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Cost-Benefit Analysis of Typhoid Vaccination Programs in Uganda: A Public Health and Economic Perspective

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ABSTRACT

Typhoid fever remains a significant public health challenge in Uganda, particularly in regions with inadequate sanitation and access to clean water. Despite efforts to improve hygiene, the disease continues to burden the healthcare system and economy, with high morbidity, mortality, and costs. This study conducts a cost-benefit analysis (CBA) of typhoid vaccination programs in Uganda to evaluate their economic and public health impact. The analysis includes the direct and indirect costs of typhoid fever, such as medical expenses, lost productivity, and long-term complications. It also assesses the costs of implementing vaccination programs, including vaccine procurement, distribution, and administration, and compares these with the potential benefits, including reduced healthcare expenditures, improved productivity, and decreased disease burden. The study highlights the significant long-term savings and health improvements that can be achieved through typhoid vaccination, particularly with the Typhoid Conjugate Vaccine (TCV). Despite challenges such as financial constraints, vaccine hesitancy, and logistical complexities, the findings support the inclusion of typhoid vaccination in Uganda's public health strategies. This study provides evidence-based recommendations for policymakers to guide resource allocation, enhance vaccine coverage, and ensure sustainable typhoid control in Uganda.

Keywords: Typhoid fever, Cost-benefit analysis, Vaccination programs, Typhoid Conjugate Vaccine (TCV).

INTRODUCTION

The disease is primarily transmitted through the Typhoid fever, caused by *Salmonella enterica* serovar Typhi, remains a major public health challenge in Uganda, particularly in regions with poor sanitation and limited access to clean water [1]. ingestion of contaminated food or water, making it highly prevalent in densely populated urban centers and rural communities with inadequate sanitation infrastructure. Despite efforts to improve water quality and hygiene practices, typhoid fever continues to cause significant morbidity and mortality, particularly among children and immunocompromised individuals [2]. The economic impact of typhoid fever is substantial, with costs incurred through medical expenses, lost productivity, and long-term health complications. Given the increasing threat of antimicrobial resistance (AMR) and the limitations of antibiotic treatment, preventive measures such as vaccination have gained attention as a viable strategy to control typhoid fever in Uganda [3].

Typhoid vaccination has been recognized as an essential tool in reducing the disease burden, but its cost-effectiveness remains a crucial factor for policymakers. Governments and public health stakeholders must weigh the financial investment in vaccination programs against the potential savings in healthcare costs and economic losses due to illness [4]. While typhoid vaccines, including the Vi polysaccharide vaccine, conjugate vaccines, and live attenuated vaccines, have demonstrated efficacy, their integration into routine immunization programs requires careful assessment of benefits and costs. This study aims to conduct a cost-benefit analysis of typhoid vaccination programs in Uganda, providing evidence-based recommendations to guide public health interventions and resource allocation [5].

Typhoid fever is endemic in many low- and middle-income countries (LMICs), including Uganda, where inadequate sanitation and limited access to clean drinking water facilitate its transmission. According to the World Health Organization (WHO), typhoid fever affects millions of people annually, leading to severe complications such as intestinal perforation, chronic carrier states, and even death if untreated [6]. The disease disproportionately affects school-aged children and young adults, significantly impacting education, workforce productivity, and economic development.

Uganda has reported multiple outbreaks of typhoid fever in recent years, particularly in urban slums and refugee settlements [7]. The reliance on antibiotics for treatment has led to growing concerns about antimicrobial resistance, making typhoid infections harder to manage. The emergence of multidrug-resistant (MDR) *S. Typhi* strains has further complicated treatment efforts, emphasizing the need for sustainable preventive strategies. While improvements in sanitation and hygiene are long-term solutions, vaccination offers an immediate and effective means to reduce the incidence of typhoid fever [8].

Cost-benefit analysis (CBA) is a critical tool in public health decision-making, helping policymakers assess the financial implications of vaccination programs. By comparing the costs of implementing typhoid vaccination to the benefits gained in terms of reduced healthcare costs, improved productivity, and decreased mortality rates, this study aims to provide a comprehensive evaluation of the economic and public health impact of typhoid vaccination in Uganda [9].

Despite the high burden of typhoid fever in Uganda, vaccination programs have not been widely implemented due to concerns about cost, feasibility, and competing public health priorities. The government has primarily relied on improving sanitation and antibiotic treatment to manage the disease [10]. However, the increasing prevalence of antibiotic-resistant *S. Typhi* strains threatens the effectiveness of treatment, making preventive measures more critical than ever.

While typhoid vaccines are available, the financial sustainability and cost-effectiveness of widespread immunization remain uncertain. Uganda faces budgetary constraints in its healthcare system, necessitating a thorough economic evaluation before allocating resources to a nationwide vaccination program [7]. The lack of comprehensive cost-benefit analyses specific to the Ugandan context has resulted in uncertainty regarding the best approach to controlling typhoid fever. This study seeks to bridge this knowledge gap by providing an in-depth analysis of the economic and public health benefits of typhoid vaccination in Uganda. The study aims to estimate the direct and indirect costs of typhoid fever in Uganda, including medical expenses, lost income, and long-term complications. It also evaluates the cost of implementing a national typhoid vaccination program, including vaccine procurement, distribution, and administration. The study also assesses the potential benefits of typhoid vaccination, including reduced healthcare costs, improved productivity, and decreased morbidity and mortality. The research questions include determining the direct and indirect economic costs, determining the cost of implementing a nationwide typhoid vaccination program, assessing the economic and public health benefits of typhoid vaccination, determining the best cost-effectiveness for large-scale immunization programs, and providing policy recommendations for optimizing typhoid fever prevention and control in Uganda.

This study aims to evaluate the cost-effectiveness of typhoid vaccination in Uganda, enabling the Ugandan government and health agencies to make informed decisions regarding resource allocation and disease prevention strategies. The study will contribute to the broader efforts of disease prevention and control in Uganda, highlighting potential cost savings such as reduced hospitalizations, lower treatment costs, and increased workforce productivity. The findings will provide evidence-based recommendations for the Ugandan Ministry of Health to develop sustainable immunization policies, integrating typhoid vaccines into routine immunization schedules and emergency outbreak response plans. The study underscores the role of vaccination in reducing reliance on antibiotics, mitigating the risk of drug-resistant S. Typhi strains. Furthermore, the study can increase public awareness and acceptance of immunization programs, encouraging higher vaccine uptake rates. Typhoid fever continues to pose a significant public health and economic challenge in Uganda, necessitating a shift towards preventive measures such as vaccination. The study aims to conduct a thorough cost-benefit analysis of typhoid vaccination programs, providing policymakers with critical data on their feasibility, effectiveness, and long-term economic impact.

Disease Burden and Economic Impact

Typhoid fever is a significant public health challenge in Uganda, causing significant economic burdens on the country's healthcare system. The disease burden can be broken down into direct, indirect, and social costs [11]. Direct costs include hospitalization, outpatient visits, diagnostic tests, and antibiotic treatments. Indirect costs include productivity losses, long-term disability, and premature mortality. Prolonged illness can significantly affect household income, especially in agriculture or the informal sector. Caretakers may also be unable to work due to sick family members, further compounding the economic burden. Severe cases may result in long-term disability, which can affect an individual's ability to return to normal work. Premature mortality can result in death, affecting household income and societal productivity. Typhoid fever's social consequences extend beyond individual levels to broader societal effects. Reduced school attendance, workforce absenteeism, and pressure on healthcare facilities are some of the social consequences. Without effective intervention strategies, such as improvements in sanitation, access to healthcare, and early detection, typhoid fever will continue to impede Uganda's healthcare infrastructure and economic growth [12]. Addressing this issue requires coordinated efforts from the government, healthcare providers, and international organizations to implement preventive measures, promote health education, and ensure timely treatment for affected individuals.

Typhoid Vaccination: Available Options and Cost Analysis

Typhoid fever, caused by the bacterium Salmonella enterica, is a major public health concern in many developing countries, including Uganda. Vaccination plays a crucial role in preventing and controlling its spread, especially in regions with inadequate sanitation and hygiene [13]. Three primary vaccines are currently available to protect against typhoid fever: Vi Polysaccharide Vaccine (ViPS), Ty21a Live Oral Vaccine, and Typhoid Conjugate Vaccine (TCV). ViPS is an injectable vaccine that provides moderate protection for 2-3 years, making it suitable for older children and adults in high-risk areas. However, it has a short-lived duration of protection and reduced immunity in young children. Ty21a is an oral vaccine consisting of live, attenuated bacteria, offering a longer duration of protection for 5-7 years [14]. It is non-invasive and easier to administer, but may not be suitable for immunocompromised individuals. TCV is a single-dose injectable vaccine that offers long-term immunity, making it cost-effective in the long run. It is suitable for young children as young as six months and provides higher and more consistent protection compared to the ViPS and Ty21a vaccines. However, it is currently more expensive than the other vaccines, which may limit its accessibility in low-resource settings. In Uganda, the selection of the appropriate vaccine should be guided by cost-effectiveness, target population, healthcare infrastructure, and desired duration of protection. While the initial investment in TCV may be higher, its long-term benefits make it a strong candidate for broader use in typhoid prevention strategies.

Cost Analysis of Typhoid Vaccination

Typhoid vaccination is an effective method for preventing the disease, but it comes with various costs, particularly in resource-limited settings like Uganda. These costs include vaccine costs, implementation costs, and potential long-term savings [5]. The cost per dose of the Typhoid Conjugate Vaccine (TCV) typically ranges from $1.50 to $5.00, depending on factors such as the manufacturer, purchasing volume, and supply agreements. Administration costs include healthcare worker training, logistics and storage, distribution, and healthcare infrastructure. These costs can be particularly challenging in remote or rural areas where infrastructure may be lacking. Long-term savings can be substantial, including reduced incidence of typhoid, fewer hospital admissions, and lower antibiotic use. Short-term costs include initial investment in vaccines, implementation, and managing logistics and healthcare training. Healthcare system strain may increase due to vaccine costs, but these costs are typically offset by long-term savings. Long-term gains include healthcare savings, economic productivity, and antimicrobial resistance mitigation. Vaccination is not the only strategy for controlling typhoid fever, as other interventions, such as improvements in water and sanitation, also play a key role [15]. However, vaccination provides immediate protection without the long-term infrastructure improvements required for water and sanitation systems. It should be part of a broader public health strategy that includes water and sanitation improvements, health education, and vector control. While the cost of vaccinating against typhoid fever may seem high in the short term, the long-term benefits far outweigh these initial investments. Reduced healthcare costs, improved economic productivity, and a reduced burden on healthcare systems make typhoid vaccination a highly cost-effective strategy.

Challenges and Considerations

Typhoid vaccination is a crucial tool for preventing the disease, but it faces several challenges, including financial constraints, public awareness and vaccine hesitancy, and logistical complexity of vaccine distribution [16]. These challenges are multifaceted and stem from financial, logistical, and social factors. Financial constraints are a primary obstacle to implementing large-scale vaccination programs, especially in resource-limited settings. Governments may struggle to allocate sufficient funds to cover the cost of vaccines, infrastructure, and human resources. Competing priorities, such as infectious diseases, maternal and child health, and non-communicable diseases, may not always prioritize typhoid vaccination programs over other pressing health concerns. International support from organizations like GAVI or the World Health Organization (WHO) may also be limited, making it difficult to secure sustainable funding for vaccination programs [17]. Public awareness and vaccine hesitancy can significantly affect uptake, with resistance or reluctance among certain groups to accept the vaccine. This resistance can stem from lack of trust in the government or healthcare system, historical experiences with previous health interventions, or negative perceptions of vaccines. Effective public health education campaigns are essential to combat vaccine hesitancy and misinformation. Distribution logistics and vaccine accessibility are critical for any vaccination program, especially in geographically diverse and underserved areas. Cold chain management, logistical planning, and vaccine accessibility are key challenges in the successful rollout of typhoid vaccines. Equity in vaccine access is another major consideration in vaccine rollout. Targeting high-risk populations, addressing the urban-rural divide, and outreach to vulnerable communities are key considerations. Despite the tremendous benefits of typhoid vaccination, these challenges must be carefully considered and addressed for a successful vaccination program. Strategic planning, government support, strong partnerships with international organizations, and community engagement can help mitigate these challenges and ensure the benefits of typhoid vaccination can be realized in countries like Uganda [18].

CONCLUSION

The cost-benefit analysis of typhoid vaccination programs in Uganda reveals the significant public health and economic potential of immunization as a preventive measure against typhoid fever. The high disease burden, including direct healthcare costs, indirect productivity losses, and long-term complications, underscores the urgent need for cost-effective interventions. Typhoid vaccination offers a promising solution to reduce disease incidence, alleviate the strain on Uganda's healthcare system, and mitigate the long-term economic consequences associated with the disease. Although the initial financial investment in vaccination programs, particularly with vaccines like the Typhoid Conjugate Vaccine (TCV), may seem daunting, the long-term benefits include reduced healthcare expenditures, enhanced productivity, and prevention of antimicrobial resistance. The potential economic savings and public health improvements justify the incorporation of typhoid vaccination into Uganda's broader public health agenda. However, successful implementation of typhoid vaccination programs in Uganda requires strategic planning, robust government support, strong international partnerships, and community engagement. If these challenges are met, typhoid vaccination has the potential to significantly reduce the burden of this preventable disease, contributing to improved health outcomes and economic stability in Uganda.

REFERENCES

1. Kim, J.-H., Im, J., Parajulee, P., Holm, M., Cruz Espinoza, L.M., Poudyal, N., Mogeni, O.D., Marks, F.: A Systematic Review of Typhoid Fever Occurrence in Africa. Clin Infect Dis. 69, S492–S498 (2019). https://doi.org/10.1093/cid/ciz525
2. Kabwama, S.N., Bulage, L., Nsubuga, F., Pande, G., Oguttu, D.W., Mafigiri, R., Kihembo, C., Kwesiga, B., Masiira, B., Okullo, A.E., Kajumbula, H., Matovu, J.K.B., Makumbi, I., Wetaka, M., Kasozi, S., Kyazze, S., Dahlke, M., Hughes, P., Sendagala, J.N., Musenero, M., Nabukenya, I., Hill, V.R., Mintz, E., Routh, J., Gómez, G., Bicknese, A., Zhu, B.-P.: A large and persistent outbreak of typhoid fever caused by consuming contaminated water and street-vended beverages: Kampala, Uganda, January - June 2015. BMC Public Health. 17, 23 (2017). https://doi.org/10.1186/s12889-016-4002-0
3. Shrestha, P., Cooper, B.S., Coast, J., Oppong, R., Do Thi Thuy, N., Phodha, T., Celhay, O., Guerin, P.J., Wertheim, H., Lubell, Y.: Enumerating the economic cost of antimicrobial resistance per antibiotic consumed to inform the evaluation of interventions affecting their use. Antimicrobial Resistance & Infection Control. 7, 98 (2018). https://doi.org/10.1186/s13756-018-0384-3
4. Bilcke, J., Antillón, M., Pieters, Z., Kuylen, E., Abboud, L., Neuzil, K.M., Pollard, A.J., Paltiel, A.D., Pitzer, V.E.: Cost-effectiveness of routine and campaign use of typhoid Vi-conjugate vaccine in Gavi-eligible countries: a modelling study. The Lancet Infectious Diseases. 19, 728–739 (2019). https://doi.org/10.1016/S1473-3099(18)30804-1
5. Agwu E (2011). Distribution of Community acquired typhoid fever among febrile patients attending clinics in Bushenyi, Uganda: case study of the year 2005. *Journal of Medical Microbiology and Diagnosis*, *1*, *(101)*, *1-4.*
6. Typhoid, https://www.who.int/news-room/fact-sheets/detail/typhoid
7. Carias, C., Walters, M.S., Wefula, E., Date, K.A., Swerdlow, D.L., Vijayaraghavan, M., Mintz, E.: Economic evaluation of typhoid vaccination in a prolonged typhoid outbreak setting: The case of Kasese district in Uganda. Vaccine. 33, 2079–2085 (2015). https://doi.org/10.1016/j.vaccine.2015.02.027
8. Masuet-Aumatell, C., Atouguia, J.: Typhoid fever infection – Antibiotic resistance and vaccination strategies: A narrative review. Travel Medicine and Infectious Disease. 40, 101946 (2021). https://doi.org/10.1016/j.tmaid.2020.101946
9. Nakisuyi J, Bernis M, Ndamira A, Kayini V, Mulumba R, Theophilus P, Agwu E, Lule H., (2023). Prevalence and factors associated with malaria, typhoid, and co-infection among febrile children aged six months to twelve years at kampala international university teaching … Heliyon, 9, (9), e19588.
10. Dickson-Gomez, J., Nyabigambo, A., Rudd, A., Ssentongo, J., Kiconco, A., Mayega, R.W.: Water, Sanitation, and Hygiene Challenges in Informal Settlements in Kampala, Uganda: A Qualitative Study. Int J Environ Res Public Health. 20, 6181 (2023). https://doi.org/10.3390/ijerph20126181
11. Kaljee, L.M., Pach, A., Garrett, D., Bajracharya, D., Karki, K., Khan, I.: Social and Economic Burden Associated with Typhoid Fever in Kathmandu and Surrounding Areas: A Qualitative Study. J Infect Dis. 218, S243–S249 (2018). https://doi.org/10.1093/infdis/jix122
12. Zhang, H., Fink, G., Cohen, J.: The impact of health worker absenteeism on patient health care seeking behavior, testing and treatment: A longitudinal analysis in Uganda. PLoS One. 16, e0256437 (2021). https://doi.org/10.1371/journal.pone.0256437
13. Alum, E. U., Uti, D. E., Agah, V. M., Orji, O. U., Ezeani, N. N., Ugwu, O. P., Bawa, I., Omang, W. A. and Itodo, M. O. (2023). Physico-chemical and Bacteriological Analysis of Water used for Drinking and other Domestic Purposes in Amaozara Ozizza, Afikpo North, Ebonyi State, Nigeria. *Nigerian Journal of Biochemistry and Molecular Biology*, 38(1), 1-8. https://doi.org/10.2659/njbmb.2023.151.

14. Booth, J.S., Goldberg, E., Barnes, R.S., Greenwald, B.D., Sztein, M.B.: Oral typhoid vaccine Ty21a elicits antigen-specific resident memory CD4+ T cells in the human terminal ileum lamina propria and epithelial compartments. J Transl Med. 18, 102 (2020). https://doi.org/10.1186/s12967-020-02263-6
15. Postma, M., Biundo, E., Chicoye, A., Devlin, N., Mark Doherty, T., Garcia-Ruiz, A.J., Jaros, P., Sheikh, S., Toumi, M., Wasem, J., Beck, E., Salisbury, D., Nolan, T.: Capturing the value of vaccination within health technology assessment and health economics: Country analysis and priority value concepts. Vaccine. 40, 3999–4007 (2022). https://doi.org/10.1016/j.vaccine.2022.04.026
16. Agwu E, Ihongbe J C, Okogun G R A, Inyang N J(2009). High incidence of co-infection with Malaria and Typhoid in febrile HIV infected and AIDS patients in Ekpoma, Edo State, Nigeria. *Brazilian Journal of Microbiology, 40, 329-332.* https://doi.org/10.1590/S1517-83822009000200022.
17. Saxenian, H., Alkenbrack, S., Freitas Attaran, M., Barcarolo, J., Brenzel, L., Brooks, A., Ekeman, E., Griffiths, U.K., Rozario, S., Vande Maele, N., Ranson, M.K.: Sustainable financing for Immunization Agenda 2030. Vaccine. 42, S73–S81 (2024). https://doi.org/10.1016/j.vaccine.2022.11.037
18. Mirembe, B.B., Mazeri, S., Callaby, R., Nyakarahuka, L., Kankya, C., Muwonge, A.: Temporal, spatial and household dynamics of Typhoid fever in Kasese district, Uganda. PLoS One. 14, e0214650 (2019). https://doi.org/10.1371/journal.pone.0214650

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