Effectiveness of rotavirus vaccine in the prevention of diarrhoeal diseases among children under age five years in Kavango East and West Regions, Namibia

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Abstract

Background: Diarrheal diseases due to rotavirus infection contribute greatly to morbidity and mortality rates of babies and young children in many developing countries. This public health concern can effectively be reduced by the use of the rotavirus vaccine, though there is an anecdotal evidence indicating that despite introduction of the vaccine the number of cases of diarrhoea diseases are still high in Namibia, particularly in Kavango east and west regions.

Objective: This study evaluated the effectiveness of the rotavirus vaccine in preventing diarrhoea cases among children under age five years in Kavango regions.

Methods: The study employed a quasi-experimental design comparing diarrhoea cases before (2010-2013) and after (2014-2017) introduction of the rotavirus vaccine among children under age five years. Data were extracted from District Health Information System version 2 and analysed by using one way analysis of covariance.

Results: Before introduction of the rotavirus vaccine, there were 14 500 diarrhoea cases, which is 1.6% rate of infection. After introduction of the rotavirus vaccine, there were 14 400 diarrhoea cases, which is 1.58% rate of infection. This is supported by the effect size (partial eta^2) of 0.01%, which is very small. The trend of diarrhoea cases after rotavirus vaccine introduction fluctuated with no major decline of diarrhoea cases.

Conclusions: The study concluded that rotavirus vaccine is less effective in preventing diarrhoea diseases among children under age five years in the Kavango regions. Further research is needed to substantiate these findings as other factors can contribute to fluctuation of diarrhoea cases.

Introduction

Rotavirus infection is virtually universal among infants and young children and is the most common contributor to morbidity and mortality in this population worldwide.[1] It is estimated that globally rotavirus infection contributes to 3% of all child deaths under five years. The vast majority of these children live in low-income, developing countries.[1,2] In Namibia, diarrhoea disease is also a major public health concern, in 2017, deaths due to diarrhoea diseases was 0.07 %. Between 2011 and 2017, deaths due to diarrhoea diseases was decreasing on average by 2.92% each year, although before that, it grew from 0.07 % in 2004 to 0.09 % in 2011.[3] Data on diarrhoea diseases directly caused by rotavirus is not yet available[4] In 2006, the World Health Organization (WHO) recommended two different types of rotavirus vaccines in national immunization programmes in North America and Europe after both vaccines had been found to show high efficacy and safety in clinical trials in these regions.[5] By 2009, the same vaccines had been found to be efficacious in Africa and Asia; therefore, WHO expanded its recommendation to include all children worldwide.[6] These two oral attenuated rotavirus vaccines, the pentavalent bovine-human and the monovalent human rotavirus vaccine, are considered by WHO as "very cost effective" interventions for under age five years, particularly in countries with high diarrheal disease burden.[7] However, the full potential impact of rotavirus immunization is yet to be realized, as some countries with large birth cohorts and where disease burden is high, especially in Africa and Asia, have not yet implemented rotavirus vaccines at sufficient scale.[8] Though significant advances have been made, demonstrating the impact of the vaccines in low- and lower-middle income countries, the modest effectiveness of the vaccines in these settings is still a challenge.[9] Vaccine efficacy for the rotavirus vaccine is defined as the percentage reduction of the rate of diarrhea incidence in vaccinated versus unvaccinated groups of children. It is well established that the efficacy of the rotavirus vaccine is not the same across all countries. With high child mortality rates, the vaccine shows much lower efficacy; whereas the rotavirus vaccine reduces the chances of getting diarrhoea by 90% in countries with low child mortality, chances are reduced by only 30% in high mortality countries.[5,8]

The rotavirus vaccine was introduced in Namibia by the Ministry of Health and Social Services (MoHSS) in 2014 as a way of responding to the then escalating number of seasonal diarrheal diseases among children under age five years in the country.[9] Together with the pneumococcal vaccine, the rotavirus vaccine is part of the normal immunization routine package, which is given at ages six weeks and 10 weeks. As stated by WHO, plans for introduction of rotavirus vaccines should consider the epidemiology of the disease by age, the coverage and actual age at vaccination, and an evaluation of the estimated public health impact and potential risks (e.g. intussusception).[10] In addition, cost-effectiveness

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assessment, issues of affordability of the vaccine, financial and operational impact on the immunization delivery system, and careful examination of current immunization practices should be taken into account.[10,11]

A study in Bolivia assessed whether rotavirus vaccine effectiveness varying by age at vaccination during routine use.[11] The study used stratified unconditional logistic regression models and indicated that early administration may improve vaccine effectiveness, hence supporting the current WHO recommendations for the rotavirus vaccine.[12-14] Statistics reveal that diarrhoeal diseases and rotavirus infection are the major cause of death among children under age five years in Namibia.[15] Several studies revealed that immunization helps to reduce diarrhoea-related mortality and morbidity by preventing rotavirus infections or reducing their severity.[9] Namibia introduced monovalent Rotavirus Vaccine (RV_1) in November 2014. As per WHO recommendation, rotavirus vaccines should be included in all national immunization programs and considered a priority in preventing diarrhoea in children, particularly in countries with high Rotavirus Gastroenteritis Associated (RVGE) fatality rates, such as Namibia.[15] However, since introduction of the vaccine in 2014, the number of children who come to public health facilities with diarrhoea related to rotavirus has kept on rising.

This study evaluated the effectiveness of RV_1 in reducing diarrhoea-associated mortality in children under five years in west and east regions of Kavango to determine whether there was a significant decrease in the incidence of diarrheal diseases since the introduction of monovalent rotavirus vaccine. The findings will be used to inform and guide the policy makers in the MOHSS with respect to the continuation, adjustment and expansion of rotavirus vaccine program depending on the current status of rotavirus infection. The results of this study will serve as a baseline data for evaluation of the effectiveness of the rotavirus vaccine in the Kavango region. Meanwhile, the study may serve as a motivating factor for other regions to analyse their data and advise the MoHSS accordingly.

Materials and Methods

Ethical considerations

Permission was sought and granted from the MoHSS (reference number 17/3/3 SNM) and from the respective study site. Furthermore, caregivers of children under five years were not consented as the researcher use patient's information from the District Health information System, version 2 (DHIS 2) database. Researchers ensured that all data from the database remained confidential and secured through the use of password protected files.

Study design and population

A retrospective, quasi experimental design with interrupted time series and pre and post intervention was employed in order to determine effectiveness of rotavirus vaccine after its introduction in 2014 in Namibia. A non-probability sampling method was used, in which all children under age five years who presented with diarrhoea at public health facilities in the Kavango regions between 2010 and 2017 were included in the study. Children were included whether they had received the rotavirus vaccine or not. Thus, all diarrhoea cases were selected as sample size.

Study sites

The east and west regions of Kavango have the highest poverty level in Namibia. More than 50% of the population are classified as poor.[14] A total of 58 public health facilities in the regions use a database known as the District Health information System version 2 (DHIS 2). DHIS 2 is a web-based, public health system database run by the Ministry of Health and Social Services. The following health facilities were included: one intermediate hospital, four district hospitals, seven health centres and 46 health clinics. According to the DHIS 2, in 2017 there was a total of 39 608 children under age five in both regions. Health centres and clinics received stock of rotavirus vaccines from the region medical store, which is located in Rundu, the capital of the east Kavango region. The range of distances from health centres and clinics to Rundu is between 30-50 kilometers. Rundu Intermediate Hospital, which is the only referral hospital that serves both Kavango east and west, receives vaccine stock from the Central Medical Store (CMS), which is located about 716 km away.[6]

Data collection and analysis

Data extracted from the DHIS 2 included: age, location and date of diagnosis. Data collected from DHIS 2 were exported to SPSS, version 24 (IBM Corp., Released 2016, IBM statistics for window, version 24.0, Armonk, New York, United States). The effectiveness of the rotavirus vaccine was determined through the Analysis Of Covariance (ANCOVA) where interrupted time series analysis of diarrhoea cases among children under age five before and after introduction of the rotavirus vaccines were evaluated. The statistical significance cut point was $p<0.05$.

Results

Demographic characteristics patients

The majority of were girls who resided in rural areas (Table 1).

Interrupted time series

In Table 2, p value is 0.06 that is $p >0.05$, this indicates that the intervention of diarrhea by introducing rotavirus vaccine is not statistically significance reduce diarrhoea cases among children under five years, while partial Eta square (η_p^2) indicates that how much the vaccine work in preventing diarrhoea is insignificant.

Before introduction of the vaccine, the number of cases of diarrhoea was highest during the winter season (Figure 1). The numbers remained high until September which seems to be a peak.

After introduction of the vaccine, the number of cases of diarrhoea was also high during the winter season with a similar peak in September (Figure 2). However, the number of cases of diarrhoea fluctuated and there was no decline in diarrhoea cases.

Discussion

The findings of this study showed that the rotavirus vaccine is less effective in preventing diarrhoeal diseases among children under age five years in the east west regions of Kavango. A majority of this population are still unable to access essential health services, such immunization, antenatal care, etc., due to various factors such as poor road infrastructure, high illiteracy rates, and poverty.[16] The findings of the current study indicate that there is not much change in terms of preventing diarrhoea among children under age five years in east and west Kavango. Before introduction of rotavirus vaccine, diarrhoea cases increased during the winter season (May to July) with the highest peak in September. This pattern differed very little after introducing rotavirus vaccine, although there was more fluctuation in the pattern of diarrhoea cases. These findings are similar to studies done in Europe and Africa, show that during winter there is always high peak of diarrhoea cases caused by rotavirus infection [17-20]

However, there have been some improvements in the WHO Expanded Programme of Immunization, where overall immunization coverage in these regions is

almost 83%.[15] Officially in Namibia the use of rotavirus vaccines in public health facilities started in 2014.[8] The finding of the current study is almost the same as the finding of a study conducted in Kenya in 2015, which estimated the efficacy of live oral rotavirus vaccines by duration of follow up, using a meta-regression of randomized controlled trial.[12] By using interrupted time series analysis, the current study's findings show that the patterns of diarrhoea cases are fluctuating up and down despite the use of rotavirus vaccines. This might indicate ineffectiveness of rotavirus vaccine. Although there is no clear explanation why rotavirus vaccine is ineffective in east and west Kavango, it is possible that other factors such as poor sanitation, poor vaccination coverage, beliefs, late vaccination, lack of breast feeding, improper immunization schedule, poor documentation, etc., contribute to it. The Kavango region is known to have very poor sanitation.[17]

The role of these factors in vaccine effectiveness are supported by post vaccine introduction as indicated by several studies conducted in the southern hemisphere countries, particularly in Latin America and the Caribbean islands. The findings of these studies show that the current rotavirus vaccine is effectives in minimizing the risk of hospitalization and mortality provided that there are improvements in sanitation, vaccination coverage and proper breast feeding.[20-24] Therefore, implementation of rotavirus vaccination should include a coordinated plan for the prevention and treatment of diarrhoea in children under age five years along with improvements in personal hygiene and sanitation, as well as access to oral rehydration therapy and other supplementation such as zinc.[18]

Recommendations

Further research is needed that includes additional aspects such as nutritional status, supply chain of rotavirus vaccines, laboratory tests, that might cause the rotavirus vaccine to be ineffective. The Namibia MOHSS is urged to conduct a study or survey to find out the exact cause of higher

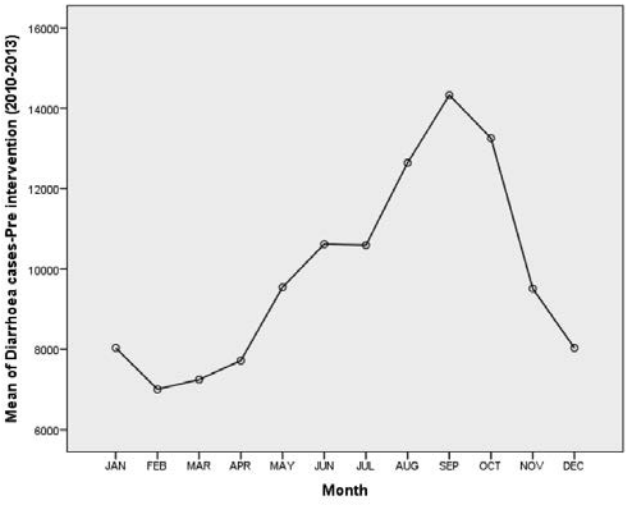

Figure 1. Number of diarrhoea cases during winter season (May – July) before introduction of rotavirus vaccine in Namibia, 2010-2013.

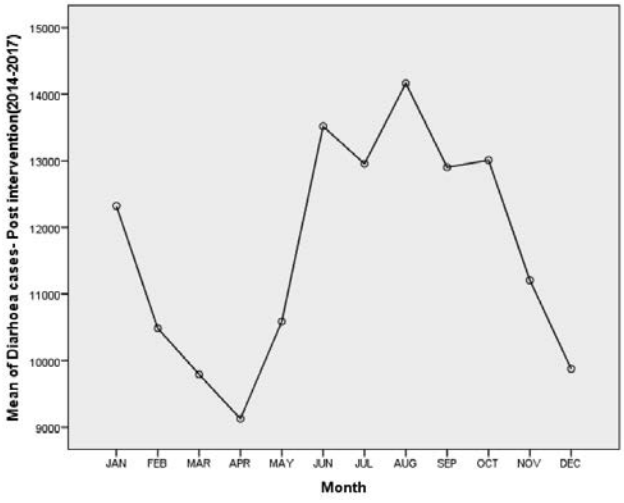

Figure 2. Number of diarrhoea cases during winter season (May – July) after introduction of rotavirus vaccine in Namibia, 2014-2017.

Table 1. Demographic information of children under age five years in Kavango regions before and after introduction of rotavirus vaccines, Namibia, 2010-2017.

		Before intervention (2010-2013)	After intervention (2014-2017)	Total
Sex	Female	63,182	75,572	138,754
	Male	55,358	64,372	119,730
Residence	Urban	52,158	65,774	117,932
	Rural	66,382	74,170	140,552

Table 2. Effectiveness of rotavirus vaccine after inception, Namibia, 2010-2017 (tests of between-subjects effects).

Source	Type III sum of squares	df	Mean square	P-value	Partial Eta squared (η_p^2)
Corrected Model	31021700.25	11	2820154.57	0.06	1.000
Intercept	26467370.65	1	26467370.66	0.02	1.000
Pre intervention 2010-2013	0.00	1	1410077.29	<0.001	1000
Month	11985042.11	10	1198504.21	0.04	1.000
Total	1663118601.00	12			
Corrected Total	31021700.25	11			

Dependent variable: Post intervention (2014-2017). a. R Squared = 1.000 (Adjusted R Squared = .) b. Computed using alpha = 0.05.

number of diarrhoea cases in east and west Kavango and explore strategies to minimize the number of diarrhoea cases during winter seasons. The MOHSS should consider taking specimens from diarrhoea cases to detect rotavirus.

Limitations

This study has several weaknesses that should be kept in mind when considering the results. First, this study did not conduct a specific laboratory investigation to confirm that all cases of diarrhoeal infection reported were caused by rotavirus. Such laboratory investigations are not done routinely in this setting due to scarcity of resources; rather, diarrhoea cases are largely assumed to be caused by rotavirus. Second, the study was not able to investigate the rotavirus vaccine supply chain due to lack of funding. Supply chain issues can contribute to the effectiveness of vaccines. Finally, the study could not asses the nutritional status of the households in the region due to limited funding. Food security is a key in strengthening immunity.

Conclusions

The rotavirus vaccine is less effective in preventing diarrhoea in children under age five years in the east and west regions of Kavango, Namibia.

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