female children within the ages of 1-12 years with a history of diarrhea were randomly recruited for the study.

2.7.2 Exclusion Criteria

Children above 12 years, those without history of diarrhea, and those whose parents did not consent to the study, were excluded from the study.

2.8 Data Collection

Before the sample collection, the demographic and clinical information of the participants were obtained through the administration of prepared questionnaires. Each questionnaire had a unique participant identification number (PIDN). The first part of this questionnaire contained the bio data of the participant e.g. age, sex and class. The second part included history of diarrhea, risk
factors and personal hygiene. Response to the questionnaire were used to collect data on epidemiology of the Rotavirus and Adenovirus infections. For the purpose of privacy, all information obtained from the participants were treated confidentially.

2.9 Specimen Collection and Storage

Stool samples were collected by the participants into a sterile universal bottle. The stool specimens were transported to the Laboratory unit of the Department of Medical Laboratory science, Babcock University and were analyzed immediately or stored at 4°C in the refrigerator where delay was anticipated.

2.10 Laboratory Analyses

Detection of Rotavirus and Adenovirus was carried out using a commercial one-step Rapid Diagnostic Test (RDT) Device, SD Bioline Rota/Adeno virus antigen rapid test kits (Standard Diagnostics, INC., South-Korea). The specificity and sensitivity of the kit are 97.2%, 100% and 97.9%, 100% for Rotavirus and Adenovirus, respectively. It is a lateral flow immunoassay for the qualitative detection and differentiation of rotavirus ad adenovirus antigens in fecal specimens. The test kit is based on immunochromatographic principle and it has an advantage of detecting Rotavirus and Adenovirus simultaneously with a single kit. The specimen was processed according to the manufacturer’s instructions.

2.11 Interpretation of RDT

2.11.1 Positive result

The presence of 2 color bands (For the test and control) within the result window regardless of the band that appeared first indicated a positive result. The presence of a band at the “A”, “R” and the “C” regions indicated positive results for both Adenovirus and Rotavirus. The presence of a band at the “A” and “C” regions only indicated positive results for Adenovirus. Whereas the presence of a band at the “R” and “C” regions only, indicated positive results for Rotavirus.

2.11.2 Negative result

The presence of only one color band at the control region of the result window indicated a negative result.

Fig. 1. SD Bioline Rota/Adeno virus rapid test cassette negative for both adenovirus and rotavirus antigens

Fig. 2. SD Bioline Rota/Adeno virus rapid test cassette positive for only rotavirus antigen
Fig. 3. SD bioline rota/adeno virus rapid test cassette positive for only adenovirus antigen

Fig. 4. SD bioline rota/adeno virus rapid test cassette positive for both adenovirus and rotavirus antigens

2.12 Data Analysis

Data was entered into Microsoft Excel. Statistical analysis was carried out using SPSS (Statistical Package for Social Sciences) software package (version 21.0), Chi square and Turkey Kramer Multiple Comparison Test. P value <0.05 was considered significant. Statistical analysis outputs were presented using tables and chart.

3. RESULTS AND DISCUSSION

The present study investigated the prevalence of Rotavirus and Adenovirus mono/co-infection among apparently healthy school aged children with history of diarrhea in Ilishan-Remo community of Ogun State. The socio-demographic characteristics of the study participants are presented in Table 1. A total of 60 participants were recruited for the study. Twenty-four (24) of them were males and the remaining 36 were females. Five (5) of them were within 1-3 years, 8 (4-6 years), 29 (7-9 years) and 18 (10-12 years). Out of the 60 participants screened, 3 (5%) were positive for Rotavirus, 2 (3.33%) were positive for Adenovirus and only 1 (1.67%) participant had co-infection. The frequency of occurrence of Adenovirus mono-infection in relation to the gender and age of the participants is shown in Table 2. Two (2) out of the 24 male participants screened were positive for Adenovirus. No infection was recorded among their female counterparts. There were no significant differences (P>0.05) with regards to gender and age.

The frequency of occurrence of Rotavirus mono-infection in relation to the gender and age of the participants is shown in Table 3. Based on gender distribution, 2 (3.33%) out of the 36 females and 1 (1%) out of the 24 males screened were positive for Rotavirus. While based on age distribution, 2 (3.33%) out of the 18 pupils aged 10-12 years screened were positive for Rotavirus and 1 (1.67%) out of the 8 pupils aged 4-6 years screened was positive for Rotavirus. The difference was not statistically significant (P>0.05).

The prevalence of Rotavirus and Adenovirus co-infection in relation to the gender and age of the study participants is shown in Table 4. Only 1 (1.67%) participant, a female, aged 10-12 years had co-infection. Meanwhile, the distribution of Adenovirus and Rotavirus mono/co-infection among the study participants in relation to the risk factors is presented in Table 5. None of the study participants had previous knowledge of Rotavirus and Adenovirus. All the participants agreed that they had a previous history of diarrhea. 57 (95%) indicated that they regularly
ate raw unwashed fruits and vegetables. 22 (36.67%) indicated that they used tap water as their source of drinking water, 11 (18.3%) drank boiled water, while 27 (45%) drank portable water.

Among the participants who regularly ate raw unwashed fruits and vegetables, 2 (3.3%) were positive for Adenovirus, 3 (5%) were positive for Rotavirus, while 1 (1.7%) showed co-infection.

Meanwhile, the relationship between indications for viral gastroenteritis and Adenovirus and Rotavirus antigens positivity among the study participants is presented in Fig. 5. Two, 2 (3.3%) participants indicated that they were currently vomiting, 9 (15%) indicated they were currently experiencing diarrhea, 4 (6.7%) had fever, while 45 (75%) indicated no symptoms. Out of the 9 participants that indicated that they were currently experiencing diarrhea, 2 (3.3%) were positive for Rotavirus, 2 (3.3%) were positive for Adenovirus, while 1 (1.7%) had co-infection. Out of the 4 participants that indicated that they were experiencing fever, 1 was positive for Rotavirus, while none of the asymptomatic participants was positive for any of the viruses.

Rotavirus and Adenovirus are very important causes of diarrhea and death globally in children and these viruses continue to have great impacts on childhood morbidity and mortality [10]. According to Arowolo et al. [11], Nigeria is one of the two countries accounting for 42% of global under-5 deaths attributable to gastroenteritis. The 5% Rotavirus infection prevalence recorded in this study is similar to the work of Mukhtar et al. [12], who reported a prevalence of 5.3% in Katsina, North-Western Nigeria.

On one hand, the prevalence of Rotavirus infection in this study was found to be lower than that observed in other studies. For instance, Arwa [13] reported a prevalence rate of 18.62% among children aged 1 to 19 years in Baghdad, Iraq, while Karim et al. [1], reported a prevalence rate of 21.7% in a study carried out among children aged 1 to 5 years in Erbil City, Iraq. Also a more recent study carried out in 2019 by Arowolo et al. [11], in Abeokuta, Ogun State, South-Western Nigeria reported a prevalence rate of 16.6% in children less than 5 years of age. On the other hand, the prevalence rate was higher than that obtained by Betina et al. [14], in a study conducted in Copenhagen, Denmark among children less than 5 years.

The difference in the prevalence rate reported in this study and those reported in other studies might be due to differences in sample size, study duration, diagnostic technique, geographical location, socio-economic status, cultural or environmental status of the study participants. The difference could also be due to seasonal variations as studies have shown that these viruses have a higher prevalence in colder, drier months.

On the basis of sex distribution, the data showed that the prevalence of Rotavirus was slightly lower (1.7%) among the males than among the females (3.3%). This agrees with a study by Ndze et al. [15], in Cameroon which reported higher incidence in females (45.3%) than in males (40.8%). However, this does not agree with the reports of some other previous studies where Rotavirus was detected in slightly higher rates in males than in females.

For example, in a study by Mukhtar et al. [12], Rotavirus was observed to be slightly higher in male (5.5%) than in female (5.0%). Modares et al. [16], in their study explained that a higher prevalence in males could be due to gender specific immunological differences. Whether this difference was due to chance is debatable and so should be further investigated. However, statistically, there was no significant difference in the prevalence of Rotavirus infection on the basis of gender.

| Characteristics | Category | Frequency (N) | Percentage (%) |
|-----------------|----------|---------------|----------------|
| Gender          | Male     | 24            | 40.0           |
|                 | Female   | 36            | 60.0           |
|                 | Total    | 60            | 100.0          |
| Age range       | 1-3 YRS  | 5             | 8.3            |
|                 | 4-6 YRS  | 8             | 13.3           |
|                 | 7-9 YRS  | 29            | 48.3           |
|                 | 10-12 YRS | 18          | 30.0           |
|                 | Total    | 60            | 100.0          |
Table 2. Frequency of occurrence of adenovirus mono-infection in relation to the gender and age of the study participants

| Characteristics | Category | Number of stool samples examined N (%) | Number positive for adenovirus antigen N (%) | Number negative for adenovirus antigen N (%) | P-value | X² |
|-----------------|----------|----------------------------------------|---------------------------------------------|---------------------------------------------|--------|----|
| Gender          | Male     | 24 (40.0)                              | 2 (3.3)                                     | 22 (36.7)                                   | 0.078  | 3.103 |
|                 | Female   | 36 (60.0)                              | 0 (0)                                       | 36 (60)                                     |        |     |
|                 | Total    | 60 (100.0)                             | 2 (3.3)                                     | 58 (96.7)                                   |        |     |
| Age range       | 1-3 Yrs  | 5 (8.3)                                | 0 (0)                                       | 5 (8.3)                                     | 0.185  | 0.185 |
|                 | 4-6 Yrs  | 8 (13.3)                               | 0 (0)                                       | 8 (13.3)                                    |        |     |
|                 | 7-9 Yrs  | 29 (48.3)                              | 0 (0)                                       | 29 (48.3)                                   |        |     |
|                 | 10-12 yrs| 18 (30.0)                              | 2 (3.3)                                     | 16 (26.7)                                   |        |     |
|                 | Total    | 60 (100.0)                             | 2 (3.3)                                     | 58 (96.7)                                   |        |     |

*P-value >0.05 is considered statistically not significant*

Table 3. Frequency of occurrence of rotavirus mono-infection in relation to the gender and age of the study participants

| Characteristics | Category | Number of stool samples examined N (%) | Number positive for rotavirus antigen N (%) | Number negative for rotavirus antigen N (%) | P-value | X² |
|-----------------|----------|----------------------------------------|---------------------------------------------|---------------------------------------------|--------|----|
| Gender          | Male     | 24 (40.0)                              | 1 (1.67)                                    | 23 (38.3)                                   | 0.809  | 0.058 |
|                 | Female   | 36 (60.0)                              | 2 (3.33)                                    | 34 (56.7)                                   |        |     |
|                 | Total    | 60 (100.0)                             | 3 (5.0)                                     | 57 (95.0)                                   |        |     |
| Age range       | 1-3 yrs  | 5 (8.3)                                | 0 (0)                                       | 5 (8.3)                                     | 0.246  | 4.152 |
|                 | 4-6 yrs  | 8 (13.3)                               | 1 (1.67)                                    | 7 (11.6)                                    |        |     |
|                 | 7-9 yrs  | 29 (48.3)                              | 0 (0)                                       | 29 (48.3)                                   |        |     |
|                 | 10-12 yrs| 18 (30.0)                              | 2 (3.33)                                    | 16 (26.7)                                   |        |     |
|                 | Total    | 60 (100.0)                             | 3 (5.0)                                     | 57 (95.0)                                   |        |     |

*P-value >0.05 is considered statistically not significant*
Table 4. Frequency of occurrence of adenovirus and rotavirus co-infection in relation to the gender and age of the study participants

| Characteristics | Category | Number of stool samples examined N(%) | Number positive for both Adenovirus & rotavirus antigens N(%) | Number negative for both Adenovirus & rotavirus antigens N(%) | P-value | X² |
|-----------------|----------|--------------------------------------|--------------------------------------------------|--------------------------------------------------|---------|----|
| Gender          | Male     | 24 (40.0)                            | 0 (0)                                             | 24 (40)                                          | 0.410   | 0.678 |
|                 | Female   | 36 (60.0)                            | 1 (1.7)                                           | 35 (58.3)                                        |         |     |
|                 | Total    | 60 (100.0)                           | 1 (1.7)                                           | 59 (98.3)                                        |         |     |
| Age range       | 1-3 yrs  | 5 (8.3)                              | 0 (0)                                             | 5 (8.3)                                          | 0.499   | 2.373 |
|                 | 4-6 yrs  | 8 (13.3)                             | 0 (0)                                             | 8 (13.3)                                         |         |     |
|                 | 7-9 yrs  | 29 (48.3)                            | 0 (0)                                             | 29 (48.3)                                        |         |     |
|                 | 10-12 yrs| 18 (30.0)                            | 1 (1.7)                                           | 17 (28.3)                                        |         |     |
|                 | Total    | 60 (100.0)                           | 1 (1.7)                                           | 59 (98.3)                                        |         |     |

*P-value >0.05 is considered statistically not significant*

Table 5. The risk factors associated with adenovirus and rotavirus mono/co-infection among the study participants

| Characteristics | Responses | Number of participants N (%) | Adenovirus antigen mono-positivity N (%) | Rotavirus antigen mono-positivity N (%) | Adenovirus and Rotavirus antigens co-positivity N (%) | P-value | Odd ratio |
|-----------------|-----------|------------------------------|------------------------------------------|-----------------------------------------|--------------------------------------------------------|---------|-----------|
| Knowledge of Adenovirus | Yes       | 0 (0)                        | 0 (0)                                    | 0 (0)                                  | 0 (0)                                                  |         | 1.7       |
|                  | No        | 60 (100)                     | 2 (3.3)                                  | 3 (5)                                  | 1 (1.7)                                                |         | 1.000     |
| Knowledge of Rotavirus | Yes       | 0 (0)                        | 0 (0)                                    | 0 (0)                                  | 0 (0)                                                  |         | 1.7       |
|                  | No        | 60 (100)                     | 2 (3.3)                                  | 3 (5)                                  | 1 (1.7)                                                |         | 1.000     |
| History of diarrhea | Yes       | 60 (100)                     | 2 (3.3)                                  | 3 (5)                                  | 1 (1.7)                                                |         | 1.000     |
|                  | No        | 0 (0)                        | 0 (0)                                    | 0 (0)                                  | 0 (0)                                                  |         | 0.0       |
| Toilet type     | Water closet | 57 (95)                    | 2 (3.3)                                  | 2 (3.3)                                | 1 (1.7)                                                | 0.144   | 1.000     |
|                  | Pit latrine | 3 (5)                       | 0 (0)                                    | 1 (1.6)                                | 0 (0)                                                  |         | 0.0       |
| Material use to clean up after using the toilet? | Tissue | 23 (38.3)                  | 1 (1.7)                                  | 0 (0)                                  | 1 (1.7)                                                | 0.602   | 0.999     |
|                  | Water     | 32 (53.3)                    | 1 (1.7)                                  | 3 (5)                                  | 0 (0)                                                  |         | 1.000     |
|                  | Both      | 5 (8.3)                      | 0 (0)                                    | 0 (0)                                  | 0 (0)                                                  |         | 0.0       |
| Eat raw unwashed fruits and vegetables | Yes | 57 (95)                      | 2 (3.3)                                  | 3 (5)                                  | 1 (1.7)                                                | 0.950   | 1.000     |
|                  | No        | 3 (5)                        | 0 (0)                                    | 0 (0)                                  | 0 (0)                                                  |         | 0.0       |
| Type of drinking water | Tap water | 22 (36.7)                  | 0 (0)                                    | 0 (0)                                  | 0 (0)                                                  | 0.227   | 1.000     |
|                  | Boiled water | 11 (18.3)             | 0 (0)                                    | 0 (0)                                  | 0 (0)                                                  |         | 1.000     |
|                  | Portable water | 27 (45)               | 2 (3.3)                                  | 3 (5)                                  | 1 (1.7)                                                |         | 0.0       |
| Characteristics                        | Responses | Number of participants N (%) | Adenovirus antigen mono-positivity N (%) | Rotavirus antigen mono-positivity N (%) | Adenovirus and Rotavirus antigens co-positivity N (%) | P-value | Odd ratio |
|---------------------------------------|-----------|-----------------------------|------------------------------------------|-----------------------------------------|-------------------------------------------------------|---------|-----------|
| Wash hands with soap and water after using the toilet | Yes       | 60 (100)                    | 2 (3.3)                                  | 3 (5)                                   | 1 (1.7)                                               | 0.268   | 0.999     |
|                                        | No        | 0 (0)                       | 0 (0)                                    | 0 (0)                                   | 0 (0)                                                 |         |           |
| Wash hands with soap and water after playing with toys | Yes       | 29 (48.3)                   | 2 (3.3)                                  | 2 (3.3)                                 | 1 (1.7)                                               | 0.304   | 0.995     |
|                                        | No        | 31 (51.7)                   | 0 (0)                                    | 1 (1.7)                                 | 0 (0)                                                 |         |           |
| Wash hands with soap and water after playing with friends | Yes       | 30 (50)                     | 2 (3.3)                                  | 2 (3.3)                                 | 1 (1.7)                                               |         |           |
|                                        | No        | 30 (50)                     | 0 (0)                                    | 1 (1.7)                                 | 0 (0)                                                 |         |           |
| Wash hands with soap and water before eating | Yes       | 60 (100)                    | 2 (3.3)                                  | 3 (5)                                   | 1 (1.7)                                               |         |           |
|                                        | No        | 0 (0)                       | 0 (0)                                    | 0 (0)                                   | 0 (0)                                                 |         |           |
| Frequency of medical check-up/ lab test | Less often | 39 (65)                     | 1 (1.7)                                  | 2 (3.3)                                 | 0 (0)                                                 | 0.878   | 0.999     |
|                                        | Often     | 20 (33.3)                   | 1 (1.7)                                  | 1 (1.7)                                 | 1 (1.7)                                               | 0.999   |           |
|                                        | More often | 1 (1.7)                     | 0 (0)                                    | 0 (0)                                   | 0 (0)                                                 |         |           |

*P-value >0.05 is considered statistically not significant*
Meanwhile, on the basis of age, data shows that 1(1.67%) out of the 8 participants, 4-6 years old was positive for Rotavirus, while 2 (3.33%) out of the eighteen (18) 10-12 years old were positive for Rotavirus. This however, contradicts the earlier reports by Arwa [13], who observed higher prevalence rate in children aged below 3 years old. However, the difference between the current study and previous studies could be due to the fact that most studies have been performed with infants and children below 5 years old and only a few have been done among children above 5 years of age. Hence, further investigation should be carried to understand the epidemiological reality of this virus.

The 3.3% Adenovirus infection prevalence rate recorded in this study is comparable to the work of Arwa [13] who reported a prevalence of 3.16% among children aged 1-19 in Baghdad, Iraq. It is also comparable to the work of Kajbaf et al. [17] who reported a prevalence of 3.3% in Southwestern Iran. However higher values of 4.8% in Denmark [14], 16.6% in Abeokuta, Nigeria [11] and 12.4% in Katsina, Nigeria [12] have been reported. As previously stated, these differences in prevalence rates could be due to differences in the geographical location or could also be due to the sample size or study duration. It could also be due to lack of exposure of the participants to the virus.

Based on sex distribution, current data showed that 3.3% of the male participants were infected with Adenovirus. Meanwhile, there was no record of infection among their female counterparts. This is slightly different from the findings of many studies in which infection was recorded among both sexes, however, the prevalence rate was not significantly different. Arowolo et al. [11], explained that this lack of significant difference could be due to the fact that at younger ages, both sexes have little or no major differences in their lifestyles.

On the basis of age distribution, data shows that 2 (3.3%) out of the 18 participants (10-12 years old) were positive for Adenovirus. This however, contradicts earlier reports by Mukhtar et al. [12], who observed higher prevalence rate in children aged below 2 years old (70.5%). However, as stated earlier, this could be due to the fact only a few studies have been done among children above 5 years of age. Hence, further investigation is needed in this regard.

A prevalence of 1.7% Rotavirus and Adenovirus co-infection recorded in this study is comparable to the outcome of a study done by Nimzing et al. [18] who reported a prevalence of 1.1%. However, the prevalence of co-infection observed here is slightly higher than the 0.6% reported by Mukhtar et al. [12], in Katsina State,
Nigeria. On the other hand, the prevalence rate is lower than those recorded in other studies. For example, Karim and Hussein [1] reported 4% in Erbil City, Iraq, while, Arowolo et al. [11], reported 5.9% in Abeokuta, Ogun State, Nigeria. Possible reasons for these differences in prevalence rates have been explained above. The occurrence of dual infections with Rotavirus and Adenovirus as observed in this current study may be due to poor hygienic conditions of the study participants. Poor hygienic conditions have been suggested to contribute to multiple infections in developing countries [19].

In this study, Rotavirus and Adenovirus infections were significantly associated with diarrhea as 5 out of the 9 participants who were currently experiencing diarrhea were infected with at least one of the viruses. 1 of the 4 participants who currently had fever was also positive for Rotavirus. Meanwhile, none of the participants who complained of vomiting were positive for any of the viruses. Meaning that they might be infected with other vomiting causing agents other than these viruses. The symptoms recorded in this study are consistent with those reported in previous studies. For example, Motamedifar et al. [20], stated that diarrhea showed the most powerful association with Adenovirus and Rotavirus and fever was in second position. Also, Mukhtar et al. [12], in their study carried out in Katsina State, observed that Rotavirus and Adenovirus shedding was highest when a combination of vomiting, diarrhea and fever occurred together. It also agrees with a study performed by Modares et al. [16], in Tehran, Iran. They observed that watery diarrhea, fever, abdominal pain, and dehydration were the most common signs and symptoms in children with Adenovirus and Rotavirus infection. The clinical features observed are suggestive of the signs and symptoms that are related with Rotavirus and Adenovirus associated gastroenteritis.

Lack of knowledge of Rotavirus and Adenovirus, history of diarrhea, eating of raw unwashed fruits and vegetables, not washing hands with soap and water after playing with toys and after playing with peers and not going to the hospital or check-up after passing watery stool are some of the risk factors associated with infection.

4. CONCLUSION
In conclusion, the outcome of this study shows that mono/co-infection with Rotavirus and Adenovirus exist among apparently healthy school aged children in Ilishan-Remo community of Ogun State, Nigeria with a prevalence rate of 5.0%, 3.3% and 1.7%, respectively. Appropriate public health measures including awareness programs, routine screening, hand hygiene and vaccination amongst others must therefore be taken to halt the cycle of infection in the community to forestall possible outbreak in the future.

CONSENT
All authors declare that ‘written’ informed consent was obtained from the parents of the participants with assurance of anonymity and confidentiality before the commencement of the study.

ETHICAL APPROVAL
Ethical approval for the study was obtained from the Babcock University Health Research Ethics Committee (BUHREC) with ethical approval registration number: BUHREC180/19. Administrative clearance from each school management was also obtained before the commencement of the study.

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COMPETING INTERESTS
Authors have declared that no competing interests exist.

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