Texila International Journal of Public Health
ISSN: 2520-3134
DOI: 10.21522/TIJPH.2013.13.01.Art073

Comparative Analysis between Vaccinated and Non-Vaccinated Sickle Cell Clients under 12 years against Influenzae and Pneumococcal Infections at Mulago National Referral Hospital, Kampala, Uganda

Kasirye Elizabeth Omagino[1*], Mubiru Denis[2], Kwesiga Justus[3]
[1]*Department of Public Health, Texilla University, Kampala, Uganda*
[2]*Department of Public Health, Malaria Consortium, Juba, South Sudan*
[3]*Department of Statistics, Joystus Consults Ltd, Kampala, Uganda*

Abstract

Sickle cell disease (SCD) is a group of inherited disorders characterized by the production of abnormal haemoglobin, known as haemoglobin S, leading to the distortion of red blood cells into a crescent shape. This disease significantly impairs the oxygen-carrying capacity of blood and results in recurrent vaso-occlusion, hemolytic anaemia, and organ damage. SCD patients are particularly vulnerable to infections due to complications such as functional asplenia, which weakens the immune system and heightens the risk of severe. Vaccination plays a crucial role in preventing infections in SCD patients, with recommended vaccines including those for pneumococcal, influenza, and meningococcal diseases. However, adherence to vaccination schedules remains a challenge, which can impact the health outcomes of these patients. This study investigated the incidence of influenza and pneumococcal infections among sickle cell disease (SCD) patients under 12 years old at Mulago National Referral Hospital in Uganda, assessing the effectiveness of current vaccination programs and identifying barriers to vaccine uptake. The study included 354 SCD patients, with 50% vaccinated and 50% non-vaccinated. Results indicate that vaccinated patients had a higher incidence of influenza (87.9%) compared to non-vaccinated patients (69.2%). However, hospitalization rates were higher among vaccinated patients, with 67.8% hospitalized for influenza. Pneumococcal infections were less frequent but still more common in vaccinated patients (11.3%) compared to non-vaccinated (5.1%). Despite this, vaccinated patients had significantly fewer hospital admissions and infections post-vaccination. Barriers to vaccine uptake were primarily due to knowledge gaps (89.3%), with fewer patients reporting issues like missed appointments or parental refusal.

Keywords: *Influenza, Pneumococcal Infections, Sickle Cell Disease, Vaccination, Vaccination Barriers.*

Introduction

Sickle cell disease (SCD) refers to a group of inherited red blood cell disorders that result in the production of abnormal haemoglobin, known as haemoglobin S. Vaccination, is the process by which an individual is made immune or resistant to an infectious disease, typically by the administration of a vaccine.

Patients with sickle cell disease are particularly vulnerable to infections due to ongoing vaso-occlusive damage to the spleen, resulting in functional asplenia and immune system impairment. The reduction in immune capacity is attributed to multiple factors, including functional asplenia, complement system defects, micronutrient deficiencies, and mechanical issues from vaso-occlusive crises [1, 2]. Functional asplenia heightens the risk of systemic infections by encapsulated bacteria like Streptococcus pneumoniae, Haemophilus

Received: 30.11.2024 ***Accepted: 22.01.2025*** ***Published on: 28.03.2025***
****Corresponding Author: betiko2007@gmail.com***

influenzae, and Neisseria meningitidis. Additionally, influenza infections can compromise respiratory mucosal immunity, leading to acute chest syndrome and fever, often necessitating hospital admission to rule out bacterial sepsis [3]. To prevent such infections, children with sickle cell disease should receive appropriate prophylactic measures, including oral penicillin until age 5 and adherence to the Advisory Committee on Immunization Practices (ACIP) recommended immunization schedule for asplenic patients.

The Advisory Committee on Immunization Practices (ACIP) recommends a specific immunization schedule for patients with sickle cell disease, which includes vaccines against Haemophilus influenzae type b, pneumococcal diseases (PCV7, PCV13, PPSV23), and meningococcal diseases (MenACWY and MenB) [4]. Research has shown that this augmented immunization schedule can significantly reduce the risk of invasive pneumococcal infections in patients under 10 years old by up to 68% [5]. Additionally, the administration of PCV7 and Hib vaccines to children with sickle cell disease has been shown to decrease mortality due to bacterial sepsis [6]. Specifically, mortality rates decreased from 0.59 to 0.52 deaths per 100 patient-years for patients with HbSS and HbSβ0 and from 0.24 to 0.1 deaths per 100 patient-years for patients with HbSC and HbSβ+ [6]. Despite the importance of these vaccines, adherence to and outcomes of the recommended immunization schedule remain a concern.

A retrospective cohort study conducted in 2014 on a Medicaid sample assessed adherence rates to the influenza vaccine, pneumococcal vaccines, and oral penicillin among patients with sickle cell disease [7]. The study revealed adherence rates of 21.6% for the influenza vaccine, 43.4% for the PPSV23 vaccine, 18.8% for penicillin prophylaxis, and 77.3% for the PCV7 vaccine. The findings indicated that children were more likely to follow the immunization schedule, though overall rates remained low. This issue of non-compliance is a common concern across many hematologic clinics in the United States.

Despite the existence of vaccines globally, SCD is a significant health concern. The World Health Organization (WHO) estimates that over 300,000 infants are born with SCD worldwide annually [7]. Vaccinations have been proven effective in preventing infections such as influenza and pneumococcal diseases, which are particularly fatal to individuals with SCD.

Sickle cell disease encompasses a group of inherited haemoglobin disorders marked by the prevalence of abnormal sickle haemoglobin in red blood cells. Sickle cell anaemia, the most common and severe form, arises from the homozygous inheritance of sickle haemoglobin from both parents [1]. When deoxygenated, sickle haemoglobin undergoes a conformational change leading to intracellular polymerization, which distorts the normal biconcave shape of erythrocytes into a pathological crescent form. This results in hemolytic anaemia, recurrent vaso-occlusion, and organ damage, causing significant morbidity and early mortality [1].

Globally, sickle hemoglobinopathies impose a considerable disease burden that remains inadequately addressed [8-10]. Accurate data is scarce, but it is estimated that 400,000 neonates are born with sickle cell disease annually, including 300,000 with sickle cell anaemia [11]. The highest burden is in sub-Saharan Africa, which accounts for over 75% of all cases and is expected to increase by 2050 [12]. In Africa, sickle cell disease significantly contributes to child mortality under five years old, hindering progress towards the UN Sustainable Development Goal 3, which aims to reduce childhood mortality [13].

In 2006, the WHO released a report on sickle cell disease in Africa, detailing its prevalence and providing care and management guidelines. The WHO emphasized the need to enhance awareness, prevention, and early detection of sickle cell disease. Sub-Saharan African

countries were urged to develop national strategies with specific goals for managing sickle cell disease. However, many health ministries face obstacles, such as the lack of accurate data on the disease's burden and distribution, preventing the creation of effective interventions [14].

Uganda was one of the first African countries to document a high burden of sickle cell disease. In 1949, significant variations in the prevalence of the sickle cell trait were reported among different tribes, from less than 5% among the Hamites in the southwest to over 20% among the northern Nilotic tribes (Lango and Acholi) [15]. Research has shown that Immunizations with conjugate vaccines against *S. pneumoniae* and *H. influenza* have significantly reduced bacteraemia in SCD [16]. Although vaccination has been conducted in Uganda, there remain some clients who have not yet been vaccinated in Uganda. No published study has been conducted at Mulago National Referral Hospital to compare the health outcomes of the vaccinated and those clients not vaccinated. Therefore, it would be good to study and compare the outcomes of the vaccinated vs those who are not yet vaccinated against these infections.

Sickle cell disease (SCD) remains a significant public health challenge, particularly in sub-Saharan Africa, where the burden is highest [17]. Vaccination has proven effective in reducing the incidence of severe infections among SCD patients, particularly against influenza and pneumococcal diseases, which are leading causes of morbidity and mortality in these patients [18]. The prevalence of SCD in Uganda is between 20% and 30%, and in some parts of Uganda, it is as high as 45% [19]. Studies have demonstrated that adherence to vaccination schedules, including the pneumococcal conjugate vaccine (PCV) and the influenza vaccine, significantly decreases infection rates and improves health outcomes in SCD patients [20, 21].

However, recent reports indicate that Mulago National Referral Hospital in Kampala, Uganda, administers these crucial vaccines to SCD patients. This remains a concern, given the hospital's pivotal role in managing SCD and the known benefits of vaccination in this vulnerable population. However, although many of these vaccines have been given to these children, the outcomes of vaccination have not been documented or followed up. This shows a knowledge gap on the outcomes/effectiveness of the vaccination. Therefore, this study was conducted to provide a comparative analysis between vaccinated and non-vaccinated SCD patients under 12 years old at Mulago National Referral Hospital to evaluate the impact of vaccination on their health outcomes.

Materials and Methods

Research Design

A comparative cross-sectional study design was employed to evaluate the health outcomes of vaccinated versus non-vaccinated SCD patients. A comparative cross-sectional study design involves comparing two or more groups to evaluate differences in a particular outcome or health parameter. In this case, the study will compare the health outcomes of two groups: vaccinated and non-vaccinated sickle cell disease (SCD) patients. The design allows researchers to assess whether there are differences in health outcomes, such as the incidence of influenza and pneumococcal infections, between these two groups. By collecting data at a single point in time, the study aims to provide insights into the potential impact of vaccination on reducing infection rates and improving overall health status among SCD patients. This design enables researchers to investigate associations between vaccination status and health outcomes, providing valuable information for informing healthcare policies and interventions aimed at enhancing the management of SCD.

Study Area

The study was conducted at Mulago National Referral Hospital, MwanaMugimu unit. This unit handles patients under 12 years of age who are Sickler. The hospital is the main National Referral Hospital and is in the heart of Kampala District, Kawempe District, Mulago Hill.

Mulago National Referral Hospital serves as the primary healthcare facility for managing SCD cases in Kampala, Uganda, making it a suitable setting for this research. By targeting this population.

Study Population

The study population comprised sickle cell disease (SCD) patients who were under 12 years old and were receiving medical care at Mulago National Referral Hospital. This population included children who had been diagnosed with SCD, a genetic blood disorder characterized by the presence of abnormal haemoglobin in red blood cells. Given that the focus is on children under 12 years old, the study aimed to assess the health outcomes and vaccination status of this specific age group within the SCD patient population.

Sample Size

Using Cochran's formula involves determining the sample size required for a study to achieve statistical validity. In this case, the formula was applied to calculate the appropriate sample size for the comparative analysis of vaccinated and non-vaccinated sickle cell disease (SCD) patients. Cochran's formula takes into account factors such as the desired level of confidence, expected proportion or prevalence, and a margin of error.

Using a prevalence of 13.5% (0.135) and the same assumptions for the confidence level (95%) and margin of error (5%), the sample size was computed using Cochran's formula:

Where:

Z= Z-score corresponding to the desired confidence level (1.96 for a 95% confidence level).

p = 0.135 (prevalence of the characteristic of interest) from Chen et al. (2019) in Uganda.

q=1−p.

e = Margin of error (0.05 for 5%).

Substituting these values into the formula:

(n=1.962·0.135· (1-0.135))/ (0.05*0.05)

n=176.8 = 177.

The study, therefore involved a sample of 177 vaccinated and 177 non-vaccinated SCD patients (354).

Data Collection Techniques and Tools

A checklist was used to collect data from records of children less than 12 years old at Mulago National Referral Hospital.

Data Analysis Plan and Statistical Tests

Data was analyzed using SPSS software version 25. Descriptive statistics and inferential analyses such as chi-square tests were conducted to compare health outcomes between vaccinated and non-vaccinated groups.

Results

Table 1. Socio-demographic Characteristics of Sickle Cell Patients

Variables	Frequency	Per cent
Gender		
Female	205	57.9
Males	149	42.1
Age		
Less than 6 years	134	37.9
6 To 12 years	220	62.1
Sickle cell disease status		
HBASI	5	1.4

HBS	5	1.4
HBSS	344	97.2

Results from the study indicate that the majority of the sickle cell patients, 205 (57.9%), were female, while 149 (42.1%) were male. Regarding age distribution, a significant proportion, 220 (62.1%), were aged 6 to 12 years, compared to 134 (37.9%) who were less than 6 years old. In terms of sickle cell disease status, most patients, 344 (97.2%), were diagnosed with HBSS, while only 5 (1.4%) had HBASI and another 5 (1.4%) had HBS.

Table 2. Vaccination Status of Sickle Cell Patients

Variables	**Frequency**	**Per cent**
Vaccination status		
Vaccinated	177	50.0
Non-Vaccinated	177	50.0
Schedules taken		
Full	24	13.6
Partial	153	86.4
Health worker who administered the vaccine		
Doctor	5	2.8
Nurse	172	97.2

Results from the study reveal that half of the sickle cell patients, 177 (50.0%), were vaccinated, while the remaining 177 (50.0%) were not vaccinated. Among those vaccinated, the majority, 153 (86.4%), had taken partial vaccination schedules, while only 24 (13.6%) had completed the full vaccination schedule. Regarding the healthcare personnel administering the vaccines, the vast majority, 172 (97.2%), were nurses, with only 5 (2.8%) being doctors.

Table 3. The Incidence of Influenza and Pneumococcal Infections among Vaccinated and Non-vaccinated Sickle Cell Disease (SCD) Patients under 12 years

Incidence of influenzas, pneumococcal among others	**Vaccinated**		**Non vaccinated**	
	Frequency	**Per cent**	**Frequency**	**Per cent**
Diagnosis of influenza infection				
Yes	153	87.9	119	69.2
No	21	12.1	53	30.8
Hospitalization against influenza				
Yes	120	67.8	74	41.8
No	57	32.2	103	58.2
Diagnosis of pneumococcal infection				
Yes	20	11.3	9	5.1
No	157	88.7	168	94.9
Hospitalized against pneumococcal infection				
Yes	21	11.9	18	10.2
No	153	88.1	159	89.8
Complications due to infections such as pneumonia, sepsis				

Yes	115	65.0	89	50.3
No	59	33.3	88	49.7
Sickle cell-related complications among non-vaccinated				
Painful	148	83.6	152	85.9
Anemia	29	16.4	25	14.1
Other relevant co-morbidities				
Asthma	3	1.8	-	-
Immunodeficiency	25	14.6	17	9.6
None	143	83.6	160	90.4
Antimicrobial/antibiotic treatments received				
No	15	8.5	42	23.7
Yes	162	91.5	135	76.3

Results from the study highlight differences in the incidence and outcomes of influenza and pneumococcal infections among vaccinated and non-vaccinated sickle cell disease (SCD) patients under 12 years old at Mulago National Referral Hospital. Among vaccinated patients, 153 (87.9%) were diagnosed with influenza, compared to 119 (69.2%) of non-vaccinated patients. Hospitalization due to influenza was higher in vaccinated patients, with 120 (67.8%) hospitalized compared to 74 (41.8%) among non-vaccinated patients.

Regarding pneumococcal infections, 20 (11.3%) vaccinated patients were diagnosed, compared to 9 (5.1%) non-vaccinated patients. Hospitalization due to pneumococcal infections was slightly higher among vaccinated patients, with 21 (11.9%) hospitalized compared to 18 (10.2%) among non-vaccinated patients. Complications such as pneumonia and sepsis were more common in vaccinated patients, affecting 115 (65.0%) compared to 89 (50.3%) among non-vaccinated patients.

Sickle cell-related complications showed slight differences; painful episodes were reported by 148 (83.6%) vaccinated patients and 152 (85.9%) non-vaccinated patients, while anaemia was observed in 29 (16.4%) vaccinated patients and 25 (14.1%) non-vaccinated patients. Co-morbidities included asthma in 3 (1.8%) vaccinated patients, immunodeficiency in 25 (14.6%) vaccinated and 17 (9.6%) non-vaccinated patients, and no co-morbidities in 143 (83.6%) vaccinated and 160 (90.4%) non-vaccinated patients.

Regarding antimicrobial or antibiotic treatments, 162 (91.5%) vaccinated patients received treatment compared to 135 (76.3%) non-vaccinated patients. Conversely, only 15 (8.5%) vaccinated patients and 42 (23.7%) non-vaccinated patients did not receive such treatments.

Table 4. The Effectiveness of Current Vaccination Programs for SCD Patients at Mulago National Referral Hospital

Variables	**Freq**	**Perce**
Number of admissions (Mean-3.1, Mode-3, Max-6)		
less than 3	109	61.6
3 to 6	65	36.7
Number of admissions after vaccination (Mean-1.4, Mode-1, Max-7)		
Less than 3	109	97.3
3 and above	3	2.7
Frequency of infections (Mean-9.8, Mode-10, Max-17)		

less than 6	37	21.3
6 to 12	93	53.4
13 and more	44	25.3
Frequency of infection after vaccination (Mean-2.95, Mode-2, Max-8)		
Less than 6	174	98.3
6 and more	3	1.7
Number of admissions among none vaccinated (Mean-3.5, Mode-4, Max-8)		
less than 3	84	48.8
3 to 6	84	48.8
More than 6	4	2.4
Frequency of infections among none vaccinated (Mean-8.7, Mode-9, Max-15)		
less than 6	45	25.4
6 to 12	118	66.7
13 and more	14	7.9

Results from the study provide insights into the effectiveness of current vaccination programs for sickle cell disease (SCD) patients at Mulago National Referral Hospital. Among vaccinated patients, the average number of admissions dropped from a mean of 3.1 (with a mode of 3 and a maximum of 6) to 1.4 (with a mode of 1 and a maximum of 7). Before vaccination, 109 (61.6%) patients had fewer than three admissions, while 65 (36.7%) experienced between three and six admissions. After vaccination, 109 (97.3%) patients reported fewer than three admissions, and only 3 (2.7%) reported three or more as seen in Figure 1.

In terms of infection frequency, vaccinated patients had a mean of 9.8 infections (with a mode of 10 and a maximum of 17) before vaccination. The majority, 93 (53.4%), experienced between six and twelve infections, and 44 (25.3%) had thirteen or more. Post-vaccination, the average frequency of infections reduced to 2.95 (with a mode of 2 and a maximum of 8), with 174 (98.3%) patients reporting fewer than six infections and only 3 (1.7%) reporting six or more as seen in Figure 2.

For non-vaccinated patients, the average number of admissions was slightly higher, with a mean of 3.5 (mode of 4 and maximum of 8). Half, 84 (48.8%), experienced fewer than three admissions, while 84 (48.8%) had three to six admissions, and 4 (2.4%) reported more than six. Regarding infection frequency, non-vaccinated patients had an average of 8.7 infections (mode of 9 and maximum of 15). Most, 118 (66.7%), had six to twelve infections, while 14 (7.9%) reported thirteen or more.

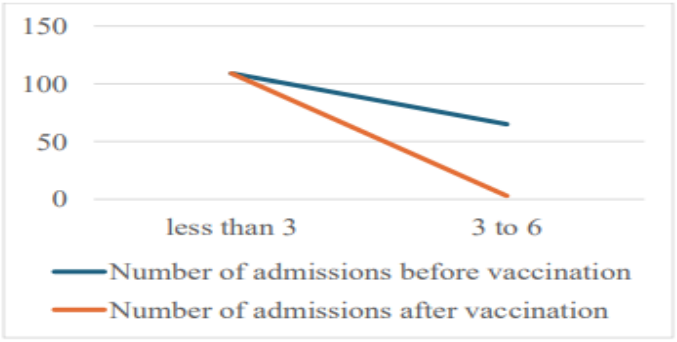

Figure 1. Number of Admissions before Vaccination and after Vaccination

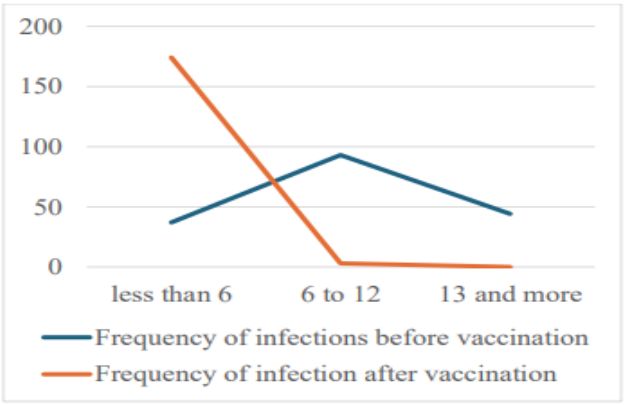

Figure 2. Frequency of Infections Before Vaccination and After Vaccination

Table 5. Barriers to Vaccine Uptake among SCD Patients

Barriers to vaccine uptake	**Frequency**	**Per cent**
Parental/guardian refusal	5	2.8
Documentation of missed vaccination appointments	10	5.6
Knowledge gaps	158	89.3
Influence of Health Facility Policies	4	2.3
Total	**177**	**100.0**

The most significant barrier identified was knowledge gaps, reported by 158 (89.3%) of respondents. This suggests a widespread lack of awareness or understanding of the importance and availability of vaccinations for SCD patients. Missed vaccination appointments, as documented, accounted for 10 (5.6%) of the cases, indicating logistical or scheduling challenges. Parental or guardian refusal to vaccinate contributed to 5 (2.8%) of the barriers, reflecting potential cultural or personal reservations. Additionally, health facility policies influenced vaccine uptake in 4 (2.3%) of the cases.

Discussion

Socio-demographic Characteristics of Sickle Cell Patients

The findings indicate that the majority of sickle cell patients at Mulago National Referral Hospital are female (57.9%), with a significant proportion (62.1%) aged between 6 and 12 years. These results align with global trends in sickle cell disease (SCD) prevalence, where

early childhood is marked by a higher disease burden and the need for intensive management. The predominance of the HBSS genotype (97.2%) in this study is consistent with the literature, which identifies HBSS as the most severe form of SCD and the most commonly diagnosed genotype in sub-Saharan Africa.

Vaccination Status of Sickle Cell Patients

The study revealed that only 50% of the patients were vaccinated, and among them, 86.4% had only partially completed their vaccination schedules. This suggests significant gaps in vaccination coverage among SCD patients, a population that is highly vulnerable to infections. The predominant role of nurses (97.2%) in administering vaccines highlights their central position in immunization programs. However, the low full-vaccination rate indicates barriers to completing vaccination schedules, warranting further exploration.

Incidence of Influenza and Pneumococcal Infections among Vaccinated and Non-vaccinated Patients

The results demonstrate notable differences in infection rates between vaccinated and non-vaccinated patients. Vaccinated patients had a higher reported incidence of influenza diagnosis and hospitalizations. This paradox may reflect better health-seeking behaviour and diagnostic vigilance among vaccinated patients. Similarly, while pneumococcal infections were relatively low in both groups, a slightly higher incidence among vaccinated patients may suggest improved identification due to regular follow-up.

Complications such as pneumonia and sepsis were more frequent among vaccinated patients, potentially reflecting a higher likelihood of these patients accessing care for severe cases. Vaccinated patients also had slightly higher antibiotic use, underscoring the role of proactive treatment in reducing disease severity.

Effectiveness of Current Vaccination Programs

Vaccination programs have significantly reduced the number of hospital admissions and infection frequencies among SCD patients. The mean number of admissions decreased from 3.1 to 1.4 post-vaccination, while the mean infection frequency dropped from 9.8 to 2.95. In contrast, non-vaccinated patients experienced higher mean admissions (3.5) and infection frequencies (8.7), underscoring the protective effect of vaccinations. These findings align with studies that highlight reduced hospitalizations and infections among vaccinated SCD populations [22, 23].

Barriers to Vaccine Uptake

The study identified knowledge gaps as the primary barrier to vaccine uptake, reflecting a critical need for targeted education and awareness campaigns. Other barriers, such as missed vaccination appointments, parental refusal, and health facility policies, point to systemic and individual challenges. These findings are consistent with other studies that identified education level and regular healthcare follow-ups as significant determinants of vaccination status [24].

The study's findings are consistent with global evidence on the impact of vaccinations in reducing the burden of influenza and pneumococcal infections among SCD patients. Studies done [25, 26] confirm the role of vaccines in reducing severe complications like pneumonia and sepsis. Vaccines such as PCV13 and influenza vaccines have shown significant efficacy [27, 28], yet challenges in coverage persist [29].

These results highlight the critical need for enhanced vaccination programs tailored to SCD patients. While current vaccinations are effective in reducing severe infections and hospitalizations, the low uptake underscores systemic gaps. The findings emphasize the importance of addressing barriers such as knowledge gaps and strengthening healthcare

systems to support adherence. Bridging the research gap in Uganda through locally relevant data and interventions can significantly improve vaccination coverage and health outcomes for children with SCD.

Implications for Clinical Practice

The findings of this study highlight critical implications for clinical practice, particularly in managing children with sickle cell disease (SCD). The significant reduction in hospitalization rates, infection frequency, and disease complications among vaccinated patients underscores the importance of prioritizing immunization in this high-risk population. Health practitioners should enhance vaccination coverage by ensuring adherence to recommended schedules for pneumococcal and influenza vaccines, addressing barriers such as knowledge gaps and logistical challenges. Integrating vaccination programs into routine SCD care, coupled with tailored education for caregivers on the benefits of immunization, could further improve health outcomes. Additionally, the role of nurses, who administer the majority of vaccines, emphasizes the need for empowering frontline healthcare workers through training and resource allocation to deliver effective immunization services. These strategies can lead to a decrease in preventable complications, improve the quality of life for SCD patients, and reduce the burden on healthcare systems.

Implications for Future Research

There is a need for longitudinal studies to evaluate the long-term effectiveness of pneumococcal and influenza vaccines in reducing morbidity and mortality among SCD patients in Uganda. Further research should explore the specific barriers to vaccine uptake, such as knowledge gaps, logistical challenges, and sociocultural factors, to design tailored interventions for improving immunization adherence. Additionally, studies comparing the efficacy of newer vaccines, such as PCV15 and PCV20, against the strains most prevalent in this region could provide valuable insights. Research into the economic impact of increased vaccination rates could also help inform policy decisions by demonstrating the cost-effectiveness of immunization programs. Finally, qualitative studies involving caregivers and healthcare providers can deepen the understanding of the challenges and opportunities in implementing comprehensive vaccination strategies for SCD patients. This evidence can guide the development of targeted policies and practices to optimize vaccination coverage and outcomes.

Limitation

The cross-sectional design of the study limits the ability to establish causal relationships between vaccination status and infection outcomes. The study was conducted at a single hospital, which may affect the generalizability of the findings to other regions or healthcare settings in Uganda.

The study also lacked funding, which made the study be conducted in one Hospital. Conducting this study in hospitals across the country would necessitate adequate resources.

The study's focus on children under 12 years old may not fully capture the vaccination challenges and outcomes for adolescents or adults with SCD and also the outcomes of vaccination.

Recommendation

The Government of Uganda should prioritize the integration of comprehensive vaccination programs into national health policies aimed at preventing infections among sickle cell disease (SCD) patients. Given the high incidence of influenza and pneumococcal infections in this vulnerable population, it is crucial to ensure that vaccines, such as the pneumococcal conjugate vaccine and influenza vaccine, are made more accessible, especially for children under 12 years. Additionally, the government should invest in educating both

healthcare providers and the public on the importance of vaccination for SCD patients. Policies should also be developed to ensure that vaccines are part of routine healthcare for SCD patients, particularly in high-risk groups, and to address barriers like missed vaccination appointments and knowledge gaps.

The Ministry of Health should work towards improving the implementation and accessibility of vaccination programs for SCD patients at national and regional levels. Efforts should be directed at raising awareness among healthcare workers and communities about the importance of immunization in reducing the burden of pneumococcal and influenza infections. The Ministry could facilitate continuous training for healthcare providers to ensure they are well-informed on the latest vaccination schedules and ensure these vaccines are included in routine check-ups for SCD patients. Furthermore, collaboration with international health organizations to provide financial and logistical support for vaccine distribution could significantly improve vaccination uptake. The Ministry should also monitor vaccine coverage and infection outcomes, establishing systems for tracking and evaluating vaccination rates and their effectiveness in preventing infections among SCD patients.

The management of Mulago Hospital should prioritize the establishment of a robust vaccine monitoring and administration system within the hospital, especially in the paediatric and haematology departments where SCD patients are treated. This includes ensuring that vaccines are readily available and accessible for all eligible SCD patients. The hospital management should work with the Ministry of Health to facilitate ongoing education for both patients and healthcare providers on the benefits of vaccination. This can be done through seminars, health talks, and regular reminders about the importance of completing vaccination schedules. Moreover, Mulago Hospital should invest in improving patient tracking systems to identify missed vaccinations and follow up with patients and guardians, addressing any logistical barriers to vaccine uptake.

Guardians of SCD patients play a pivotal role in ensuring that their children receive the necessary vaccinations to prevent infections. It is essential for guardians to actively engage with healthcare providers to understand the vaccination schedule and ensure that all doses are completed. Guardians should prioritize vaccination as part of their child's routine healthcare, as it can significantly reduce the risk of serious infections like pneumonia, sepsis, and influenza. By ensuring timely vaccination and consistent follow-up, guardians can help improve the health outcomes of children with SCD and reduce the likelihood of severe infections and hospitalizations.

Conclusion

In conclusion, this study aimed to assess the incidence of influenza and pneumococcal infections among vaccinated and non-vaccinated sickle cell disease (SCD) patients under 12 years old at Mulago National Referral Hospital, evaluate the effectiveness of current vaccination programs, and identify barriers to vaccine uptake. The findings indicate that vaccination significantly reduces the incidence of both infections and related hospitalizations, with vaccinated patients experiencing fewer complications compared to non-vaccinated patients. Additionally, the study highlighted the suboptimal vaccination rates among SCD patients and identified knowledge gaps, missed appointments, and logistical barriers as key factors influencing vaccine uptake.

Funding Sources

This study was entirely self-funded by the principal investigator, with no external financial support from donors or organizations. However, a potential funder for this project is welcomed so that a country-wide study is done. Despite the absence of external funding, this study is crucial in shedding light on the

Comparative analysis between vaccinated and non-vaccinated Sickle Cell Clients under 12 years against influenza and pneumococcal infections.

Conflict of Interest

The authors declare no conflicts of interest regarding the publication of this research.

Acknowledgements

I would like to express my deepest appreciation to all those who provided me with the possibility to complete this report. Special gratitude goes to the management of Mulago Hospital, Mwanamugimu, co-Author Dr Mubiru Denis, Mr Kwesiga Justus, and Aguti Bridget for the guidance and support that helped me accomplish my research on time and for writing this report.

References

[1]. Rees David, C., Williams Thomas, N., and Gladwin Mark, T., 2010,"Sickle-cell disease," *The Lancet*, vol. 376, pp. 2018-2031, 2010.

[2]. Yawn Barbara, P., Buchanan George, R., Afenyi-Annan Araba, N., Ballas Samir, K., Hassell Kathryn, L., James Andra, H., *et al.*, 2014,"Management of sickle cell disease: summary of the 2014 evidence-based report by expert panel members," *Jama*, vol. 312, pp. 1033-1048, 2014.

[3]. Bundy David, G., Muschelli John, Clemens Gwendolyn, D., Strouse John, J., Thompson Richard, E., Casella James, F., *et al.*, 2016,"Preventive care delivery to young children with sickle cell disease," *Journal of pediatric hematology/oncology*, vol. 38, pp. 294-300, 2016.

[4]. Advisory Committee on Immunization Practices, 2017,"Recommended immunization schedule for children and adolescents aged 18 years or younger, United States, 2017," ed: US Department of Health and Human Services, CDC, Atlanta, GA.

[5]. Adamkiewicz Thomas, V., Silk Benjamin, J., Howgate James, Baughman Wendy, Strayhorn Gregory, Sullivan Kevin, *et al.*, 2008,"Effectiveness of the 7-valent pneumococcal conjugate vaccine in children with sickle cell disease in the first decade of life," *Pediatrics*, vol. 121, pp. 562-569, 2008.

[6]. Quinn Charles, T., Rogers Zora, R., Mccavit Timothy, L., and Buchanan George, R., 2010,"Improved survival of children and adolescents with sickle cell disease," *Blood, The Journal of the American Society of Hematology*, vol. 115, pp. 3447-3452, 2010.

[7]. Beverung Lauren, M., Brousseau David, Hoffmann Raymond, G., Yan, Ke, and Panepinto Julie, A., 2014,"Ambulatory quality indicators to prevent infection in sickle cell disease," *American Journal of Hematology*, vol. 89, pp. 256-260, 2014.

[8]. Weatherall David, J., 2010,"The inherited diseases of hemoglobin are an emerging global health burden," *Blood, The Journal of the American Society of Hematology*, vol. 115, pp. 4331-4336, 2010.

[9]. Weatherall David, J., 2011,"The challenge of haemoglobinopathies in resource-poor countries," *British Journal of Haematology*, vol. 154, pp. 736-744, 2011.

[10]. Mcgann Patrick, T., 2014,"Sickle cell anemia: an underappreciated and unaddressed contributor to global childhood mortality," *The Journal of Pediatrics*, vol. 165, pp. 18-22, 2014.

[11]. Piel Frédéric, B., Patil Anand, P., Howes Rosalind, E., Nyangiri Oscar, A., Gething Peter, W., Dewi Mewahyu, *et al.*, 2013,"Global epidemiology of sickle haemoglobin in neonates: a contemporary geostatistical model-based map and population estimates," *The Lancet*, vol. 381, pp. 142-151, 2013.

[12]. Piel Frederic, B., Hay Simon, I., Gupta Sunetra, Weatherall David, J., and Williams Thomas, N., 2013,"Global burden of sickle cell anaemia in children under five, 2010–2050: modelling based on demographics, excess mortality, and interventions," *PLoS medicine*, vol. 10, p. e1001484, 2013.

[13]. Grosse Scott, D., Odame Isaac, Atrash Hani, K., Amendah Djesika, D., Piel Frédéric, B., and Williams Thomas, N., 2011,"Sickle cell disease in

Africa: a neglected cause of early childhood mortality," *American journal of preventive medicine*, vol. 41, pp. S398-S405, 2011.

[14]. Diallo Dapa, A., and Guindo Aldiouma, 2014,"Sickle cell disease in sub-Saharan Africa: stakes and strategies for control of the disease," *Current opinion in hematology*, vol. 21, pp. 210-214, 2014.

[15]. Lehmann Hermann, and Raper Alan, B., 1949,"Distribution of the sickle-cell trait in Uganda, and its ethnological significance," *Nature*, vol. 164, pp. 494-495, 1949.

[16]. John, A. B., Ramlal, A., Jackson, H., Maude, G. H., Sharma, A., Waight, and Serjeant, G.R., 1984,"Prevention of pneumococcal infection in children with homozygous sickle cell disease," *Br Med J (Clin Res Ed)*, vol. 288, pp. 1567-1570, 1984.

[17]. Hsu, Lewis, Nnodu, Obiageli E., Brown, Biobele J., Tluway, Furahini, King, Shonda, Dogara, Livingstone G., *et al.*, 2018,"White paper: pathways to progress in newborn screening for sickle cell disease in sub-Saharan Africa," *Journal of tropical diseases & public health*, vol. 6, 2018.

[18]. Schembri Stuart, Morant Steve, Winter John, H., and Macdonald Thomas, M., 2009,"Influenza but not pneumococcal vaccination protects against all-cause mortality in patients with COPD," *Thorax*, vol. 64, pp. 567-572, 2009.

[19]. Who. (2016, Uganda Prioritizes response to Sickle Cell Disease. Available: https://www.afro.who.int/news/uganda-prioritizes-response-sickle-cell-disease

[20]. Sobota, Amy, Sabharwal, Vishakha, Fonebi, Gwendoline, and Steinberg, Martin, 2015,"How we prevent and manage infection in sickle cell disease," *British Journal of Haematology*, vol. 170, pp. 757-767, 2015.

[21]. Jarovsky Daniel, Bastos Phillipe Romanzini, De Matos Samantha Faria, Almeida Flávia Jacqueline, Sáfadi Marco Aurélio Palazzi, Hegg Izabella Campos Oliveira, *et al.*, 2022,"Vaccination in pediatric patients with sickle-cell disease: uptake report and mini-review," *Journal of Tropical Pediatrics*, vol. 68, p. fmac034, 2022.

[22]. Oligbu, G., Fallaha, M., Pay, L., and Ladhani, S., 2019,"Risk of invasive pneumococcal disease in children with sickle cell disease in the era of conjugate vaccines: a systematic review of the literature," *Br J Haematol*, vol. 185, pp. 743-751, May 2019.

[23]. Gomes, L. M., Vieira, M. M., Reis, T. C., Barbosa, T. L., and Caldeira, A. P., 2011,"Knowledge of family health program practitioners in Brazil about sickle cell disease: a descriptive, cross-sectional study," *BMC Fam Pract*, vol. 12, p. 89, Aug 19 2011.

[24]. Vardavas, C., Nikitara, K., Aslanoglou, K., Lagou, I., Marou, V., Phalkey, R., *et al.*, 2023,"Social determinants of health and vaccine uptake during the first wave of the COVID-19 pandemic: A systematic review," *Prev Med Rep*, vol. 35, p. 102319, Oct 2023.

[25]. Luna, C. M., 2022,"Impact of vaccination on the epidemiology and prognosis of pneumonia," *Rev Esp Quimioter*, vol. 35 Suppl 1, pp. 104-110, Apr 2022.

[26]. Rademacher, Jessica, Therre, Markus, Hinze, Christopher Alexander, Buder, Felix, Böhm, Michael, and Welte, Tobias, 2024,"Association of respiratory infections and the impact of vaccinations on cardiovascular diseases," *European Journal of Preventive Cardiology*, vol. 31, pp. 877-888, 2024.

[27]. Berical, A. C., Harris, D., and Dela Cruz, C. S., 2016,"Pneumococcal Vaccination Strategies. An Update and Perspective," vol. 13, pp. 933-44, Jun 2016.

[28]. Dunne Eileen, M., Cilloniz Catia, Von Mollendorf Claire, Lewnard Joseph, Grant Lindsay, R., Slack Mary, P. E., *et al.*, 2023,"Pneumococcal Vaccination in Adults: What Can We Learn From Observational Studies That Evaluated PCV13 and PPV23 Effectiveness in the Same Population?," *Archivos de Bronconeumología*, vol. 59, pp. 157-164, 2023/03/01/ 2023.

[29]. Licciardi, P., and Papadatou, I., 2019,"Pneumococcal Vaccines: Challenges and Prospects," *Vaccines (Basel)*, vol. 7, Feb 27 2019.