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Original Paper

# Rotavirus Diarrhoea among Children Aged <5 Years in Hospital Setting in Dar Es Salaam, Tanzania

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## ABSTRACT

**Background:** Diarrhoea remains among the highest causes of death in children under 5 years of age in developing countries. Before the introduction of rotavirus vaccine in Tanzania, rotavirus infection was the leading cause of severe diarrhoea in children below the age of 5 years but there is a paucity of studies reporting the severity of this infection after the introduction of rotavirus vaccine. This hospital-based study reports the proportion of children with rotavirus-associated diarrhoea in Dar es Salaam, its severity and associated factors.

**Methods:** A hospital-based cross-sectional study was conducted at the inpatient and outpatient paediatrics departments of the selected health facilities from September 2018 to February 2019. A total of 314 children meeting inclusion criteria were enrolled into the study. A structured questionnaire was used to collect demographic and medical history, anthropometric measurements were taken and a stool sample was collected from each patient for rotavirus antigen detection using CTK Biotech Onsite rotavirus antigen rapid test

**Results:** A total of 314 children were included in the study with age range between 2 and 59 months. The median age was 12 months with an interquartile range of 8–19 months. Symptoms of rotavirus diarrhoea were vomiting ($p$-value = 0.018) and severe dehydration ($p$-value = 0.000). Independent associated factors of rotavirus diarrhoea included: age of mother between 35 and 49 years (AoR 4.1, 95% CI 1.0–17.1, $p$-value = 0.05), geographical distribution (Ilala District, AoR 4.0, 95% CI 1.1–10.4, $p$-value = 0.039), poor hand hygiene (AoR 8.5, 95% CI 2.6–28.1, $p$-value = 0.000) and drinking bottled/home-treated water (AoR 5.4, 95% CI 1.3–22.7, $p$-value = 0.02).

**Conclusion:** Rotavirus infection is still prevalent and severe among children with diarrhoea. The difference in prevalence among the districts is also of concern and hence larger community-based cohort studies are needed to assess the association of rotavirus diarrhoea with the geographical variation across districts and regions. Improving sanitation and hygiene through health education amongst households is crucial for disease prevention.

**KEYWORDS**: rotavirus diarrhoea, associated factors

## INTRODUCTION

Diarrhoea is the second leading cause of mortality among children aged <5 years and it contributes up to about 2 million childhood deaths annually globally [1]. Studies have reported a significant association between diarrhoea in children and several important factors including inadequate potable water supplies, limited sanitation, poor hygiene practices [2] and nutritional status among others [3].

It is estimated that more than a third of diarrhoea hospitalizations among children under 5 years of age are attributed to rotavirus infection [4]. In 2008, rotavirus caused an estimated 453 000 deaths in children younger than 5 years, more than half of which occurred in developing countries [5]. To reduce the burden of diarrhoea, World Health Organization (WHO) recommends that rotavirus vaccine be included in national routine vaccinations programs, especially in areas where the disease is common [6]. This is done along with promoting breastfeeding, hand-washing, clean water and good sanitation. The vaccine is given by mouth, it requires two complete doses and it is given starting ∼6 weeks of age [7].

In Tanzania, there has been a slight reduction of rotavirus prevalence from 33.2% to 26.4% since the introduction of rotavirus vaccine in 2013 [4]. Despite this reduction, children with diarrhoeal cases are still seen in our hospital settings, however, there is paucity of studies that report on the severity of these cases after the introduction of the vaccine. Therefore, this study aimed at assessing the proportion as well as clinical severity and identifying associated factors for rotavirus infection in children aged <5 years in hospital setting.

## METHODOLOGY

### Study design and setting

This was a hospital-based cross-sectional study that was conducted in the Paediatrics inpatient and outpatient departments of eight selected health facilities in Dar es Salaam (Muhimbili national hospital which serves as the national referral hospital, Amana, Temeke and Mwananyamala hospitals which are the regional referral hospitals and Health centres: Pugu, Mnazi mmoja, Buguruni and Tandale health centres). These hospitals are located in the three administrative districts of Dar es Salaam; Ilala, Kinondoni and Temeke districts. Study population consisted of children aged below 5 years with diarrhoea attending both inpatient and outpatient departments of the selected hospitals.

### Sample size

A sample size of 314 children was required for the study using the Kish Leslie formula for cross-sectional studies, estimating the true prevalence of 26.4% [4] and adopting a precision of 5% with 95% confidence interval.

### Sampling procedure and data collection

Convenient sampling technique was used in this study where hospitals were selected due to their well-established inpatients and outpatients' departments with high flow of children with diarrhoea coming from different localities. Children who met inclusion criteria were obtained among those attending or admitted within the selected health facilities consecutively as per patients flow until the intended sample size was achieved.

Data were collected using a researcher-administered standardized structured questionnaire. Research assistants for this study were medical students and paediatrics nurses who were trained on how to extract data from the case files, conduct interview using a standardized structured questionnaire and detect the rotavirus infection in the stool sample by using the validated tools and appropriate standard operating procedures.

Anthropometric measurements were taken including: length/height (cm), weight (kg) and mid-upper arm circumference (cm). The child's weight was taken using a SECA scale to ∼100 g. Height for children ageing >24 months and length for children ageing <24 months or unable to stand was measured to ∼0.1 cm using a portable length board. The mid-upper arm circumference was measured using the WHO standard mid upper arm circumference tape. The WHO growth standard charts were used to assess nutritional status in terms of weight for height

or length and mid upper arm circumference for age (to assess wasting). Critically ill children with signs of severe dehydration were rehydrated according to the WHO guidelines (100 ml/kg of Ringers lactate infusion; for infants, 30 ml/kg over 1 h then 70 ml/kg over 5 h and for children ageing 1–5 years, 30 ml/kg over 30 min then 70 ml/kg over two and a half hours) before obtaining consent.

A single fresh stool specimen was collected from each participant using wide mouthed sterile plastic container that was labelled with patient's identity sticker.

Following collection, each stool specimen was tested immediately for the presence of rotavirus antigen.

Rotavirus antigen was detected from each stool specimen using the commercially available CTK Biotech Onsite rotavirus antigen rapid test (CTK Biotech, Inc., San Diego, USA. Date of Manufacture: April 10, 2018. Onsite$^{TM}$). The relative sensitivity and specificity for this test are 100% and 97.2%, respectively.

Following stool collection from a participant, an aliquot of diluted stool sample was added to the sample well of the test cassette for antigen detection. Test results were then read within 15 min and recorded appropriately. After interpreting the results, the used devices were disposed according to the standard infection and prevention control procedures.

### Inclusion and exclusion criteria

Children below 5 years of age with diarrhoea and who had received rotavirus vaccine which has been documented in Reproductive and Child Health card number 1 were included in the study; those with no available Reproductive and Child Health card number 1 were excluded from the study.

### Variables

Dependent variable was rotavirus diarrhoea, whereas independent variables were factors associated with rotavirus diarrhoea; these included age of the child, age of the mother, gender, malnutrition (severe wasting), poor hygiene, poor sanitation and low maternal education.

### Data management and analysis

Data entry and cleaning was done using SPSS software version 20. Frequency and consistency checks were performed routinely to ensure quality of data entered. Errors found during cleaning and consistency check were rectified through revising the questionnaires.

Analyses were done to produce descriptive and analytical results. Descriptive statistics (frequencies and measures of central tendency, i.e., median) were used to summarize data. Charts and graphs were used in non-textual presentations. Overall proportion of children with rotavirus infection was calculated and Contingency tables were constructed for bivariate analysis to explore factors associated with rotavirus infection. Chi-square and Fisher's exact tests were used to determine significance difference between responses. Level of significance was set at $p \leq 0.05$.

Multivariate logistic regression was used to assess the risk factors, the model permit determination of having rotavirus infection in relation to associated factors. Factors with $p$-value $\leq 0.2$ in bivariate analysis were posted in multivariable analysis. Odds ratios and 95% confidence intervals were used to report estimates of each studied factor. Factors with $p$-value $\leq 0.05$ were considered statistically significant.

### Ethical consideration

Ethical approval to conduct the study was obtained from Ethics Review Committee of the Muhimbili University of Health and Allied Sciences. Written informed consent from the parents was sought for all children prior to joining the study.

## RESULTS

### Socio-demographic characteristics of children with diarrhoea and their caretakers

A total of 314 children were included in the study. The median age of children was 12 months (IQR 8–19 months) and that of mothers was 27 years (IQR 23–32 years). Children who attended outpatient departments predominated and most of them were in Ilala district $n = 134$ (42.7%) as shown in Table 1.

**Table 1: Socio-demographic characteristics of children and their mothers (N = 314)**

| Variable | Category | Frequency |
|---|---|---|
| Age group of a child (months) | | |
| | 2–6 | 49 (15.6) |
| | >6–12 | 111 (35.4) |
| | >12–24 | 105 (33.4) |
| | >24–59 | 49 (15.6) |
| | Median (IQR) | 12 (8–19) |
| Sex of a child | | |
| | Male | 170 (54.1) |
| | Female | 144 (45.9) |
| Age of mother (years) | | |
| | ≤20 | 39 (12.4) |
| | 21–30 | 186 (59.2) |
| | >30–40 | 81 (25.8) |
| | >40–50 | 8 (2.6) |
| | Median (IQR) | 27 (23–32) |
| Marital status of mother | | |
| | Single | 49 (15.6) |
| | Married | 230 (73.2) |
| | Co-habiting | 28 (8.9) |
| | Divorced | 6 (1.9) |
| | Widowed | 1 (0.3) |
| Education level of mother | | |
| | None | 20 (6.4) |
| | Primary | 175 (55.7) |
| | Secondary | 102 (32.5) |
| | College | 17 (5.4) |
| Occupation of mother | | |
| | Housewife | 146 (46.5) |
| | Employed | 46 (14.6) |
| | Self-employed | 118 (37.6) |
| | Peasant | 4 (1.3) |
| Facility department | | |
| | Out-patient | 200 (63.7) |
| | In-patient | 114 (36.3) |
| District | | |
| | Kinondoni | 107 (34.1) |
| | Ilala | 134 (42.7) |
| | Temeke | 73 (23.2) |

IQR, interquartile range.

### Clinical characteristics of children with diarrhoea in Dar Es Salaam

Majority (96.8%) of children had completed rotavirus vaccine doses and most of them had duration of diarrhoea of between 1 and 3 days. Fewer children had severe dehydration, $n = 50$ (15.9%) and only 13 (4.1%) had severe acute malnutrition. Most mothers (55.1%) always washed hands before feeding their children and about half of the mothers never washed hands after cleaning a child who has passed stool. Almost half of the children (47.1%) were given unboiled water for drinking, as seen in Table 2.

### Proportion of rotavirus diarrhoea among children aged <5 years in Dar Es Salaam

Of the 314 children, 33 children had positive rotavirus infection test making an overall proportion of 10.5%.

### Clinical severity of rotavirus diarrhoea among children aged <5 years with rotavirus diarrhoea

From Table 3, the most severe symptoms that were seen in children who tested positive for rotavirus infection were vomiting ($p$-value = 0.018) and severe dehydration ($p$-value = 0.000).

### Independent factors associated with rotavirus diarrhoea

Following adjustment for confounders as shown in Table 4, children whose mothers aged between >35 and 49 years were 4.1 times more likely to have rotavirus diarrhoea. Those who came from Ilala district were 4 times more likely to be infected with rotavirus than those in Temeke district ($p$-value = 0.039). Other factors that were independently associated with rotavirus diarrhoea were mothers not washing hands before feeding the children or preparing the children's meal (AoR 8.5, $p$-value = 0.000) and children drinking commercially available bottled/home-treated water (AoR 5.4, $p$-value = 0.020).

## DISCUSSION

The high burden of rotavirus diarrhoea among children aged <5 years has been well documented with the majority of mortality occurring in developing countries [8]. There was 10.5% prevalence among these children who have been vaccinated at ∼99%. We expect herd immunity if over 80% are vaccinated [9], this is not seen in our population and is further discussed below.

The proportion of children with rotavirus diarrhoea among under-five children in this study was almost comparable to that in the study done in Nigeria in 2016 [10]. This similarity could be attributed to the fact that both studies were carried out in hospital settings with similar study population.

In contrast to the findings from this study, prevalence of rotavirus infection among under-five children with diarrhoea was found to be higher in a study that was done in Moshi in 2017 [4]. The variation in geographical characteristics between Moshi and Dar es Salaam regions may explain the difference in prevalence of rotavirus diarrhoea between these two regions.

Before the introduction of rotavirus vaccine in the country in January 2013, the prevalence of rotavirus diarrhoea in Dar es salaam was much higher [5] than the one in this study.

Furthermore, previous studies had also reported a similar trend of reduction in rotavirus infection among under-five children during pre-vaccine years (2009–2012) and post-vaccine years (2014–2015) in which the rotavirus positivity rates had dropped significantly in Tanga and Mwanza regions, respectively [11].

This trend of prevalence from pre-vaccine to post-vaccine era is attributable to the good coverage of rotavirus vaccine across country which was also clearly seen in this study where all participants had received the vaccine and only a few had received incomplete doses of vaccine.

Despite a substantial decline in the prevalence of rotavirus diarrhoea in this study, two of the most commonly reported clinical symptoms of severe disease were found to be significant among children who had positive test results for rotavirus infection, these were vomiting and severe dehydration, indicating the need for adherence to other preventive measures in addition to the immunization.

Persistence of severe symptoms of rotavirus diarrhoea in this study even after the introduction of vaccine may be attributable to the diversity of rotavirus strains circulating in children aged <5 years with diarrhoea in sub-Saharan Africa from pre- to post-

**Table 2: Clinical characteristics of children with diarrhoea in Dar Es Salaam (N = 314)**

| Variable | Category | Frequency |
|---|---|---|
| Rotavirus vaccination status | | |
| | Complete | 304 (96.8) |
| | Incomplete | 10 (3.2) |
| Duration of diarrhoea (days) | | |
| | 1–3 | 240 (76.4) |
| | 4–7 | 57 (18.2) |
| | 8–14 | 14 (4.5) |
| | >14 | 3 (1.0) |
| Stool consistency | | |
| | Watery | 224 (71.3) |
| | Mucoid | 88 (28.0) |
| | Blood stained | 2 (0.6) |
| Fever | | |
| | Yes | 183 (58.3) |
| | No | 131 (41.7) |
| Vomiting | | |
| | Yes | 139 (44.3) |
| | No | 175 (55.7) |
| Abdominal pain | | |
| | Yes | 90 (28.9) |
| | No | 224 (71.3) |
| Convulsion | | |
| | Yes | 14 (4.5) |
| | No | 300 (95.5) |
| Loss of consciousness | | |
| | Yes | 9 (2.9) |
| | No | 305 (97.1) |
| Hydration status | | |
| | No dehydration | 156 (49.7) |
| | Some dehydration | 108 (34.4) |
| | Severe dehydration | 50 (15.9) |
| Nutrition status (wasting) | | |
| | Normal | 222 (70.1) |
| | Mild | 52 (16.6) |
| | Moderate | 27 (8.6) |
| | Severe | 13 (4.1) |
| Type of latrine used at home | | |
| | Pit latrine | 133 (42.4) |
| | Flush latrine | 181 (57.6) |
| Hand-washing after toilet use | | |
| | Always | 162 (51.6) |
| | Sometimes | 127 (40.4) |
| | No | 25 (8.0) |

**(continued)**

**Table 2: Continued**

| Variable | Category | Frequency |
|---|---|---|
| Hand-washing before feeding a child/preparing child's meal | | |
| | Always | 173 (55.1) |
| | Sometimes | 110 (35.0) |
| | No | 31 (9.9) |
| Hand-washing after cleaning a child who has passed stool | | |
| | Always | 81 (25.8) |
| | Sometimes | 93 (29.6) |
| | No | 140 (44.6) |
| Tool for hand-washing | | |
| | Water without soap | 162 (51.6) |
| | Water with soap | 152 (48.4) |
| Child's drinking water | | |
| | Boiled | 86 (27.4) |
| | Un-boiled | 148 (47.1) |
| | Treated | 8 (2.6) |
| | Bottled | 63 (20.1) |
| | Exclusive breastfeeding | 9 (2.9) |

vaccine years which was also observed in a study done in Zambia from 2008 to 2015 [12]. These newly evolving rotavirus genotypes have also been reported in a pre-vaccination study done in Tanzania in which the phylogenetically related vaccine strain genotype G1 predominated but there was the emergence of other new genotypes (G8 and G12) [5]. We are not sure whether the genotype of the rotavirus in the vaccinated vs. vaccine naive population is the same. Moreover, the current rotavirus vaccine contains G1P[8] genotype [13] and may not be the one circulating in the community.

In this study, age of the mothers between 35 and 49 years was found to be independently associated with rotavirus diarrhoea when compared to that between 17 and 25 years. These results contradict the ones which were reported in previous study done in the USA in which age distribution of the mothers did not have any association with rotavirus infection on their children [14]. We speculate that this finding could be explained by the fact that children of older mothers are mostly under non-maternal care at home including the housemaids and older siblings who might not be practicing hand hygiene as much as the mother would be.

On the other hand, our study did not find any significant association between age and rotavirus diarrhoea indicating virulence of the human rotavirus strains across all age groups of under-five children in these settings. This may warrant an appropriate strain booster vaccine for the children, let us say at around age 3 years.

We observed a significant variation in rotavirus infection across the three districts in Dar es Salaam. Participants from Ilala district had the highest proportion of rotavirus diarrhoea compared to those from Temeke and Kinondoni districts. The difference in terms of location, population density, infrastructure and water supply between Ilala district and the other two districts may have contributed to such findings in this study. The demographics and socioeconomic status of the three districts also have delineation, although this is hard to document. On the other hand, this heterogeneity could be due to a wide range of geographical distribution of the rotavirus genotypes and serotypes.

**Table 3: Clinical severity of rotavirus diarrhoea among children with rotavirus infection**

| Variable | Rotavirus test results | | |
|---|---|---|---|
| | Positive, $N = 33$ | Negative, $N = 281$ | $p$-Value |
| Duration of diarrhoea (days) | | | |
| 1–3 | 25 (75.8) | 215 (75.8) | 0.582[a] |
| 4–7 | 8 (24.2) | 49 (17.4) | |
| 8–14 | 0 (0) | 14 (5.0) | |
| ≥14 | 0 (0) | 3 (1.1) | |
| Convulsion | | | |
| Yes | 2 (6.1) | 12 (4.3) | 0.648[a] |
| No | 31 (93.9) | 269 (95.7) | |
| Loss of consciousness | | | |
| Yes | 2 (6.1) | 7 (2.5) | 0.242[a] |
| No | 31 (93.9) | 274 (97.5) | |
| Fever | | | |
| Yes | 19 (57.6) | 164 (58.4) | 0.931 |
| No | 14 (42.4) | 117 (41.6) | |
| Vomiting | | | |
| Yes | 21 (63.6) | 118 (42.0) | 0.018 |
| No | 12 (36.4) | 163 (58.0) | |
| Abdominal pain | | | |
| Yes | 11 (33.3) | 79 (28.1) | 0.53 |
| No | 22 (66.7) | 202 (71.9) | |
| Hydration status | | | |
| No dehydration | 10 (30.3) | 146 (52.2) | 0.000 |
| Some dehydration | 10 (30.3) | 98 (34.9) | |
| Severe dehydration | 13 (39.4) | 37 (13.2) | |

[a]Fischer's exact test was used to find the difference in these variables.

Review of scientific literatures makes it clear that faecal–oral is the main route of transmission of rotavirus infection in which the virus spreads through contaminated hands, objects and occasionally food and water [15]. In this study, children whose mothers never washed hands before preparing their foods or feeding them as well as children who drank commercially available bottled or home-treated water were significantly infected by rotavirus. The higher proportion observed among those who drank commercially available bottled or home-treated water may be explained by the transferring of the virus from the contaminated hands to the bottles during opening or handling of the feeding cups. These ways of contamination are consistent with those previously reported in the rotavirus scientific review in 2018 [16]. This further calls for Water Sanitation and Hygiene (WASH) to be undertaken more seriously.

The proportion of rotavirus infection was found to be higher in children who had normal nutritional status. This finding conforms to the virulent characteristics of rotavirus which depends on a healthy intestinal epithelium for attachment and pathogenesis. However, we did not find any significant association between rotavirus infection and nutritional status in regression model.

### Strength and limitation of the study

This study covered multiple tiers of health facilities from the level of national hospital to the health

**TABLE 4: Univariate and multivariate logistic regression to assess the independent associated factors for rotavirus diarrhoea**

| Factors | CoR (95% CI) | *p*-Value | AoR (95% CI) | *p*-Value |
|---|---|---|---|---|
| Age of a child (month) | | | | |
| 2–12 | 1.3 (0.6–3.3) | 0.51 | 1.0 (0.3–2.9) | 0.952 |
| >12–24 | Ref | | Ref | |
| >24–59 | 2.7 (1.0–7.6) | 0.05 | 2.2 (0.6–7.4) | 0.225 |
| Age of mother | | | | |
| 17–25 | Ref | | Ref | |
| >25–35 | 1.5 (0.7–3.4) | 0.311 | 1.2 (0.4–3.4) | 0.73 |
| >35–49 | 3.5 (1.2–10.7) | 0.027 | 4.1 (1.0–17.1) | 0.05 |
| Marital status of mother | | | | |
| Living alone | Ref | | Ref | |
| Living together | 3.7 (0.8–15.9) | 0.08 | 4.8 (0.9–26.4) | 0.07 |
| Occupation of mother | | | | |
| Peasant/housewife | 1.1 (0.5–2.6) | 0.807 | 1.1 (0.4–3.3) | 0.856 |
| Employed | 2.6 (1.0–7.0) | 0.05 | 2.8 (0.8–10.4) | 0.114 |
| Self-employed | Ref | | Ref | |
| District | | | | |
| Kinondoni | 1.0 (0.3–3.8) | 0.971 | 1.5 (0.3–7.5) | 0.593 |
| Ilala | 3.6 (1.2–10.8) | 0.024 | 4.0 (1.1–10.4) | 0.039 |
| Temeke | Ref | | Ref | |
| Type of latrines | | | | |
| Pit latrine | 2.3 (1.1–4.8) | 0.028 | 1.6 (0.6–4.4) | 0.337 |
| Flush latrine | Ref | | Ref | |
| Hand-washing before feeding a child | | | | |
| Always | Ref | | Ref | |
| sometimes | 1.6 (0.6–4.0) | 0.293 | 1.2 (0.4–3.5) | 0.704 |
| No | 11.8 (4.5–30.7) | 0.000 | 8.5 (2.6–28.1) | 0.000 |
| Hand-washing after cleaning a child who passed stool | | | | |
| Always | Ref | | Ref | |
| sometimes | 2.8 (0.9–8.7) | 0.068 | 3.0 (0.8–11.3) | 0.101 |
| No | 2.6 (0.8–8.4) | 0.117 | 2.1 (0.5–8.8) | 0.319 |
| Tool for hand-washing | | | | |
| Water without soap | 2.3 (1.1–5.1) | 0.031 | 1.5 (0.6–3.9) | 0.437 |
| Water with soap | Ref | | Ref | |
| Drinking water given to a child | | | | |
| Boiled | Ref | | Ref | |
| Un-boiled | 1.8 (0.6–5.2) | 0.26 | 1.8 (0.5–6.8) | 0.351 |
| Bottled/treated | 3.0 (1.0–9.0) | 0.05 | 5.4 (1.3–22.7) | 0.020 |
| Exclusive breastfeeding | 4.6 (0.8–28.4) | 0.098 | 3.2 (0.8–11.2) | 0.111 |

CoR, crude odds ratio; AoR, adjusted odds ratio; CI, confidence interval.

centres hence results are representative of the burden of rotavirus diarrhoea among children aged <5 years in Dar es Salaam hospitals. Rotavirus infection in this study was detected using a directly observed rotavirus antigen rapid test which has the relative sensitivity and specificity of 100% and 97.2%, respectively, hence good diagnostic accuracy.

However, this was a hospital-based study and therefore the statistical results obtained cannot be generalized to the entire population of Dar es Salaam.

## CONCLUSION

Rotavirus genotypic is recommended to see if the same variant is being delivered in the vaccine, WASH needs to be emphasized and continued surveillance be undertaken.

## REFERENCES


1. Bryce J, Boschi-Pinto C, Shibuya K, *et al.* WHO estimates of the causes of death in children. Lancet 2005;365: 1147–52.
2. Feleke H, Medhin G, Abebe A, *et al.* Enteric pathogens and associated risk factors among under-five children with and without diarrhea in Wegera district, northwestern Ethiopia. Pan Afr Med J 2018;29:1–10.
3. George CM, Perin J, De Calani KJN, *et al.* Risk factors for diarrhea in children under five years of age residing in Peri-urban Communities in Cochabamba, Bolivia. Am J Trop Med Hyg 2014;91:1190–6.
4. Mchaile DN, Philemon RN, Kabika S, *et al.* Prevalence and genotypes of Rotavirus among children under 5 years presenting with diarrhoea in Moshi, Tanzania: a hospital based cross sectional study. BMC Res Notes 2017;10:4–9.
5. Moyo SJ, Blomberg B, Hanevik K, *et al.* Genetic diversity of circulating rotavirus strains in Tanzania prior to the introduction of vaccination. PLOS One 2014;9:e97562.
6. Tate JE, Burton AH, Boschi-Pinto C, *et al.* 2008 estimate of worldwide rotavirus-associated mortality in children younger than 5 years before the introduction of universal rotavirus vaccination programmes: a systematic review and meta-analysis. Lancet Infect Dis 2012;12:136–41.
7. Abeid KA, Jani B, Cortese MM, *et al.* Monovalent rotavirus vaccine effectiveness and impact on rotavirus hospitalizations in Zanzibar, Tanzania: data from the first 3 years after introduction. J Inf Dis 2017;215:183–91.
8. Mokomane M, Kasvosve I, Melo E. D, *et al.* The global problem of childhood diarrhoeal diseases: emerging strategies in prevention and management. Ther Adv Inf Dis2018;5:29–43.
9. Pollard SL, Malpica-llanos T, Friberg IK, *et al.* Estimating the herd immunity effect of rotavirus vaccine. Vaccine 2015;33:3795–800.
10. Junaid SA, Umeh C, Olabode AO, *et al.* Incidence of rotavirus infection in children with gastroenteritis attending Jos university teaching hospital. Virol J 2011;8:233.
11. Jani B, Hokororo A, Mchomvu J, *et al.* Detection of rotavirus before and after monovalent rotavirus vaccine introduction and vaccine effectiveness among children in mainland Tanzania. Vaccine 2018;36:7149–56.
12. Simwaka JC, Mpabalwani EM, Seheri M, *et al.* Diversity of rotavirus strains circulating in children under five years of age who presented with acute gastroenteritis before and after rotavirus vaccine introduction, University Teaching Hospital, Lusaka, Zambia, 2008–2015. Vaccine 2018;36: 7243–7.
13. Zeller M, Heylen E, Tamim S, *et al.* Comparative analysis of the Rotarix TM vaccine strain and G1P [8] rotaviruses detected before and after vaccine introduction in Belgium. PeerJ 2017;5:e2733.
14. Duffy LC, Byers TE, Riepenhoff-Talty M, *et al.* The effects of infant feeding on rotavirus-induced gastroenteritis: a prospective study. Am J Public Health 1986;76:259–63.
15. Parashar UD, Nelson EAS, Kang G. Diagnosis, management, and prevention of rotavirus gastroenteritis in children. BMJ 2013;347:f7204–10.
16. Sadiq A, Bostan N, Yinda KC, *et al.* Rotavirus: genetics, pathogenesis and vaccine advances. Rev Med Virol 2018; 28:1–13.