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Comparative Study of Vaccination Programs against Typhoid Fever in East Africa

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ABSTRACT

Typhoid fever remains a significant public health challenge in East Africa, where waterborne diseases are prevalent due to poor sanitation and limited access to clean water. Vaccination is an effective preventive measure against typhoid fever, and multiple vaccination programs have been implemented across the region. This review explores the scope, effectiveness, and challenges of typhoid vaccination programs in East African countries, including Kenya, Uganda, Tanzania, Rwanda, Burundi, and Ethiopia. By comparing program structures, vaccine coverage, policies, and outcomes, this review aims to provide insights into the successes and limitations of current efforts. Special attention is given to innovative strategies, public health campaigns, and the role of international partnerships. Recommendations for improving vaccination coverage, addressing barriers, and integrating new vaccines are also discussed to inform future policy and practice.

Keywords: Typhoid fever, vaccination programs, East Africa, public health, immunization, waterborne diseases, typhoid vaccine, health policy.

INTRODUCTION

Typhoid fever, caused by the bacterium *Salmonella enterica* serovar Typhi, is a life-threatening infectious disease that poses a significant global public health challenge, particularly in low- and middle-income countries [1]. The disease is primarily transmitted through contaminated food and water, making it especially prevalent in regions with poor sanitation and inadequate access to clean drinking water. Symptoms of typhoid fever range from high fever, fatigue, abdominal pain, and diarrhea to severe complications such as intestinal perforation, which can be fatal if not treated promptly. Globally, millions of cases are reported annually, with a disproportionately high burden in sub-Saharan Africa, South Asia, and Southeast Asia [2].

In sub-Saharan Africa, and particularly in East African countries, typhoid fever remains a leading cause of morbidity and mortality. The disease's prevalence is exacerbated by overcrowded living conditions, insufficient water and sanitation infrastructure, and limited access to healthcare services. Children and young adults are most vulnerable to the disease, often due to exposure to contaminated water supplies, poor hygiene practices, and the lack of preventive health measures in schools and communities [3]. The combination of these factors makes typhoid fever a major public health issue in East Africa, contributing to increased healthcare costs, lost productivity, and considerable strain on already overburdened health systems.

Despite being a preventable and treatable disease, the control of typhoid fever has been historically challenging due to several factors, including antibiotic resistance, underdiagnosis, and inadequate preventive measures. In recent years, rising concerns over the emergence of drug-resistant strains of *Salmonella Typhi*, particularly in parts of Africa, have underscored the urgent need for effective public health interventions [4].

Vaccination has emerged as one of the most effective tools for preventing typhoid fever and mitigating its severe complications. Vaccines not only reduce the incidence of the disease but also lower the risk of outbreaks in high-burden areas [5]. Recognizing the critical need for immunization, the World Health Organization (WHO) recommended the introduction of typhoid conjugate vaccines (TCVs) into routine immunization programs in endemic regions [6]. TCVs have several advantages over traditional vaccines, including longer-lasting immunity, suitability for younger children, and the ability to be incorporated into existing immunization schedules.

Following the WHO's recommendation, several East African countries have launched typhoid vaccination programs, with support from global health partners such as Gavi, the Vaccine Alliance. These vaccination initiatives aim to reduce the disease burden by targeting vulnerable populations, particularly children, in high-risk areas [7]. The introduction of TCVs has also been complemented by broader public health interventions aimed at improving sanitation, access to clean water, and hygiene practices to address the root causes of typhoid transmission.

This review presents a comparative analysis of the structure, implementation, and outcomes of typhoid vaccination programs in East Africa, focusing on Kenya, Uganda, Tanzania, Rwanda, Burundi, and Ethiopia. Each of these countries faces unique challenges related to healthcare infrastructure, vaccine access, and public health awareness, yet they also share commonalities in terms of disease burden and public health goals [8]. By examining the various vaccination strategies employed across these countries, this review seeks to highlight successful approaches, identify gaps in implementation, and provide recommendations for future improvements in vaccine coverage and disease control.

In addition to exploring the successes and challenges of existing programs, this review also delves into the role of international partnerships, such as those with Gavi, in supporting these efforts. Gavi and other global health organizations have played a critical role in funding, coordinating, and delivering vaccines to low-income countries. Their involvement has been instrumental in helping East African countries overcome financial and logistical barriers to vaccine access.

The ultimate goal of this comparative analysis is to provide a comprehensive overview of how different countries in East Africa are tackling typhoid fever through vaccination and related public health measures. By understanding the factors that contribute to successful vaccination campaigns, as well as the barriers that hinder progress, this review aims to inform future policy and practice, thereby improving health outcomes and reducing the burden of typhoid fever across the region [9, 10].

Epidemiology of Typhoid Fever in East Africa

Typhoid fever is a significant public health issue in East Africa, characterized by socioeconomic challenges and infrastructural deficiencies. The disease is associated with poor sanitation, inadequate access to safe drinking water, overcrowded living conditions, and population displacement, making it conducive to the spread of *Salmonella enterica* serovar Typhi [11]. Despite efforts to reduce the incidence of typhoid fever through vaccination campaigns, improved sanitation, and health education, recurrent outbreaks continue to affect communities in East Africa. Kenya, Uganda, Tanzania, Rwanda, Burundi, Ethiopia, and Ethiopia all face endemic typhoid fever. In Kenya, typhoid fever remains endemic in densely populated urban areas like Nairobi and Mombasa due to overcrowding and inadequate water and sanitation systems. In Uganda, rural areas with limited healthcare access and poor water quality also experience high incidence rates. Tanzania faces endemic typhoid fever in urban areas with high population density, particularly in Dar es Salaam and other rapidly growing cities. Tanzania has made strides in improving its healthcare system and infrastructure, including implementing targeted public health interventions, including typhoid vaccination campaigns. However, challenges remain in maintaining high vaccination coverage and ensuring equitable access to clean water and sanitation in all parts of the country. Burundi faces endemic typhoid fever due to inadequate sanitation infrastructure, particularly in rural areas and informal urban settlements. Ethiopia's healthcare infrastructure remains uneven, with significant disparities in access to clean water and sanitation between urban and rural regions. The high prevalence of drug-resistant *S. Typhi* strains complicates treatment, necessitating broader public health interventions aimed at improving water and sanitation systems and strengthening healthcare infrastructure [12, 13].

Vaccination Programs in East Africa

1. Kenya

Kenya has implemented multiple vaccination campaigns targeting typhoid fever, supported by partnerships with Gavi and the WHO. In 2019, Kenya introduced the typhoid conjugate vaccine (TCV) as part of a large-scale pilot program in Nairobi, aiming to vaccinate children aged six months to 15 years. The program, which incorporated routine immunization in urban areas, achieved high coverage and demonstrated a reduction in typhoid incidence. Kenya's vaccination efforts have been coupled with public health education campaigns emphasizing the importance of vaccination alongside improved hygiene practices. One of the key strengths of Kenya's program is the integration of typhoid vaccination into existing health services, including maternal and child health clinics.

2. Uganda

Uganda has a long history of combating typhoid fever through vaccination campaigns, particularly in response to large outbreaks in urban areas. In 2018, Uganda conducted a mass vaccination campaign using TCVs in the capital, Kampala, where over 600,000 people were vaccinated following a major outbreak.

Despite these efforts, Uganda faces challenges in sustaining high vaccine coverage due to logistical difficulties in rural areas, limited healthcare infrastructure, and vaccine hesitancy among certain populations. The Ugandan government has also focused on improving water, sanitation, and hygiene (WASH) initiatives to complement vaccination efforts.

3. Tanzania

Tanzania has made strides in introducing TCVs, particularly in urban areas where typhoid fever is most prevalent. The Tanzanian government has worked closely with international partners to roll out vaccination campaigns in high-risk areas, targeting school-aged children. Despite these efforts, vaccine coverage remains uneven, with rural regions lagging behind due to logistical constraints and funding shortages.

Efforts to integrate typhoid vaccination into routine immunization schedules have been met with success in certain districts, though national coverage remains a challenge. The government is working on scaling up vaccination in conjunction with broader health and sanitation initiatives.

4. Rwanda

Rwanda's approach to typhoid vaccination is characterized by strong government leadership and effective use of data to inform public health interventions. Rwanda introduced TCVs into its national immunization program in 2020, targeting children and adolescents in high-burden areas. The program has been highly successful, with Rwanda achieving one of the highest vaccine coverage rates in East Africa [14].

Rwanda's success can be attributed to its robust healthcare infrastructure, strong political commitment, and use of mobile health (mHealth) technology to track vaccine distribution and coverage. Public awareness campaigns have also played a significant role in promoting vaccine acceptance.

5. Burundi

Burundi faces significant challenges in implementing typhoid vaccination programs due to its fragile healthcare system and recurrent political instability. Nevertheless, the government, with support from Gavi and the WHO, has launched targeted vaccination campaigns in high-risk regions, focusing on children under the age of five.

While vaccine coverage has improved in recent years, access to vaccines in remote and conflict-affected areas remains a major obstacle [15]. Burundi's efforts have been bolstered by international aid, though long-term sustainability of the program remains uncertain.

6. Ethiopia

Ethiopia has prioritized typhoid vaccination as part of its broader strategy to combat waterborne diseases. The introduction of TCVs in 2019 marked a significant step forward in Ethiopia's fight against typhoid fever. The government has focused on vaccinating children and adolescents in both urban and rural areas, though logistical challenges have hindered full coverage in remote regions.

Ethiopia's program has also been supported by extensive WASH initiatives, aiming to address the root causes of typhoid transmission. Vaccine coverage rates vary across the country, with urban areas generally achieving higher rates than rural regions.

Comparative Analysis of Typhoid Vaccination Programs Vaccine Coverage and Distribution

Rwanda leads in terms of vaccine coverage, benefiting from strong political commitment and efficient health infrastructure.

Kenya and Uganda have made significant strides in urban areas, though rural regions still face coverage challenges.

Tanzania and Ethiopia have implemented vaccination campaigns but face logistical hurdles, especially in rural areas.

Burundi struggles with consistent vaccine coverage due to ongoing political and economic instability.

Government and International Support

All countries benefit from international partnerships, particularly with Gavi, the Vaccine Alliance, and the WHO. However, the level of government commitment varies, with Rwanda and Kenya demonstrating the strongest leadership in implementing and scaling up vaccination programs [16]. Countries like Burundi and Ethiopia rely heavily on international aid to sustain their programs, making long-term sustainability a concern.

Integration with Other Public Health Initiatives

Rwanda and Kenya have successfully integrated typhoid vaccination into routine immunization schedules and broader public health campaigns.

Uganda and Tanzania have combined vaccination with WASH initiatives, though the success of these programs is variable across regions.

Ethiopia has made significant progress in combining vaccination with sanitation improvements, though challenges remain in achieving uniform success.

Challenges and Barriers

Logistical issues: Remote and rural regions across all countries face challenges in vaccine delivery, storage, and administration.

Vaccine hesitancy: Cultural beliefs and misconceptions about vaccines have hindered uptake in some regions, particularly in Uganda and Tanzania.

Funding constraints: Financial limitations pose a significant barrier to scaling up vaccination programs, particularly in Burundi and Ethiopia.

Recommendations for Improving Typhoid Vaccination Programs in East Africa

1. **Enhancing Public Awareness:** Increasing awareness about the benefits of typhoid vaccination through community education and media campaigns can help overcome vaccine hesitancy and improve uptake.
2. **Strengthening Health Infrastructure:** Investing in healthcare infrastructure, especially in rural areas, is crucial for improving vaccine distribution and administration. Mobile health technologies can also be utilized to monitor vaccine coverage and distribution more effectively.
3. **Expanding WASH Initiatives:** Combining vaccination with WASH programs can reduce the incidence of typhoid fever by addressing its root causes. Governments should prioritize investments in clean water, sanitation, and hygiene to complement vaccination efforts.
4. **Sustaining International Partnerships:** Continued collaboration with international organizations like Gavi, the WHO, and UNICEF will be essential for securing funding, technical support, and vaccines to sustain and expand current programs.
5. **Introducing New Vaccines:** As new typhoid vaccines become available, countries should consider incorporating them into their national immunization programs. Future research should focus on developing vaccines that are effective for longer durations and in a broader age range.

CONCLUSION

This comparative study of typhoid vaccination programs across East Africa highlights both the successes and challenges that countries face in combating typhoid fever. Despite the widespread introduction of the typhoid conjugate vaccine (TCV) and its integration into national immunization schedules, significant gaps remain in vaccine coverage, particularly in rural and conflict-affected areas. Countries like Rwanda and Kenya have made notable progress, achieving high vaccination rates due to strong government leadership, effective health infrastructure, and international support. However, in countries like Burundi and Ethiopia, logistical challenges, political instability, and healthcare access disparities continue to hinder vaccination efforts. The analysis underscores the importance of complementary public health measures, such as improving water, sanitation, and hygiene (WASH), to sustain the gains made by vaccination programs. Additionally, the role of international partnerships, such as those with Gavi and the World Health Organization (WHO), remains critical in providing financial and logistical support to East African nations. For future success, it is essential to address barriers to vaccine access, scale up innovative delivery strategies, and ensure equitable distribution, particularly to underserved populations. By strengthening vaccination programs and addressing the root causes of typhoid transmission, East African countries can make meaningful strides toward reducing the burden of typhoid fever and improving public health outcomes.

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