

Incidence of Rotavirus Infection among Under-Five Children Attending Health Centres in Selected Communities of Ndola, Copperbelt Province, Zambia

Julia Shachakanza¹, Joseph Mumba Zulu², Margaret Maimbolwa³

¹School of Medicine, Copperbelt University, Michael Chilufya Sata Campus, Ndola, Zambia

²Department of Public Health, School of Medicine, Health Promotion and Education Unit, University of Zambia, Ridgeway Campus, Lusaka, Zambia

³Department of Nursing Science, School of Medicine, Ridgeway Campus, Lusaka, Zambia

Email: juliashachakanza@yahoo.com, josephmumbazulu@gmail.com, mmaimbolwa@yahoo.com, margaret.maimbolwa@unza.zm

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Abstract

Rotavirus infection is a highly infectious public health concern among under-five children characterized mainly by diarrhoea, vomiting and fever spread through oral fecal route from contaminated water, food and objects. Diarrhoea ranks third among the common causes of mortality in Zambia among under-fives which accounts for about 9%. Statistics obtained at Ndola District Health Management Office revealed that in spite of high coverage of rotavirus vaccine, diarrhoea incidence had risen over the years from 2011 to 2015 by 32.9/1000. Currently stool is not routinely tested for rotavirus infection, making it difficult to determine its incidence and effectiveness of rotavirus vaccine (Rotarix™), an intervention that was put in place on 27th November 2013 to mitigate diarrhoea disease. The objective of this study is to determine incidence of rotavirus infection among under-fives attending health centres in selected communities of Ndola. Purposive sampling was used to select 380 under-fives aged 3 months - 36 months who presented at health facilities with diarrhoea, vomiting and fever. Stool specimen was tested for rotavirus infection using Combi-Strip Rapid Diagnostic Test. The study was conducted at specified period in time from 1st March 2017 to 28th September 2017 to determine relationships and associations among suspected variables using cross-sectional analytic community based study design. Statistical Package for Social Science software was used for data analysis. Tests used included Pearson's Chi-square and logistic regression. Results have revealed 11% incidence rate of rotavirus infection and significant statistical association among severi-

ty categories of rotavirus infection with uptake of rotavirus vaccine ($p \leq 0.001$). Children who took two recommended doses of the vaccine 185 (59.5%) were more likely to have mild category (<7 score) of rotavirus infection. In conclusion, results clearly indicate that rotavirus vaccine reduces incidence and if a child has diarrhoea it is less severe which yields good outcomes.

Keywords

Incidence, Rotavirus Infection, Uptake, Vaccine

1. Introduction

Diarrhoeal diseases are ranked as the second most common cause of morbidity and mortality in children in the developing world [1]. Rotavirus infection is the top most cause of diarrhoea hospitalization among children worldwide [2]. Chilengi [3] revealed that rotavirus infection accounted for approximately 230,000 child deaths in sub-Saharan Africa and that half a million children died yearly worldwide. Rotavirus infection is of public health concern because it is highly contagious and yet can be prevented. The characteristics of rotavirus infection are vomiting, fever, diarrhoea and loss of appetite which may contribute to dehydration due to body fluid loss and electrolyte imbalance which may be fatal [4]. When the rotavirus enters the body through ingestion, it infects the stomach and intestinal tract (gastroenteritis) damaging the cells of the small intestine making it difficult for absorption of water and nutrients by the body [5]. To combat severe diarrhoea caused by the rotavirus, a rotavirus vaccine was introduced to mitigate the rotavirus infection. In order to assess the effectiveness of the immunisation programme that was implemented in 2013 in Zambia, this study attempted to determine incidence of rotavirus infection among under-five children.

In Jos, Nigeria a study was conducted by Junaid on the incidence of rotavirus infections among children with gastroenteritis [6]. The study results of children screened revealed that 22 (13.8%) out of the 160 children tested were positive for rotavirus infection, while 138 (86.2%) tested were negative for rotavirus excretion. Rotavirus incidence distribution in relation to gender indicated a total of 64 (40%) male and 96 (60%) female cases of gastroenteritis. The highest incidence of the infection was seen in children whose parents (either one or both) were involved in business. The highest incidence of rotavirus was also observed among children whose parents had not reached secondary school level or no formal education.

Further, the study results revealed that children whose parents were married had the highest rotavirus infection incidence of 18 (11.3%) as compared to single and divorced parents with 2 (1.3%) each. In addition, 12 (7.5%) of the children aged between 7 and 12 months had the highest rate of infection while those aged between 0 and 6 and 25 - 60 months had the lowest at 2 (1.3%). A cross-sectional

study was conducted by Ndze [7] from October 2010 to July 2011 on epidemiology of rotavirus diarrhoea in children under-five years in Northern Cameroon at the Regional Hospital Maroua and at the Domayo Djama integrated health center in the Far North region; and at the regional hospital of Bamenda and Esu health centre in the North West region. The study revealed that highest number of rotavirus infection cases was observed in the age group between 0 and 12 months (47.9%) while the age group between 49 and 60 months had the lowest prevalence rate (25%). It was observed that children positive for rotavirus was accompanied with vomiting and fever in both the outpatient and inpatient groups (13.0% and 28.6% respectively, $p = 0.03$).

Due to the fact that symptoms and duration of diarrhoea, vomiting, fever, and dehydration are also commonly experienced with diarrhoeal illnesses caused by other etiologies, researchers have concluded that there is no combination of symptoms or specific duration which easily confirms that a person has rotavirus. For these reasons, the Vesikari Clinical Severity Scoring System (VCSSS) must be used in combination with laboratory assays in identifying the efficacy of the rotavirus vaccine and severe gastroenteritis caused by rotavirus [8] [9].

The study conducted by Tindall indicated that the vaccine uptake rates from 2014 February to March 2015 in Anglia and Essex among the under-five children was between 90% and 92% each month [10]. This was after the introduction of an oral attenuated rotavirus vaccine (Rotarix™) into the infant immunization program as a two-dose schedule at 2 and 3 months of child's age in July 2013. Other studies conducted by Braeckman [11] in Flanders, Belgium revealed uptake of rotavirus vaccine among under-five children to be at 92.2% where as those of Merten [12] in Congo revealed 99%.

Zambia became the 18th GAVI-eligible country on 27th November 2013 to introduce rotavirus vaccine (Rotarix™) in its immunization program which was combined with community projects to teach mothers to stop children from getting diarrhoea. The burden of rotavirus infection in Zambian children could be reduced through use of rotavirus vaccines to prevent childhood deaths and hospitalizations [1] [13] [14]. The vaccine is administered in two doses the first of which is given from 6 weeks but not later than 15 weeks of age while the second is given at 10 weeks (or 4 weeks from the first dose) but not later than 32 weeks of age [4]. According to Ndola District Health Management Office [15] on the Copperbelt Province in Zambia, statistics have shown a high coverage of vaccinations at the health facilities among the eligible under-five children which is above the target of 85%.

Many studies have been conducted globally on the impact of rotavirus vaccine in prevention of diarrhoea disease caused by rotavirus infection although not much has been published in Zambia. A study conducted by Tate [16] estimated that globally, the mortality of under-five children declined from 528,000 (range, 465,000 - 591,000) in 2000 to 215,000 (range, 197,000 - 233,000) in 2013. The predicted annual rotavirus detection rate from these studies declined slightly over time from 42.5% (95% confidence interval [CI], 37.4% - 47.5%) in 2000 to

37.3% (95% CI, 34.2% - 40.5%) in 2013 globally. In the same study it was revealed that out of the 22% of global mortalities, almost half (49%) of the mortalities occurred in the four countries namely: India, Nigeria, Pakistan, and Democratic Republic of Congo during the same year. About 47,100 mortalities occurred in India alone. By this period of time rotavirus vaccine had been introduced in more than 60 countries although mostly by countries that recorded low mortality rates.

Only one known and published study has been conducted in the capital city of Zambia (Lusaka) at the University Teaching Hospital by [17] between January 2009 and December 2014. The study results revealed that there was a decline in the incidence of rotavirus among the under-five children from 40.1% (449/1121) before the introduction of rotavirus vaccine to 30.2% (250/828; $p < 0.001$) in 2013 and 24.7% (157/635; $p < 0.001$) in 2014. The study results also showed that there was a reduction of 18% to 29% in hospitalizations due to all cause diarrhoea and 27% to 33% in mortality among children under one year of age in 2013 and 2014 respectively. According to Ndola District Health Management Team, statistics have shown that despite the high coverage of vaccinations at health facilities in Ndola among the eligible under-five children which is above the target of 85%, incidence of diarrhoea disease over the years has risen from 108.3/1000 in 2011 to 141.2/1000 in 2015 [15] which gives an upward increase of 32.9/1000.

2. Method

The study was conducted from 1st March 2017 to 28th September 2017. The sample size was 380 under-five children aged between 3 months and 36 months who reported to the two health facilities residing within the two communities namely Chipokota Mayamba and New Masala with history of diarrhoea, vomiting and fever. Purposive sampling was used to select the health centres and children for the study. Cross-sectional analytic community based study design was used to ascertain whether certain suspected factors could have contributed to having rotavirus infection among under-fives. This study was a cross-sectional because it was conducted at one point in time while its analytical component looked at factors which could have had an association to rotavirus infection incidence such as health facility, age, sex, and uptake of rotavirus vaccine. Vesikari Clinical Severity Scoring System (VCSSS) tool was used to collect history data which included diarrhoea and vomiting frequency and duration, temperature, dehydration, treatment and severity of category while stool specimen was assessed for rotavirus infection using Combi-Strip Rapid Diagnostic Test. Statistical Package for Social Sciences (SPSS) version 24 software was used for data entry and analysis of quantitative data. Pearson's Chi-square was used in a bivariate regression to determine relationships and associations between two nominal variables and Fisher's Exact Significant test in a 2×2 table with values less than five.

3. Results

The study results included 380 under-five children aged 3 months - 36 months

who reported to the two health facilities with diarrhoea, vomiting and fever. Stool specimen was collected from these children and tested for rotavirus infection. Study results have revealed that incidence of rotavirus infection was more at Chipokota Mayamba 25 (59.5%) than at New Masala health facility 17 (40.5%). Majority 205 (53.9%) of these children were males while 175 (46.1%) were females.

Results revealed that out of the 380 children that were tested for rotavirus infection in stool, 42 (11%) were positive (**Figure 1**). The highest incidence of the infection was seen in children aged 7 - 12 months 14 (33.3%) followed by those in age group between 13 and 18 months 9 (21.4%). The least incidence was in children aged 6 months and below 3 (7.1%). In spite of these results there was no significant statistical association between health facility and age in relation to incidence of rotavirus infection in stool. Similarly, there was no significant statistical association between sex and incidence of rotavirus infection as both were affected equally at 21 (50%) each (**Table 1**).

Analysis using multivariate backward logistic regression revealed that under-five children whose stool specimen was semi-formed were 0.67 times less likely to have rotavirus infection in stool than those with watery stool (**Table 2**). Results have shown significant statistical association between maximum number of vomiting episodes per day ($p = 0.001$), vomiting duration in days ($p = 0.003$), severity category of rotavirus infection in under-five children ($p = 0.003$) and incidence of rotavirus infection in stool. Majority of those under-five children that presented with maximum number of vomiting episodes per day 16 (38.1%) had a positive stool test result for rotavirus infection than those that had none or 1 episode of vomiting 12 (28.6%). In addition, majority 27 (64.3%) of under-five children that had a moderate score of 7 - 10 had a positive stool test result for rotavirus as compared to those 3 (7.1%) that had severe score of 11 and above. These results have revealed no significant statistical association between under-fives' maximum number of stools passed per day, diarrhoea duration in days, temperature and dehydration on first contact at health facility and treatment provided to them in relation to incidence of rotavirus in stool.

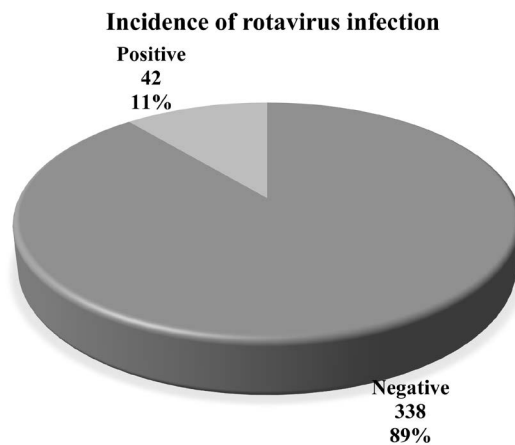


Figure 1. Pie chart on incidence rate of rotavirus infection in stool.

Table 1. Child's demographic data by incidence of rotavirus infection in stool.

Characteristics	Total = 380	Incidence of rotavirus infection		X ²	p-value
		Negative = 338	Positive = 42		
Health facility name					
New Masala	175 (46.1)	158 (46.7)	17 (40.5)	0.59	0.442
Chipokota Mayamba	205 (53.9)	180 (53.3)	25 (59.5)		
Age					
6 months & below	37 (9.7)	34 (10.1)	3 (7.1)	1.74	0.884
7 - 12 months	100 (26.3)	86 (25.4)	14 (33.3)		
13 - 18 months	96 (25.3)	87 (25.7)	9 (21.4)		
19 - 24 months	63 (16.9)	57 (16.9)	6 (14.3)		
25 - 30 months	36 (9.5)	32 (9.5)	4 (9.5)		
31 - 36 months	48 (12.6)	42 (12.4)	6 (14.3)		
Sex					
Male	205 (53.9)	184 (54.4)	21 (50.0)	0.29	0.586
Female	175 (46.1)	154 (45.6)	21 (50.0)		

Table 2. Clinical stool consistency by incidence of rotavirus infection in stool.

Steps	Characteristics	p-value	Odds	95% CI
Step 1	Stool appearance/consistency			
	Formed	0.083	0.25	0.05, 1.20
	Semi-formed	0.001	0.32	0.16, 0.64
	Watery (reference)			
Step 2	Stool appearance/consistency			
	Formed	0.086	0.26	0.05, 1.21
	Semi-formed	0.001	0.32	0.16, 0.64
	Watery (reference)			
Step 3	Stool appearance/consistency			
	Formed	0.076	0.25	0.05, 1.16
	Semi-formed	0.001	0.33	0.16, 0.65
	Watery (reference)			

CI = Confidence Interval.

Results further revealed that majority of under-five children had high uptake of rotavirus vaccine 311 (81.8%). Majority of children that had high uptake of rotavirus vaccine 34 (81%) had a positive stool test result for rotavirus infection while only 8 (19%) had low uptake. These results revealed no significant statistical association between uptake of rotavirus vaccine and incidence of rotavirus infection (**Table 3**).

In conclusion, it is clear that incidence of rotavirus infection is associated with

Table 3. Child's uptake of rotavirus vaccine by incidence of rotavirus infection in stool.

Characteristics	Total = 380	Incidence of rotavirus infection		X ² p-value
		Negative = 338	Positive = 42	
Child's uptake of rotavirus vaccine				
Low uptake	69 (18.2)	61 (18)	8 (19)	*0.834
High uptake	311 (81.8)	277 (82)	34 (81)	

*Fishers Exact Test.

other parameters which include watery diarrhoea, vomiting and severity category of the condition.

4. Discussion and Interpretation of Results

This study has revealed that under-five children who participated in both household questionnaire and stool specimen testing for rotavirus were aged between 3 months and 36 months. This age group was chosen because it fell within the age group that started receiving the rotavirus vaccine when it was first introduced in Zambia on 27th November 2013.

This study has shown that the incidence of rotavirus in stool is still high at 11% according to the set indicators of 10% and below. Out of those that tested positive for rotavirus infection, Chipokota Mayamba had a higher incidence of the infection at 59.5%, while New Masala had 40.5%. Study results have shown that in spite of this difference, there was no significant statistical association between health facility and incidence of rotavirus. These study results have revealed a reduction in incidence of rotavirus infection when compared to the study conducted in the capital city of Zambia (Lusaka) at the University Teaching Hospital by [17] between January 2009 and December 2014 which revealed a decline in the incidence of rotavirus among under-five children from 40.1% (449/1121) before the introduction of rotavirus vaccine to 30.2% (250/828; $p < 0.001$) in 2013 and 24.7% (157/635; $p < 0.001$) in 2014. To some extent the incidence of rotavirus has reduced when compared to the latter results. However, this cannot be substantiated as the study sites may be different from those used in this study.

In this study, results reveal that children aged between 7 and 12 months have the highest incidence rate of rotavirus infection in stool specimen at 33.3% while those aged 6 months and below have the lowest with 7.1%. In Zambia there is a policy for mothers to practice exclusive breast feeding which means that the child should not be given any other foods until the age of 6 months to prevent diarrhoea diseases. As the child grows up, there is a tendency of putting anything they come across in the mouth which predisposes them to diarrhoea disease. The results are similar to study conducted by study [6] in Jos, Nigeria which revealed high and low incidence rates respectively in above mentioned age groups. The high incidence in age group in this study is assumed to be due to the fact that children like eating anything that they come across without washing hands.

Results obtained using VCSSS in this study have revealed that there was a significant statistical association between maximum number of vomiting episodes per day ($p = 0.001$), vomiting duration in days ($p = 0.003$), severity category of rotavirus in under-five children ($p = 0.003$) and incidence of rotavirus in stool. Majority of under-five children that presented with maximum number of vomiting episodes per day 38.1% had a positive stool test for rotavirus infection as compared to those that had none or 1 episode of vomiting at 28.6%. Study results have revealed that more than half (64.3%) of under-five children that had a moderate score of 7 - 10 had a positive stool test result for rotavirus as compared to the 7.1% that had severe score of 11 and above. This shows that condition is less likely to be severe if child receives the two doses of the recommended rotavirus vaccines. The study results agree with those revealed by study mentioned earlier [7], where it was revealed that among the parameters that were assessed, vomiting accompanied rotavirus infection ($p = 0.003$). However, this study's results did not reveal significant statistical association between fever and rotavirus infection ($p = 0.078$) as revealed by earlier studies ($p = 0.003$) [7]. These study results also agree with earlier studies [8] and [9] where it was revealed that there is no combination of symptoms or duration which can easily confirm that a person has rotavirus infection without stool laboratory investigations for rotavirus.

Further analysis of results using multivariate backward logistic regression revealed that semi-solid formed stool was 0.67 times less likely to have rotavirus infection as compared to watery stool. This simply means that children who passed watery stool were more likely to have rotavirus infection than those with either semi-solid or well-formed stool.

In addition, at the age of 3 months a child who started taking the rotavirus vaccine at an appropriate age of 6 weeks would have completed the two recommended doses of rotavirus vaccine. These results agree with those shown by earlier study [10] in Anglia and Essex which also revealed high uptake of rotavirus vaccine. Rotavirus vaccine is recommended worldwide as a policy in prevention of diarrhoea diseases caused by rotavirus infection.

In this study, results have shown that majority (81.8%) of under-five children who were tested for rotavirus infection in stool at the two health facilities received the two recommended rotavirus vaccines for the control of diarrhoea diseases. The study results revealed slightly lower percentage as compared to target statistics by Ndola District Health Management Office [15] obtained on uptake coverage of 85%. In addition, the study results were also lower as compared to study conducted by [10] in Anglia and Essex which revealed 90% - 92% coverage and study of [11] in Flanders, Belgium which was at 92.2% as well as the earlier study [12] in Congo which revealed 99% uptake of rotavirus vaccine among under-five children.

5. Conclusion

Results have revealed that incidence of rotavirus infection is associated with wa-

tery diarrhoea and vomiting and that rotavirus vaccine is effective in diarrhoea prevention if taken according to national policy and guidelines.

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Declaration

I, Julia Shachakanza, do declare that this work is our own and that the work of other persons utilized in this dissertation has been duly acknowledged. This work presented here has not been previously presented at this or any other university for similar purposes.

Approval

Approval was obtained from Research Ethics Committee at Tropical Disease Research Centre (TDRC). Permission was sought from Ministry of Health, Ndola District Health Management Office and Provincial Health Office. Participants were assured of confidentiality and non-persecution arising from their responses. No names were written on the questionnaires concerning their responses.

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Conflicts of Interest

The authors declare no conflicts of interest associated with this study.

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