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Proportion of Rota Virus Infection in Vaccinated vs Unvaccinated Children at KIMS Hospital

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Abstract

Introduction: Rotavirus is a major cause of severe diarrhea in young children, posing significant health risks, particularly in low-resource settings. Vaccines like Rotarix and RotaTeq have greatly reduced rotavirus-related hospitalizations and mortality worldwide. However, vaccine effectiveness varies by region, emphasizing disparities in health outcomes between vaccinated and unvaccinated children and the need for targeted approaches to optimize vaccine impact.

Objective: This study aims to assess rotavirus infection rates, severity of dehydration, and clinical outcomes in vaccinated versus unvaccinated children, examining demographic, socioeconomic, and nutritional factors associated with infection.

Methods: A prospective study was conducted over 18 months at Kempegowda Institute of Medical Sciences, Bangalore. Children aged 6 months to 5 years presenting with diarrhea were included, excluding cases of dysentery and lactose intolerance. Cases were detected by ELISA method .Data on vaccination status, nutritional grade, socioeconomic class, and clinical symptoms were collected.

Results: Among 100 cases, 21 cases (21%) were rotavirus-positive, predominantly affecting females (61.9%) as compared to males (38.1%)and children aged 1–2 years (52.3%). Lower socioeconomic groups exhibited higher rotavirus rates (85.71%) compared to middle socioeconomic children (14.29%) and 28.57% in those with Grade 1 undernutrition. Out of 21(21%) rota positive cases, 9 children (42.8%) had taken all 3 doses of vaccine,9 children (42.8%) were incompletely vaccinated and 3(14.2%) children were unvaccinated. In rota positive cases, 18 (85.7%) had some dehydration, and 4(19%) had severe dehydration. All children who were completely vaccinated that is 9 cases (42.8%) all had some dehydration (42.8%) with no case of severe dehydration. Out of 9 (42.8%)incompletely vaccinated rota positive cases, 7(33,3%) had some dehydration, 2 cases (9.5%) had severe dehydration. Out of 3

unvaccinated children, 1 (4%) case had some dehydration, 2 (9%) cases had severe dehydration.

Conclusion: Rotavirus vaccination reduces infection severity but does not prevent rota virus diarrhea. Higher proportion is seen in children who are undernourished and belonging to low socio economic status. By creating awareness about rota virus infection and importance of complete vaccination with better hygiene and nutrition rota virus assosciated diarrhea morbidity and mortality can be reduced. Undernourished and low socioeconomic status children were more in rota virus diarrheal cases hence along with vaccination, hygiene like hand wash and awareness about vaccination can decrease the burden, morbidity and mortality of diarrheal death in society.

Keywords: Rotavirus, Vaccination, Diarrhea, Socioeconomic Factors, Nutrition, Pediatric Gastroenteritis.

Introduction

Rotavirus is a significant cause of severe diarrhea, especially among young children, and poses a major health risk worldwide, particularly in regions with limited healthcare resources. Before the introduction of vaccines, nearly all children under five would contract rotavirus, often resulting in severe dehydration, hospitalization, and even death. The virus, which spreads primarily through the fecal-oral route, can cause intense gastroenteritis, leading to dehydration and other complications [1]. However, since the introduction of rotavirus vaccines, there has been a significant reduction in rotavirus cases, changing the infection landscape in both vaccinated and unvaccinated populations globally. Despite this progress, there remain questions about how the vaccine's protective effects vary in different settings and among vaccinated and unvaccinated children [2].

The introduction of rotavirus vaccines has proven to be a highly effective measure for preventing severe cases of the disease. Since 2006, two widely used vaccines, Rotarix and RotaTeq, have been included in national immunization programs across many countries. Research shows that these vaccines effectively prevent severe rotavirus infections, particularly in high-income countries where efficacy rates reach 85-98% [3]. Organizations such as the World Health Organization (WHO) recommend including the rotavirus vaccine in national immunization schedules, especially in regions with high rotavirus-related illness and death rates. The vaccines work by generating immunity that reduces both the viral load and severity of symptoms, which also helps limit the spread of the virus in communities through herd immunity. This has led to reduced hospitalizations and lower mortality rates in many countries, even benefiting older children and adults indirectly by decreasing virus transmission within communities [4].

Although rotavirus vaccines are highly effective, their performance varies based on geographic and socioeconomic factors. In general, vaccine efficacy is higher in high-income countries than in low- and middle-income ones. For instance, while efficacy rates are near 90% in Europe and North America, studies in African and South Asian populations have shown efficacy between 50% and 70% [5]. Contributing factors to this discrepancy include differences in nutrition, the presence of other pathogens, maternal antibodies, and variations in gut microbiota. These differences underscore the challenges in implementing vaccines worldwide and highlight the need for targeted approaches to improve vaccine performance across diverse populations. In some settings, where vaccine

efficacy is lower, vaccinated children may still contract rotavirus, though cases tend to be less severe than in unvaccinated children [6].

Examining rotavirus infections among vaccinated versus unvaccinated children provides valuable insights into the vaccine's effectiveness and areas for improvement. In vaccinated children, rotavirus infections, when they occur, tend to be much less severe, with lower rates of hospitalization and complications like dehydration. Vaccinated children typically experience shorter and milder symptoms, which reduces the strain on healthcare facilities—a particularly important factor in areas with limited resources [7]. On the other hand, unvaccinated children are more prone to severe illness, frequently requiring hospitalization and facing higher risks of complications. This contrast between vaccinated and unvaccinated cases highlights the vaccine's role in reducing the clinical and economic impacts associated with rotavirus infection [8].

Another major benefit of rotavirus vaccination is the indirect protection it provides, often called herd immunity. When a significant portion of a population is vaccinated, the overall transmission rate of rotavirus drops, which also reduces the risk of exposure for unvaccinated individuals. This phenomenon has been observed in numerous settings, including the United States, Australia, and various European countries, where a decrease in rotavirus cases among unvaccinated children was noted after vaccine introduction [9]. This decline is attributed to reduced viral circulation in communities, which limits infection opportunities for susceptible individuals, including those who may not be vaccinated for medical or personal reasons. Consequently, widespread vaccination offers broad societal benefits, extending protection to both vaccinated and unvaccinated individuals and supporting broader disease control [10]. However, challenges remain in achieving optimal vaccine coverage and addressing disparities in vaccine response. In some regions, logistical issues like maintaining the cold chain, vaccine supply shortages, and barriers to healthcare access prevent vaccines from reaching all children. Additionally, vaccine hesitancy—stemming from misinformation, concerns over vaccine safety, or cultural beliefs—presents a barrier in certain communities [11]. To overcome these issues, public health efforts must include awareness campaigns, community outreach, and infrastructure improvements. Ongoing research is also exploring ways to enhance vaccine performance, particularly in settings where efficacy is lower. Potential strategies include modified vaccine formulations, booster doses, and approaches that focus on gut microbiome health to improve immune response to the vaccine [12].

The differing outcomes in rotavirus infection between vaccinated and unvaccinated populations underscore the importance of vaccination as a preventive measure and the complexities involved in providing universal protection. Among vaccinated children, the reduced severity and incidence of rotavirus infections represent substantial progress, lowering mortality rates and enhancing children's quality of life [13]. Nevertheless, the variability in vaccine effectiveness across different populations points to the need for continued research and improvements in vaccine design and delivery. Addressing logistical challenges and encouraging community acceptance of vaccination are essential steps toward maximizing the benefits of rotavirus vaccines [14]. Rotavirus vaccination is a critical intervention that has significantly reduced severe gastroenteritis cases

among children worldwide. The benefits of vaccination are evident in both direct protection against severe illness and the wider community protection through reduced viral transmission. By improving accessibility, addressing efficacy disparities, and fostering public trust in vaccines, healthcare providers and public health authorities can further lessen the global impact of rotavirus [15]. This study aims to compare the incidence, severity, and outcomes of rotavirus infections in vaccinated versus unvaccinated groups, focusing on disease presentation, hospitalization rates, and mortality to evaluate vaccine efficacy. It also explores indirect benefits like herd immunity and identifies barriers to optimal vaccine coverage, especially in low-resource areas. Findings will inform policy recommendations to improve vaccination uptake, accessibility, and effectiveness, ultimately supporting strategies to reduce the global impact of rotavirus infections.

Materials and Methods

This prospective study was conducted over 18 months, from November 2022 to June 2024, in the In-patient Department (IPD) of Kempegowda Institute of Medical Sciences, Bangalore. The study population included children aged 3 months to 5 years admitted with diarrhea, as reported by their parents or caretakers. Inclusion criteria required participants to be within the specified age range, have diarrhea symptoms, and have parents or caretakers able to provide informed consent. Exclusion criteria included children with dysentery or lactose intolerance to ensure a focused study on general cases of paediatric diarrhoea.

Results

Table 1: Distribution of rota virus according to age

Age (Years)	Rota virus Positive		Rota virus Negative	
	No of cases	%	No of cases	%
<1 years	3	14.20%	13	16.40%
1 - 2	11	52.30%	22	27.80%
2 - 3	4	19.00%	17	21.50%
3 - 4	3	14.20%	15	18.90%
4 - 5	0	0.00%	12	15.10%
TTOTAL	21	100%	79	100%

The study found that 21% of cases tested positive for rotavirus, with positivity highest in the 1–2-year age group, while no positive cases were observed in the 4–5-year group. Rotavirus prevalence decreased with age, showing higher rates in younger children. Among the positive cases, 61.90% were female (13 cases) and 38.10% were male (8 cases), indicating a higher rate of rotavirus positivity in females

Figure 1: Age distribution of rota virus and non rota virus cases

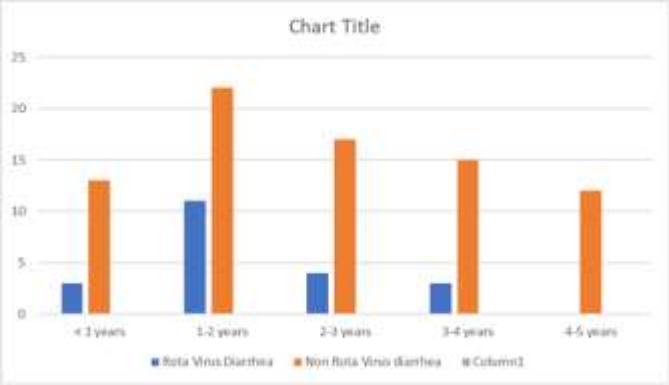
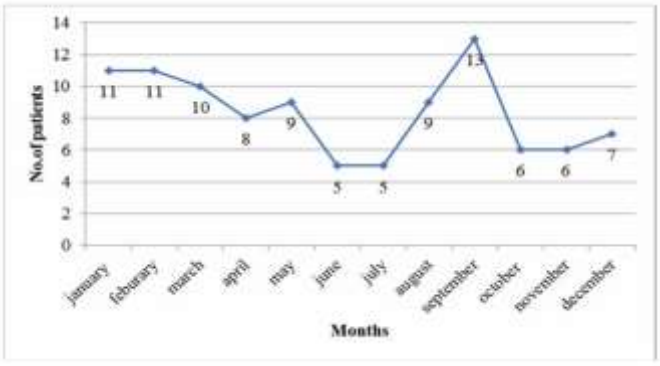


Table 2: Relation of rota virus according to Socio Economic class

Socio Economic class	No. of cases of Acute gastroenteritis	Rota virus positive	Rota virus negative
lower class	90	18(85.71%)	72(91.14%)
middle class	10	3(14.29%)	7(8.86%)
Total	100	21(100.00%)	79(100.00%)

Among the cases, 90 were from the lower socioeconomic class, where 18 (85.71%) tested positive and 72 (91.14%) tested negative for rotavirus. The remaining 10 cases, from the middle class, had 3 (14.29%) positive and 7 (8.86%) negative results.

Figure 2: Seasonal variation of rota virus



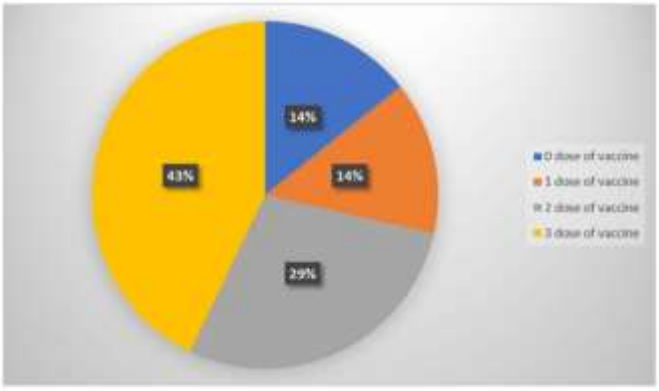
Analyzing the distribution of rotavirus cases, September had the highest number of positive cases at 14.29%, while June reported none. Out of a total of 100 cases, 21 tested positive and 79 tested negative for rotavirus. This indicates a seasonal variation, with increased positivity in certain months and a complete absence in others.

Table 3: Relation of rota virus with nutrition

Inference (under nutrition -IAP)	No. of cases	Rota positve
Grade 1	34	6(28.57%)
Grade 2	6	0(0.00%)
Normal	60	15(71.43%)
Total	100	21(100.00%)

Among the cases, 6 out of 34 children (28.57%) with Grade 1 undernutrition tested positive for rotavirus, while none of the 6 children with Grade 2 undernutrition were positive. In contrast, 15 out of 60 children (71.43%) with normal nutritional status tested positive, highlighting a higher rotavirus positivity rate among those with normal nutrition compared to undernourished groups.

Figure 3: Vaccine dose given in rota positive cases



Among the children, 3 had received no dose of the vaccine, 3 had received one dose (14.29%), 6 had received two doses (28.57%), and 9 had received three doses (42.86%). This distribution shows a varied level of vaccination coverage, with the highest proportion of children having completed the three-dose schedule.

Table 4: Number of vaccine doses taken in cases of diarrhea

Number of vaccine doses	No. of cases	%
0	10	10.00%
1	13	13.00%
2	32	32.00%
3	45	45.00%
Total	100	100%

The above table showed that, 45 children had received 3 vaccine doses, representing 45% of the total cases. Children are less frequent among those with 2 doses (32%), 1 dose (13%), and no doses (10%)

Table 5: Rota virus positivity and number of vaccine dose taken

Rota virus positive cases(21)	0 dose of vaccine taken	1 dose of vaccine taken	2 dose of vaccine taken	3 dose of vaccination taken
No of cases	3	3	6	9
Percentage	14.29%	14.29%	28.57%	42.86%

The above table showed that 3 children received 0 dose of the vaccine, 3 had received 1 dose of the vaccine (14.29%), 6 had received 2 doses (28.57%), and 9 had received 3 doses (42.86%).

Figure 4: Vaccine dose given in rota positive cases

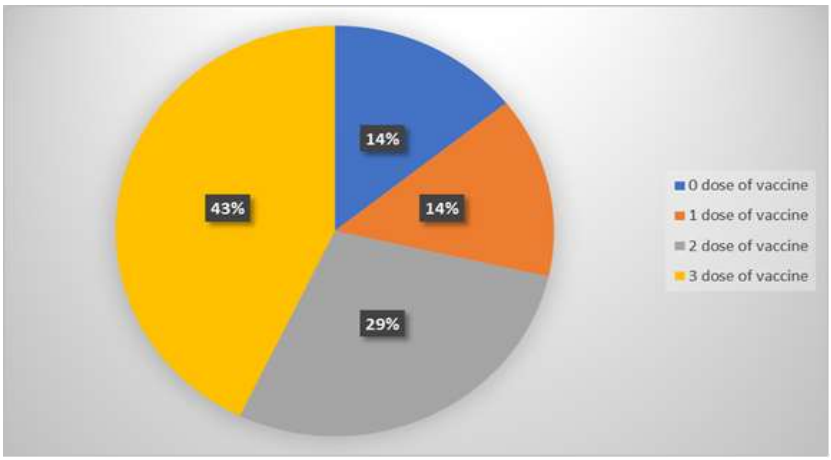


Table 6: Distribution of severity of dehydration according to Rota virus (ELISA)

No of doses of vaccine taken in rota diarrhea cases	Some dehydration(18 cases)	%	Severe dehydration(4 cases)	%
0 dose taken	1	5.5	2	50
1 dose taken	2	11.1	1	25
2 doses taken	5	27.7	1	25
3 doses taken	9	50	0	0

In the rotavirus ELISA testing, having severe dehydration 50% of cases had taken 0 dose of vaccine, 25% cases had taken at least 1 dose or 2 doses each, while 0% cases were there with severe dehydration who had taken all 3 doses. This gives the importance of complete vaccination in reducing the severity of cases

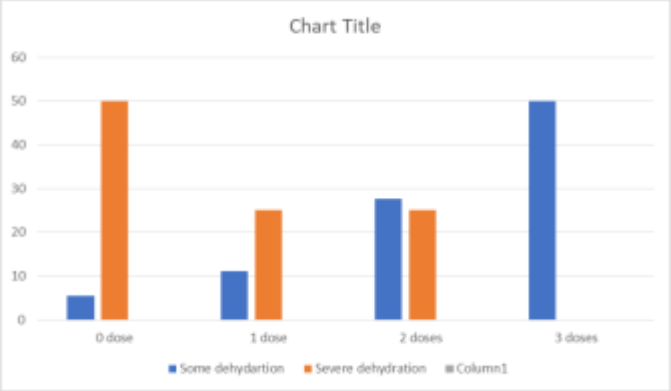


Figure 5: Percentage of cases having some and severe dehydration based on no of doses of vaccine given

Discussion

Rotavirus, a leading cause of severe diarrhea in young children, has seen reduced cases globally since the introduction of vaccines like Rotarix and RotaTeq, which significantly lower hospitalization and mortality rates. Although vaccine efficacy is high in wealthier regions, it varies in low-income countries due to factors like nutrition and gut microbiota. Vaccination provides both direct and indirect protection through herd immunity, but barriers like logistical challenges and vaccine hesitancy persist, highlighting the need for targeted outreach and improved accessibility [16].

In this study of 100 children with diarrhea, 57% were female and 43% male. Of these, 21 children tested positive for rotavirus antigen, including 13 females (61.9%) and 8 males (38.1%). John et al. (2014) reported a higher rotavirus incidence in boys (55-60%), attributed to the higher likelihood of boys being taken to hospitals. Most positive cases in our study were in the 1–2 years age group (52.3%), with none in the 4–5 years group, indicating vulnerability in younger children. Shrestha et al. reported a mean age of 13.6 months for rotavirus cases, with 45% under 12 months and 50% in the 13–24 months range. Kang et al. (2012) found a 39% incidence in a hospital-based surveillance of Indian children [17, 18, 19].

The study found that rotavirus diarrhea was more prevalent among children from lower socioeconomic backgrounds, with 18 out of 90 (85.71%) testing positive, compared to 3 out of 10 (14.29%) from middle socioeconomic backgrounds. Seasonal peaks were noted in February, August, and September (14.29% each), while June had no cases. This aligns with Troeger et al. (2018), who observed higher rotavirus incidence during cooler months and a minor peak in the rainy season in India. While 71.43% of cases were in well-nourished children, Bhandari et al. (2014) noted that undernourished children face higher infection rates and severe complications [20, 21].

The study identified a higher prevalence of rotavirus diarrhea among children from lower socioeconomic backgrounds, with 85.71% testing positive, compared to 14.29% from middle backgrounds. Seasonal peaks occurred in February, August, and September, aligning with Troeger et al. (2018), who found increased cases in cooler months and minor peaks during rainy seasons in India. Although 71.43% of cases involved well-nourished children, Bhandari et al. (2014) reported that undernourished children have a higher infection rate and face severe complications. Furthermore, non-exclusively breastfed children showed a high prevalence (83.87%), with rotavirus being more fatal in low-income than high-income countries [20, 21].

The present study found that among rotavirus-positive cases, 3 children (14.29%) had received only one vaccine dose, 6 (28.57%) had two doses, 9 (42.86%) completed all three doses, and 3 were unvaccinated. In the rotavirus ELISA testing, having severe dehydration 50% of cases had taken 0 dose of vaccine, 25% cases

had taken at least 1 dose or 2 doses each, while 0% cases were there with severe dehydration who had taken all 3 doses. This gives the importance of complete vaccination in reducing the severity of cases

This suggests that, although vaccination reduces severity and incidence, it doesn't entirely prevent infection, likely due to factors such as waning immunity or strain variations. Middleton B.F. et al. found that rotavirus vaccination reduced all-cause diarrheal incidence by 41% and rotavirus-specific cases by 52% in Indian children under five. Vomiting was observed in 67.90% of rotavirus-positive cases in this study, supporting findings by Muendo C. et al. and Goel et al, who noted higher vomiting and fever rates in rotavirus infections. Giri et al. reported that rotavirus gastroenteritis is more severe and frequent in children under two years, with common symptoms including fever, vomiting, frequent diarrhea, and dehydration [22,23,24,25].

Conclusion

This study highlights that rotavirus remains a leading cause of acute diarrhea in children under five, often resulting in prolonged illness. Children with rotavirus were more likely to have symptoms like vomiting, fever, and greenish-yellow stools. Higher infection rates were observed among females, younger children with anemia, and those from lower socioeconomic backgrounds. The post-COVID era saw reduced cases, likely due to improved hygiene practices. Despite vaccination, rotavirus diarrhea persists, but the severity reduces drastically with complete immunisation. This asertain need for ongoing prevention efforts through good personal hygiene, balanced nutrition, and environmental cleanliness to further reduce its burden in vulnerable populations.

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