

**| RESEARCH ARTICLE****Effectiveness Of Reminders On Birth,Health Outcomes And Breastfeeding Practices Among HIV Exposed Infants In Nyahururu County Referral Hospital. Kenya****Lodeke L. Silas<sup>1</sup>✉, Simon Karanja K<sup>2</sup> and Lihana Raphael W<sup>3</sup>**<sup>1&2</sup> College of Health Sciences, School of Public Health, Jomo Kenyatta University of Agriculture and Technology<sup>3</sup>Centre for Virus Research Kenya Medical Research Institute**Corresponding Author:** Lodeke L. Silas, **E-mail:** [silaslodeke@gmail.com](mailto:silaslodeke@gmail.com)**| ABSTRACT**

Globally, about 1.5 million infants are born to HIV-positive mothers each year, with 90% of these births occurring in Sub-Saharan Africa, where the burden of HIV is greatest. Despite the proven effectiveness of antiretroviral therapy (ART), 300,000 to 400,000 infants are still born into HIV-positive environments annually due to inadequate access to ART, weak healthcare systems, and low maternal adherence. Without proper treatment and care, a significant number of HIV-infected children die before the age of two, with over 50% dying in early infancy, where mortality peaks. This study aimed to determine the effectiveness of reminders on birth outcomes, health status, and breastfeeding practices among HIV-exposed infants at Nyahururu County Referral Hospital. The research was conducted at the hospital's Comprehensive Care Centre using a quasi-experimental design. Systematic sampling was employed to select 220 HIV-exposed infants receiving reminders and social support, and 220 infants from historical records on routine follow-up. Data were collected using standardized questionnaires and analyzed using SPSS. Descriptive statistics, including frequencies and percentages, were used alongside inferential statistics—such as correlation analysis, simple linear regression, and Chi-square tests—with a significance level set at  $p < 0.05$ . The study found that a significantly higher proportion of infants in the reminder group tested HIV-negative (98.2%) compared to 95.0% in the routine care group. A correlation coefficient of 0.78 indicated a strong positive relationship between the use of reminders and improved health outcomes for HIV-exposed infants, including higher survival rates. The regression coefficients ( $\beta$ ) suggested that each unit increase in the use of reminders corresponded with improved outcome variables. A low p-value of 0.01 confirmed the statistical significance of these relationships. The Chi-square value of 20.8 demonstrated a significant association between the use of reminders and better health outcomes, highlighting the impact of reminder systems on enhancing infant health and survival. The study concludes that reminders significantly improve infant health outcomes. It recommends integrating structured reminder systems and social support into maternal and child health programs to strengthen adherence to antenatal care (ANC) and ART, improve birth outcomes, encourage exclusive breastfeeding, and enhance the survival of HIV-exposed infants.

**| KEYWORDS**

Breastfeeding practices, Health Outcomes, Birth Outcomes, HIV Exposed Infants

**| ARTICLE INFORMATION****ACCEPTED:** 04 May 2026**PUBLISHED:** 28 May 2026**1. Introduction**

HIV Exposed Infants (HEI) refers to infants born of an HIV positive mother (Tariq & Kasadha, 2022). This category of infants is at a greater risk of facing complications as, HIV infections, prematurity, low weight, or sepsis. According The prevalence of HIV infection among infants born to HIV positive mothers is 5.5% (WHO,2023). With lack of proper treatment and care, a significant number of HIV infected children die before the age two years, with more than 50% dying before the age of two years and a peak mortality at early infancy (Prendergast & Evans, 2023).

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Infants exposed to HIV who do not receive timely HIV testing, antiretroviral therapy (ART), and appropriate healthcare services face a significantly higher risk of early mortality, particularly in the absence of prompt diagnosis and treatment (Ameyaw *et al.*, 2024). Due to their weakened immune systems, HIV exposed infants (HEIs) are highly susceptible to infections, including respiratory, gastrointestinal, and invasive bacterial diseases, further increasing their vulnerability (Kawuma *et al.*, 2021). Additionally, poor maternal health, inadequate nutrition, and insufficient infant care contribute to malnutrition, growth failure, and stunting. This is especially concerning in Sub-Saharan Africa, where underweight and stunting are common among children, particularly those exposed to HIV (UNICEF, 2020).

To address these gaps, strategies such as reminder systems and strong social support networks have proven effective in reducing default rates and improving care outcomes. ART non-adherence increases viral load, which significantly raises the risk of HIV transmission during pregnancy and lactation (Slogrove&Powis, 2021). In Ghana, Ameyaw *et al.* (2024) observed that social support considerably contributed to adherence to antiretroviral therapy (ART) and encourage retention among HIV positive pregnant. In Uganda, Sabin *et al.* (2020) indicate that it is crucial for HIV exposed infants (HEIs) to have timely follow up visits for growth monitoring, basic HIV screening, immunizations, and readily treatable infection control.

Unfortunately, many mothers do not show up for health visits because of apparent reasons such as great expense, significant distance to health facilities, and lack of appropriate attendant systems. To assist in increasing turn up rates for infant health check-up appointments, SMS and automated phone reminder systems have been utilized. A SMS reminder for caregivers' study in Uganda proved to increase attendance rates for the immunization and HIV testing (Kawuma *et al.*, 2021). As noted by Abbo (2022), the implementation of reminder systems aids in the reduction of lost chances for an HIV assessment in different parts of Kenya, allowing for faster detection and swift action, which helps in HIV prevention and protects the health of the child. Although reminder systems have helped with increased engagement in health care, the primary effects on birth results, including low birth weight, preterm births, and infections, are yet to be fully understood (Mogaka *et al.*, 2023).

Reminders, such as SMS messages, phone calls, or app-based alerts, are used to prompt timely clinic visits, medication adherence, and infant testing appointments (Mogaka *et al.*, 2023). These tools help counteract forgetfulness, improve routine engagement with healthcare services, and address gaps in adherence to antiretroviral therapy (ART) and early infant diagnosis (EID) schedules. Subandi (2023) has shown that reminders significantly increase the rate of HIV testing among infants and promote maternal retention in PMTCT (Prevention of Mother-To-Child Transmission) programs (Sabin *et al.*, 2020). The use of reminders is especially valuable in resource-limited settings where physical follow-up may be challenging and health system infrastructure is often strained. Equally critical is the role of social support, which includes emotional, informational, and instrumental assistance from family, peers, healthcare workers, and the community (Wang *et al.*, 2020).

In South Africa, Dube-Pule *et al.* (2021) evaluated the effectiveness of an SMS-based mobile health (mHealth) intervention in enhancing adherence to infant antiretroviral (ARV) prophylaxis and improving the uptake of early infant diagnosis (EID) and PMTCT practices. Among the 251 mothers enrolled, 73.3% of infants received HIV PCR testing at 10 weeks postpartum—a rate notably higher than typically reported in national studies, though not statistically significant compared to the district's data at the time.

The intervention helped address gaps in maternal knowledge regarding EID timing and highlighted challenges in the implementation of PMTCT protocols. High-risk mothers tended to be younger, initiated antenatal care later, had less knowledge of prophylaxis, and delivered lower-birthweight infants. In Tanzania, Saleh *et al.* (2023) investigated the associations between maternal antenatal depression, social support, and infant growth and developmental outcomes among mothers living with HIV. Among 2,298 pregnant women living with HIV, 67% exhibited symptoms consistent with antenatal depression.

In Kenya, Kinuthia *et al.* (2021) evaluated the effectiveness of short message service (SMS) messaging in improving maternal retention in HIV care, viral suppression, and infant HIV survival among pregnant and postpartum women living with HIV. Among 824 pregnant women enrolled across six maternal-child health clinics, the study found no statistically significant improvement in viral suppression, clinic attendance, or infant HIV survival between women receiving SMS (either one-way or two-way) and those receiving no SMS.

### **1.1 Statement of the Problem**

Globally, about 1.5 million infants are born to HIV positive mothers each year, with 90% of these births occurring in Sub-Saharan Africa, where the burden of HIV is greatest (UNAIDS, 2021). Despite ART's proven effectiveness, 300,000 to 400,000 infants are still born into HIV positive environments annually due to inadequate ART access, weak healthcare systems, and low maternal adherence (UNAIDS, 2020). Sub-Saharan Africa continues to bear the greatest burden of HIV exposure among infants, accounting for roughly 90% of global cases, with over one million infants born to HIV positive mothers each year (UNICEF, 2020).

The prevalence of HIV among pregnant women in the region ranges from 10% to 30% depending on the locality, fueling the high number of HIV exposed infants (UNAIDS, 2021). Although antiretroviral therapies (ART) are widely promoted, their effectiveness is often undermined by poor access and inconsistent adherence (Ameyaw et al., 2024). In areas where ART coverage is incomplete, vertical transmission rates can reach between 15% and 45% (WHO, 2021). In 2020, Sub-Saharan Africa, more 160,0000 infants were newly infected (UNAIDS, 2021). In East Africa, the prevalence of HIV infection among HIV exposed infants (HEIs) stands at 7.68%, highlighting the persistent challenge of preventing mother-to-child transmission (Belachew, Tewabe&Malede, 2020).

In Kenya, the MTCT rate is 6.1%, indicating that for every 100 HIV positive mothers, over six infants are born with the virus. Laikipia County reflects an even more concerning trend, with a 7.9% infection rate among children in 2019. Currently, HIV transmission at six weeks of age is 4.1%, which poses a serious threat to infant survival. Laikipia alone contributed 0.5% of Kenya's total new HIV infections (Mwangi *et al.*, 2019). Laikipia County in Kenya has made significant strides toward the eradication of mother-to-child transmission (MTCT) of HIV through a multi-sectoral and community-based approach. A survey by Makokha et al. (2018) found that integrating community-led interventions contributed to increased antenatal care (ANC) attendance, higher rates of HIV testing, and lower transmission rates. These interventions have enhanced awareness and accessibility of prevention of mother-to-child transmission (PMTCT) services across the county. The study also emphasized how grassroots health education and local support networks have helped reduce stigma and encouraged expectant mothers living with HIV to seek timely and consistent care. Further research by Mogaka *et al.* (2023) in Laikipia County demonstrated that using point-of-care early infant diagnosis (EID) significantly improved health outcomes for HIV exposed infants. The findings showed a reduced turnaround time for diagnosis, which enabled prompt initiation of treatment and improved retention in care programs. These challenges highlight the urgent need for effective interventions such as on reminders and social support frameworks to improve health outcomes for HIV exposed infants, particularly in settings like Nyahururu County Referral Hospital.

## 2. Literature Review

### 2.1 Health outcomes and survivorship of infants born of HIV positive mothers

The health outcomes and survivorship of infants born to HIV positive mothers are closely linked to the mother's adherence to antiretroviral therapy (ART) and the timely use of preventive measures to reduce mother-to-child HIV transmission (Philemonetal., 2022). With effective ART and early infant testing, the risk of HIV transmission can be significantly reduced, ensuring better health outcomes for the child (Theunissen, 2020). Infants born to HIV positive mothers who receive appropriate care, such as postnatal prophylaxis and regular follow-up, are less likely to develop HIV (Abdihakim, 2023). However, challenges such as delayed diagnosis, access to healthcare, and other underlying conditions can still impact the infant's overall health and survivorship. Early intervention, consistent monitoring, and a supportive healthcare environment are key to improving survival rates and ensuring long-term health for these infants.

### 2.2 Health outcome among HIV exposed infants

Early initiation of antiretroviral therapy (ART) for mothers and prophylactic treatments for infants significantly improve health outcomes for HIV exposed infants, including decreased mortality and better physical development. Interventions such as early infant diagnosis (EID) and cotrimoxazole prophylaxis further enhance health and reduce the risk of death, especially in resource-limited settings. In South Africa, research has shown that ART during pregnancy and breastfeeding significantly improves the health of HIV exposed infants, resulting in decreased mortality and better physical development (Goga *et al.*, 2018). This shows the importance of early ART initiation and strict adherence to the regimen throughout pregnancy and breastfeeding in reducing the risk of HIV transmission and improving infant health.

Further research from Malawi demonstrated that early initiation of cotrimoxazole prophylaxis, an affordable antibiotic, was associated with improved health outcomes among HIV exposed neonates. These infants experienced lower mortality rates and better physical development (Phiri *et al.*, 2019). This study highlights the potential of low-cost interventions to enhance maternal and child health in resource-limited settings. Additionally, studies emphasizing early infant diagnosis (EID) and the timely initiation of ART for HIV positive infants, such as one conducted in Uganda, confirm that early ART initiation leads to improved health status and reduced mortality rates (Kiyaga et al., 2019). Together, these findings emphasize the critical role of early interventions in ensuring the well-being of HIV exposed infants.

In Nairobi County, Kiilu (2021) looked at health outcomes of infants enrolled in early infant diagnosis (EID) services for HIV in selected hospitals, with a focus on factors influencing HIV positivity, infant survival, and nutritional status. The study found an HIV incidence rate of 9 cases per 100 person-years among infants over one year. Non-disclosure of HIV status was a significant risk factor for infant HIV positivity, with a 5.33-fold and 4.54-fold increased risk at 6 and 12 months, respectively. Stunting was identified as the most common form of malnutrition, linked to maternal underweight, with mothers having a BMI categorized as

underweight having higher odds of their infants being stunted. Additionally, younger maternal age (18-24 years) and recent HIV diagnosis ( $\leq 2$  years) were associated with poorer infant survival outcomes.

In another study, Neary *et al.* (2022) compared growth outcomes, including stunting and poor growth, between HIV exposed uninfected (HEU) and HIV unexposed uninfected (HUU) infants in Kenya. The findings indicated that HEU infants had significantly poorer growth outcomes compared to HUU infants. At 6 weeks, HEU infants had lower mean weight-for-age (WAZ) and length-for-age (LAZ) z-scores than HUU infants. Stunting was more prevalent in HEU infants at both 6 weeks and 9 months, with 34% of HEU infants stunted at 6 weeks, compared to 18% of HUU infants. At 9 months, the stunting rate in HEU infants was 20%, compared to 10% in HUU infants. HEU infants also had lower mean head circumference at 9 months and higher prevalence of microcephaly compared to HUU infants.

### **2.3 Survivorship of HIV exposed infants**

The survivorship of HIV exposed infants is heavily influenced by early diagnosis, timely interventions, and continuous care. In Lesotho, Tukeiet *al.* (2020) assessed the 24-month HIV survival among HIV exposed infants (HEIs). The study found that the 24-month HIV free survival rate among HEIs was 91.8%, with a 2.9% risk of HIV transmission by 24 months. The infant mortality rate among HEIs was 6.0%, which was slightly higher than the 3.8% observed among HIV unexposed infants (HUIs). The study also found that lower maternal age and birth weight were associated with an increased risk of HIV infection or death among infants.

A study conducted in South Africa also revealed that cotrimoxazole prophylaxis was related to better survival in HIV exposed infants, thus reducing infant mortality by 40 percent if they were given prophylaxis (Cotton *et al.*, 2019). Also, the study emphasized on the need for EID HIV and timely initiation of ART among infants who test positive for the virus at birth. 94 percent of the HIV positive infants survived to reach 12 months of age, according to the study carried out in Kenya linking early ART initiation with better survival rates. Taken together, these studies underscore the need to intervene early if the survival rate for infants born with HIV is to be increased.

In rural Zimbabwe, Evans and Chasekwa (2021) evaluated the mortality, HIV transmission rates, and growth outcomes in children exposed to HIV. The findings indicated that HIV exposed children had a 40% higher mortality rate compared to HIV unexposed children, with a hazard ratio of 1.41. Of the HIV exposed children, 3% tested HIV positive, and the vertical transmission rate ranged from 4.3% to 7.7%, exceeding elimination targets. In addition, HIV exposed uninfected children (CHEU) had a lower mean length-for-age z-score, indicating poorer growth. Only 40% of children exposed to HIV in non-IYCF arms were alive, HIV free, and non-stunted by 18 months, compared to 60% of HIV unexposed children.

In northern Uganda, Aguti *et al.* (2020) looked at HIV free survival rate among breastfed infants born to HIV positive women in two tertiary facilities. The study found that the HIV survival rate among the 365 HIV exposed infants was 93.7%, with 2.7% testing HIV positive and 3.6% dying during the study period. A majority of the infants (94.5%) were exclusively breastfed, although only 29% of these were exclusively breastfed for at least six months. The study identified that the age of infants at enrollment in care and the treatment facility were independently associated with improved HIV survival. Infants enrolled at a younger age and those treated at certain facilities had better outcomes.

### **2.4 Reminders and social support framework**

Reminder and Social Support Framework is an approach increasingly applied to improve health outcomes in the context of HIV care, particularly for pregnant and breastfeeding women (Abbo, 2022). Reminders, such as SMS messages, phone calls, or app-based alerts, are used to prompt timely clinic visits, medication adherence, and infant testing appointments (Mogaka *et al.*, 2023). These tools help counteract forgetfulness, improve routine engagement with healthcare services, and address gaps in adherence to antiretroviral therapy (ART) and early infant diagnosis (EID) schedules. Subandi (2023) has shown that reminders significantly increase the rate of HIV testing among infants and promote maternal retention in PMTCT (Prevention of Mother-To-Child Transmission) programs (Sabin *et al.*, 2020). The use of reminders is especially valuable in resource-limited settings where physical follow-up may be challenging and health system infrastructure is often strained. Equally critical is the role of social support, which includes emotional, informational, and instrumental assistance from family, peers, healthcare workers, and the community (Wang *et al.*, 2020). Social support systems create an enabling environment where HIV positive women can navigate stigma, adhere to treatment, and make informed choices for themselves and their infants (Sabin *et al.*, 2020). Peer-led groups, mother-to-mother support programs, and community health workers have been instrumental in enhancing maternal mental health, ART adherence, and infant care practices (Mogaka *et al.*, 2023). The synergy of reminders and social support systems creates a robust framework that fosters accountability, empowers women, and ensures continuity of care, contributing to better maternal and child health outcomes in HIV affected populations.

## 2.5 Impact of reminders and social support on HEIs' health outcomes

In Indonesia, Apriani (2022) conducted a qualitative study to explore the types and roles of social support experienced by pregnant women living with HIV/AIDS (PLWHA) in Cilacap District. Using a phenomenological approach and thematic analysis, the study identified four major themes from interviews with pregnant women and their family members: pregnant women often feel insecure and emotionally distressed about their HIV status; families generally demonstrate acceptance of the women's condition; both families and pregnant women express a need for stronger support from healthcare providers; and there is a desire for structured systems, such as On reminders, to help ensure consistent ARV adherence.

In South Africa, Dube-Pule *et al.* (2021) evaluated the effectiveness of an SMS-based mobile health (mHealth) intervention in enhancing adherence to infant antiretroviral (ARV) prophylaxis and improving the uptake of early infant diagnosis (EID) and PMTCT practices. Among the 251 mothers enrolled, 73.3% of infants received HIV PCR testing at 10 weeks postpartum—a rate notably higher than typically reported in national studies, though not statistically significant compared to the district's data at the time. The intervention helped address gaps in maternal knowledge regarding EID timing and highlighted challenges in the implementation of PMTCT protocols. High-risk mothers tended to be younger, initiated antenatal care later, had less knowledge of prophylaxis, and delivered lower-birthweight infants.

In Tanzania, Saleh *et al.* (2023) investigated the associations between maternal antenatal depression, social support, and infant growth and developmental outcomes among mothers living with HIV. Among 2,298 pregnant women living with HIV, 67% exhibited symptoms consistent with antenatal depression. These depressive symptoms were significantly associated with an increased risk of infant wasting (RR 2.61), though not with other growth or developmental outcomes. While overall maternal social support was not linked to infant growth, greater affective and instrumental support were associated with improved cognitive, motor, and overall developmental scores.

In Kenya, Kinuthia *et al.* (2021) evaluated the effectiveness of short message service (SMS) messaging in improving maternal retention in HIV care, viral suppression, and infant HIV survival among pregnant and postpartum women living with HIV. Among 824 pregnant women enrolled across six maternal-child health clinics, the study found no statistically significant improvement in viral suppression, clinic attendance, or infant HIV survival between women receiving SMS (either one-way or two-way) and those receiving no SMS. Viral non-suppression occurred in 9.8% of viral load assessments, with similar rates across all groups. On-time visit attendance was high across the board (89%), and the incidence of infant HIV or death was 3.01 per 100 person-years, with an HIV infection rate of 0.94%.

In another study, Nordberg *et al.* (2021) assessed whether weekly interactive text messaging (the WelTel intervention) could improve early infant diagnosis (EID) of HIV among HIV exposed infants in Kenya. The intervention involved sending weekly messages to pregnant women living with HIV, asking about their well-being and prompting responses, to support engagement in prevention of mother-to-child transmission (PMTCT) care. Among 600 enrolled women, the uptake of EID HIV testing by eight weeks of age was 85.5% in the intervention group and 84.7% in the control group. The difference was not statistically significant. The proportion of infants diagnosed with HIV was slightly lower in the intervention group (0.8% vs. 1.2%). Overall, the study found no evidence that the WelTel text messaging intervention improved EID HIV testing uptake.

In addition, Mabachiet *al.* (2021) explored the design preferences for SMS messages intended to support prevention of mother-to-child transmission (PMTCT) care among pre- and post-partum women living with HIV and their male partners. The participants expressed a preference for ART adherence messages that were deliberately vague (low verbal immediacy), anonymous, and personalized in terms of timing and frequency. Contrary to some previous research, ambiguity in messaging was favored over personalization of message content for privacy concerns. However, for clinic appointment reminders and retention in care, participants preferred messages that were direct (high verbal immediacy), mentioned the baby, and came from identifiable clinical sources.

## 2.6 Theoretical framework

The effectiveness of reminders and social support in improving birth and health outcomes among HIV exposed infants can be understood through several key theoretical frameworks, particularly those that emphasize behavioral change, social influence, and health-related behaviors. The Health Belief Model (HBM) suggests that individuals' health-related behavior is influenced by their perceptions of the severity of a health threat and the benefits of taking action (Green *et al.*, 2020). In relation to HIV exposed infants, reminders (such as text or phone reminders) can strengthen perceived susceptibility and severity, while social support can reinforce the benefits of taking preventive actions (Kyandoet *al.*, 2024). Reminders can help increase the perceived danger of failing to prevent the spread of HIV, highlighting the severity of the risks involved. This heightened awareness can motivate caregivers to adopt the correct health behaviors to protect both the infant and themselves (Nkhonjeraet *al.*, 2021).

Additionally, social support from family members, healthcare providers, and peer groups can serve as a powerful motivator for caregivers to adhere to recommended health practices. Kyando et al. (2024) indicated that by strengthening caregivers' belief in their ability to succeed with protective measures, such as timely breastfeeding, social support encourages consistent care and improves overall health outcomes for HIV exposed infants. Albert Bandura's social cognitive theory emphasizes the significance of observational learning, self-efficacy, and social influence to health behaviors (Bandura, 2023).

This found that individuals learn and enact behaviors through observing others and receiving feedback in terms of reinforcement for what they did. Reminders serve as environmental cues to behavior, which reinforce and sustain the actions of caregivers and parents in managing HIV exposed infants (Boruchovitch, 2023). Social Support is significant in modeling behaviors because caregivers may observe others (e.g., family, healthcare providers, peer networks) implement suggested practices to promote infant health outcomes.

The Theory of Planned Behavior (TPB) proposes that attitudes, subjective norms (social pressure), and perceived behavioral control have an effect on intention to engage in a behavior (Ajzen, 1991). Reminders, under the theory, have the potential to influence attitudes and perceived control, while social support has the potential to influence subjective norms and enhance the intention to act. Reminders influence the caregiver's attitude by encouraging timely information reminding them about the importance of preventive actions (e.g., adherence to ART, immunization).

Social Support (e.g., from family or healthcare workers) enhances perceived social approval and reinforces medical advice compliance, thereby leading to positive health effects among HIV exposed infants. Social support theory focuses on the psychological and functional assistance provided by other individuals in an individual's social support system, which assists in reducing stress and improving health outcomes (Jolly *et al.*, 2021).

Support can be emotional, informational, or instrumental in type. Social Support as emotional support, encouragement, and guidance from health professionals and social networks (support groups and family) can enhance caregivers' mental health and adherence to healthcare behaviors (early diagnosis and ART adherence). Reminders are a form of informational support that motivates caregivers to stay on track with needed healthcare behaviors for HIV exposed infants.

Ecological systems theory suggests that human development is influenced by many systems within the environment, including the microsystem (family), mesosystem (interactions between family and health care providers), ecosystem (policy), and macrosystem (cultural beliefs) (Bronfenbrenner, 1979).

Ecological Systems Theory emphasizes the interrelatedness of environmental forces in creating health outcomes. Social Support is one of the key elements of the microsystem (family support) and mesosystem (healthcare networks) that influence the capacity of caregivers to comply with health regulations for HIV exposed infants. Reminders are effective at the microsystem and can be tailored to caregivers based on their specific setting.

## 2.7 Conceptual Framework

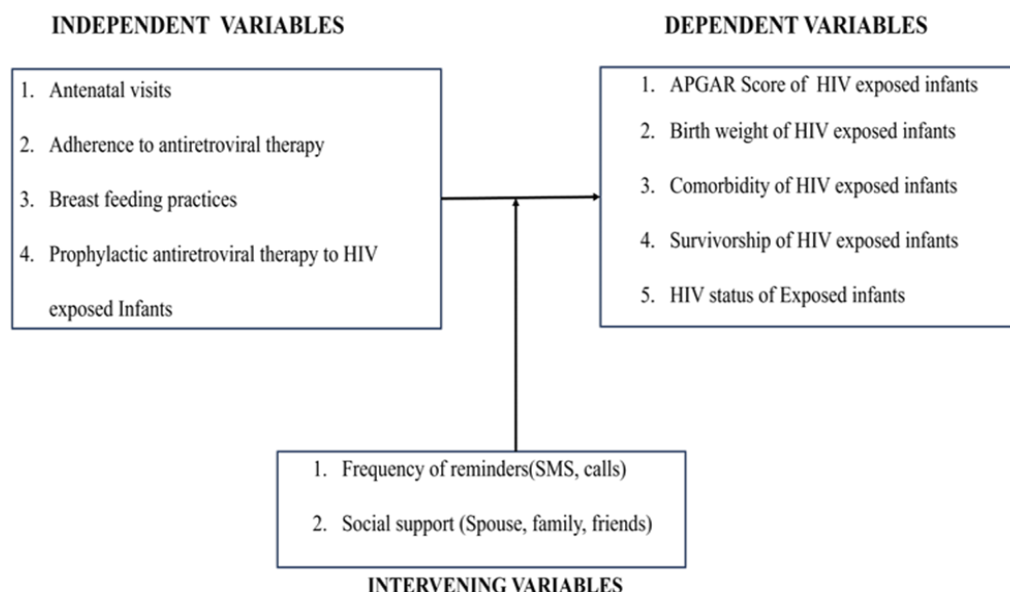


**Figure 1: Conceptual Framework**

## 3. Methodology

The study was carried out in the Antenatal clinic/Comprehensive Care Centre in Nyahururu County referral hospital, Laikipia west Sub-County located in Laikipia County in the Rift Valley region. This study adopted a quasi-experimental (Non-Equivalent Groups design) to select HIV positive pregnant mothers and HIV exposed infants receiving prevention of mother-to-child transmission (PMTCT) services at Nyahururu County Referral Hospital. Infants born from HIV positive pregnant mothers were followed for twelve months. Reminder package (SMS and calls) was introduced to follow the antenatal uptake, adherence to ART.

The study also included a retrospective component, where previous medical records and files of HIV positive pregnant mothers and their HIV exposed infants who had previously received PMTCT services at the facility were reviewed. The study population comprised of 399 confirmed HIV positive pregnant mothers attending the antenatal clinic and PMTCT Centre at Nyahururu County Referral Hospital. Mother were recruited from the second trimester of pregnancy and followed up until delivery while neonates were followed for one year. Additionally, the study included a review of previous medical files of HIV positive pregnant mothers and HIV exposed infants who had received MTCT services at the facility. The Slovin's formula (1967) for sample size determination from a finite or known population was used to calculate the sample size for the study. This formula helped to ensure that the sample was statistically representative of the population, considering the desired level of precision. The formula was as follows;  $n = \frac{N}{(1+Ne^2)}$

Where:

n= Required sample size,

N =The Given population size (399)

e= acceptable Error and Degree of Accuracy (=0.05).

$$\text{Therefore: } n = \frac{399}{(1+399 \times 0.05^2)}$$

=200 pregnant mothers, add 10% to cater for loss to follow-up.

Therefore,  $n_1 = 220$  HIV positive pregnant mothers on reminders

$n_2 = 220$  HIV positive pregnant mothers on routine care

A systematic sampling technique was employed to recruit HIV positive pregnant women attending antenatal care at Nyahururu County Referral Hospital. All HIV positive expectant mothers were identified through clinic records, and a follow-up system was implemented using a combination of SMS messages, direct phone calls, and engagement through spouses and social networks to enhance communication and participation.

The study used both primary and secondary data. Primary data was collected by use of structured questionnaires. The questionnaires captured key socio-demographic characteristic, antenatal profiles, adherence to ART, maternal and HIV exposed infants health outcomes, breastfeeding practices and survivorship of HIV exposed infants. Secondary data was obtained by reviewing previous antenatal records. Additionally, mother and child handbooks that constituted the part of the checklist, commonly used during routine antenatal visits, were reviewed and provide a good follow-up. These handbooks contained essential medical records, including diagnosis, laboratory and imaging results, treatment plans, mode of delivery, and post-natal follow-ups.

A site visit to Nyahururu County Referral Hospital was conducted for data collection. Three research assistants and the principal investigator assisted by the Comprehensive Care Centre staffs administered questionnaires during face-to-face interviews with participants. The use of research assistants aimed to minimize potential biases from the principal investigator.

To further enhance engagement, short text messages (SMS) were sent to participants registered mobile numbers as on reminders. Direct phone calls were also made to clarify any concerns and confirm study participation. Follow-up efforts extended through participants' husbands and social networks to ensure maximum engagement and comprehensive data collection. This multifaceted approach ensured accuracy and completeness of the collected data

Before implementation, study tools were pre-tested at Samburu County Referral Hospital. In accordance with Hall (2020), a pre-test sample size of 10% (20 respondents) was selected. This pilot study was conducted by the principal investigator and a trained research assistant to standardize the questionnaires and detect any deficiencies in the study design. All completed questionnaires and checklists were reviewed daily for completeness, consistency, and clarity by the principal investigator and trained research assistants. The data from structured questionnaires and checklist forms were coded, entered into a secure database using Microsoft Excel, and later exported to Statistical Package for Social Sciences (SPSS) version 25.0 for cleaning and analysis. Descriptive statistics such as frequencies and percentages were used to summarize socio-demographic, antenatal profile, level of adherence to ART, breastfeeding patterns, health outcomes of HIV exposed infants. For inferential analysis, chi-square tests were used to determine associations between categorical variables. Simple linear regression analysis was employed to identify predictors of maternal and infant health outcomes, particularly focusing on the impact of SMS reminders on the uptake of PMTCT services. To test the statistical significance of associations, a p-value of less than 0.05 was considered statistically significant at a 95% confidence level. The results were presented in tables and figures such as bar charts and pie charts.

The study received ethical approval from the Kenyatta National Hospital-University of Nairobi Ethics and Research Committee, County director of Medical services Laikipia county and Jomo Kenyatta University of Agriculture and Technology Board of Post graduate studies. Additionally, official permission to carry out the research was obtained from the Chief Executive Officer (CEO) of Nyahururu County Referral Hospital. Participation in the study was strictly voluntary. All potential participants were clearly informed about the purpose, procedures, benefits, and potential risks of the study before being asked to participate.

## **4. Results**

### **4.1 Birth outcome of HIV exposed infants born from HIV positive pregnant mothers in Nyahururu County referral hospital**

#### **4.1.1 APGAR score of HIV exposed infants born from HIV positive pregnant mother**

The results indicated that, out of 220 HIV exposed infants born from HIV positive pregnant mother on reminders and social support, 178 (80.9%) had an APGAR score of 9.01-10.00 while 6 (2.7%) had an APGAR score of 7.01-8.00. Similarly, the study indicated that out of 220 HIV exposed infants born from HIV positive pregnant mothers on routine follow-up, 146 (66.3%) had an APGAR score of 9.01-10.00 while 25 (11.4%) had an APGAR score of 7.01-8.00.

**Table 1: APGAR Score of HIV Exposed Infants Born from HIV Positive pregnant mothers in the study**

|                    | On reminders (n=220) |            |           | On routine follow-up (n=220) |            |           |
|--------------------|----------------------|------------|-----------|------------------------------|------------|-----------|
|                    | Frequency            | Percentage | CI        | Frequency                    | Percentage | CI        |
| <b>&lt;=7.00</b>   | 0                    | 0.0        | 0.0-0.02  | 0                            | 0          | 0.00-0.02 |
| <b>7.01-8.00</b>   | 6                    | 2.7        | 0.01-0.06 | 25                           | 11.4       | 0.07-0.16 |
| <b>8.01-9.00</b>   | 36                   | 16.4       | 0.12-0.22 | 49                           | 22.3       | 0.17-0.28 |
| <b>9.01- 10.00</b> | 178                  | 80.9       | 0.73-0.86 | 146                          | 66.3       | 0.60-0.73 |

#### 4.2 Average Weight of HEIs' Born from HIV Positive Pregnant Mothers

The results indicated that, out of 220 HIV exposed infants born from HIV positive pregnant mother on reminders and social support, 179 (81.4%) weighed 2.51-3.00 kgs while 2 (0.9%) weighed 0.51-2.00 kgs. Similarly, the study indicated that out of 220 HIV exposed infants born from HIV positive pregnant mothers on routine follow-up, 111 (50.5%) weighed 2.51-3.00 kgs while 5(6.8%) weighed 0.51-2.00 kgs.

**Table 2: Average Birth Weight of HEIs' Born from HIV Positive Pregnant Mothers in the study**

|                 | On reminders (n=220) |            |           | On routine follow-up (n=220) |            |           |
|-----------------|----------------------|------------|-----------|------------------------------|------------|-----------|
|                 | Frequency            | Percentage | CI        | Frequency                    | Percentage | CI        |
| 0.51 to 2.00 kg | 2                    | 0.9        | 0.00-0.03 | 15                           | 6.8        | 0.04-0.11 |
| 2.01-2.50 kg    | 15                   | 6.8        | 0.04-0.11 | 75                           | 34.0       | 0.28-0.41 |
| 2.51-3.00 kg    | 179                  | 81.4       | 0.78-0.86 | 111                          | 50.5       | 0.44-0.57 |
| 3.10-3.50       | 18                   | 8.2        | 0.45-0.13 | 14                           | 6.4        | 0.04-0.10 |
| 3.51 and above  | 6                    | 2.7        | 0.01-0.06 | 5                            | 2.3        | 0.01-0.05 |

#### 4.3 Administration of Initial Prophylaxis Nevirapine/Zidovudine among HEIs' born from HIV positive pregnant mothers

The results indicated that, out of 220 HIV exposed infants born from HIV positive pregnant mother on reminders and social support, 209 (95.0%) received initial Nevirapine/Zidovudine prophylaxis while 11 (5.0%) did not receive initial Nevirapine/Zidovudine prophylaxis. Similarly, the study indicated that out of 220 HIV exposed infants born from HIV positive pregnant mothers on routine follow-up, 197 (89.5%) received initial Nevirapine/Zidovudine prophylaxis while 23 (10.5%) did not receive Nevirapine/Zidovudine prophylaxis.

**Table 3: Administration of Initial Prophylaxis Nevirapine/Zidovudine among HEIs' born from HIV positive pregnant mothers in the study**

|                 | On reminders (n=220) |            |           | On routine follow-up (n=220) |            |           |
|-----------------|----------------------|------------|-----------|------------------------------|------------|-----------|
|                 | Frequency            | Percentage | CI        | Frequency                    | Percentage | CI        |
| Received        | 209                  | 95.0       | 0.91-0.97 | 197                          | 89.5       | 0.85-0.93 |
| Did not receive | 11                   | 5.0        | 0.03-0.87 | 23                           | 10.5       | 0.67-0.15 |

#### 4.4 Collection on Spot DBS among HIV Exposed Infants

The results indicated that, out of 220 HIV exposed infants born from HIV positive pregnant mother on reminders and social support, 209 (95.0%) had Dried Blood Sample (DBS) taken while 11 (5.0%) had Dried Blood Sample (DBS) taken. Similarly, the study indicated that out of 220 HIV exposed infants born from HIV positive pregnant mothers on routine follow-up, 197 (89.5%) had Dried Blood Sample (DBS) taken while 23 (10.5%) had Dried Blood Sample (DBS) taken.

**Table 4: Collection on Spot Dried Blood Sample among HEIs' in the study**

|                   | On reminders (n=220) |            |           | On routine follow-up (n=220) |            |           |
|-------------------|----------------------|------------|-----------|------------------------------|------------|-----------|
|                   | Frequency            | Percentage | CI        | Frequency                    | Percentage | CI        |
| DBS collected     | 209                  | 95.0       | 0.91-0.97 | 197                          | 89.5       | 0.85-0.93 |
| DBS not Collected | 11                   | 5.0        | 0.03-0.87 | 23                           | 10.5       | 0.67-0.15 |

#### **4.5 Breastfeeding Practices of HIV Positive Mothers Six Months Post-Delivery**

The findings indicated that, out of 220 HIV positive pregnant mothers on reminders and social support, 171 (77.7%) opted for exclusive six months breastfeeding while 16 (7.3%) opted for exclusive replacement feeding. Additionally, out of 220 HIV positive pregnant mothers on routine follow-up, 143 (65.0%) opted for exclusive six months breastfeeding while 28 (12.7%) opted for exclusive replacement feeding.

**Table 5: Breastfeeding Options among HEIs' born from HIV positive pregnant mothers in the study**

|                                              | On reminders (n=220) |            |           | On routine follow-up (n=220) |            |           |
|----------------------------------------------|----------------------|------------|-----------|------------------------------|------------|-----------|
|                                              | Frequency            | Percentage | CI        | Frequency                    | Percentage | CI        |
| Exclusive breastfeeding                      | 171                  | 77.7       | 0.72-0.83 | 143                          | 65.0       | 0.58-0.71 |
| Exclusive breastfeeding with early cessation | 33                   | 15.0       | 0.11-0.20 | 49                           | 22.3       | 0.17-0.28 |
| Exclusive replacement feeding                | 16                   | 7.3        | 0.04-0.12 | 28                           | 12.7       | 12.7      |

#### **4.6 Health Outcomes and Survivorship of HIV positive Exposed Infants Born of HIV Positive Pregnant Mothers in Nyahururu County referral hospital**

##### **4.6.1 HIV status among HIV Exposed infants after 1 year in the study**

The results indicated that, out of 220 HIV exposed infants born from HIV positive pregnant mothers on reminders and social support, 216 (98.2%) of the HIV exposed infants turned HIV negative while 4 (1.8%) turned positive. In addition, out of 220 HIV exposed infants born from HIV positive pregnant mothers on routine follow-up, 209 (95.5%) of the HIV exposed infants turned HIV negative while 11(5.0%) turned HIV positive.

**Table 6: HIV status among HIV Exposed infants**

|              | On reminders (n=220) |            | On routine follow-up (=220) |            |
|--------------|----------------------|------------|-----------------------------|------------|
|              | Frequency            | Percentage | Frequency                   | Percentage |
| HIV Positive | 216                  | 98.2       | 209                         | 95.5       |
| HIV Negative | 4                    | 1.8        | 11                          | 5.0        |

##### **4.6.2 Survival and Mortality among HIV Exposed Infants after a year**

The results indicated that, out of 220 HIV exposed infants born from HIV positive pregnant mothers on reminders and social support, 210 (95.5%) of the HIV exposed infants born from HIV positive pregnant mothers survived after one year while 10 (4.5%) did not survive. In addition, out of 220 HIV exposed infants born from HIV positive pregnant mothers on routine follow-up, 189 (86.0%) of the HIV exposed infants turned survived after one year while 31 (14.0%) did not survive.

**Table 7: Survival and Mortality among HIEs born of HIV positive mothers in the study**

|          | On reminders (n=220) |            |           | On routine follow-up (n=220) |            |           |
|----------|----------------------|------------|-----------|------------------------------|------------|-----------|
|          | Frequency            | Percentage | CI        | Frequency                    | Percentage | CI        |
| Survived | 210                  | 95.5       | 0.92-0.98 | 189                          | 86.0       | 0.81-0.90 |
| Died     | 10                   | 4.5        | 0.22-0.08 | 31                           | 14.0       | 0.10-0.19 |

### Correlation Analysis

The correlation analysis reveals strong, statistically significant positive relationships between the use of reminders and key health outcomes among HIV positive mothers.

**Table 8: Correlation Analysis Results**

| Variables                            | Correlation Coefficient (r) | P-Value |
|--------------------------------------|-----------------------------|---------|
| Reminders vs. Infant Health Outcomes | 0.78                        | 0.0041  |

### 4.7 Relationship between use of reminders and infant survival

The regression coefficients ( $\beta$ ) suggest that for every unit increase in the use of reminders, there is a corresponding increase in the outcome variables. The low p-values indicate that these relationships are statistically significant.

**Table 9: Relationship between use of reminders and infant survival**

|                  | Dependent Variable |          | Regression Coefficient ( $\beta$ ) | Standard Error | P-Value | Odds Ratio ( $e^{\beta}$ ) |
|------------------|--------------------|----------|------------------------------------|----------------|---------|----------------------------|
| Use of reminders | Infant Rate        | Survival | 1.25                               | 0.28           | < 0.01  | 3.49                       |

### 4.8 Association between use of reminders vs. infant health outcomes

The Chi-Square value of 20.8 with a p-value of 0.009 indicates a strong and significant association between the use of reminders and improved health outcomes for HIV-exposed infants (HEIs).

**Table 10: Association between use of reminders vs. infant health outcomes**

| Variables    | Reminders | Routine Follow-up | Chi-Square Value | P-value |
|--------------|-----------|-------------------|------------------|---------|
| HIV Negative | 216(97.2) | 209(95.5)         | 20.8             | 0.009   |
| HIV Positive | 4(1.8)    | 11(5.0)           |                  |         |

## 5. Discussion

- Mothers receiving reminders were significantly more likely to practice exclusive breastfeeding for the recommended six months.
- The survival rate of infants beyond one year was significantly higher in the reminder group.
- The correlation coefficient of 0.78 indicates a strong positive relationship between the use of reminders and improved infant health outcomes.
- Regression analysis and Chi-Square tests with low p-values (0.01 and <0.05 respectively) confirm that the observed improvements in health outcomes are statistically significant and likely due to the intervention.

## 6. Conclusion

This study demonstrated that reminder interventions significantly improved healthcare utilization and infant care practices among HIV-exposed infants attending Nyahururu County Referral Hospital. The findings revealed that mothers and caregivers who received reminders were more likely to adhere to scheduled clinic appointments, ensure timely infant immunization, and comply with recommended follow-up visits for HIV care services. The intervention also contributed positively to early infant diagnosis and continuity of care, which are essential in reducing mother-to-child transmission of HIV and improving infant survival outcomes.

In addition, the study established that reminders enhanced breastfeeding practices among mothers of HIV-exposed infants. Participants who received consistent reminders demonstrated better adherence to exclusive breastfeeding recommendations during the first six months of life compared to those who did not receive reminders. This suggests that reminder systems can serve as an effective health education and behavioral reinforcement strategy, particularly in resource-limited healthcare settings where missed appointments and poor adherence to infant feeding guidelines remain major challenges.

The improvement in health outcomes observed among HIV-exposed infants further highlights the importance of integrating reminder-based interventions into maternal and child healthcare programs. By promoting timely healthcare-seeking behavior and strengthening communication between healthcare providers and caregivers, reminder systems can help reduce infant morbidity and mortality associated with HIV exposure.

The study therefore concludes that reminder interventions are practical, cost-effective, and sustainable tools for improving birth outcomes, healthcare attendance, and breastfeeding practices among HIV-exposed infants. Healthcare policymakers and practitioners should consider scaling up reminder-based programs within prevention of mother-to-child transmission (PMTCT) services and maternal-child health programs in Kenya and similar settings. Further studies are recommended to evaluate the long-term impact of reminder systems on HIV-free survival and overall child development outcomes among HIV-exposed infants.

## **7. Recommendations**

- The Ministry of Health should implement reminder systems and social support interventions to ensure higher adherence to ANC services and ART.
- Community health workers should be trained to offer personalized follow-up and counseling to sustain adherence throughout the pregnancy and postpartum periods.
- Structured reminder and social support programs should be integrated into maternal care to reduce labor complications and improve birth outcomes. This support should be extended to ensure timely HIV prophylaxis and testing for newborns, enhancing neonatal health.
- Postnatal care should include consistent counseling and on reminders to encourage exclusive breastfeeding for six months. Healthcare providers should offer lactation support and address any concerns around HIV transmission through breastfeeding.
- PMTCT programs should prioritize early infant diagnosis and consistent follow-up to improve survival and reduce HIV transmission. Structured support interventions for mothers, including on reminders and counseling, should be reinforced to enhance infant health outcomes and survivorship.
- Health facilities should consider developing a home-grown, user-centric mobile application specifically designed for HIV positive mothers attending antenatal clinics (ANC). This app should send timely reminders for ANC visits, ARV adherence, and health checks. The application should be simple to navigate, offer multilingual support to cater to diverse language speakers, and have a notification system that ensures mothers receive relevant reminders and health-related information,

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**Conflict of interests**

The authors have no competing interest in this manuscript submitted for publishing.

**Availability of data**

This data is the original work of the authors. No data has been published in any other journal.