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Review Article

Breastfeeding Outcomes and Associated Risks in HIV-Infected and HIV-Exposed Infants: A Systematic Review

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Abstract

Purpose: To critically appraise recent literature regarding breastfeeding outcomes and associated risks in AU2 ▶ HIV-infected (HI) and HIV-exposed (HE) infants, using the PRISMA-P statement guidelines.
Materials and Methods: Five electronic databases were systematically searched to obtain English publications from the last 10 years (2010–2020), pertaining to breastfeeding outcomes and associated risks of HI and HE infants and children. Gray literature sources were also included. Data were extracted according to various data items and were synthesized using thematic synthesis.
Results: Of the initial 7,151 sources identified, 42 articles were eligible for final inclusion. The final selection included 19 cohort studies and 2 expert committee reports, classified as gray literature. The remaining 21 studies comprised case–control, cross-sectional, and randomized controlled trial studies. The following themes were identified: breastfeeding outcomes in HI and HE infants, risks for suboptimal breastfeeding, HI and HE infant growth and developmental outcomes, and barriers and facilitators to feeding decisions. Most studies highlighted HE infants' growth and developmental outcomes and did not directly interrogate breastfeeding outcomes. The most prevalent risks for suboptimal breastfeeding were maternal factors affecting decision making for breastfeeding.
Conclusions: This systematic review adds to the evidence of breastfeeding in HIV-affected mother-infant dyads. Findings reiterated that exclusive breastfeeding has a positive outcome on growth and development of all infants irrespective of HIV status. The review highlighted a dearth of research on breastfeeding outcomes of HI and HE infants. Large-scale prospective comparative studies should profile breastfeeding and developmental outcomes of infants with HIV infection or exposure and antiretroviral treatment exposure to enable early identification and intervention for this vulnerable population in low-income settings.

Keywords: breastfeeding outcomes, associated risks, HIV infected, HIV exposed, infants, Sub-Saharan Africa, systematic review

Introduction

AU3 ▶ Sub-Saharan Africa (SSA) accounts for 76% of the world's HIV-infected (HI) population and has the largest number of HI women of childbearing age.[1] New childhood infections mainly occur due to mother-to-child transmission (MTCT) during pregnancy, birthing, and breastfeeding.[2] Many infants may be exposed prenatally or postnatally, but do not acquire HIV due to the effective use of antiretroviral treatment (ART) in MTCT prevention programs.[2] Newborns, if not yet infected, can remain HIV and ART exposed with an unconfirmed HIV status until 18 months, or until post-cessation of breastfeeding.[3] This infant population is termed HIV-exposed (HE) infants. To date, literature has mostly centered around HI infants' neurological development and breastfeeding, and less on breastfeeding outcomes of HE infants.[4,5] Recent research shows that HE infants may have distinct and complex breastfeeding profiles differing from those HI and HIV-unexposed (HU) infants.[6,7] Evidence of growth delays in HE infants because of biological factors, in-utero exposure to ART, and socioeconomic factors has emerged.[7] ◀ AU0

A convergence of environmental and biological factors describes the impact that HIV and AIDS has on families

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in SSA, comprising economic, psychological, cultural, and political challenges. Environmental risks, related to low socioeconomic statuses of many families in SSA, include poverty, food insecurity, and malnutrition, making infants exposed to HIV more susceptible to contracting the virus.[8] Breastfeeding difficulties are further exacerbated by mothers' HIV symptoms, and the potential lack of family and maternal education.[9,10] The combination of these factors, together with possible postpartum depression and psychosocial distress, may negatively affect breastfeeding outcomes of HI and HE infants and their mothers.[11]

Early breastfeeding difficulties in both HE and HI infants could be linked to biological factors such as possible neurodevelopmental differences between HI, HE, and HU infants.[12,13] Research shows HE infants may display neurodevelopmental differences when compared to other infant populations,[12,13] although contradictory results have been reported.[14] Further description of breastfeeding outcomes and associated risks in HE infants is warranted.[14]

In addition to supporting childhood development, numerous other benefits are associated with breastfeeding, including improved maternal and infant health.[15,16] South African national breastfeeding recommendations encourage breastfeeding initiation within 1 hour of birth, and exclusive breastfeeding (EBF) for the first 6 months of life, with continued breastfeeding until 2 years of age, regardless of maternal HIV status.[16] In contrast, high-income countries recommend formula feeding from birth for HI mothers.[17] The benefits of breastfeeding must be weighed against the risk of transmission of HIV through breast milk.[18]

In South Africa, health care facilities aim to uphold the Baby-Friendly Hospital Initiative (BFHI).[19] As health care professionals involved in breastfeeding, speech-language pathologists (SLPs) support the BFHI by advocating for breastfeeding when possible and managing EBF difficulties, especially for families from low-income settings who experience greater barriers to successful breastfeeding.[20,21]

One South African study identified swallowing and feeding difficulties, or oropharyngeal dysphagia, in a group of HE versus HU infants (>3 months) with cleft lip and palate.[21] Other studies have, however, reported no difference in early swallowing and feeding of neonates with HE compared to HU peers.[14,22] Further research is required to develop a profile of breastfeeding outcomes of HE infants.

A well-defined profile of breastfeeding skills and risks among HI and HE neonates could result in customized feeding and swallowing intervention when the need arises. In addition, breastfeeding support to families consistent with the BFHI as well as national and international policies may be improved when SLPs and other health care professionals query the description of HI and HE infants' breastfeeding profiles, in addition to standard biographical information. The aim of the study was to critically appraise recent literature regarding breastfeeding outcomes and associated risks in HI and HE infants, using the PRISMA-P statement guidelines.[23]

Materials and Methods

Eligibility criteria

To be eligible for inclusion, articles had to be English, peer reviewed, or gray literature sources published during or after 2010, which described either the breastfeeding outcomes or associated risks of HI and HE breastfeeding infants (0–23 months) and children (>23 months) and their mothers. After employing keyword searches across all five electronic databases and Google, suitable sources were identified, after which eligibility criteria were strictly applied, during three screening phases. Duplicates and systematic reviews were excluded.

Information sources

Before conducting searches, the review was registered with the International Prospective Register of Systematic Reviews (PROSPERO; ID No. 244643). Searches across five electronic databases were conducted in July 2020. The databases that were included were Scopus, PubMed, Science direct, EBSCOHost, and Web of Sciences Core Collection. The use of various databases ensured an inclusive search strategy, to heighten the quality of the review.[22] In addition, keyword phrases were entered into Google and reference lists of the articles were hand screened, to include gray literature for a comprehensive search strategy, thereby reducing selective reporting bias.[24]

Search strategy

The keyword searches included the following: ''(Breastfeeding) AND (HIV) AND (Infected),'' ''(Breastfeeding) AND (HIV) AND (Exposed),'' ''(Breastfeeding) AND (HIV) AND (Infected) AND (Infant),'' ''(Breastfeeding) AND (HIV) AND (Exposed) AND (Infant),'' ''(Breastfeeding) AND (HIV) AND (Infant) AND (Risk),'' ''(Breastfeeding) AND (HIV) AND (Infant) AND (Infected) AND (Risk)'' AND ''(Breastfeeding) AND (HIV) AND (Infant) AND (Exposed) AND (Risk).'' Interrelated keyword categories were created using concept mapping.[24,25] The combination of the six selected keywords was consistently used across the selected databases to ensure reliability, sensitivity, and specificity across databases and to limit bias during the searches.[23]

Study selection and data management

Agreement was reached by the four authors pertaining to search phrases and eligibility criteria before conducting database searches. Distiller Systematic Review,[26] the most common online systematic review software program, was used to manage data. The functions of de-duplication, title screening, abstract screening, and full-text screening were used. Any uncertainties regarding inclusion were discussed between the authors to reach consensus. A tailored data extraction sheet was used to record data items from the final selection. The data extraction sheet was compiled using the customized Distiller Systematic Review eligibility template. The computerized organization of data prevented errors occurring during data entry.[26]

Data items and data collection

Data items were identified according to the study objective and used to collect information from the included articles. The data items included title; author; year of publication; study design; geographical location, participant type (infant, child, or mother), and sample size; age range of participants; participant HIV status (HI, HE, or HU); presence of any breastfeeding, growth, and health outcomes; feeding method;

and any associated risk. In addition to ensure that the level of evidence was appropriately graded, the authors employed the American Speech-Language-Hearing Association (ASHA) evidence rating scale (Table 1), which is widely accepted in the field of speech-language pathology.[27] This rating scale is a framework for classifying research on several criteria, including study design, validity, and/or methodological quality. The scale comprises four levels in descending order from I to IV (highest level to lowest level of evidence).[27] The ASHA evidence rating scale contributed to determining the confidence in the cumulative evidence collated during the systematic review.

Risk of bias

The assessment of the risk of bias is critical to the internal validity of systematic reviews.[23] To assess the risk of bias in randomized control trial studies, the Cochrane Collaboration Tool for assessing the risk of bias, as included in the Cochrane Handbook for Systematic Reviews of Interventions, was utilized.[28] This tool covers six domains of possible bias, including random sequence generation, allocation concealment, reporting bias, performance bias, detection bias, and attrition bias. Each domain was evaluated and rated as posing a ''low,'' ''high,'' or ''unclear'' risk of bias, by three independent raters. The Newcastle-Ottawa scale (NOS)[29] was employed to evaluate nonrandomized studies' methodological value. Three independent raters rated the studies, by allocating ''stars'' depending on their level of evidence. The higher the evidence, the more stars were awarded. Domains included selection, comparability, and outcome and exposure. A maximum of one star per subdomain in selection (representation of exposed cohort, selection of nonexposed cohort, and ascertainment of exposure; demonstration of outcome), outcome (assessment of outcome; adequacy of follow-up of cohorts), and exposure (ascertainment of exposure and method of ascertainment; non-response rate) could be awarded, whereas a maximum of two stars are awarded per subdomain in comparability (comparability of study on basis of design or analysis). Conflicts between raters were resolved through discussion.

Data synthesis

Data were synthesized both quantitatively with descriptive statistics and qualitatively using thematic synthesis.[30–32] Qualitative synthesis involved thematic synthesis, which entails detecting, evaluating, and reporting themes within data.[32] The main themes or categories were compiled by the authors by employing the principles of thematic synthesis.

Outcome and prioritization

Outcomes were grouped according to breastfeeding, health, and growth outcomes, feeding method, and associated risks for suboptimal breastfeeding. Study findings related to breastfeeding outcomes and risks in mothers and HE or HI infants are detailed in Table 1.

Meta biases

According to the PRISMA-P, biases that can arise during a systematic review should be identified to ensure transparency when reporting the methodological aspects and results of the review.[22] During this study, selection and publication biases may have occurred.[33] Selection bias refers to specifically including or excluding sources in a review, despite eligibility criteria, and may result in bias if review findings are used in policy development or to make medical choices.[33] To reduce selection bias, the study inclusion criteria were based on clear and unambiguous eligibility criteria, and the PRISMA-P statement guidelines were rigorously and systematically followed.[23,33] Publication bias mostly occurs during the selection process. The risk of publication bias was minimized by searching five electronic databases and by entering relevant and consistent search terms. Selection and publication biases were further reduced by including gray literature, including reports, case series, and dissertations. This makes noteworthy contributions to reviews and enhances sensible reporting of data, by providing data not found in commercially published sources.[24]

Results

Study characteristics

Of the initial 7,151 sources identified, 5,942 duplicates were detected, resulting in 1,209 sources eligible for title screening (Fig. 1). At this level, 921 sources were excluded as they did not meet the eligibility criteria. Thereafter, the first author commenced with abstract screening, during which 180 sources were excluded. Subsequently, 108 sources were screened during full-text screening, after which a final total of 42 articles were deemed eligible for inclusion. The final study sample included 19 cohort studies (45.2%) and 2 expert committee reports (4.8%), which were considered gray literature.[24] The remaining 21 studies (50%) were cross-sectional and case–control studies.

Most studies were conducted in middle-income countries ($n=29$; 69.0%), with seven studies conducted in low- and middle-income countries (16.7%), four studies conducted in low-income countries only (9.5%), and a single study (2.4%) conducted in a high-income country (Table 1). All the studies were conducted, at least in part, in SSA countries ($n=42$; 100%).

Six (14.3%) studies focused on HE, HI, and/or HU infants 0–24 months of age, and eight studies (19.0%) focused on HE, HI, and/or HU children 24 months to 11 years of age. Some studies ($n=8$; 19.0%) described only maternal breastfeeding practices and perspectives and not infant outcomes. The two (4.8%) expert committee reports focused on the growth and immunological outcomes of the HE infant population at large. The feeding method most often described in the literature ($n=19$; 45.2%) was mixed formula feeding and breastfeeding, with one study (2.4%) describing exclusive bottle feeding, using formula milk. Outcomes of HI and HE infant growth and development were discussed in most of the studies ($n=28$; 66.7%). Infant-focused breastfeeding outcomes were, however, only discussed in two (4.8%) studies. Most studies ($n=40$; 95.2%) considered the impact of maternal, environmental, and biological risk factors on breastfeeding outcomes.

Risk of bias in individual studies

The Cochrane Risk of Bias Tool[28,29] was used to evaluate the 5 randomized controlled trials, and the NOS[29] evaluated

TABLE 1. STUDY CHARACTERISTICS (N=42)

Study features			*Participants*			*Study variables and outcomes*			*Levels of evidence (ASHA, 2004[27])*
Author (year)[Ref.]	*Design*	*Geographic location*	*No.*	*Age range in months/years*	*HIV status*	*Breastfeeding, growth, and health outcomes*	*Feeding method*	*Associated risks*	
Thakwalakwa et al. (2014)[53]	Randomized controlled trial	SSA: Malawi, low-income country	280 HI women; 248 HE infants	HE and HU infants up to 18 months of age; mean = 24.7 months; SD^{+} = 2.6 months	HI mothers; HE and HU infants/children	Length and weight for height in EBF[#] infants: using ready-to-use complementary food at 12 months decreased length for age compared to cow milk users.	EBF, breastfeeding, complementary feeding	Infant, socioeconomic, feeding decisions	1b
Wynn et al. (2017)[54]	Cluster randomized controlled trial	SSA: South Africa, middle-income country	1,238 Pregnant women: 644 Intervention group (HI); 594 standard care group	IG mean age = 26.5 months and SD mean age = 26.3; children <6 years	HI; HIV-negative mothers	Mentor mothers' program increases maternal and child health outcomes in a LMIC and lower cost than nurses/intervention.	Breastfeeding	Socioeconomic, psychological, environmental, biological	1b
Ijumba et al. (2014)[61]	Nonrandomized controlled trial	SSA: South Africa, middle-income country	11 HI mothers, 9 HIV-negative mothers	Mothers: 16–19 years, infants <6 months	HI, HIV-negative mothers, HE and HU infants	Dependence on FF lead to prelacteal feeding.	FF, breastfeeding—mixed feeding	Social pressures, maternal, family support	IIa
Morden et al. (2016)[34]	Retrospective cohort study	SSA: South Africa, middle-income country	Total of 2,621 HE and HU mother-infant dyads	Infants younger than 28 days CA and mothers 23–35 years of age; maternal mean = 29.81; SD = N/I	HE and HU infants; their mothers	HE infants born to mothers using ARTs antenatally had higher birth weight than HE infants born to mothers not taking antenatal ARTs. Infants with any breastfeeding exposure showed slower growth compared to FF infants.	FF, EBF, breastfeeding with unknown exclusivity and mixed breastfeeding	Biological, maternal, and pharmacological	III
Goga et al. (2012)[71]	Retrospective cohort study	SSA: South Africa, middle-income country	665 HI mothers; 218 HIV-negative mothers	Mothers 3–36 weeks postpartum; mean HI = 25; mean HIV negative = 23	HI and HIV-negative mothers	More HI mothers EBF until 4 months than HIV-negative mothers.	EBF, mixed breastfeeding, exclusive FF; mixed FF	Socioeconomic, maternal, environmental, pharmacological	III
Hampanda (2016)[35]	Cross- sectional survey	SSA: Zambia, middle-income country	320 Married HI postpartum women	Mothers older than 18 years with infants 3 months of age; maternal mean = 29.1	HI women; mothers	Intimate partner violence increases early mixed feeding.	Early mixed feeding	Psychological, maternal, environmental, socioeconomic	III
le Roux et al. (2020)[69]	Observational study	SSA: South Africa, middle-income country	132 HI; 336 HIV-negative mothers	Children 3–34 months postpartum; HI mothers mean = 23.8; SD = 7.2; HIV-negative mothers mean = 27.8; DS = 6.1	HI; HIV-negative mothers	All HI mothers reported taking ART. Rate of depressed mood and intimate partner violence similar across groups. HI mothers significantly decreased alcohol use when pregnant and were more likely to EBF when compared to HU mothers. Across groups, children had similar growth in the first 24 months of life.	EBF	Socioeconomic, environmental, maternal, biological	III

(*continued*)

Table 1. (Continued)

Study features			Participants			Study variables and outcomes			Levels of evidence (ASHA, 2004[27])
Author (year)[Ref.]	Design	Geographic location	No.	Age range in months/years	HIV status	Breastfeeding, growth, and health outcomes	Feeding method	Associated risks	
Archary et al. (2019)[51]	Case series	SSA: Zambia, Zimbabwe, Botswana, middle-income countries	Infants, children; mothers affected by HIV	Infants/children 0–2 years old	Infants, children; mothers affected by HIV	HE children were more at risk of stunting at 18 months and developmental delays at 24 months than HU children.	N/I	Socioeconomic, maternal, infant	IV
le Roux et al. (2018)[36]	Observation al study (not well specified)	SSA: South Africa, middle-income country	214 HI Mothers; their HE children	HE infants from delivery to 1 year of age; maternal mean = 29 years	HI mothers; HE children	Maternal viremia in utero results in adverse HE child developmental outcomes, despite ARV use.	Breastfeeding (EBF or any breastfeeding noted)	Maternal, socioeconomic, psychological, environmental, biological	III
Tuthill et al. (2017)[11]	Retrospective cohort study	SSA: South Africa, middle-income country	68 HI postpartum women	Women 18- 40 years of age; maternal mean = 27.59. SD = 6.08	HI women	Maternal psychological well-being; prenatal depression results in suboptimal EBF. Counseling is necessary to reduce HIV transmission.	EBF	Socioeconomic, maternal, psychological, environmental	III
Coetzee et al. (2017)[9]	Prospective cohort study	SSA: Nigeria, middle-income country	37 Pregnant and postpartum women: 25 HI; 12 HIV-negative women	Women older than 18 years; HI women mean = 33; HIV-uninfected women mean = 30	HI; HIV-negative women	Barriers to EBF included physiological problems, employment, and time constraints, where EBF facilitators included affordability and support from partners. Facilitators of FF included flexibility for working mothers.	EBF and FF	Maternal, socioeconomic, environmental	III
Taha et al. (2010)[37]	Cohort study—retrospective analysis of randomized controlled trial	SSA: Malawi, low-income country	1,589 HI and HU children: their mothers	Postpartum mothers: infants 6–24 months of age; maternal mean age = 24 years	HI; HU mother-child dyads	Stunting (weight and length) in HE and HU infants prevalent due to lack of breastfeeding	Breastfeeding	Maternal, economic, environmental	I
Chaudhury et al. (2017)[38]	Prospective observational study	SSA: Botswana, middle-income country	912 Mothers: 454 HI mothers, 458 HIV-negative mothers (453 HE infants; 457 HU infants)	Mothers from 18 years of age onward, pregnant or from 7 days postpartum to 24 months	HI and HIV-negative mothers; HE and HU infants	99.5% HU children breastfed compared with only 9% of HEU children. No developmental domain score was significantly lower among HE children in adjusted analyses. Cognitive and personal-social domain scores significantly higher in HE children than in HU children, but differences were small.	FF, breastfeeding; mixed feeding	Maternal, biological, socioeconomic, psychological	III

(*continued*)

Table 1. (Continued)

Study features			*Participants*			*Study variables and outcomes*			*Levels of evidence (ASHA, 2004[27])*
Author (year)[Ref.]	*Design*	*Geographic location*	*No.*	*Age range in months/years*	*HIV status*	*Breastfeeding, growth, and health outcomes*	*Feeding method*	*Associated risks*	
Rupérez et al. (2017)[39]	Case–control study	SSA: Mozambique, low-income country	966 HE children; 909 HU children	0–18 Months	HI and HIV-negative women; their HE and HU infants	Increased hospital admissions, shorter survival in the first 18 months and moderate to severe malnutrition HE children compared with HU children. Incidence of outpatient attendance in HE children was associated with being male, older, and mothers being on ARVs. HE children who were never breastfed, or who were weaned or only partially breastfed, had an increased incidence of hospital admissions compared with children who were EBF.	EBF, breastfeeding; partial breastfeeding	Pharmacologic al, maternal, and biological	IIb
Kesho Bora Study Group (2017)[56]	Cohort study	SSA: Burkina Faso, Kenya, South Africa, low; middle-income country	728 HE mother-child dyads	HE children 2 days to 18 months of age	HE children; their HI mothers	EBF infants had better outcomes in growth and length compared to FF HE infants.	FF and EBF	Maternal and socioeconomic	III
Zash et al. (2014)[40]	Prospective cohort study	SSA: Botswana, middle-income country	128 HE infants; 272 HU infants; 49 HIV unknown infants	Infants younger than 28 days postdelivery	HE, HU; HIV unknown infants in the NICU	NICU infant mortality in LMICs was not affected by HIV exposure or feeding type.	Breastfeeding, FF, mixed feeding, and nil per oz	Biological, maternal, and psychological	III
Strehlau et al. (2020)[75]	Cross-sectional analysis	SSA: South Africa, middle-income country	70 HE mother-child dyads	Infants/children from birth to 48 months; maternal mean = 29.7; SD = 5.33; infant mean = 0.77 months; SD = 0.49	HE, HU; HI children and their HI mothers	No neurodevelopmental effects of ART exposure on HE children.	EBF and FF	Maternal, socioeconomic, biological, pharmacological	III

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Table 1. (Continued)

Study features			Participants			Study variables and outcomes			Levels of evidence (ASHA, 2004[27])
Author (year)[Ref.]	Design	Geographic location	No.	Age range in months/years	HIV status	Breastfeeding, growth, and health outcomes	Feeding method	Associated risks	
Phakisi and Mathibe-Neke (2019)[41]	Cohort study	SSA: South Africa, middle-income country	15 HI mothers	HI mothers 20–40 years of age	HI mothers	HI mothers had positive experiences of EBF in first 6 months of infants' lives, such as motivation, satisfaction, and being well informed. Negative experiences included anxiety, family pressure, and guilt, leading to nonadherence to EBF. Experiences were influenced by sociocultural issues and information from health care workers.	EBF and FF	Maternal and socioeconomic	III
Wubneh et al. (2019)[83]	Retrospective cohort study	SSA: Ethiopia, low-income country	408 HE mother-child dyads	HE infants younger than 18 months and their mothers	HE infants; their HI mothers	Predictors of HE infant mortality were death of at least one parent, non-EBF, growth failure, presence of sign and symptom of HIV, and low birth weight.	EBF and non-EBF	Maternal, socioeconomic, environmental, biological	III
le Roux et al. (2019)[70]	Prospective cohort study	SSA: South Africa, middle-income country	461 HE; 411 HU mother- child dyads	6 Weeks to 12 months postdelivery	HE and HU mothers; their infants	Birth characteristics were similar across groups. Median duration of breastfeeding was shorter among HE than HU children. HE children had consistently lower mean weight for age scores than HU children. Length for age scores decreased in both groups after 9 months. At 12 months, HE children had lower mean length for age scores than HU children, with a higher proportion of children stunted. Overweight was common in both groups of children at 12 months.	N/I	N/I	III
Thomas et al. (2017)[42]	Prospective cohort study	SSA: South Africa, middle-income country	899 Mother-infant dyads: 192 HI mothers; 707 HIV-negative mothers	Mean age of HI mothers = 29.7 and mean age of HIV-negative mothers = 24.8	HI; HIV-negative mothers	Mental disorders do not predict maternal initiation and continuation of breastfeeding.	Breastfeeding, FF, and mixed feeding	Maternal, socioeconomic, environmental biological, pharmacological	III

(*continued*)

Table 1. (Continued)

Study features			*Participants*			*Study variables and outcomes*			*Levels of evidence (ASHA, 2004[27])*
Author (year)[Ref.]	*Design*	*Geographic location*	*No.*	*Age range in months/years*	*HIV status*	*Breastfeeding, growth, and health outcomes*	*Feeding method*	*Associated risks*	
Somé et al. (2017)[52]	Randomized controlled trial	SSA: Burkina Faso, Uganda, South Africa, low; middle-income countries	1,225 HI mothers; their HU infants	7 Days postpartum to 50 days postpartum, mothers 25–30 years	HI mothers; their HU infants	Mean duration of EBF 20–40 weeks, mothers who were married, educated, employed, multiparous, or had C-sections stopped EBF and breastfeeding early.	EBF, predominant breastfeeding, and mixed feeding	Socioeconomic, maternal	Ib
Zash et al. (2016)[55]	Randomized controlled trial	SSA: Botswana, middle-income country	1,499 HI mothers; 1,501 HU mothers and children; 1,483 HE infants	Mothers and children 0–24 months postpartum; HI maternal mean = 29; HIV-negative maternal mean = 24	HI and HIV-negative mothers; HU and HE children	Risk factors for child mortality included maternal death, HIV infection, and HIV exposure. Replacement feeding predicts mortality when viewed apart from HIV exposure.	FF; ever or never breastfeeding	Socioeconomic, maternal, environmental, biological	Ib
Cournil et al. (2013)[48]	Randomized controlled trial	SSA: Burkina Faso, Kenya, South Africa, low; middle-income countries	795 HI mothers; their infants	Mother-infant pairs from 2 weeks to 12 months postdelivery; maternal mean = 27	HI mothers; HE and HU infants	Mortality among HE and HU infants was 6% and 38%, respectively. Never breastfed and early weaned infants were at greater risk of mortality, despite intervention and feeding mode.	EBF, partial and predominant breastfeeding	Infant, maternal, socioeconomic, environmental	Ib
McGrath et al. (2012)[43]	Cohort study (analysis of randomized controlled trial)	SSA: Kenya, middle-income country	338 HE infants; their HI mothers	HE infants and their HI mothers from postpartum to 24 months; maternal mean = 24 years	HE infants; their HI mothers	By 2 years of age 29% of the HE infants, children were underweight, 18% were wasted, and 58% were stunted (LAZ, 22), with no difference by feeding method type. Higher maternal education and taller stature were associated with a decreased risk of underweight and stunting. Diarrhea was associated with increased risk of wasting. FF was associated with slower declines in length velocity. HE infants showed frequent growth faltering.	Breastfeeding and FF	Maternal, socioeconomic, infant	III

(*continued*)

Table 1. (Continued)

Study features			*Participants*			*Study variables and outcomes*			*Levels of evidence (ASHA, 2004[27])*
Author (year)[Ref.]	*Design*	*Geographic location*	*No.*	*Age range in months/years*	*HIV status*	*Breastfeeding, growth, and health outcomes*	*Feeding method*	*Associated risks*	
Nlend and Ekani (2010)[49]	Cross-sectional study	SSA: Cameroon, middle-income country	64 HI mothers; 47 infants	Mothers more than 28 weeks pregnant intending to breastfeed	HI pregnant and breastfeeding mothers; their HE infants	The rate of initiation to breastfeeding was observed to be 53% within 1 hour of delivery. At 13 weeks, 96.1% were still EBF. 4.9% of mothers were practicing mixed feeding. Access to ART reduces mixed feeding and mother-to-child HIV transmission rate to 4.3% in breastfeeding populations.	Breastfeeding, mixed feeding; EBF	N/I	III
Petraro et al. (2011)[44]	Prospective observational study	SSA: Tanzania, middle-income country	795 HI women; their newborns	Mothers/women 20–30 years of age; maternal mean = 24.7 years; SD = 4.7	HI women	EBF declined from 95% at 12 months to 11% at 24 months. Breastfeeding cessation significantly associated with increasing calendar year of delivery, new pregnancy, overweight, underweight, and introduction of cow's milk to 4-month-old infant. Material and social support associated with decreased likelihood of cessation. Breastfeeding counseling for HI African women should consider individual maternal, social, and health contexts.	Breastfeeding	Maternal, socioeconomic; infant	III

(*continued*)

Table 1. (Continued)

Study features			*Participants*			*Study variables and outcomes*			*Levels of evidence (ASHA, 2004[27])*
Author (year)[Ref.]	*Design*	*Geographic location*	*No.*	*Age range in months/years*	*HIV status*	*Breastfeeding, growth, and health outcomes*	*Feeding method*	*Associated risks*	
Tomasoni et al. (2011)[80]	Cross-sectional observational study	SSA: Burkina Faso, Cameroon, Chad, Uganda, Tanzania, Zambia, low; middle-income countries	225 HI pregnant women; 1,887 HIV-negative pregnant women	Women 20–30 years	HI; HIV-negative pregnant women	Most women declared EBF as the preferred feeding modality. The practice of strictly defined EBF in previous pregnancies was inversely correlated with education and parity. HI pregnant women's knowledge about lactation-associated risk associated with previous dead children. Introduction of fluids other than maternal milk within 6 months of age is common practice in SSA.	Exclusive FF, EBF; early and later mixed feeding	Maternal, socioeconomic, psychological	III
Patel et al. (2010)[82]	Nonrandomized intervention cohort study	SSA: South Africa, middle-income country	1,261 HI mother-child dyads; 1,061 HIV-negative mother-child dyads	Birth-9 months and 10–24 months; mothers 16–54 years of age; HI maternal mean = 22; HIV-negative maternal mean = 25 years; HU infant mean = 39 days GA; HE infant mean = 37 days GA	HI and HIV-negative mothers; HE and HU infants	HE infants' growth was like HU infants' irrespective of feeding mode. HI infants had lower Z scores than other infants, but better outcomes when breastfeeding, versus infants not breastfeeding.	EBF and feeding including breast milk	Maternal, infant, socioeconomic; environmental	IIa
Magadi (2011)[45]	Cohort study	SSA: Burkina Faso, Cameroon, Congo, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Liberia, Malawi, Mali, Niger, Rwanda, Senegal, Sierra Leone, Swaziland, Zambia, Zimbabwe, low; middle-income countries	N/I	Children 0–4 years of age and mothers 20–35 years of age	HI mothers; HE and HU infants or children	Breastfeeding duration >6 months led to lower risk for malnutrition.	EBF and breastfeeding	Maternal, socioeconomic; environmental	III

(*continued*)

Table 1. (Continued)

Study features			*Participants*			*Study variables and outcomes*			*Levels of evidence (ASHA, 2004[27])*
Author (year)[Ref.]	*Design*	*Geographic location*	*No.*	*Age range in months/years*	*HIV status*	*Breastfeeding, growth, and health outcomes*	*Feeding method*	*Associated risks*	
Semrau et al. (2011)[81]	Cohort study (retrospective analysis of randomized controlled trial)	SSA: Zambia, middle-income country	947 HI breastfeeding mothers	Mothers from breastfeeding initiation to 24 months postpartum; maternal mean = 26.1 years; SD = 5.1	HI mothers	Non-EBF women had increased risk of breast problems and mastitis compared with exclusive breastfeeders. Women with a CD4 count <200 cells/L had increased risk of abscess. EBF is optimal for infant and maternal health.	EBF, non- EBF, mixed feeding; stopped breastfeeding	Maternal and socioeconomic	III
Sugandhi et al. (2013)[50]	Expert committee report	United States, SSA: Botswana, South Africa, middle; high-income countries	Various studies, not specifically indicated	From birth to 24 months	HE infants; their HI mothers	HE infants and mothers need increased follow-up care until 24 months	N/I, but EBF recommended	Infant, pharmacological, maternal, psychological, socioeconomic; environmental	IV
Umeobieri et al. (2018)[65]	Cross-sectional descriptive study	SSA: Nigeria, middle-income country	550 HI mothers	24–35 years HI mothers; public health mean = 30.41; SD = 3.25; private health mean = 31.02; SD = 3.8	HI mothers	Majority of HI mothers perceived any type of breastfeeding as beneficial to the infant. Over 75% of mothers breastfed their infants for reasons including personal choice, cultural norms, fear of HIV status being disclosed, and pressure from family members.	Breastfeeding	Maternal, socioeconomic; psychological	III
Lane et al. (2019)[72]	Case–control study	SSA: Rwanda, low-income country	581 Mother-infant pairs (HE infants)	2 Weeks to 24 months	HI women; HE and HU infants	Current WHO recommendations of Option B+ (universal, lifelong ART for all HIV-positive pregnant and breastfeeding women) and extended breastfeeding may induce higher weight for length z-scores and lower length for age z-scores early in infancy.	EBF, extended breastfeeding; FF/complementary feeding	Maternal, infant, socioeconomic; environmental	IIb
Rosala-Hallas et al. (2017)[46]	Case–control study	SSA: Zambia, middle-income country	65 HE infants, 787 HU infants; 392 children	Infancy (1 week) and school-aged infants (7.5 years) and children	HE; HU infants and children	HE children had poorer early growth than HU children, persists into later childhood growth.	Breastfeeding	Maternal, socioeconomic; environmental	IIb
le Roux et al. (2017)[73]	Cohort study	SSA: South Africa, middle-income country	464 Mother-infant pairs (HE infants)	Birth to 48 weeks postpartum; Maternal mean = 28 years; Infant mean GA = 39 weeks	HI and HIV-negative mothers; their HE and HU infants	Duration of ART exposure not associated with length for age.	Breastfeeding	Infant, maternal; socioeconomic	III

(*continued*)

TABLE 1. (CONTINUED)

Study features			*Participants*			*Study variables and outcomes*			*Levels of evidence (ASHA, 2004[27])*
Author (year)[Ref.]	*Design*	*Geographic location*	*No.*	*Age range in months/years*	*HIV status*	*Breastfeeding, growth, and health outcomes*	*Feeding method*	*Associated risks*	
Rochat et al. (2016)[64]	Nonrandomized cohort intervention study	SSA: South Africa, middle-income country	508 HE children (exposed in utero); 781 HU children (not exposed in utero)	Children 7–11 years	HI and HIV-negative mothers; HE and HU children	EBF did not affect cognition and was associated with fewer conduct disorders.	EBF	Maternal, socioeconomic, environmental, psychological; child	IIa
Onyango-Makumbi et al. (2019)[74]	Cohort study (secondary analysis of a randomized controlled trial)	SSA: Uganda, Tanzania, Zimbabwe, South Africa, low, middle-income countries	1,504 Mother-infant dyads (HE infants)	HI mothers 23–31 and HE infants 6 weeks to 6 months; maternal mean = 27 years	HI mothers; HE infants	Extended ART did not restrict growth in breastfeeding HE infants.	EBF or any breastfeeding noted	Biological, maternal; pharmacological	III
Sudfeld et al. (2016)[47]	Cross-sectional survey	SSA: Botswana, middle-income country	396 HE children; 1,109 HU children	Children 5 years of age or younger; HE infants' mothers mean = 30.1 years; SD = 5.7; HU infants' mothers mean = 25.9 years; SD = 6.0; HE infant mean = 2.1 years; SD = 1.3; HU infant mean = 2.1 years; SD = 1.4	HE; HU mother-child dyads	HE infants increased risk for stunting during breastfeeding weaning and FF.	Breastfeeding and FF	Socioeconomic, maternal; biological	III
Krüger et al. (2019)[22]	Cross-sectional study	SSA: South Africa, middle-income country	71 Mother-infant dyads (13 HE infants; 58 HU infants)	Mothers and their healthy, term newborns younger than 4 days	HI; HIV-negative mother-infant dyads	No significant difference between HE and HU infants' breastfeeding outcomes; promotion of EBF; early identification and diagnosis of infants at risk oropharyngeal dysphagia recommended.	Breastfeeding	Maternal; socioeconomic	III
Visser et al. (2018)[21]	Case–control study	SSA: South Africa, middle-income country	12 HE infants with unrepaired CLP; 13 HU infants with unrepaired CLP and their mothers	Infants older than 3 months; HE infant mean = 47.9 days; SD = 29.42; HU infant mean = 37 days; SD = 27.91	HE; HU infants	HE infants had distinctive symptoms of oropharyngeal dysphagia, probably related to neurological involvement.	Bottle feeding	Infant, maternal; pharmacological	IIb
Lalbahadur (2018)[58]	Cross-sectional case–control study	SSA: South Africa, middle-income country	75 Infants (HE = 30 and HU = 45)	Infants 6–8 and 9–12 months of age; HE infants' mothers mean = 33.13 years; SD = 5.95; HU infants' mothers mean = 28.27 years; SD = 7.25	HE; HU infants	More oral-motor difficulties in older HE infants across food consistencies were found, when compared to younger HE infants.	Breastfeeding, mixed feeding, cup feeding, bottle feeding; puree-solid consistencies	Maternal, infant; socioeconomic	IIb

ART, antiretroviral treatment; ARV, antiretroviral; CA, chronological age; EBF, exclusive breastfeeding; FF, formula feeding; GA, gestational age; HE, HIV exposed; HI, HIV infected; HU, HIV unexposed; IG, interest group; LMIC, lower-middle-income country; N/I, not indicated; SD, standard deviation; SSA, sub-Saharan Africa.

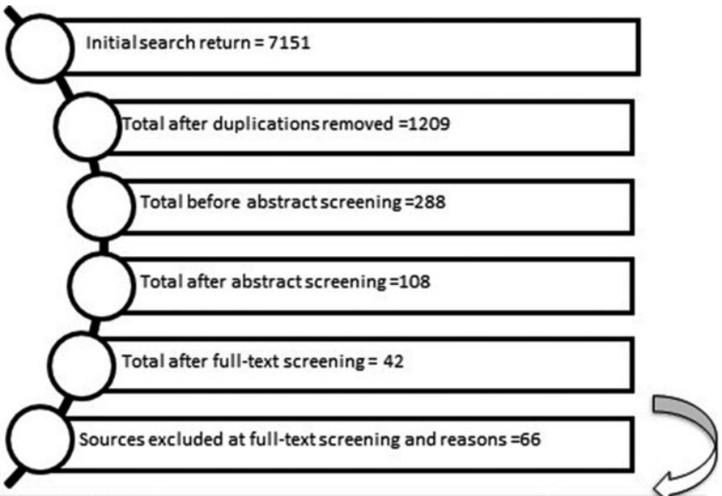

FIG. 1. Screening of abstracts with reasons for inclusion and exclusion.

Reason for exclusion	Number (n=66)
Participants exclusively cup, tube or syringe fed	1
Duplicate datasets	16
Sources published before 2010	0
Systematic reviews or meta-analyses	7
Sources not English	2
Sources focusing primarily on outcomes not related to breastfeeding	16
Sources focusing primarily on PMTCT or intervention as such	22
Consenting participants younger than 18 years of age	2

T3 ▶ T2 ▶ the risk of bias of the remaining 35 studies (Tables 2 and 3). Two studies (4.7%) classified as gray literature were not rated by either tool as they were collations of expert opinion.[50,51] The Cochrane Risk of Bias Tool indicated that the majority ($n=3$; 60%) of randomized controlled trials ($n=3$; 7.1% of the 42 studies) had low risk of bias.[52–54] The remaining two studies (4.7%) had higher risk of bias due to difficulty in controlling for variables, namely random selection of participants and complete blinding of personnel during the entire process.[55,56] Results from the NOS (Table 3) indicated that 19 (45.2%) studies were at high risk of bias, mostly present in the aspects of comparability and outcome. It is known that comparability can be challenging to manage when conducting research with high-risk populations, due to the limited

TABLE 2. RISK OF BIAS RESULTS OF RANDOMIZED CONTROLLED TRIALS ($N=5$)

Study	*Selection bias*		*Reporting bias: selective reporting*	*Other bias: other sources of bias*	*Performance bias: blinding (participants and personnel)*	*Detection bias: blinding (participants and personnel)*	*Attrition bias: incomplete outcome data*
	Random sequence generation	*Allocation concealment*					
Thakwalakwa et al. (2014)[53]	Low risk	Low risk	Unclear risk	Low risk	Low risk	Low risk	Unclear risk
Wynn et al. (2017)[54]	Low risk	Low risk	Unclear risk	Low risk	Unclear risk	Unclear risk	Unclear risk
Somé et al. (2017)[52]	Low risk	Low risk	Unclear risk	Low risk	Unclear risk	Unclear risk	Some concerns
Zash et al. (2016)[55]	High risk	Unclear risk	Low risk	Low risk	Unclear risk	High risk	Low risk
AU22 ▶ Cournil et al. (2013)[48]	Low risk	Unclear risk	Low risk	Low risk	Unclear risk	Unclear risk	Low risk

AU23 ▶ *Source:* Higgins et al.[28]

Table 3. Risk of Bias Results of Nonrandomized Studies ($n=35$)

Study	NOS adapted to study design: Selection	NOS adapted to study design: Comparability	Outcome[a]/exposure[b]	Total rating and level
Ijumba et al. (2014)[61]	***	*	**[b]	6/8 Low risk
Morden et al. (2016)[34]	***	*	*[a]	5/8 High risk
Goga et al. (2012)[71]	**	*	*[a]	4/8 High risk
Hampanda (2016)[35]	**	*	*[a]	4/8 High risk
le Roux et al. (2020)[69]	***	**	***[a]	8/8 Low risk
le Roux et al. (2018)[36]	**	—	***[a]	5/8 High risk
Tuthill et al. (2017)[11]	*	*	**[a]	4/8 High risk
Coetzee et al. (2017)[9]	***	**	N/A	5/8 High risk
Taha et al. (2010)[37]	***	*	**[a]	6/8 Low risk
Chaudhury et al. (2017)[38]	***	**	**[a]	7/8 Low risk
Rupérez et al. (2017)[39]	****	*	**[b]	7/8 Low risk
Kesho Bora Study Group (2017)[56]	**	*	***[a]	6/8 Low risk
Zash et al. (2014)[40]	***	**	*[a]	6/8 Low risk
Strehlau et al. (2020)[75]	**	—	**[a]	4/8 High risk
Phakisi and Mathibe-Neke (2019)[41]	**	—	*[a]	3/8 High risk
Wubneh et al. (2019)[83]	**	—	**[a]	4/8 High risk
le Roux et al. (2019)[70]	***	*	***[a]	7/8 Low risk
Thomas et al. (2017)[42]	***	**	**[a]	7/8 Low risk
McGrath et al. (2012)[43]	**	*	**[a]	5/8 High risk
Nlend and Ekani (2010)[49]	**	*	*[a]	4/8 High risk
Petraro et al. (2011)[44]	**	—	***[a]	5/8 High risk
Tomasoni et al. (2011)[80]	***	*	*[a]	5/8 High risk
Patel et al. (2010)[82]	***	*	***[a]	7/8 Low risk
Magadi (2011)[45]	**	*	*[a]	4/8 High risk
Semrau et al. (2011)[81]	**	**	***[a]	7/8 Low risk
Umeobieri et al. (2018)[65]	**	—	*[a]	3/8 High risk
Lane et al. (2019)[72]	***	*	**[b]	6/8 Low risk
Rosala-Hallas et al. (2017)[46]	***	*	**[b]	6/8 Low risk
le Roux et al. (2017)[73]	**	—	***[a]	5/8 High risk
Rochat et al. (2016)[64]	***	*	**[a]	6/8 Low risk
Onyango-Makumbi et al. (2019)[74]	**	—	**[a]	4/8 High risk
Sudfeld et al. (2016)[47]	***	*	*[a]	5/8 High risk
Krüger et al. (2019)[22]	***	*	*[a]	5/8 High risk
Visser et al. (2018)[21]	****	*	**[b]	6/9 Low risk
Lalbahadur (2018)[58]	****	*	**[a,b]	6/9 Low risk

[a]Outcome was evaluated for cohort, cross-sectional, and longitudinal studies.
[b]Exposure was evaluated for case–control studies.
NOS, Newcastle-Ottawa scale.
Source: Wells et al.[29]

population sizes of ''exposed'' or ''affected'' cohorts in specified age ranges in some diseases.[57] Within the NOS, the aspect of outcome is specific to the ''assessment of outcome'' and whether health care professionals conducted it, as well as the adequacy of follow-up. Studies included in this review were mostly cohort and not longitudinal in design, therefore making follow-up information unavailable to report.

From the collected data items, the following themes were identified according to the review objectives: breastfeeding outcomes in HI and HE infants and children, risks for suboptimal breastfeeding, HI and HE infant growth and developmental outcomes, and barriers and facilitators to feeding decisions.

Breastfeeding outcomes in HI and HE infants and children

Two studies (4.8%) reported on specific breastfeeding outcomes and oral-motor skills affecting feeding among HE infants.[22,58] In one study, no difference between HE and HU newborns' early breastfeeding skills was found,[22] while another study found more oral-motor difficulties in older HE infants across food consistencies than younger HE infants.[58] Mixed findings regarding breastfeeding and feeding outcomes were noted by two (4.8%) studies, which found HE infants, particularly infants older than 9 months, showed feeding skills that differed from HU infants, related to the increasing oral-motor feeding demands, such as biting and chewing, as infants matured.[59,60] Feeding difficulties among HE infants when compared with those of HU infants may be due to possible neurodevelopmental differences in HE infants.[7]

Risks for suboptimal breastfeeding

Apart from oral-motor and breastfeeding skills, various risk categories are also known to influence breastfeeding among HIV-affected infant populations.[45] Risks for suboptimal breastfeeding that were identified across the included studies were categorized as follows: socioeconomic,

environmental, infant biological, maternal psychological risks, and pharmacological agents. Maternal risks were described in most studies ($n=40$; 95.2%), specifically maternal HIV status and progression of the disease ($n=23$; 54.8%) and feeding type preference ($n=20$; 47.6%), including early mixed feeding and/or prelacteal feeding decisions. Other maternally related factors identified were returning to work, adherence to a type of feeding method, literacy level, age, maternal psychological factors, breastfeeding duration, mother as the main income provider, and cultural beliefs. Socioeconomic risks were highlighted by most studies ($n=37$; 88.1%), with financial insecurity being the most prevalent ($n=12$; 28.6%).[15,18,61] Other socioeconomic risks included financial expenditure, food and financial insecurity, and limited access to primary health care, which related to environmental risks.

Environmental risks were noted in a third of studies ($n=14$; 33.3%), with emphasis on resource-poor settings. These included reduced access to water, electricity, primary health care, sanitation, and sources of fuel. Increased housing density, poor daycare attendance, rural versus urban residence, intimate partner and emotional violence, and HIV stigma were also associated with suboptimal breastfeeding.[35,64,65] Infant biological risks influencing breastfeeding were discussed in over half of the studies ($n=25$; 59.5%), of which preterm, low birth weight ($n=11$; 26.2%), poor growth ($n=8$; 19.0%), and infant illness and infections ($n=5$; 11.9%) were the most prominent risks associated with suboptimal breastfeeding.[66–69] Other infant biological risks included hospitalizations and diarrhea, as well as poor immunization adherence ($n=4$; 9.5%). Infants with HE and CLP have greater risk of oropharyngeal dysphagia compared to HU infants with CLP.[21]

Pharmacological agents ($n=8$; 19.0%), which are known to affect breastfeeding and may include ART exposure, and psychological factors ($n=5$; 11.9%) were less prominent in the included studies. Maternal substance abuse was described in three studies (7.1%).[11,54,70] Three (7.1%) studies described breastfeeding patterns and practices of HI mothers, including psychological and maternal factors and their negative impact on breastfeeding.[61,71]

HI and HE infant growth and developmental outcomes

Most studies ($n=28$; 66.7%) reported on growth or neurodevelopmental outcomes of HI and HE infants or children. Of these studies, nine (21.4%) compared growth trajectories, neurodevelopment, and mortality rates of HE and HU infants and children. Most studies reported no difference in growth and developmental outcomes between HE and HU infants. One study, however, showed better developmental outcomes among breastfed HE infants as opposed to breastfed HU and HI infants.[72] Only four studies (9.5%) explored the effect of prenatal and postnatal ART exposure on developmental outcomes of breastfed HE infants.[70,73–75] Mixed results were noted, which identifies an urgent need for future well-designed research projects in this regard. However, findings appeared to show that ART does not adversely affect development of HE breastfed infants.

Barriers and facilitators to feeding decisions

In most income settings, breastfeeding is widely accepted as the most beneficial means of feeding, regardless of maternal and infant HIV status and feeding method (breast, syringe, cup, or bottle).[16,19,76] There are, however, various factors that may facilitate or hinder breastfeeding decisions. Main barriers to maternal feeding decisions were psychological and socioeconomic in nature, mostly related to employment status. Main findings indicated that mothers working away from home could not adhere to providing exclusive breast milk through direct breastfeeding or bottle feeding, due to difficulties expressing at work or with milk storing.[15,77] Mothers might consequently decide to select either exclusive formula feeding or mixed feeding, which could negatively impact their financial status and their infants' growth and development.[63] Main facilitators were environmental in nature, particularly pertaining to social support.[43] Familial involvement and support, specifically related to breastfeeding, contributed to optimal feeding decisions being made by mothers.[15,44,61]

Three studies[52,54,61] identified interventions that would encourage EBF adherence for improved maternal and infant health and infant growth and developmental outcomes.[64] Adherence improved with greater social support and counseling, especially when mothers were taking antiretrovirals.[52,54,61]

Discussion

Breastfeeding outcomes in HE and HU infants and children

Studies investigating breastfeeding of HI and HE infants mainly highlighted growth and nutritional and developmental outcomes related to breastfeeding. Only two studies referred specifically to breastfeeding and oral-motor skills and infant outcomes.[22,58] There are conflicting findings regarding whether differences exist between the breastfeeding and bottle-feeding skills of HE and HU infants.[6,7,13,78] While there may be some similarities in infants' sucking skills during breast and bottle feeding, the feeding skills remain different for these activities. Findings from research on bottle feeding cannot be generalized to breastfeeding infants,[79] necessitating further research specifically investigating breastfeeding skills in HI and HE infant populations.

Various studies emphasize possible neurological involvement and motor delays in HE infants, which may impact breastfeeding capabilities and future development.[7,14,57,59,60,62,63,66] Oral-motor difficulties were found in older HE infants, placing them at higher risk for oropharyngeal dysphagia.[58] This review found limited information on breastfeeding outcomes of HE infants compared with their HU and HI counterparts, warranting further research. Despite this dearth in literature, various risk factors known to directly affect mother-infant breastfeeding capabilities were synthesized from the reviewed studies.

Risk factors for suboptimal breastfeeding

The risks for suboptimal breastfeeding were mostly related to mothers' socioeconomic status as it influenced their maternal knowledge, attitudes, and practices. These in turn affected feeding decisions and consequently led to early mixed feeding with adverse health and nutritional outcomes for HE and HI infants.[10] Unemployment and financial strain result in food insecurity, which was identified as a risk factor associated with poor breastfeeding outcomes.[15,18] Among mothers

affected by social stigma and fear of HIV transmission during breastfeeding, the inability to afford costly formula milk and lack of clean water can result in maternal anxiety, reduced mother-infant bonding, and other women in the community stepping in as replacement mothers.[80,81] Stressful, low-resourced environment, which is prominent in SSA, is known to affect successful breastfeeding.[71,81] Optimal family and material support are necessary to encourage breastfeeding and to reduce the risk of food insecurity.[81] Allied health care professionals, such as SLPs, must enquire about mothers' breastfeeding environments and must look beyond traditional assessment of breastfeeding abilities that can be observed. Supportive environments encourage ideal breastfeeding behavior.[15]

HI and HE infant growth and development

In descending order, most studies focused on weight, length, and/or growth trajectories. At 6 weeks, breastfed HI infants had greater weight gain than non-EBF HE and HU infants.[16] Two studies reported HE infants' increased risk of stunting, malnutrition, and shorter survival rates at 18 months when formula fed compared with HU infants.[58] A few studies investigated ART exposure and its effect on the health of mothers and the growth of their infants ($n = 4$; 9.5%).[8,9,61,78] ART exposure appeared to increase infant mortality and negatively affect neurodevelopment in breastfed HE infants,[6] and some studies reported growth deficits in HI and HE infants receiving ART, when compared with the growth of HU infants. Further research investigating the long-term influence of ART on the neurodevelopment of breastfeeding HI and HE infants would be valuable.[78]

EBF is beneficial to all infants, as HU infants are at an increased risk of stunting during early breastfeeding weaning, compared with HE infants practicing continued breastfeeding.[22] It is also known that HE children weaned early have increased hospital admissions compared with exclusively breastfed HE children. Despite national and global progress made in PMTCT programs, breastfeeding counseling for HI mothers remains necessary to increase EBF adherence for improved growth and development outcomes.

Barriers and facilitators to feeding decisions

Maternal knowledge, attitudes, and practices were the main barriers to maternal EBF decisions.[13,14,22] Targeting improved maternal well-being is integral to facilitating EBF.[7] Depression in HI mothers is a barrier to maternal well-being and may result in breastfeeding cessation before 2 months, breastfeeding difficulties, or even no breastfeeding.[55] In another study, breastfeeding was not significantly affected by mental illness, which indicates that effective breastfeeding, with counseling and support can still occur, regardless of maternal psychosocial status.[22]

Various risk categories and factors are known to affect breastfeeding, specifically in the HIV-affected populations. Maternal factors such as socioeconomic, environmental, and psychological risks, along with infants' exposure to pharmacological agents, have a cumulative negative effect on the growth and developmental outcomes of HI and HE infants, when compared with HU infants.

Included studies support recommendations put forth by the South African and WHO guidelines to encourage EBF for HE and HI infants.[56,74] The adoption of these guidelines has been generally successful and HI women exclusively breastfeed more consistently than HIV-negative mothers. This is due to consistent PMTCT programs focused on counseling and providing EBF support for HI women.[71,82] Despite recent strides in HI mothers choosing to exclusively breastfeed, maternal factors identified in this review still complicate breastfeeding decisions taken by HI mothers.[14,58,61] These factors need to be considered during assessments by health care professionals like SLPs, although they do not directly relate to the traditional assessment domains.[64,73,81,83]

Additional social factors we found that should be considered by health care professionals were the fear of EBF practice and the feeding practices and beliefs of significant others, for example, replacement mothers' and partners' adherence to EBF.[8] Facilitators to maternal knowledge, attitudes, and practices regarding breastfeeding did not feature predominantly in the reviewed literature. The few facilitators found were social and familial support, economic independence, and material resources.[7] Maternal and partner support and counseling on the importance and benefits of EBF remain important. Breastfeeding support can be improved when SLPs and other allied health care professionals query social support, material resources, and mothers' environments, in addition to standard biographical information.

Confidence in cumulative evidence

The strength of the cumulative evidence for the breastfeeding outcomes of HE and HI infants is low as only two studies[22,58] specifically evaluated infants' feeding skills. A caveat in this literature is that many of the publications that were included did not directly interrogate breastfeeding outcomes, but had a focus on weight and nutritional outcomes, with breastfeeding being only one of the possible variables examined. The data extraction for this study, in terms of whether breastfeeding outcomes were reported, interrogated, or directly measured, is therefore limited and findings should be interpreted with caution. A limitation of this study is that all publications included in this review did not necessarily directly examine breastfeeding. Additional research is highly likely to contribute to the description of breastfeeding outcomes in this population. The strength of the cumulative evidence regarding the associated risks that impact effective EBF in HE and HI infant populations was, however, moderate and continued research will have an important impact on the field.

Conclusion

The results of this systematic review of 42 publications add to the evidence base of breastfeeding in HIV-affected mother-infant dyads. Findings reiterated the perspective that EBF has a positive outcome on growth and development of all infants irrespective of HIV status. Numerous maternal factors associated with HIV may lead to suboptimal breastfeeding of HI and HE infants. The review highlighted a dearth of research on breastfeeding outcomes of HE and HI infants. Despite good PMTCT programs in lower-middle-income countries such as South Africa, few studies are aimed at investigating HE infants' breastfeeding skills and the impact of ARTs on developmental domains, or intervention approaches to improve breastfeeding outcomes in HI and HE infants.

Large-scale prospective comparative studies should profile breastfeeding and developmental outcomes of infants with HI, HE, and ART exposure to enable early identification and intervention for this vulnerable population in low-income settings. Future research should aim to analyze maternal and infant risks that may be the most predictive of suboptimal breastfeeding and to evaluate proposed early intervention thereof.

Authors' Contributions

All authors were involved in the study conception, systematic review implementation, result analysis, and article writing.

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