Barriers and Strategies for Rotavirus and Cholera Vaccine Uptake: A Systematic Review of Community-Based Interventions in Bangladesh, India, and Pakistan"

ABSTRACT

Background: Diarrhea is the second leading cause of death in children and poses a major threat to public health. It is mainly caused by pathogenic organisms of viral, bacterial, or fungal origin, two of which has been preventable via vaccination and has been identified as rotavirus and cholera. In 2020, India, Pakistan, and Bangladesh were among the top 10 South Asian countries with the highest mortality rates from childhood diarrhea. India and Pakistan are further listed by the WHO among the top five countries with the highest recorded mortality among children under five years old. Bangladesh has experienced the highest number of cholera epidemics. Vaccination is recommended as a potent preventive approach against rotavirus and cholera induced diarrhea and is considered the most cost-effective prevention method. However, despite their proven effectiveness, other factors appear to affect the impact of vaccination strategies in these countries. Therefore, this study aimed to explore these nonclinical factors.

Method - This study was conducted as a systematic review which involved the systematic search and selection of qualitative data from primary studies concerning the research topic which was developed using the SPIDER framework. The PRISMA tool was used to carry out this process, and the CASP was used to evaluate the methodological quality of each study. The combined data were then harmonized using meta-synthesis and analyzed thematically.

Findings: Four themes emerged from the analysis of the study data: pre-vaccination strategy experience, post-vaccination strategy impact, opportunities for vaccination strategies, and threats to successful implementation of vaccination strategies. This formed the basis of the study discussion and expounded on the impact of vaccine strategies in the selected countries.

Conclusion: The results of this study showed that providing the participants with correct information, vaccine education, willingness to learn despite poor knowledge, and access to vaccination are important solutions to the factors that surround the uptake and coverage of cholera and rotavirus vaccines in Bangladesh, India, and Pakistan as critical influencers of the prevalence of childhood diarrhea induced by rotavirus and cholera pathogens, respectively.

Keywords: Bangladesh, Cholera, India, Pakistan, Rotavirus, vaccination

INTRODUCTION

Diarrhea is considered a sign/symptom of an intestinal infection caused by an invasion of the intestinal tract, which could be a viral, parasitic, or bacterial organism [World Health Organization (WHO), 2024]. According to WHO (2017), diarrhea is a major indicator of health inequality and inequity, as this global public health burden is both preventable and treatable if appropriate measures are instituted and maintained. Rotavirus and cholera are highlighted as the leading causes of diarrhea especially in children, accounting for most of the hospital admissions due to diarrhoea in Asia and Africa.

While diarrhea is the second global cause of death in children under five, it is the leading cause in South Asia (Murugesan et al., 2022). In 2020, India, Pakistan, and Bangladesh were the South Asian countries listed in the top 10 countries with the highest mortality rates in the

aforementioned population (WHO, 2020). India and Pakistan are further listed by the WHO among the top five countries with the highest recorded mortality of children under five years old (WHO, 2022). While Manetu et al. (2021) recorded these three countries among the top 10 regions of the world with the highest number of under-5 deaths due to diarrhea, with India topping the list, Ghosh et al. (2021) further listed India and Pakistan among the five countries bearing half of the burden of fatal childhood diarrhea. The study by Das et al. (2023) documented that Bangladesh is the world's cholera hotspot zone as it harbors the Ganges delta from which cholera is thought to have originated; hence, the endemicity of cholera in Bangladesh, where most of the seven recorded cholera pandemics originated. The high number of deaths caused by cholera-induced diarrhea underscores the importance of promptly tackling this public health burden. Although various interventions have been put in place to mitigate the vast inter-regional/intra-regional health inequalities, which predispose different populations to the risk factors associated with contracting and spreading cholera, such as access to clean and safe water, proper sewage management, sanitation, and cholera vaccine coverage, over four million cases of cholera are still recorded annually, with over 100,000 deaths in Bangladesh (Das et al., 2023).

Therefore, this study explored the impact of vaccination strategies on reducing the prevalence of cholera-induced diarrhea in Bangladesh, India, and Pakistan, to identify the strategies currently in use, the extent of vaccine coverage, equitable distribution of vaccines, and factors limiting vaccine uptake, and to highlight the relationship between cholera vaccination and other prevalent risk factors for cholera-induced diarrhea in these countries. This review provides a comprehensive understanding of the impact of vaccination strategies vis-à-vis other population demographics and social determinants of health in Bangladesh, India, and Pakistan with respect to cholera-induced diarrhea. In addition to sanitary means of preventing cholera, vaccination has proven to be a potent way to prevent the transmission of pertinent pathogens (WHO, 2017; Zeng et al., 2021). Despite being the most common bacteria causing diarrhea in children, there is no effective vaccine against E. coli infection (WHO, 2017). Hence, this study focused on the most common virus and second most common bacteria causing diarrhea in children, identified as rotavirus and cholera, respectively, as they have been confirmed to have highly potent vaccines. A range of vaccination strategies have been proposed and implemented with varying levels of impact on the target population and related challenges (GailanQasem et al., 2022; Khan et al., 2019). These strategies are mostly reported in isolation, and systematic reviews that exist on the subject have a wider scope of including many types of vaccines or are focused on global vaccination. However, this study focused on the impact of rotavirus and cholera vaccine programs on the uptake of vaccines using endemic regions in South Asia (Bangladesh, India, and Pakistan) as case studies. Therefore, this study aimed to integrate evidence from primary studies on vaccination strategies for rotavirus and cholera in Bangladesh, India, and Pakistan as a preventive method against diarrhea in children and to discuss its impact on the target population.

METHODOLOGY

The method chosen for this study was systematic qualitative review. Conducting such a study requires adherence to a guide to ascertain its quality, thereby requiring selection of a suitable reference for the process (Gentles et al., 2016). Since the introduction of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), it has been useful in studies such as this. As an updated version, the PRISMA guide is more detailed and ensures coherence than the QUORUM (Quality of Reporting of Meta-analyses) statement, further confirming its appropriateness among other options (Sohrabi et al., 2021). It covers all aspects of the study from the formation of the research question to the conduction of the study and reporting (Sohrabi et al., 2021). The keywords for this search were obtained from the SPIDER framework to derive secondary qualitative study questions (Tawfik et al., 2019).

S - Children in Bangladesh, India, and Pakistan
Pi - Cholera and rotavirus vaccination
D - Qualitative E - Vaccination strategy impact
R - Qualitative

Inclusion criteria

Studies were included in the review if they were as follows:

- Conducted in Bangladesh, India, and Pakistan
- Addressing cholera and rotavirus vaccination
- Published in peer-reviewed journals, and more specifically, in the desired databases
- Reported in English
- Primary literature
- Published no later than 2013

Exclusion criteria

- quantitative studies
- clinical trials
- low quality studies

Literature selection

The search for relevant literature was performed using the corresponding search strings on Google Scholar, ScienceDirect, Scopus, and PubMed, producing initial search results of 699, 4337, 5, and 103 articles, respectively. A date filter was applied to include articles published no later than 2013. This led to the elimination of 994 studies from all databases. Another filter was applied to include only primary research, further eliminating 3,129 studies combined. A final filter was applied to include only articles written in English, leading to the elimination of 18 studies. This process led to the remainder of 1003 studies to be passed through title screening. All clinical trials and reviews were eliminated from the study titles, leading to the deduction of 158 and 281 study results, respectively. Letters, unrelated titles, and studies without substantial relevance were eliminated, leading to the combined removal of 513 results. The abstract and rapid full-text review were then conducted for 61 studies, of which 11 duplicate records, 13 studies with inadequate relevant information, and 24 studies with inappropriate methodological designs were removed. From this, 13 research articles remained for quality assessment, a process that resulted in the final selection of 10 articles. Analysis of Data Owing to technological advancements, the thematic analysis process was automated using NVivo software. However, one of the drawbacks of its use is the tendency to

read data out of context and fail to identify expressions that mean the same but are written differently, thereby increasing the probability of inadequate extraction of representing themes (Lunny et al., 2017). Thus, this study employed the manual thematic analysis outlined by Lachal et al. (2017) to obtain familiarity with the data through an in-depth study of each, extracting codes identified as keywords used in the study results, identifying the frequency of code occurrences, and merging them to produce themes and subthemes. The themes that arose were individually discussed by employing all the corresponding data from each included study.

Ethical considerations

In the current study, this test was conducted by assessing the methods to ensure the quality of the literature, synthesis, and analysis processes to ensure transparency (Chin et al., 2022). Types of bias include subjectivity on the part of the researcher during analysis, publication bias, and other types encountered during selection (Page et al., 2021). Objectivity was observed during the data analysis and interpretation. This study employed only one researcher but used eligibility criteria and the use of relevant guidelines to show transparency. Chin et al. (2022) assessed systematic reviews that complied with the PRISMA checklist vis-a-vis those that did not and highlighted the latter as having a higher risk of bias than the former. This study, however, gathered only peer-reviewed articles as the quality of their methods could be assessed.

RESULT

Theme 1- Pre-vaccination strategy hindered by misinformation and myths.

The interviews conducted with most community dwellers in the studies showed high levels of misinformation among the participants. Some of these people obtain their information from informal and other unreliable sources that could largely prevent proper education on rotavirus and cholera vaccination. Some of these sources include intuition stemming from personal beliefs or external sources, such as religion. “They said, if you follow naturopathy, you don’t require any vaccination at all” (Erchick et al., 2022). “As Allah is the best protector; he has given us children then he will protect them too. We don’t believe anyone other than Allah, these vaccinations are not bigger than Him” (Tabassum et al., 2022). “I see that the section of Christian population that is in the coastal population, they don’t believe in vaccination, they don’t believe in medicines also” (Erchick et al., 2022). “They deny that this is due to the viruses or bacteria, and there is no need for any vaccination or preventive strategy” (Erchick et al., 2022). According to another report, the level of education may not affect this personal intuition, and due reference was made to the lower acceptance of vaccination recorded in the urban regions of India when compared with the rural regions. “In our urban areas, the hesitancy is more among educated people” (Erchick et al., 2022). In addition, these information sources could be from unproven tales and circulating myths of unverified origin, instilling fear into the individuals and leading to their hesitancy to vaccinate their children. “We want to vaccinate our kids, but we fear as some people said that it has risk and may cause disability” (Singh et al., 2019). Other sources are informal and less reliable, such as websites, blogs, and social media. “People are now receptive to natural

medicines. It's increasing due to social media or misinformation or disinformation" (Erchick et al., 2022). "I check up online about vaccines and see what is said there" (George et al., 2016).Furthermore, people do not follow true messages, they tend to follow only messages which have some attraction. So, all these negative messages get full support, and they are getting forwarded repeatedly(Erchick et al., 2022). Also, whenever they say the vaccine contains something, which we should not have taken so it is against our religion, people tend to follow that message" (Erchick et al., 2022). Finally, misinformation can originate from people perceived to be medical professionals or practitioners who are inadequately trained in vaccines, further posing a threat to the encouragement of vaccination. A participant said "…well I see if the site is run by a doctor or by some good agency…then I feel it would be correct…don't you think so?" (George et al., 2016).Another person interviewed said "My doctor only told me not to give, he said that there was no use in giving this vaccine, and he had not given it to his own daughter. When my doctor says that, then why will I give it to my child? Whatever he told us to do we have done that." (George et al., 2016).According to Erchick et al. (2022), until quite recently, even professionals in the health sector, were not aware that diarrhea can be prevented by vaccines.

Theme 2 - Post-vaccination strategy improved knowledge gain.

The approach of providing vaccine education to the populations of interest as a strategy to improve uptake and reduce the prevalence of childhood diarrhoea was met with deep appreciation, and there was an evident change in perception. "The nurse sometimes seats with a few of us parents and explains why the vaccine is being given and when the next vaccine is due. They also tell us the site of administration of the vaccine" (Francis et al., 2021). "I am very much satisfied to have the cholera vaccine. My daughter-in-law delivered a child 10 days before the campaign, she was reluctant to come here, but I insisted on her and she had received the vaccine. I felt that she would be benefited by having the vaccine" (Uddin et al., 2014). In addition, some studies have tested post-education knowledge and reported sound reasoning regarding the importance of vaccination in participants. Wahed et al. (2013) argued that if any member of a household is affected by cholera, other members of the household have a higher risk of getting infected as well. Thus, members of each household must be careful and trust the vaccination process as an effective way of preventing cholera spread (Wahed et al., 2013). Regardless of the implemented strategies, Uddin et al. (2014) identified 'trust' as being critical in the success of the vaccination campaign, as it was fundamental for vaccine acceptance. For some people, there is a significant trust in the government and an automatic acceptance of the vaccines as one person said, "It is safe, since the Government implemented the vaccination programme" (Uddin et al., 2014).Nonetheless, some people had their reservations towards the vaccination scheme due to mistrust. Some studies highlighted the resentment expressed by some people as they perceived that if these vaccines are delivered to each household free of cost, there may be some underlying agenda (Erchick et al., 2022; Uddin et al., 2014).A participant was noted to say, "It's just not vaccination" (Erchick et al., 2022). Another participant opined thatthe project is using the people of Bangladesh as guinea pigs to test the cholera vaccine (Uddin et al., 2014). Consequently, if government is not providing proper services and amenities to particular villages, people in those areas will start avoiding the government programs, as they don't

understand that this vaccination campaign is not associated with government's campaign promise and is important for them (Erchick et al., 2022). On the other hand, trust in healthcare professionals also varies. Some participants had no opposition to the professional recommendations by healthcare practitioners. "We are satisfied with whatever he says so there is nothing like asking questions and all. Whatever he says you have to give this vaccine, you have to give that." (George et al., 2016). Some participants said, "Whenever they come for vaccination, we ask Sapna [Anganwadi worker] about it. We only go for it after asking her." (Das et al., 2023). Contrastingly, other people had reasons to doubt the procedure based on previous encounters or a show of lack of expertise, as some were noted to say, "I don't trust health care providers as their practice is unethical and immoral, I have witnessed a case where the doctor implanted birth control pill without taking consent after delivery, which had made me doubtful" (Tabassum et al., 2022).Erchick et al. (2022) argued that health workers, especially at the grass root level, are not able to answer the questions asked by the parents or the public because they are not properly trained. Thus, if a person asked that question "How does this vaccine prevent a disease?" or "What are the side effects of this vaccine?" some of the workers are not able to give an answer in a convincing manner (Erchick et al., 2022). A participant also opined thatsince year 2000, there has been a lot of changes in the vaccination schedule, and this has encouraged misbelief and mistrust among people (Erchick et al., 2022). Despite the gain in knowledge and the established trust influenced by the post-vaccination strategies, vaccine uptake could still be poor due to the low socio-economic status of most of the population (Francis et al., 2021).A participant said, "The government is giving vaccination free, if we had to get those vaccines in private clinics it would cost us 1000 or 2000 INR [15 – 30 USD], we cannot afford that, so we take the vaccines given by the government" (Francis et al., 2021). Another said, "…majority of the people are daily wagers, labourers in fields, brick furnaces, or sugar mills. Their income does not even cover their expenses, so when they are faced with disease, they come to government hospitals. Here treatment and medicines are free, and there are no doctors' fees" (Das et al., 2023). In cases where vaccines are given free of charge, logistics issues may also be a barrier to uptake, thus hindering a wide coverage. One of the healthcare personnels interviewed said, "Oh, we face a lot of difficulties in reaching health facilities in the suburbs and in emergency situations we hardly get a vehicle, sometimes we are out of money" (Das et al., 2023).Another participant said, "Lack of transport is a major issue for us…" (Das et al., 2023). However, Erchick et al. (2022) highlighted a participant who said, "Accessibility is not much a problem in the state of Kerala because we are a small state with high population and all of these decentralised facilities, infrastructure is very good." According to Francis et al. (2021),neglect can also be responsible for low coverage, as some reports showed that parents treated the exercise with less priority, thereby reducing accine uptake. There are parents who delay vaccines by a month or two, probably due to the distance they will travel to get the vaccines" (Francis et al., 2021). Some participants said, "My child has missed vaccines as we had been out of town for a long time while she was younger. As far as I know, she only received two vaccines" (Francis et al., 2021); "After new year we go out to attend Pongal and we stay out for 20 to 25 days" (Francis et al., 2021). A change in the environment could also affect adherence to the vaccination schedule, as one participant reported a lack of proper navigation around an unfamiliar place of residence. "We do not know anything there, it is a new place and we do

not know where to get vaccination, so we wait till we return home, and get our child vaccinated then" (Francis et al., 2021).Also, patient services affect their willingness to adhere to vaccination schedules, and time management was documented as one of the factors that influence vaccine uptake and coverage. In addition, the active participation of community members in implementing strategies to improve the uptake of rotavirus and cholera vaccines contributed to the achievement of a reduced prevalence of childhood diarrhoea (Das et al., 2023). "We formed a community group and have included influential people such as an imam (religious leader), landlords, shopkeepers, and other respected members of the community. This helps us convince people that work we are doing is for their betterment" (Das et al., 2023). A community leader who was interviewed said, "If there is any unvaccinated child, we tell them to vaccinate their child. This is good for the child. There are 12 months in a year and 24 hours in a day. What if anything happened to the child at that time? It is important to vaccinate children to keep them protected at all times" (Francis et al., 2021). The parents are more amenable to take a vaccine if they have heard that their friend's children or relatives' children have taken it (George et al., 2016). On the part of the target population, there was a constant report of a positive impact on the decision of others to partake in vaccination. "If someone in the family has done it then we will do it for our child also" (George et al., 2016). "My neighbours had children before me. They told me that the vaccines were good and told me to get my children vaccinated" (Dhaliwal et al., 2022).

Theme 3 - Opportunities for vaccination strategies

The willingness to learn regardless of the prevalent poor vaccine knowledge could be leveraged for strategic vaccination approaches that would promote uptake and, therefore, reduce disease prevalence, as there is a thriving zeal to gain more knowledge on this topic (Singh et al., 2019). A rural dweller said, "we want to know more about the diseases, how they come and how vaccines help reduce them, this advice would be very helpful to us. We want to keep our children safe, and healthy, that is very important to us" (Francis et al., 2021).Although some perceive this education and empathy as basic prerequisites for compliance with vaccination, healthcare service providers need to guide, educate, respect, and be sensitive to the issues and challenges like family problem, loss of wages, insecurities, faced by the larger population (Singh et al., 2019). In addition to seeking vaccine knowledge, studies highlighted an existing demand for vaccines by both parents and community stakeholders (Francis et al., 2021; Singh et al., 2019). Some participants showed ardent adherence to and prioritisation of the process (Singh et al., 2019).A community leader said, "even if it means we have to forego something, we will not compromise giving our child vaccines. If it is good for the child, then we will go ahead and do it even if it is costly" (George et al., 2016). Some of these views were formed as a direct consequence of witnessing the implications of being unvaccinated (Das et al., 2023).According to Das et al. (2023),following the death of some children due to diarrheal diseases, mothers began making conscious efforts to get their children vaccinate.

Theme 4 - Threats to the successful implementation of vaccination strategies

Access to the vaccines: Following the success of any vaccination strategy to improve uptake and effectiveness, it is important that these vaccines be made accessible to the target

population (Das et al., 2023). Reports have demonstrated the impact of poor access on the success of these strategies. In some cases, this is due to barriers faced in unfamiliar environments. “I hesitate to get vaccinated or to advocate it as I am a ‘non-Marathi’ meaning ‘nonlocal’. I am from a different state, in which culture and languages are completely different. I do not know what the local healthcare service providers will think and how they may behave” (Singh et al., 2019). In some other cases, geographical locations may have poor road structures and therefore affect access to vaccines and predisposing such places to a higher prevalence of childhood diarrhoea (Singh et al., 2019).

Fear of adverse events: Adverse Events Following Immunisation (AEFI) are unpleasant experiences that could occur after a vaccination procedure(Erchick et al., 2022). Due to the occurrence of some of these events, a high level of reluctance would threaten the success of vaccination coverage, and this could be reflected in not just a group of individuals but a whole community. Diverse reports exist on this situation from the interviews conducted in the included studies. In some cases, there is a fear of potential adverse events. “If there is already a case [AEFI], which has been registered in the area of the child whogot vaccination, and something happened to that child, that entire community would develop a kind of resistance” (Erchick et al., 2022). There are many parents who are afraid that their child may get fever after vaccination, or that their child may have some defects (Francis et al., 2021). However, in some cases, the past experience of an unpleasant vaccine-related incident leads to fear.Some participants had these to say, “the last time fever and pain persisted for one week and we were lost as no one was there to respond. I do not want to vaccinate my kid again” (Singh et al., 2019). “When my child received first injection, it caused swelling and fever. I got worried and started crying then my mother in-law told me that it happens” (Tabassum et al., 2022). “An incident occurred with my cousin’s daughter, when after vaccination blister was formed, leg got swollen and become shrink and weak. Our family believed that it wouldn’t have happened if the vaccination was not given to the child” (Tabassum et al., 2022). “My child got hospitalised as she fainted after vaccination and got high grade fever. After treatment, the patient was stable. This incident frightened and made me doubtful about all vaccines due to which I refused for all vaccinations but when counselled by community people, neighbours and LHWs, I resumed her vaccination again” (Tabassum et al., 2022). “Our whole family is reluctant and have a rigid perspective about polio drops and vaccination because my mother-in-law’s child got sick and died in result of vaccination” (Tabassum et al., 2022). This factor must thus be considered in detail when designing a rotavirus and cholera vaccination strategy for children.

Resource availability: With respect to the aforementioned barriers faced in vaccination, the availability of resources to ensure a sustainable supply and uptake of these vaccines must be prioritised. Despite the success of some strategies, the study participants laid their complaints of low impact due to unavailable resources. The lack of human resources was highlighted on one hand, while the lack of qualification of the available human resources was also mentioned on the other hand. “No, vaccinators are not enough. In our area of Shah Kareem, we only have two vaccinators” (Das et al., 2023). “There is a lack of training sessions for LHWs. Mostly doctors attend trainings and then brief us (LHWs) in a superficial way” (Das et al., 2023). Also, educational resources were lacking as neglect was detected in health professionals towards the rotavirus and cholera vaccination “The LHWs do not provide us

with any information about diarrhoea and pneumonia. They are only concerned with the polio campaign." (Das et al., 2023) "The health care providers can utilise short counselling with clear language, which will maintain a positive relationship between the personnel and the mother. Simple but effective messages such as the benefits of immunization and the number of doses until the age of one can be transferred through counselling" (Karim et al., 2023).

Cultural barriers

Demographics and sociocultural activities in a given population and region also play significant roles in determining the values and practices associated with vaccination against diarrhoea, including other preventive measures. While being potential causes of low immunity, traditional alternatives may be considered sufficient, and the need for vaccination may be poorly identified. "they use traditional methods, like mint water, sago, banana and yogurt, to treat children suffering from diarrhea" (Das et al., 2023). "Exclusive breastfeeding is not practiced in our culture. We give honey, sweet paste, and water during the first six months of life" (Das et al., 2023). "People living in rural areas are unaware of the importance of maintaining personal hygiene. They avoid bathing, brushing teeth, combing hair and children walk and play barefooted in muddy surroundings" (Das et al., 2023). Low vaccine knowledge The majority of the included studies in this review uniformly agree that the level of vaccine knowledge in the study areas is low. In fact, the affirmation of this situation by recent studies raises concerns regarding the strategies applied hitherto to boost vaccine uptake. This may be caused by the low focus on rotavirus and cholera during the implementation of vaccination strategies, as other vaccines seemed to be more popular in some cases. "...Most people don't have much awareness about vaccines" (Francis et al., 2021). "Majority did not have any idea except for polio…some talked about BCG and measles" (Singh et al., 2019). "Not at all aware of the (Rotavirus) vaccine" (Karim et al., 2021). Health professionals have been proven to be one of the influencers of this state, as some were reported to refrain from giving the required information to patients before and during vaccination. In addition, some of these community dwellers request education and are met with disappointing feedback, further making the process less desirable. "Before they vaccinate our children, they do not give us enough information" (Francis et al., 2021). "I was angry because she said it's for the children's benefit, but she never clarified the benefits" (Das et al., 2023). "I do not have sufficient knowledge about this virus,butI have heard as well as vaccinated my child against it. The only information given by the vaccinator is that this virus is responsible for causing diarrhea and this vaccine protects against diarrhea" (Karim et al., 2021). Again, some individuals said, "vaccination is purposeless, we recite Quran and spiritually heal our children" (Tabassum et al., 2022); "personally, I do not believe that vaccination will stop my child from diarrhea" (Karim et al., 2021).

DISCUSSION

Pre-vaccination strategy experience: In the absence of public health approaches to promote rotavirus and cholera vaccination, there is a high incidence of misinformation, poor knowledge of the importance of these vaccines, and poor diarrhea prevention practices (Erchick et al., 2022; Francis et al., 2021; George et al., 2016). This finding underscores the

need for educational interventions, particularly in developing countries, as in the case studies used in this study. The low level of knowledge of parents critically affects their willingness to vaccinate their children, and is a challenge that must be overcome to increase uptake (Francis et al., 2021; Karim et al., 2023; Singh et al., 2019). Unhealthy practices and a lack of hygiene further necessitate the vaccines in question, making the implementation of vaccination strategies of immense importance (Das et al., 2023; Wahed et al., 2013).

Post-vaccination strategy impact: As a result of the implemented strategies for vaccination against rotavirus and cholera, the studies reported positive impacts such as a significant enhancement of vaccine knowledge for the prevention of diarrhoea and understanding the role of healthcare professionals in the exercise (Francis et al., 2021; Wahed et al., 2013). In contrast, new challenges arose, such as impediments to the achievement of vaccine coverage outlined as mistrust and a lack of required means of accessing the vaccines (Erchick et al., 2022; Francis et al., 2021; George et al., 2016; Uddin et al., 2014). Community involvement was further recognized as being pivotal to the successful implementation of pertinent strategies (Das et al., 2023). The interplay between these factors underlies the impact of the implemented strategies on the prevalence of rotavirus and cholera-induced childhood diarrhoea in the regions under study.

Opportunities for vaccination strategies: The observed willingness of parents to learn and vaccinate their children serves as a window of opportunity to implement rotavirus and cholera vaccination strategies (Francis et al., 2021; Singh et al., 2019). Therefore educational interventions should be encouraged to improve the knowledge of the target population and further increase their involvement in the prevention of childhood diarrhoea (Varghese et al., 2022). Threats to the successful implementation of vaccination strategies: Inequalities in terms of access to these vaccines pose a threat to their uptake as well as the availability of required resources. Varghese et al. (2022) highlighted the paradox of vaccine unavailability in endemic countries, where they are needed because of a lack of available resources. The study findings confirm this situation and call for a prioritized approach. In addition, the fear of adverse events discourages adherence in parents and threatens the impact of vaccination strategies, which are scarcely mitigated by vaccinators due to neglect (Karim et al., 2023). A study by Zaidi et al. (2021), which evaluated the knowledge and practices of medical students regarding rotavirus vaccination, showed high levels of complacency and indicated a similar attitude in the future. Although studies are continually being conducted to introduce new options, existing vaccination strategies should be strengthened (Luquero&Azman, 2018). The perception and participation of parents in childhood vaccination against rotavirus and cholera directly affecst the incidence of rotavirus and cholera induced diarrhea in Bangladesh, India, and Pakistan (Wahed et al., 2013). Hence, the themes of discussion mentioned above, should be considered to properly design and implement effective strategies aimed at reducing childhood diarrhea in these regions via vaccination.

Strengths and limitations

This study was conducted as a systematic review and therefore employed standardized tools in its methods, ranging from literature search and selection to data synthesis and analysis. Therefore, this study holds high recognition as being reliable source of evidence on this topic. Its high reproducibility due to astute reporting based on guidelines also improves the

transparency and study quality. Strength refers to the process of acquiring primary studies using high-quality methods, further enhancing the reliability of the review. Furthermore, most of the included studies were recently conducted, thus providing up-to-date information on the subject. Despite these strengths, this study had some limitations. First, the availability of primary studies with qualitative data on the subject was a challenge, and, as a result, the process of systematic literature search was time-consuming. Furthermore, rich data on the desired populations were lacking, which led to the inclusion of only ten studies after a rigorous selection process, despite being sourced from three different countries.

Recommendation

As evidenced by the study results and recommended by Singh et al. (2019), in planning any vaccination strategy, attention should be given to creating awareness that would help strengthen trust in the parents of the target children. Educational interventions have proven to be effective and sustainable in terms of their impact on perception and vaccine uptake, thus promising a reduction in disease prevalence as a long-term effect (Sultana et al., 2023). This education must also include exposure to the cost-effectiveness of prevention and debunk vaccine myths to address hesitancy due to personal, cultural, and religious biases (Varghese et al., 2022). It is also recommended that a combination of strategies is explored to address complex issues and eliminate the threats that arise in these endemic areas, such as simultaneously improving vaccine affordability, accessibility, and knowledge (Desai et al., 2014). To achieve a sustained uptake, a sustained supply must also be ensured. Hence, the provision of facilities to aid storage and dissemination would facilitate the use of these vaccines (Sarker et al., 2022). Professionals must also be trained to adequately deliver vaccine and vaccine education to children and parents, respectively, thereby building trust and adherence to immunization schedules (Singh et al., 2019). Finally, further research should be conducted to promote other forms of prevention for childhood diarrhea caused by pathogens other than from rotavirus and cholera.

CONCLUSION

This study was conducted to gather qualitative data from primary studies focused on the impact of vaccination strategies carried out in Bangladesh, India, and Pakistan to improve the uptake and effectiveness of vaccines for the prevention of childhood diarrhea caused by cholera and rotavirus. To achieve this, a systematic review was conducted by adhering to the checklist items of the PRISMA guidelines. The research question was framed using the SPIDER framework from which the literature search was structured. Having defined the criteria for the selection of the primary literature to be used, the CASP tool was used to appraise the individual methodologies, after which ten studies were chosen for inclusion in the review. Meta-synthesis was thereafter employed to combine the individual results for thematic synthesis, thereby producing four themes from which the study discussion was conducted. Therefore, at the end of the study, it can be concluded that there is a dire need for the implementation of vaccination strategies targeted at debunking myths and improving the knowledge of all involved stakeholders. This should be followed by providing adequate training for vaccinators and the required facilities, and aids in the sustainability of vaccination exercises to achieve the desired goal. Finally, all the methods should be constantly reviewed

to ensure that the impact is maintained, and further studies should be conducted to measure this impact.

Ethical Approval

The present research work does not contain any studies performed directly with animals/human subjects by any of the authors.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

REFERENCES

Chin, J. M., Growns, B., Sebastian, J., Page, M. J., & Nakagawa, S. (2022). The transparency and reproducibility of systematic reviews in forensic science. Forensic Science International, 340, 111472.

Das, J. K., Siddiqui, F., Padhani, Z. A., Khan, M. H., Jabeen, S., Mirani, M., ... &Bhutta, Z. A. (2023). Health behaviors and care seeking practices for childhood diarrhea and pneumonia in a rural district of Pakistan: A qualitative study. Plos one, 18(5), e0285868.

Desai, S. N., Cravioto, A., Sur, D., &Kanungo, S. (2014). Maximizing protection from use of oral cholera vaccines in developing country settings: an immunological review of oral cholera vaccines. Human vaccines &immunotherapeutics, 10(6), 1457-1465.

Erchick, D. J., Gupta, M., Blunt, M., Bansal, A., Sauer, M., Gerste, A., ... &Limaye, R. J. (2022). Understanding determinants of vaccine hesitancy and acceptance in India: A qualitative study of government officials and civil society stakeholders. PloS one, 17(6), e0269606.

Francis, M. R., Nuorti, J. P., Lumme-Sandt, K., Kompithra, R. Z., Balraj, V., Kang, G., & Mohan, V. R. (2021). Vaccination coverage and the factors influencing routine childhood vaccination uptake among communities experiencing disadvantage in Vellore, southern India: a mixed-methods study. BMC Public Health, 21, 1-14.

GailanQasem, A., Lam, S. S., &Aqlan, F. (2022). A fuzzy-based approach for cholera risk assessment and vaccine allocation. International Journal of Fuzzy Systems, 24(8), 3366-3383.

Gentles, S. J., Charles, C., Nicholas, D. B., Ploeg, J., &McKibbon, K. A. (2016). Reviewing the research methods literature: principles and strategies illustrated by a systematic overview of sampling in qualitative research. Systematic Reviews, 5, 1-11.

George, M. S., Negandhi, P., Farooqui, H. H., Sharma, A., &Zodpey, S. (2016). How do parents and pediatricians arrive at the decision to immunize their children in the private sector? Insights from a qualitative study on rotavirus vaccination across select Indian cities. Human Vaccines &Immunotherapeutics, 12(12), 3139-3145

Ghosh, K., Chakraborty, A. S., &Mog, M. (2021). Prevalence of diarrhoea among under five children in India and its contextual determinants: A geo-spatial analysis. Clinical Epidemiology and Global Health, 12, 100813.

Karim, S. (2021). Role of rotavirus vaccine in reducing diarrheal episodes among children aged 6 months to 2 years at private PHC clinics in Karachi: A mixed method study.

Khan, I. A., Khan, A. I., Rahman, A., Siddique, S. A., Islam, M. T., Bhuiyan, M. A. I., ... &Qadri, F. (2019). Organization and implementation of an oral cholera vaccination campaign in an endemic urban setting in Dhaka, Bangladesh. Global health action, 12(1), 1574544.

Lachal, J., Revah-Levy, A., Orri, M., & Moro, M. R. (2017). Metasynthesis: an original method to synthesize qualitative literature in psychiatry. Frontiers in psychiatry, 8, 269.

Lunny, C., Brennan, S. E., McDonald, S., & McKenzie, J. E. (2017). Toward a comprehensive evidence map of overview of systematic review methods: paper 1—purpose, eligibility, search and data extraction. Systematic reviews, 6, 1-27.

Luquero, F. J., &Azman, A. A. (2018). Protection of young children with cholera vaccine. The Lancet Infectious Diseases, 18(9), 947-948.

Manetu, W. M., M'masi, S., &Recha, C. W. (2021). Diarrhea disease among children under 5 years of age: a global systematic review. Open Journal of Epidemiology, 11(03), 207-221.

Murugesan, M., Abraham, D., Samuel, P., &Ajjampur, S. S. (2022). Campylobacter diarrhea in children in South Asia: A systematic review. Indian Journal of Medical Microbiology, 40(3), 330-336.

Saha, A. (2018). Improved intervention strategies with oral cholera vaccine in an endemic setting (Doctoral dissertation, UNSW Sydney).

Sarker, A. R. (2023). Economic assessment of childhood rotavirus vaccination in Bangladesh. Journal of Infection and Public Health, 16(5), 816-822.

Singh, S., Sahu, D., Agrawal, A., &Vashi, M. D. (2019). Barriers and opportunities for improving childhood immunization coverage in slums: a qualitative study. Preventive medicine reports, 14, 100858.

Sohrabi, C., Franchi, T., Mathew, G., Kerwan, A., Nicola, M., Griffin, M., ... & Agha, R. (2021). PRISMA 2020 statement: What's new and the importance of reporting guidelines. International Journal of Surgery, 88, 105918.

Sultana, T., Moniruzzaman, M., &Dey, S. R. (2023). Knowledge, Attitudes, and Practice (KAP) Study for Reducing Invalid Vaccine Doses in Routine Immunization: A Cross-Sectional Study in Urban Slums of Bangladesh. Qeios.

Tabassum, F., Nazia, T., Nooruddin, S., Hussain, I., Umer, M., Feroz, K., ... & Habib, A. (2022). Journey to vaccination using a heuristic approach in Pakistan: a qualitative study. International Journal of Community Medicine and Public Health, 9(2), 667.

Tawfik, G. M., Dila, K. A. S., Mohamed, M. Y. F., Tam, D. N. H., Kien, N. D., Ahmed, A. M., & Huy, N. T. (2019). A step by step guide for conducting a systematic review and meta-analysis with simulation data. Tropical medicine and health, 47(1), 1-9.

Uddin, M. J., Wahed, T., Saha, N. C., Kaukab, S. S. T., Khan, I. A., Khan, A. I., ... &Qadri, F. (2014). Coverage and acceptability of cholera vaccine among high-risk population of urban Dhaka, Bangladesh. Vaccine, 32(43), 5690-5695.

Varghese, T., Kang, G., & Steele, A. D. (2022). Understanding rotavirus vaccine efficacy and effectiveness in countries with high child mortality. Vaccines, 10(3), 346.

Wahed, T., Kaukab, S. S. T., Saha, N. C., Khan, I. A., Khanam, F., Chowdhury, F., ... & Uddin, J. (2013). Knowledge of, attitudes toward, and preventive practices relating to cholera and oral cholera vaccine among urban high-risk groups: findings of a cross-sectional study in Dhaka, Bangladesh. BMC public health, 13(1), 1-12.Vaccine, 35(49), 6790-6792.

WHO (2017). Diarrhoeal disease. World Health Organisation. https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease

WHO (2020). Children: improving survival and well-being. World Health Organisation. https://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality

WHO (2022). Child mortality (under 5 years). World Health Organisation. https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-child-under-5-mortality-in-2020

WHO (2024). Diarrhoea. World Health Organisation. https://www.who.int/health-topics/diarrhoea#tab=tab_1

Zaidi, T. H., Zafar, M., Naz, R., Ahmed, S. S., Saleem, I., Sundardas, K., ... &Siraj, T. (2021). Knowledge and attitude regarding rotavirus and its vaccination among medical students in Karachi, Pakistan. Public Health in Practice, 2, 100171.

Zeng, W., Cui, Y., Jarawan, E., Avila, C., Li, G., Turbat, V., ... & Shen, J. (2021). Optimizing immunization schedules in endemic cholera regions: cost-effectiveness assessment of vaccination strategies for cholera control in Bangladesh. Vaccine, 39(43), 6356-6363.