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Why is mother to child transmission (MTCT) of HIV a continual threat to new-borns in sub-Saharan Africa (SSA)

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ABSTRACT

Sub-Saharan Africa (SSA) accounts for more than two thirds of the world's HIV infection. Despite scaled-up prevention of mother-to-child transmission of HIV (PMTCT) programmes, mother to child transmission of HIV (MTCT) continues to escalate. We describe the challenges faced by PMTCT in MTCT in SSA. The study reviewed articles and reports published online. The most common barriers and challenges were non-disclosure of HIV status, late initiation of ARVs treatment/adherence, STIs screening, long clinics waiting time, non-involvement of men in ANC/PMTCT, infant feeding methods and sensitization of community members on ANC/PMTCT programmes. The study highlights the need to expand PMTCT coverage and the implementation of the 90-90-90 programme toward MTCT elimination in SSA. That is "≥90% of pregnant and breast-feeding mothers must know their HIV status; ≥90% of those that are positive are enrolled on ARVs treatment and care; ≥90% of those on ARVs treatment and care are virally suppressed.

Introduction

Women of reproductive age in sub-Saharan Africa (SSA) suffer high disproportionate burden of HIV when compared to women of other regions [1]. The region houses approximately 70% of global HIV infection of which women account for 60% of the infections and related incidences, morbidity and mortality [2–5]. Despite HIV scale up prevention programmes, the epidemic in the region continues to rise amongst females of reproductive age [5].

In SSA, maternal mortality during labour and delivery is estimated at 500 maternal deaths per 100,000 live births in 2010 [6,7]. Of this, HIV accounted for 10% related maternal deaths the highest globally [6]. The burden is higher than the WHO Millennium goals (Goals: 4–6) "safe maternal health, safe child deliveries, and decrease pregnancy-related deaths [6,8].

The gaps in clinical care of women and infants suffering from HIV and HIV-related diseases in both rural and urban settings in SSA are in multiple-compound layers including poverty [6–9]. Despite increasing availability and free antenatal care (ANC) and PMTCT programmes in some settings, the prevalence of MTCT still range from 15–40% [10,11]. However, in some settings there a significant decline from approximately 26% (23–28%) in 2009 to 17% (15–18%) in 2012 [5]. Therefore, the promotion of comprehensive combination intervention packages of socio-behavioural, biomedical and broader community approaches involving reproductive health needs may contribute in the elimination MTCT to zero in SSA. Approaches such as HIV education, decentralization and availability of HIV testing services (HTS) and support, early initiation and commencement of ARV for all eligible parents/infants, scale-up of ARV treatment programmes, innovative PMTCT (free internet at centres-attract adolescents) uptake programmes and retention in care (SMS as follow-up) are essential component of eliminating MTCT of HIV [11]. The harmonization of these approaches and strategies can improve the course of pregnancy among HIV positive mothers leading to safer mother-infant delivery and HIV free infants.

Most women of reproductive age in SSA are still not aware of their HIV status [5]. In some settings, a significant number of women living with HIV and needing ARV are not on treatment during pregnancy [14]. A large proportion remain either undiagnosed or are unwilling to start PMTCT programmes [14]. Studies have shown that engaging mothers in PMTCT programmes can help them make informed choices about safer labour/delivery and growth of their babies [5,11–13]. Another interesting factor is the loss to follow-up on those eligible for ARV and PMTCT programmes

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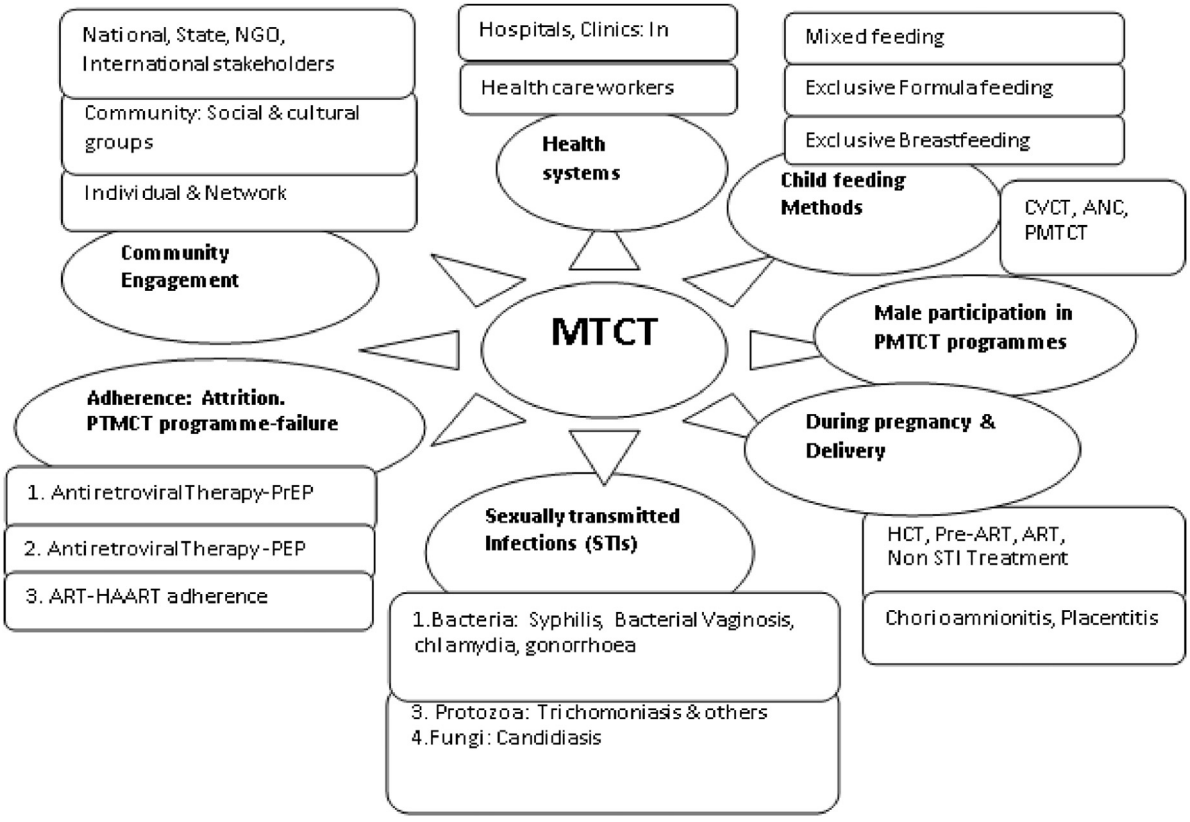

Fig. 1. The theoretical framework of Mother-to-child transmission of HIV [18,91,102–103].

[15,16]. The low uptake and losses to follow-up account for poor PMTCT effectiveness and the likely emergence of HIV resistant strains. The concern and challenges of PMTCT effectiveness is how to retain mothers in PMTCT programmes in SSA [5]. Because of scarce and limited information on MTCT in SSA. This review collates and highlights MTCT risks and challenges of PMTCT uptake in SSA. The information will contextualize and inform PMTCT programmes as well as underpin the reasons for the escalation of MTCT. Fig. 1, below indicates the theoretical framework of MTCT.

Methods

The review was conducted based on information retrieved from PubMed, technical reports, the International AIDS Society (IAS), and other data related indexing sources. We used the online proxy review search procedure to extract studies describing MTCT of HIV published in English or French. These studies were used to understand the challenges and the risks faced in MTCT of HIV in SSA. The key searched words used were: “prevention of mother to child HIV transmission programmes”, “mother to child transmission of HIV”. The French search words were: “prévention de la transmission du VIH de mère à l’enfant”, “transmission du VIH de mère à l’enfant”. Fig. 2 shows the flow chart of the articles and report summary.

Selection of studies and management

Studies included were those describing MTCT, PMTCT programmes covering a wide range of methodologies: qualitative, quantitative and reports in SSA. The process was a general open ended review process, no year specific, however aligned to MTCT of HIV and PMTCT programme interventions from inception of PMTCT to 2016. Four post graduate students assisted in extracting the relevant information and two independent reviewers: CSY and ET supported the screening and extraction of the titles and abstract results from the search online databases. Full-text articles, conference proceedings and reports of MTCT of HIV and PMTCT studies were further review. The articles were contained and screened for duplicates and other irrelevant information (Fig. 2). Using Microsoft excel designed sheet CSY and ET reviewed the relevant extracted articles and information. Ethical clearance was not required because the information used in this article were those available and freely online.

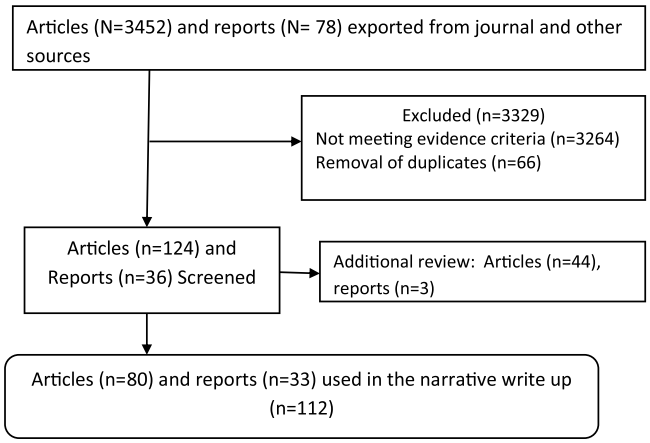

Fig. 2. Flow chart of articles and reports used in Mother to Child Transmission (MTCT) of HIV: Why a Continual Threat to New-borns in Sub-Saharan Africa (SSA).

Result and discussion

Out of the 3329 studies encountered during the review process, 80 journal articles and 33 reports were found eligible and used in

describing the MTCT in SSA as shown in Fig. 2. Of the 33 reports, 3 (9.1%) were from student thesis and the remaining 30 from organizational webpages. The MTCT description span from mother's pregnancy including prenatal, intrapartum, postnatal, child feeding methods (exclusive breast feeding, exclusive formula feeding and mixed feeding) and ARVs treatment of mothers and babies. Included in the review are information regarding adherence to PMTCT, health seeking behavior and the role of the community and men in PMTCT programmes as described below.

Pregnancy and mother to child transmission of HIV

Pregnancy

The gestation period which includes fertilization of the embryo and its development till birth and represent a very delicate course in a woman's life [19–27]. This period requires full ANC/PMTCT follow-up. Family planning, despite its benefits for fertility and child health – including its usefulness in reducing MTCT – is still a challenge in SSA. To achieve the elimination of MTCT, a combination intervention such as PMTCT programmes are needed to achieve free HIV infants [19]. However, most PMTCT programmes in SSA are limited in resource constrained, working conditions, social and economic barriers in accessing health services [20]

WHO and UNICEF data show that approximately 35% of HIV infected infants are accounted for by vertical transmission of HIV from mothers [21–23]. This is influenced by myriad of factors or a plethora of factors during pregnancy including education, long distances from nearest health facilities; non-availability of family planning support, and patronage of traditional healers by pregnant mothers as alternative family planning [24]. Therefore, scaling PMTCT programmes, HIV testing services (HTS) and know your status awareness including early initiation of ARV and retention in care [15] are key indicators in eliminating MTCT. This improves treatment since most paediatric MTCT infections occur during pregnancy, labour, delivery and breastfeeding [16,25,26].

The rate of vertical HIV transmission is highly expressed among mothers with high peak viral load, weak immune status and chronic diseases [16,19,25,26]. During PMTCT programmes information regarding viral and CD4 counts, uptake of ARVs, methods of feedings are provided [19].These are strategic approaches necessary in elimination MTCT as well as improvement of mother's health.

Prepartum/prenatal mother to child transmission of HIV

This the period before labour and delivery. The success rate for reducing risk of vertical transmission of HIV during prenatal-pregnancy depends mostly on the mother's HIV status and comprehension of ANC and PMTCT [10]. Knowing mother's status is an important indicator that can be used to optimize early prevention interventions. Early HCT can prepare the way for proper counselling, early uptake of treatment and care, linkage to proper PMTCT programmes and other health benefits [19]. According to report by Drake et al. [19], early identification of mother's unmet sexual reproductive health (SRH)/HIV needs that improves maternal health and reduces MTCT are necessary. This falls under the WHO declaration of global elimination of MTCT of new HIV infections [27]. Studies show that 5–10% of MTCT occurs during prenatal (before child birth) when interventions are non-available [13,27]. This account for late uptake of PMTCT as well as low coverage couple with high attrition rate in PMTCT programmes [10]. The course of prenatal-pregnancy and the risk associated with MTCT can be decline if early novel innovative prevention approaches including 90% of pregnant women knowing their status and linking to treatment and care are implemented.

Intrapartum and mother to child transmission of HIV

Period during labour and delivery. Intrapartum activities play a significant role in determining the likely MTCT during labour and delivery [31]. The transmission of HIV from mother to child during the labour and delivery has been well documented [6,22,25,28,29]. Studies show that without intervention approaches approximately 5–10% of infected mothers are likely to infect their babies during pregnancy and 10–20% during labour [12,22]. Other causes are due to chorioamnionitis that is the inflammation of the amniotic membrane that facilitate rapid it ruptures exposing the baby directly to maternal blood highly associated with HIV viral density [30,31]. According to findings conducted by Tita et al. [30] found that chorioamnionitis was twice as likely to cause early neonatal deaths and other negative health outcomes among HIV pregnant women when compared with non-HIV pregnant women [30]. Similar study by Minkoff et al. [31] revealed that women with low CD4 are more likely to transmit HIV if amniotic membranes are rupture [31]. Similarly, placentitis: inflammation of the placenta increases the passage of HIIV cross the placenta and exposing infant directly to maternal umbilical HIV fluid [28,30,31].

Other Intrapartum events include the transmission of sexually transmitted infections (STIs) and other compromised factors that reduces mother's immunity [10,19]. These vulnerable factors escalate MTCT. The vulnerabilities are more pronounced among mothers who are unaware of their HIV status and other STIs labour/delivery [14]. According to report by Ekouevi et al. [33] testing of mothers for HIV during labour should be incorporated as a standard procedure [34]. In that regard, cases missed during prenatal can be linked to treatment and care. In addition, pregnant women who test negative in the past three months should be re-tested during labour. This provide opportunity to detect missed cases and window period of HIV infections [35].

Post-partum/postnatal exposure of mother to child transmission of HIV

Period immediately after delivery and during breastfeeding. The elimination and eradication of MTCT after delivery has been one of the crucial period to fight HIV paediatric epidemics [10,36]. Despite continuous revision and scaling up of PMTCT programmes and infants born HIV free are still a challenge [13,27]. Because, approximately 10–20% MTCT occurs during post-natal period in settings with no available interventions versus 1.3–4% in setting with availability prevention interventions [13,27]. Most Infants exposed to HIV during post-natal period are associated to infant feeding methods, maternal education level — and to a lesser extent from blood transfusions and exposure to infected sharp objects [26]. Others include mother's breast inflammation such as mastitis, nipple sores, and abscess [16,19,25,26].

Feeding of HIV exposed infants remain a huge challenge in elimination and controlling of the spread of HIV in SSA. In some settings there are confusion regarding infant feeding methods -i.e.- exclusive breastfeeding (EBF), exclusive formula feeding (EFF) and mixed feeding (MF). Some mothers still perceived wrong messages from ANC and PMTCT programmes regarding infant feeding methods10. However, a significant proportion of MTCH depend on the type of feeding method adopted. Most risk is significant associated with MF when compared to EFF and EBF [10,22].

Despite mothers attending health services- mothers are still faced with the dilemma of deciding on which child-feeding methods to adopt [26]. In most settings breastfeeding is the most adopted and falls within the WHO guideline of EBF for the first 6 months of life[26] and ARVs to all HIV breastfeeding mothers[21,37]. Informing parents on the various feeding methods that best suit their infants account for better health outcomes. Also included are the public health implications of infant feedings, the national infant feeding policy and ARVs available to support PMTCT

programmes. Although, socio-cultural differences may influence feeding practices [36]. For example, in South Africa factors such as maternal age, HIV stigma, economic factors and cultural beliefs about breast milk and HIV transmission have been found to influence family choices on infant feeding methods, despite government policy [38].

The infant feeding strategies adopted must be those that enhance and improve HIV free infants. Such prevention interventions must be acceptable, feasible, affordable, sustainable and safe according to WHO [5]. Where infants are already infected with HIV, the best counselling methods should include breastfeeding and lifesaving methods that include immediate treatment, care and suitable nutrition [21].

Child feeding methods

Exclusive Breastfeeding (EBF) and mother to child transmission of HIV

Period 0–6 months where infants receive no other food including water other than breast-milk with exception of vitamins supplement including vaccines. Breast feeding is an old and most common method practised by mothers in most settings [23,39]. The method is very beneficial and provides essential child survival intervention during early infant growth [6,14]. EBF is less expensive, sustainable and affordable in low income settings. According to WHO, EBF is highly complementary to HIV-born free surviving infants including ARVs/care scale-up intervention among HIV-exposed mothers [22]. Studies have shown that EBF when implemented for the first 6 months of baby's life, lowered the risk of MTCT by 3–4 times when compared to MF22. This indicates that HIV paediatric programmes should be tailored towards the support of EBF for the first 6 months of infant's birth. With these advantages, mothers attending PMTCT in some settings are still less aware of health benefits of EBF. For example, according to study conducted by Ndubuka et al. [23] in Botswana approximately 50% of women attending PMTCT embraced EBF knowledge and only 19.8% were able to exclusively breastfeed their babies. Similarly, Kazaura [99] reported 30% mothers practising EBF in rural setting of Tanzania. This shows that knowledge about EBF is still a problem since fewer women are unable to comprehend and adopt EBF programmes [23]. Although, studies from evidence-based implementation have shown that receiving counselling on infant feeding methods at PMTCT programmes is highly associated with EBF practices [22]. This has shown to depend on well-informed EBF and comprehension of health outcomes associated with EBF by mothers [23]. Other correlate factors include maternal education, attitude toward EBF and insufficient mothers' breast milk [99].

Notwithstanding studies have shown that 10–20% of infants acquire HIV through breastfeeding if no HIV intervention strategies are available [13,22,27]. Other findings have also shown MTCT risks higher among mothers with high viral loads, mastitis, breast abscesses, cracked nipples, low immune resistance, sores around the nipples and other mother's infections [21,22]. In addition, approximately 11–13% of EBF mothers experience one or more of the aforementioned episodes during their lifespans [13]. Mothers with compromised immunity systems have also shown strong association with HIV-related morbidity and mortality in low income settings [21,39]. Breastfeeding mothers with competent immune systems have strong, healthier infants when compared to mothers with compromised immune systems. Mothers on ARVs and EBF usually experience significant reduction in postnatal vertical HIV transmission [13], estimated at less than 2% [21,40]. This is because EBF promote early healthy infant gut development as well as provide resistant to infectious microbial agents, including HIV [13]. Apart from that, breast milk carries anti-microbial properties which are missing from other feeding methods [29]. Studies show that breastfed children under five years of age have less than 1% mortality when compared to other feeding methods [21,23]. Other feeding methods — especially EFF can only be opted when EBF mother is ill and unable to breastfeed. Apart from that, more evidence base researches are needed to provide sufficient insights into alternative safer, affordable, less expensive and easy to comply feeding methods. In fact, Infected HIV women who exclusively breastfeed from 0–6 months of life while on highly active antiretroviral therapy experience better infant health outcomes when compared to EFF and MF infants [21]. Studies from clinical trials have shown that HIV infected mothers who breastfeed while on Atripla ARVs are able to prevent MTCT during postnatal period to less than 1% [41]. Because of the successes and health outcomes of breastfeeding most government have revised breastfeeding policy to promote EBF to faced out the distribution of free infant formula to babies born to HIV-positive/negative mothers[12]. The algorithm for HIV-exposed Infants who are exclusively breastfed and whose mothers are on lifelong ARV[42] is shown in Fig. 3.

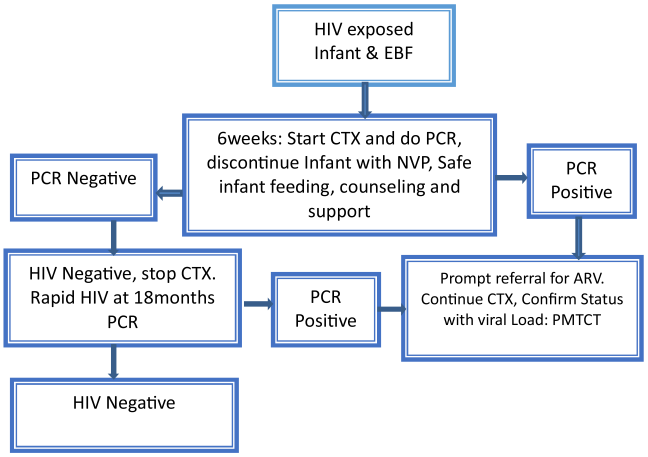

Fig. 3. The antiretroviral algorithm treatment for HIV exposed Infants who are exclusively breastfed[42]. **Key**: CTX = Co-trimoxazole, PCR = Polymerase chain reaction, NVP = Nevirapine, BF = Breastfeeding, ART = Antiretroviral.

Importance of breastfeeding*: Breastfeeding or lactation mothers are less likely to store fat soluble carcinogens and the period reduces a woman's exposure to estrogens. EBF is also important for low-birth-weight infants, especially in the first 6 months because the infant grows better and healthier when compared to other feeding methods during the first six months [13]. Diarrhoea and respiratory infections are also a common phenomenon among non-breastfed infants due to poor sanitary conditions and contaminated water in SSA [22]. Breastfed infants are less likely to develop intestinal infections, colds, asthma and other allergies in the first 6 years of life [13]. In addition, exclusively breastfed babies are less likely to grow up into fat healthy kids. Maternal antibodies provide infant protection by minimizing exposure to infectious pathogens by 13% and deaths of children under 5 years [13]. This is important in developing appropriate PMTCT programmes because EBF is the best survival intervention in reducing MTCT of HIV [13,22]. According to WHO all HIV positive pregnant women should be placed on long-life ARV treatment and their infants breastfed during the first 6 months of life. See Figures. 3 & 4.*

Exclusive formula feeding (EFF) and mother-to-child transmission of HIV

Feeding method that is restricted to commercial supplementary food form 0–6 months of baby's life before introducing complementary foods. It is an early child nutrient supplemented feeding strategy used by most HIV infected mothers and other busy working women. This include the feeding of infant with other commercial supplement through from 0–6-months of life rather than breast milk. In some setting HIV positive women may replace EBF with EFF or other local homemade feeding [10,13]. Exclusive formula feeding is supportive in some developing settings where better sanitation and hygiene are high. However, not recommended in impoverished settings, where poor sanitation compliance and other hygiene services are limited [29].

The disadvantages of EFF and bottle-feeding are alarming when compared to EBF. Although in some community's women prefer EBF to EFF because of the societal norms associated with breastfeeding [10]. In addition, EFF is costly and associated with risk of infant dying due to diarrhoea and other infections among 0–5 months of age by more than two-fold [13,17]. Replacement of EBF with formula or feeding supplement methods should be done with caution after options of EBF have been exhausted [10,42]. WHO prefers EBF in the first 6 months of life, where EFF is not feasible, acceptable, safe and sustainable [5]. In some industrialized countries HIV-infected mothers are advised not to breastfeed but rather use EFF versus impoverished settings, where EFF method must be considered as a less option about AFASS because the risks associated with EFF. This is because the risk of infant morbidity and mortality are higher with EFF when compared to EBF. Globally SSA has the most frequent infant infectious disease mortalities [5]. These infectious agents/diseases can disrupt infant life since mother's immunity is the most essential and available supportive immunity during the 0–6 months of infant life [6].

Moreover, EFF is expensive and most SSA women are unable to afford, and governments are unable to maintain regular supply at ANC [10,29]. However some women prefer EFF over EBF for fear of a spill-over effect of HIV transmission to their babies [29]. In addition, some HIV infected women opt for EFF because of pressure and encouragement from their health-care providers, despite the advantages of EBF over EFF [10,23]. This has been demonstrated in earlier studies in South Africa where mothers' infant feeding methods and choices were influenced by health-care providers [38,43], rather than by informed choices. To achieve a higher success rate of HIV-free infants through EFF, there must be strategies and policies that promote HAART programmes. This also include strategies that strengthen PMTCT programmes as well as motivate families to access proper health-care. Fig. 4, indicates the ARV for EFF-PMTCT algorithm for HIV exposed mothers in Southern Africa [42].

Mixed feeding (MF) and mother-to-child transmission of HIV

Feeding of 0–6-month infants with breast-milk and other food substitutes. Mixed feeding involves a compound of infant breast feeding and other food or liquid intake, including water during the first 6 months of life [10,22]. For example, in South Africa MF has been discouraged among HIV positive mothers [37] because of the high risk associated with MTCT when compared to EBF and EFF. MF carries greater risk of HIV than any other feeding method for the first 6 months of life because of the delicate gut of the infant which is likely to be compromised or debilitated during feeding, increasing postnatal HIV acquisition [13,22]. Unfortunately some HIV-infected mothers in SSA still practice MF with the belief that MF is more nutritious than breast milk and disregard health-care provider advice on EBF [37]. HIV infected mothers who take ARVs and practice MF, still have a higher rate of postnatal MTCT [44], when compared to EBF ARV mothers. Babies of mothers who do not breastfeed are 14 times more likely to contract diarrhea and respiratory infections than babies of mothers who exclusively breastfeed for the first 6 months [45]. In addition, in a study conducted by Baghianimoghadam et al. [17] to implement exclusive breast-feeding programme, 15% of mother were found to be practising. In the same study, daily infants feeding with formula food was 4–5 times as well as breast-feeding [17]. Similar study conducted by Kazaura [99] found that out of 342 nursing mothers in rural area of Tanzania, only 30% were able to exclusively implement EBF within the first 6 months of life. Therefore, continual engagement and education of parents on the consequences of MF in the first 6 months of infant life is paramount. This may include the use of short weekly or monthly Mhealth reminder SMS-messages informing the mother/parent regarding the feeding mechanism options, ARVs uptake.

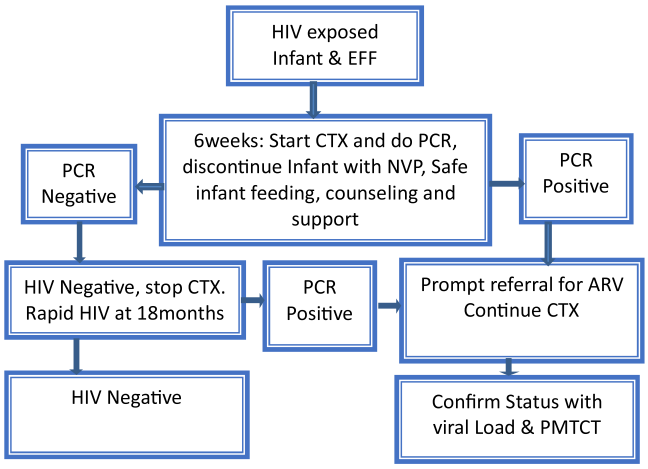

Fig. 4. The antiretroviral algorithm treatment for HIV exposed exclusively formula-fed children in Southern Africa [42].

Antiretroviral (ARV) therapy and mother-to-child transmission of HIV

The introduction of HTS and ARV prophylaxis for pregnant and breastfeeding mothers regardless of CD4 cell counts have drastically reduced MTCT in SSA [42]. The scientific advancement in ARVs and comprehensive continuum of PMTCT programmes has play a significantly role in global reduction in paediatric MTCT [5]. To this regard WHO proposed to scale-up PMTCT programmes by 80% especially in SSA with respect to the HIV 90-90-90 agenda [5]. This include 90% of pregnant and breastfeeding mother knowing their HIV status, 90% on lifelong ARV and 90% virally suppressed. Treatment and care of all HIV positive pregnant and breastfeeding women are regardless of CD4 count or WHO clinical staging [21]. With these efforts some settings have achieved tremendous improvement in ARV-PMTCT scale-up and the successes are underpinned by extensive interrelated, evidence-based guided strategic, operational and public health policy guidelines [46]. For example, in Botswana and South Africa nearly all HIV positive pregnant and breast-feeding mothers are enrolled in PMTCT programmes [10,23]. Successful implementation of PMTCT programmes have shown significant reduction in both viral load suppression and the course of infectivity by 80% MTCT [21]. Some countries, including South Africa, are already providing treatment to over 80% HIV positive pregnant and breastfeeding women at all health facilities while some countries are still below 20% mark. Several factors including poor and weak health systems account for floppy PMTCT scale-up [5] and need effective acceptable PMTCT support programmes.

The scaling of efficient and acceptable PMTCT programmes, such as community engagement, HTS and ARV programmes have

improved PMTCT outcomes in most settings [5]. This has helped to prevent over 800,000 new infections among children between 2005 and 2012. However, challenges faced in PMTCT programmes in SSA are enormous including difficulty in accessing ARV, mother's attitude toward the programmes and poor uptake. This affects compliance and adherence to PMTCT uptake [10]. In addition, mathematical modelling has shown that introducing more effective ARV uptake yield only marginal MTCT reductions, except where health facilities achieve higher levels of performance at each step of the PMTCT cascade[47].

The WHO has recommended the commencement of ARVs to all HIV positive individuals [48]. This will enhance early ARV initiation and better health outcomes, especially viral load reduction by 90%, thus boosting CD4 cells and beating the emergence of HIV associated infections as well as increasing life expectancy [5]. However, stock shortages, coverage and lack of ARVs have been a phenomenon in most settings, putting those eligible for treatment and those already on ARVs at risk, including the danger of ARVs-resistance complications [49,50]. The shortage is due to increasing incidences of HIV infection due to escalating risky sexual behavioral characteristics including unprotected sex and other factors [49–51]. For example, in some settings, most health facilities often run out of ARVs and other essential drugs. According to one of the daily newspapers in South Africa 21% of public health facilities experience a "*stock out" or* shortage of ARV and/or TB dugs [52]. Similar problems occur in Cameroon [51] and the Central African Republic [50]. Some drug addicts smoke ARVs in supplement to substance abuse drugs [53]. For example, the *Mail and Guardian* reported attacks by thugs on patients, robbing them of ARVs [53] thereby causing ARVs shortages. These proximal criminal offences may contribute to incidence of HIV resistance, emergence of new HIV strains, increase viral loads and infectivity in the population. Thus, high levels of non-adherence as well as disengagement from care can undermine the benefits of ARV in MTCT and maternal health [54]. For example, studies by Phillip et al. [54] demonstrate that missed visits and disengagement from care are common behaviours exhibited by women who initiate ARV during pregnancy [54]. Those who are newly diagnosed are also very vulnerable and require urgent interventions and retention in PMTCT care. Also, recurrence HIV testing is required among HIV-negative pregnant mothers after 3-month and during pregnancy, labour/delivery, 6 weeks post-delivery and every 3 months during breastfeeding. While HIV positive and breastfeeding mothers on ART should receive regular viral load testing after every 3 months [37,51–54]. To strengthen PMTCT programmes focus should also be targeted toward key population especially adolescent's girls and female sex workers by supporting and preventing them from HIV infection and transmission.

Adherence to prevention of mother-to-child transmission of HIV

PMTCT adherence is the potential use of PMTCT programmes and information by pregnant and breastfeeding mothers including ARVs uptake and other treatment as prescribed, keeping to PMTCT appointments, referrals and utilization of further health services as indicated [56–58]. Adherence, according to Mepham et al. [58], is keeping to appointments and treatment of ARVs above 95%. Effective and successful PMTCT adherence programmes for pregnant and breast-feeding mothers is accomplish above 95% of PMTCT as prescribed. For example, a study conducted in Uganda in accessing HIV care in postnatal PMTCT programmes found only 38% of breastfeeding mothers capable of adhering to required PMTCT and appointments after eight weeks of postpartum care [59]. Adherence is crucial in understanding health outcomes for both mother and the baby. Adherence to PMTCT has shown a significant reduction in MTCT in all settings [21]. Excellent adherence maintains viral loads to undetectable or to a significant low level as well as significant reduction in MTCT to less than 1% [41]. The failure of PMTCT adherence has been a major hindrance in reducing vertical transmission of HIV and associated mortality and morbidity in SSA [55]. Attrition of pregnant and breastfeeding mother in PMTCT programmes are strongly associated with PMTCT adherence failure and poor health outcomes [56,57]. Poor PMTCT adherence less than 95% may lead to viral resistance as well as non-suppression of viral density.

Several variables/barriers are causally associated with poor PMTCT adherence performances. The most common related independent variables and barriers include biological, behavioral, social, demographic, psychological and cultural norms [60–63]. Other causes include disease variables such as chronic disease conditions, stigma, health care provider attitudes and national variables such as shortage of ARVs in clinics and shortage of health-care providers responsible for PMTCT programmes [60–63]. For example, according to study conducted by Ochigbo [64] in Francistown in Botswana found that pregnant women defaulting PMTCT programmes are related to pregnancy-related illnesses and ARV side effects. In the same study women adherence became less as the women approach delivery period [64]. Other factors include forgetfulness of medication PMTCT days [63]; stopping medication to explore traditional healers' treatments [58]; home births [65]; stigma and discrimination in health settings [61,62]; weak health infrastructure and long distances to access medication, malfunctioning and improper working phones to remind mothers on medication time [58,59,66]; misunderstandings and misconceptions of treatment, misunderstanding of drug instructions and change of location during holidays [58]. Other poor adherence problems include stealing or sharing ARVs with other HIV-infected relatives, domestic violence; rats eating of tablets — and patients having no food [58,61].

Therefore, improving adherence counseling of pregnant and breastfeeding mothers in PMTCT programmes through all stages: prenatal labour & delivery post-delivery will significantly improve health outcomes including the reduction of premature deaths [67]. In addition, WHO strategies for ANC and PMTCT include prevention of HIV infection among women of reproductive age, prevention of unintended pregnancies among HIV infected mothers, provision of specific interventions to that MTCT – and provision of treatment, care and support for HIV-infected mothers and their families [21]. Similarly, the strengthening of PMTCT infrastructures in SSA, including HIV therapy, family planning, expanding and decentralising PMTCT care services and promoting of integrated health services will play a significant role. This will increase access and wide coverage to care, keeping abreast with advances in science, supporting and improving infant feeding methods as well as monitoring and evaluating PMTCT programmes [21,68]. Other innovative methods include the improvement of PMTCT therapies; use of M-health and E-Health as proxy adherence methods [60,61,64], promoting adherence techniques through direct observed therapy, especially in settings where the infected mother is unable to support herself [60,61,64]; drugs delivered at homes [58] and improved social support from spouses [59]. In addition, regular viral load screening of all HIV positive pregnant and breastfeeding mothers.

Health system and personal contribution of prevention of mother to child transmission of HIV

Despite the availability of various alternative models of HIV sensitization/awareness, screening, testing, treatment and care including health care facilities, mobile HTS, home HTS and treatment, most health systems "*mode operanda*" remain a challenge in SSA. Some of the challenges faced in most settings include long

distances to HTS sites [69]; limited HIV screening and testing consumables, storage facilities; electricity shortages/non-availability; poorly trained manpower and limited PMTCT services [16]. Most importantly shortage of staff and unskilled birth attendants in some settings. In addition, long waiting time at the health facility as well as delays in returning HIV results such as CD4 and creatinine [16,58-59;70-71] which in some settings take longer periods than required, limiting early uptake and initiation of treatment [72].

Studies have shown that the introduction of HIV point-of-care testing facilities including CD4, creatinine and on the spot initiation of ARV have enhanced the uptake, treatment and linkages to care in some settings [10,42,71]. But in some countries these services are either limited or unavailable. Although the facilities may be available, the fear and stigma of receiving HIV positive results have restricted some women from undergoing HTS, treatment and care [72]. In addition, the increasing demands for safer donor blood required improved screening techniques/kits but some of these listings are limited in some settings. Furthermore, most health care settings and facilities are too far from the needy population especially in remote rural areas thus, negatively influencing the PMTCT good outcomes [10].

Community engagement and mother to child transmission (MTCT) of HIV

Another model for eliminating MTCT includes the participation and social mobilization of the community, including community health workers, mothers, counsellors, traditional birth attendants, faith-based and civil organization [72]. Others include advocacy and promotion of policies that support PMTCT and the right to health [72]. The community — rather than being a recipient of PMTCT services should be capacitated to play a significant central and complementary supporting role in strengthening PMTCT programmes. Studies show that PMTCT programmes focus mostly on facility-based interventions, neglecting the significant role of community-driven processes in scaling up PMTCT programmes and coverage [72]. Empowerment of community leaders and social groups in participating in PMTCT programmes and partnering with other national governance bodies can ensure a more appropriate design, reach, and quality of PMTCT health services. This can create safe environments that advocate proper PMTCT measures in communities [73]. The Global Fund, and the US Presiden's Emergency Plan for AIDS Relief (PEPFAR), Tuberculosis and Malaria has assisted several ANC and PMTCT community health programmes in SSA [74]. Although most PMTCT programmes in SSA are still fully supported by various national, regional, international, and NGO organisations when compared to developed settings [5,14]. However, poor health systems and limited support from some governments and societies in SSA deter these efforts in scaling upPMTCT programmes and reduction in MTCT [72]. Limited community-led and poorly supported PMTCT services and ineffective information dissemination [72–74] on PMTCT stem from poor engagement and inadequate participation by the community and politicians has led to poor PMTCT programmes. Community leaders are usually excluded from PMTCT health policies, thus limiting the participation of social groups in PMTCT programmes [72–74]. The inclusion of community organizations, community peer support groups, community-based coalitions in PMTCT programmes, highlight community successes in reducing MTCT in communities [72–74].

Participation of Males in antenatal and PMTCT programmes

Transmission of HIV in SSA is mainly through heterosexual means and infection of infants during pregnancy and postnatal, is mostly through vertical transmission from parental lineage [16,75]. Therefore the first stage of eliminating MTCT is by voluntary counselling and testing of couples. This provide families with informed choices on sexual reproductive health (SRH), HIV/STIs and safe-free HIV babies [70,75]. This applies to discordant or concordant HIV positive partners who intend to have children. The supportive role of men in reproductive health practices during pregnancy and PMTCT are cost effective in reducing MTCT and other SRH consequences. Seemingly, continuous empowerment of men in PMTCT is a shared responsibility as well as opportunity for men to learn more about SRH, ANC and PMTCT programmes. With strong male empowerment SRH, HIV/STIs can increase constructive engagement and promote community uptake of SRH, ANC and PMTCT programmes.

Studies have shown strong association with males' participation and better maternal SRH outcomes during PMTCT [76] and men who participate in PMTCT programmes benefit more in terms of health outcomes [76]. For example, study conducted by Auvinen et al. [77] among Congolese men in Zambia on men's perspectives and participation in PMTCT programmes, found men ready to engage with their wives and creating intimate relationships with regards to health-care services utilisation and infants free HIV. In the same study men advocated for increase transparency in ANC and support during marital crises that ensure men trust in maternity services [77]. Other studies show that men who participate in PMTCT programmes become more knowledgeable about HIV and SRH knowledge minimising the perception of ANC as "woman's affair [70,75]. However, in other similar study men thought attending ANC programmes, were to be recognized as 'weak men' a patriarchal cultural norm in most SSA settings [70].

Challenges faced by some men are the long waiting time and other women clinical conditions at ANC [70,78]. Putting a supportive family attitude into practice remains a difficult task for many SSA men70. Because of the patriarchal system majority of men envisage their role in ANC primarily as financial providers [70,79,80].

Involving men however, in ANC programmes reduces stigma, and gender base violence — and increases good HIV outcomes such as adherence to PMTCT programmes [75,80,81]. The adherence to PMTCT programmes by both partners plays a significant role in family health outcomes. Encouraging men to attend PMTCT increases the incidence of male HCT programmes [82].

The non-attendance of PMTCT by men is a behavioural belief and an attitude that can be overcome with time [83]. Although socio-demographic determinant factors such as, level of education, income status, PMTCT service opening hours and the attitudes of health-care providers continue to affect male involvement in PMTCT programmes[77,83]. According to study by Auvinen et al. [77] men whose wives attend PMTCT programmes exhibit negative attitudes, fear of testing, fear of health-care services and other cultural barriers. For example, a randomized trial by Darbes et al. [84] in rural KwaZulu-Natal, South Africa, found improved uptake of SRH/HIV outcomes by couples via HIV counselling and testing (CHCT). This shows that failure in CHCT programmes is inhibited by lack of community mobilization and support by stakeholders [79–85] and late initiation of ART [79,85]. Similarly, CHCT has been proven to improve family support, reduce gender base violence, and increase ARV uptake, retention and adherence and excellent SRH outcomes. This has helped to reduce poor behavioural changes exhibited by couples attending ANC and PMTCT programmes [84]. So far, provision of continual information and awareness are methods needed to broader family ANC and PMTCT programmes' outcomes and reduction of MTCT. Involvement of males in ANC services makes the programmes friendlier. This can shift family

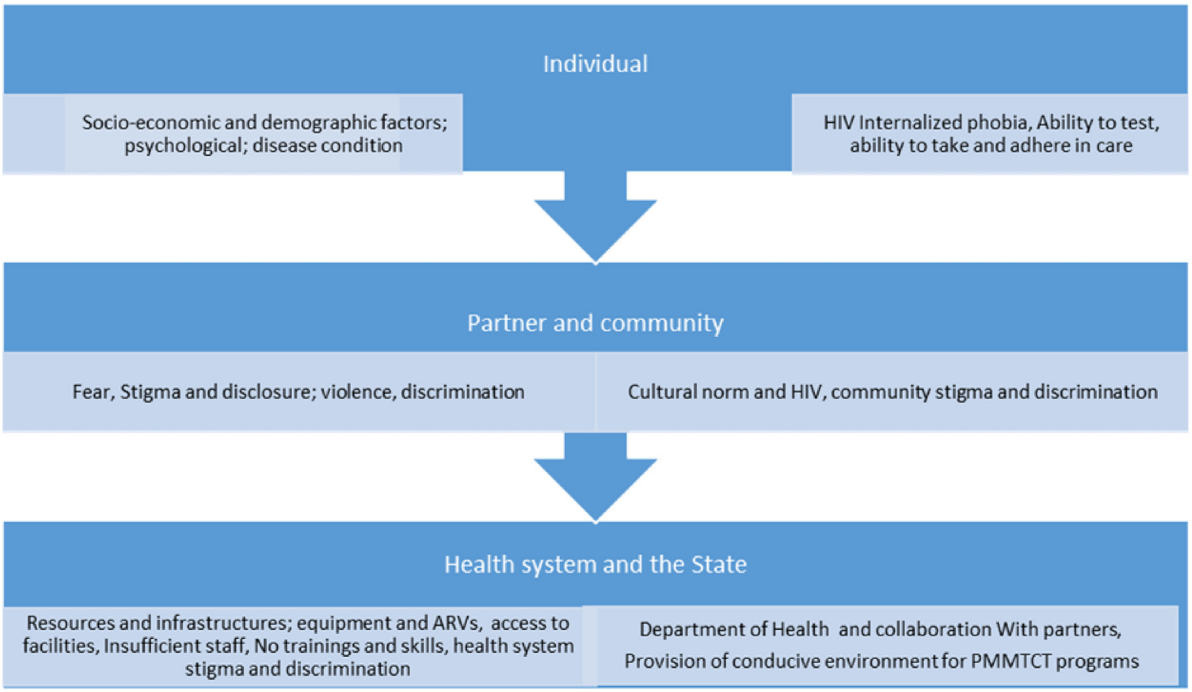

Fig. 5. Structural barriers affecting women attending PMTCT [2,10,16,71,87,90–93].

paradigm from an individual base to a more integrated family approach in HIV prevention [84,86].

Factors promoting mother-to-child transmission of HIV in Sub Saharan Africa

There are several barriers that constitute the continual burden of MTCT in SSA. The first is denial and refusal to admit HIV existence [87]. The slow uptake of PMTCT by women of reproductive age including HTS, despite the scale-up accesses to PMTCT in most settings [10]. Studies show that a majority who pre-test to HIV and are HIV positive do not show up for results such as CD4/HIV viral load/liver and kidney function test or do not engage in PMTCT programmes [10]. As earlier eluded poor infant feeding choices and failure to diagnose maternal HIV infection during prenatal, intrapartum, postnatal was one of the root causes for missing PMTCT prophylaxis and timely infant HIV testing [16,23,25,26,35,39]

Other independent barriers are social norms and structural barriers such as fear, stigma, violence and discrimination especially HIV positive mothers [88,89]. In some settings women deter HCT for fear of stigma and discrimination among their peers "as HIV positives" [2] while some mistrust and/or do not believe in PMTCT programmes [16,90]. Some prefer to seek and patronage native traditional healers because traditional healers will always attribute HIV and HIV-related diseases to witchcraft and curses [79–85]. Some local communities even believe that traditional healers and spiritual practices can treat and eliminate HIV infections [78–85].

In some instances, women do not share information about their HIV status with their partners for fear of violence, lack of support and/or divorce from the partner. For example, studies by Eide et al. [2] reported that only one third (1/3) of women receive support from their partners during PMTCT programmes. Also women participating in PMTCT programmes may be stigmatized by healthcare workers and other women in the community [92]. To remove structural factors deterring women from attending PMTCT, some communities have incorporated PMTCT into wellness programmes to reduce stigma and discrimination by community members [93]. Fig. 5, shows the structural barriers, ranging from individual to health system barriers, affecting women attending PMTCT programmes. The individual level includes internalized phobias, fear and psychological factors while partner and community barriers include violence, discrimination, divorce and a host of others [2,16]. Health systems factors such as safe spaces and health care provider factors, non-availability of reproductive umet needs of women as well as government policy influence PMTCT uptake [71].

Fig. 5

Socio-cultural factors of mother -to-child transmission of HIV in sub Saharan Africa

Socio-cultural and economic factors are associated with MTCT [16,26,94]. The problems faced in this context are beyond structural factors of vertical transmission of HIV. The vast diverse ethnic groups cultures and practices in SSA make the integration of PMTCT programmes uptake difficult. That is why disclosure of HIV status to partners/family members is still a complex and difficult decision in SSA. This is compounded by fear, stigma, discrimination, physical abuse and violence, divorce, accusations of infidelity and community rejection [16,26,94,95]. For example, an investigation of non-disclosure of status in Zimbabwe shows majority of women in PMTCT programmes refusing to disclose their HIV status to their partners or family members [95]. Since HIV is envisage as a life-threatening stigmatized disease [95]. Non-disclosure of status is associated with mother's high viral density and MTCT [26].

According to WHO [96], disclosure of HIV status among women in wealthier countries ranged from 42–100% vs 17–32% in low income countries. Enhancing PMTCT programmes and disclose of HIV status to partners have been seen as a protective factor of MTCT of HIV. Disclosure provides better HIV treatment and infant feeding methods [26]. Studies by Iwelunmor et al. [94] and Darbes et al. [84] propose the use of education interventions centred toward family and cultural orientation, rather than a generalized intervention. Although Bucagu et al. [26] showed that non-educated women are less likely to disclose their HIV status to partners when compared to educated women. In some instances, HIV-positive women are willing to access PMTCT programmes but are constrained by

operational factors and structural factors such as stigma, blackmail, human rights and criminalization [26]. Fears of disclosure impede access and utilization of PMTCT services [16] as well as undiagnosed HIV and untreated STIs.

In some settings home deliveries by traditional birth attendance is preferred to ANC [97,98]. Women who deliver at home are less likely to receive HIV-ARV care during pregnancy, labour/delivery and are more likely to infect babies [97,98]. According to World Bank report of 2004, approximately 90% of deliveries occur at home without the assistance of well-trained health professionals and supportive obstetric-care opportunities are missed [16,100]. The preference for home delivery is more of trust and has become a behavioural and cultural norm. Since TBA are from the community and speak the native language [100]. Some of the home births are associated with traditional and cultural beliefs [94,97]. Therefore, expanding the scope of education, including TBAs in terms of PMTCT programmes empowerment, is paramount [97].

Biological factors (Sexually transmitted infections (STIs)) of mother-to-child transmission of HIV

Sexually transmitted infections (STIs) are risk factors highly associated with HIV acquisition globally [101,102]. Diagnosis and management of STIs during pregnancy has been a huge problem in reducing MTCT in SSA. Countries without affordable diagnostic tools suffer from STIs complications and MTCT. This is because some STIs are asymptomatic in nature and remain as long-term sequelae risks of MTCT during child delivery [103]. However, with good laboratory diagnostic tools, STIs can be identified and treated, thus reducing the burden of STIs-related MTCT. STIs cause a wide spectrum of disease which is highly associated with MTCT. Most common STIs include syphilis, trichomoniasis, gonorrhoea, chlamydia, hepatitis B-Virus, bacterial vaginosis and genital herpes [18,103]. These infections can cause either a sore or inflammation in the vagina which stimulates more immune cells, including CD4+ cells (HIV loving cells) that migrate to the vagina-site of infection. These immune cells that migrate to site of infections –vagina are usually HIV carrier and end up releasing more HIV into the vagina fluid as well [91]. In some instances, they produce proteins at the site of infection that promote the released HIV to infect more CD4+ cells [91]. This causes the release of more viral particles in the vagina fluids, facilitating MTCT risk during birth. Also, women with cervicitis can suffer increase HIV shedding in the vaginal fluid [18]. For example, an HIV-positive mother co-infected with STIs has higher probability of infecting her baby during birth [18]. Other infections such as bacterial vaginosis is asymptomatic and are the leading cause of low birth-weight or premature infants [18]. Chlamydia infections are usually very difficult to treat and tend to persist longer [17]. Others such as the human papillomavirus infection are also often observed in HIV-infected women [103]. However, most SSA settings do not have affordable diagnostic tools that detect most of these STIs and usually go unnoticed and become risk factors of MTCT during birth.

Conclusion

The study indicated the participation of both men and women as an integral part of PMTCT and ANC programmes including the regular screening and treatment of all forms of STIs. The study found ARVs and breastfeeding mechanisms as a vital survival approach toward the elimination of MTCT of HIV in SSA. This study also highlights the influence of MTCT of HIV by strong cultural norms, structures and social barriers. Also, to eliminate MTCT, adequate and quality of ANC and PMTCT programmes that will provide better informed choices of preventing MTCT including breastfeeding methods are essentials. Other interventions include strong advocacy and implementation of the 90-90-90 cascade toward elimination of MTCT through scale up PMTCT coverage programmes. This includes the continuous supply of essential quality PMTCT services, regular health care workers sensitization training that abreast changing knowledge, tools and guidelines. Strengthening of health systems especially those of SRH/HIV. The correlated gaps of MTCT and PMTCT-risk highlighted in this study should be used toward the formulating of evidence-based approaches in eliminating MTCT free HIV. Finally, appropriate and timely maternal HIV diagnosis that facilitates PMTCT uptake, implementation of adherence strategies and follow-up including Mhealth-SMS-reminder responsive messages that will improve PMTCT uptake and ensure mother and infant wellbeing.

Conflict of interest

None declared.

Contribution

CY conceived the idea and develop the concept note. Data extraction was supported by post graduate students. CY and TE reviewed the data and CY wrote the initial draft of the article which was further reviewed by TE. The authors have read and consented to the information reviewed and not based on any organization.

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