

Early Childhood Development Programs in Low Middle-Income Countries for Rearing Healthy Children: A Systematic Review

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ABSTRACT

Introduction: Early Childhood Development (ECD) includes physical, social, emotional, cognitive and motor development in first eight years of life. Positive parenting, strong families, and encouraging, stimulating environments are critical to a child's early development.

Aim: To assess the efficacy of stimulation programs for improving ECD in Low and Middle-income Countries (LMICs).

Materials and Methods: Observational and randomised controlled trials that examined the efficacy of different programs for improving ECD in LMICs were included. Studies were identified through systematic searches of bibliographic databases in July 2018 and were further updated in February 2019. The findings of the included studies were narratively described.

Results: The evidences in hand indicate that early stimulation interventions can avert early inequalities and encourage cognitive and socio-emotional development in young children and can also improve maternal outcomes. These effects tend to sustain over a long term. More research is also required to identify the comparative effectiveness of different modes of delivery and cost-benefit of early stimulation interventions.

Conclusion: Current evidences advocate that interventions for improving ECD can help in preventing the loss of development in disadvantaged children and those amendments can ensue quickly. The health sector can play a crucial role as it has the potential to reach families, and can provide efficient interventions for optimum child development.

Keywords: Cognitive and socio-emotional development, Positive parenting, Responsive parenting, Stimulating environment

INTRODUCTION

Early childhood refers to the period of upto eight years of age and ECD includes physical, social, emotional, cognitive and motor development in first eight years of life [1]. This period is very vital as maturation of brain ensues in all domains: cognitive, socio-emotional and physical [2]. It is during this period that the developing brain is very pliable and receptive to transformation as billions of neural networks are formed, footing for which is placed for healthiness and well-being throughout lifetime [1]. The brain matures speedily via growth and development of nervous tissue and synapses, axonal and dendritic growth, synaptogenesis, cell death, axon and dendrite pruning, formation of myelin sheath around a nerve, and production of glial progenitor cells and their differentiation into mature glia [3]. These processes develop on each other, and minor trepidations in these developments can have prolonged influences on the organisational and functional capability of brain. Epigenetic, immunological, physical, and mental adaptations to the environment occur from the time of conception, and these adaptations influence development throughout the life [4].

Of 559 million children below the age of five years in developing countries, over 200 million children do not attain their developmental potential [2,5]. In LMICs, 39% of children below the age of five years have compromised brain development [2], usually due to insufficient nutrition and insufficient stimulus [6]. The greatest percentage of disadvantaged children reside in sub-Saharan African countries with highest number residing in south Asia [2]. Recent 2016 estimations disclose that 250 million i.e., 43% of children in LMICs are not able to realise their full development potential because of adversities they face in their initial, formative years [1].

A stimulating atmosphere, sufficient nutrient and social interaction with caregivers is necessary for optimum development of brain in young children [7]. It is adapted by the quality of upbringing. Deprived children in LMICs fail to reach their developmental potential [2]. They are subjected to various risks, comprising poverty, undernourishment,

poor health, and unstimulating or neglecting home environment [2]. Animal research demonstrates that malnutrition, iron-deficiency, environmental pollutants, worry, and meager stimulation and societal communication in early years of life can disturb brain organisation and function, and have long-term cognitive and emotional outcomes [8,9]. Parents' communications with their children are a key driver of beneficial growth through these vital early years of life [6,10]. In animals and humans, discrepancies in the class of parental care can create lifelong modifications in stress reactivity, anxiety, and recall function in the progeny [2]. Still research shows that parents who are economically or communally insecure often feel overawed by the tasks of child-rearing and struggle to deliver the likable prospects and communications that will promote strong cognitive, societal, emotional, and motor development [11,12].

The occurrence of risk factors and their influence on development are considerable [6]. These risk factors have insinuations for their educational and adult functioning and can adversely disturb social, emotional, cognitive, and motor development and are in that way less expected to be fruitful grown-ups [2,13]. These underprivileged children are expected to do below par in academics and consequently have lower incomes [2]. Interventions are now required to decrease children's risk exposure and to further development in affected children [10]. In spite of the susceptibility of the brain to initial insults, notable salvage is frequently feasible with mediations [14,15], and usually the earlier the mediation the better the advantage [16].

The shielding results of responsive parenting can avert early inequalities and encourage cognitive and socio-emotional development in young children [17,18]. Intervention that fosters shielding factors can raise the prospect that children accomplish their developmental potential by shrinking inequalities [19].

Creating a firm foundation for healthy growth by capitalising in ECD and aiding these children attain that potential by improving their physical, cognitive, and socio-emotional dimensions will help not only these underprivileged children but also parents, schools, community

leaders and policy-makers. Failure to create such investments will have intense insinuations for children, their families, and their societies, worsening disparities and intensifying social splits [20].

Substantial body of evidence has exhibited moderate-to-large effect sizes for responsive parenting interventions on numerous attributes of ECD, comprising cognitive and socio-emotional development [21-24], and early growth and nutrition [25-27].

The knowledge of ECD and its essential neurobiology is increasingly raised worldwide addressing on education, wellbeing, social and child protection [28]. ECD is in the priority list for WHO as it provides a prospect to enhance wellbeing and equity of children [1]. The UN Sustainable Development Goals offer a momentous prospect to execute interventions to promote ECD. To accomplish the Millennium Development Goals of decreasing poverty and safeguarding primary education, authorities and civil society should contemplate intensifying quality, cost-effective ECD programs [29].

Most effective ECD programmes deliver direct learning to children and their family members, are directed to younger and deprived children, are of lengthier period, better quality, and are amalgamated with family support, wellbeing, nutrition, edifying systems and other service programmes [5]. Along with health and nutrition support, ECD programs stress on encouraging stimulation of children. Parenting programs provide families with information and assistance to aid survival, growth, and well-being of children [30]. Though there are several methodologies to parenting programs, it is accepted that information distributing alone may not be sufficient to encourage changes in parenting behaviours [31].

Specific programs that deliver quality, high-intensity edification program for parents [32], nested in larger assistance for families, have demonstrated evidence of effectively bettering child-rearing practices [33]. As children below three years are particularly susceptible and reliant on their mothers for food and stimulation, investigators at present recognise that psychological health of mother is vital for development of children [10,34]. Brief, combined interventions that cater to the psychological health of mothers as well as growth and development of children may augment importance to interventions that address only outcomes related to children.

Several studies have demonstrated positive and encouraging effects of stimulation programs in LMICs. However; there is a need to synthesise the evidence of effectiveness of different modes of delivery and understand whether such programs can be scaled up to aid entire populations. Hence, this review was undertaken to assess the efficacy of stimulation programs for improving ECD in LMICs.

MATERIALS AND METHODS

Search methods for identification of studies: Studies were identified through systematic searches from bibliographic databases including PubMed, CENTRAL, BIOSIS via ISI web of science, PsychInfo, EMBASE, along with published reports from the World Bank, UNICEF, and UNESCO's International Bureau of Education in July 2018 and further updated the search in February 2019. All databases were searched from their inception to the present with no restriction on language and publication status. Text word terms and Medical Subject Headings (MeSH) were used and were tailored to individual databases. Synonyms and keywords were used to sensitise the search. Preliminary search strategy for PubMed was adapted for use in other databases. The search strategy for PubMed is shown in [Table/Fig-1].

Eligibility Criteria for Considering Studies

Inclusion criteria:

1. Observational and Randomised Controlled Trials (RCTs) that examined the efficacy of different programs for improving ECD in LMICs.

Search strategy

Search ((((((((((Children [Title/Abstract] OR Child [Title/Abstract] OR Under-five [Title/Abstract] OR "Under five" [Title] OR Infant* [Title/Abstract] OR Toddler* [Title/Abstract] OR Kid* [Title/Abstract] OR childhood [Title/Abstract] OR "Child" [Mesh])) AND (((((((((((("responsive care" [Title/Abstract] OR "positive parenting" [Title/Abstract] OR "parenting program" [Title/Abstract] OR "parenting intervention" [Title/Abstract] OR "child stimulation" [Title/Abstract] OR "psychosocial stimulation" [Title/Abstract] OR "early childhood development" [Title/Abstract] OR ECD [Title/Abstract] OR "early development" [Title/Abstract] OR "child development intervention" [Title/Abstract] OR "home Intervention" [Title/Abstract] OR "home visiting" [Title/Abstract] OR "responsive stimulation" [Title/Abstract] OR "early childhood stimulation" [Title/Abstract] OR "early stimulation" [Title/Abstract] OR "caregiver training program" [Title/Abstract] OR "environmental enrichment" [Title/Abstract] OR "mother-infant relationship" [Title/Abstract] OR "maternal education" [Title/Abstract] OR "Parenting" [Mesh])).

[Table/Fig-1]: Search strategy for PubMed.

2. Studies that used any type of ECD program either singly or in combination with other programs with a clear focus on improving child development and/or maternal outcomes.
3. Studies that used concomitant interventions were permitted for inclusion as long as they had both the intervention and the control group.

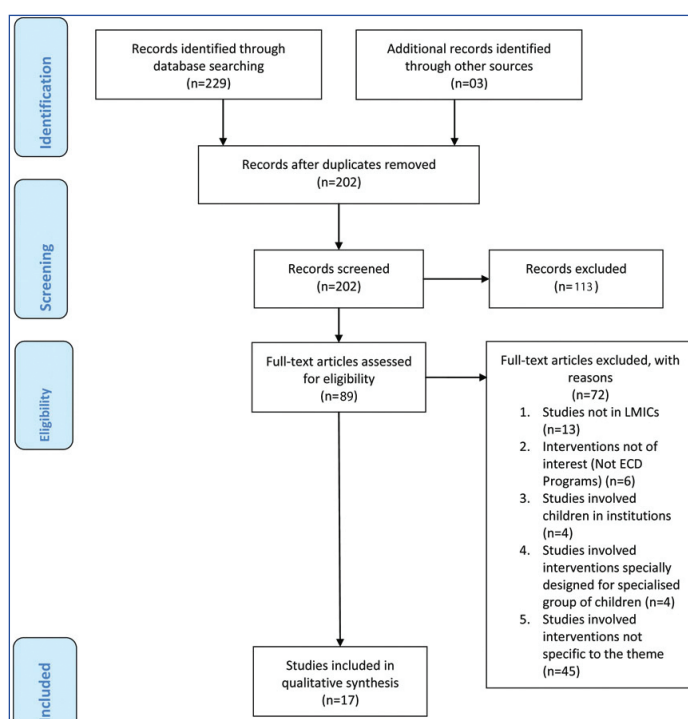
Exclusion criteria:

1. Studies conducted in High-Income Countries and High Middle-Income Countries.
2. Studies that involved children in institutions or were specially designed to be suitable for a specialised group of children like kangaroo-care for premature infants and community rehabilitation for disabled children.

The authors checked the reference lists of all primary studies and review articles for additional references and contacted experts in this field to seek information on any ongoing and/or unpublished studies on ECD programs.

RESULTS

Total 229 reports were identified from electronic sources and three additional records from which 202 abstracts were screened for eligibility after removing duplicates and irrelevant reports. Eighty nine potentially relevant full text articles were obtained and screened for eligibility. Seventy two articles that did not meet the eligibility criteria were excluded and finally 17 studies were included in the qualitative synthesis in this review as shown in prisma flowchart in [Table/Fig-2].



[Table/Fig-2]: PRISMA 2009 Flow Diagram.

Stimulation programmes: Stimulation programmes comprises community-based separate parent counselling or parent group sessions, or center-based preschool and day care programs which deliver early childhood stimulation primarily through play, reading, music and tactile stimulation [35]. A systematic review shows that stimulation consistently benefited child development [13]. Stimulation improved weight gain in study that included severely malnourished children [35]. Bayley mental development index [35] and Griffiths developmental quotient are the most frequent used developmental diagnostic tests [36]. In another study; stimulation promoted developmental quotient, hearing and speech, and performance scores [37]. Stimulation provided sizeable advantages for developmental quotient, hearing and speech, eye-hand coordination, performance, and for mothers' child-rearing knowledge and practices [25]. However, in another study, children who received only stimulation did not exhibit sizeable difference in either weight or height [27]. Stimulation (either stimulation alone and blended with other interventions) promoted mental scores but had no effect on motor scores [38].

Responsive programmes: Responsive parenting is an essential parenting skillfulness to reinforce children's survival and development [22]. It is the capability to be conscious of a child's gestures and deliver a timely suitable reaction [22]. Responsive parenting includes delivery of personal attention and play tools that are personalised to child's aptitude and interest. Regardless of cultural differences, responsive parenting has been proved to improve cognitive and language development [39]. Encouraging responsive caregiving behaviors via training [40,41] or by use of or play [42] or shared book reading [43] have showed enhancements in child's development [42], maternal temperament [41], protected infant attachment [41], and quality of mother-child interactions [40,41,43]. Responsive feeding has shown improvements in maternal verbal responsiveness [27,44], child's reception of food [27,44], and nutritional intake [26]. Child development components in several studies were generally provided through home visits to give a demonstration of various stimulation acts and involved mother in responsive play with her child [23,25,26,36,37,45,46]. Advantages were likewise seen when intervention was provided through separate play sessions at a centre [35,47] or parent group sessions [27].

Combined interventions: While the evidence base for significance of ECD has increased, exploration is dispersed through sectors, populations, and settings [48]. In LMICs, parenting programmes have amalgamated stimulation interventions with nutrition interventions to tackle co-occurring risk factors [13]. A study observed that there is no meaningful loss of any effect when interventions were pooled. However, there is not much indication of synergistic relation between stimulation and nutrition on child development [13]. A recent review provided a thorough analysis of ECD interventions through nutrition, education, child protection, and social protection and deduced that programmes can be fruitful and viable if it employs multi-pronged intervention packages attached in fostering care [48]. Recommendations in this review highlight that intervention programmes must be deployed at developmentally suitable period, at direct numerous risks, and should be built on prevailing delivery platforms with a possibility of transition to scale [48]. Evidences in the review strongly recommends that parents, caregivers, as well as their families need to be backed in delivering fostering care for children so that they reach their full developmental potential [48].

Three distribution models have been employed in ECD: separate home visits, health center visits, and community-based group sessions with or without home visits [49,50]. Investigators have recognised numerous fruitful execution approaches, comprising a designed syllabus, demonstration with materials, practicing new skills, and dialogues with other parents [50]. The designed syllabus for these programs is notified by hypothetical frames of responsive parenting that encourage ECD.

Two studies have assessed separate results of stimulation or nutrition and combined interventions and found that these intervention promoted mental development [26,27]. When stimulation was supplemented with multiple-micronutrient supplementation, an added advantage ensued to weight gain [27]. In one study, nutrition edification promoted height for age [26]. When psychosocial stimulation was supplemented, an advantage to mental development was observed, although increase in height was not substantial [26]. However, the variance in increase in height for age with stimulation compared with nutrition edification only was not substantial [26]. In another study, participants who were delivered stimulation-with-sprinkles demonstrated higher weight gain as compared to those children who received only stimulation [27].

Four trials indicated that effects of stimulation interventions on ECD were alike when provided separately or mixed with nutritional interventions [27,35,36,45]. Another trial found that stimulation interventions mixed with zinc supplementation had higher synergistic advantages on eye-hand coordination than the total of interventions delivered separately [37]. Other studies, assessed supplementary effect of psychosocial stimulation with nutritional supplementation and demonstrated advantages to ECD [23,25,26,46,47,51]. Thus, there seems a clear evidence that advantages from psychosocial stimulation are preserved when given along with nutritional interventions.

A cluster randomised control trial showed that interventions to improve learning through play and interventions to improve mother-child vocal communications through either home-visits or through groups sessions, or both, improved ECD, and that a combined intervention can concurrently improve ECD as well as mental health of mothers [52].

Factors Modifying the Effects of Intervention

1. Type and frequency of child stimulation: Interventions of higher quality, greater intensity and of longer duration are likely to be the most effective.
2. Child nutritional status and health: A study observed that repeated child stimulation, had better advantages for ECD [53]. The Jamaican intervention [36] found that advantages from stimulation and supplementation ensued in first two years of life, so that the overall advantages improved with time. The advantages to growth, happened in first six months. Similarly, advantages from stimulation in iron deficient children, happened in the first year of intervention [46]. Results of nutritional supplementation on growth and cognition were not apparent, though the results of psychosocial stimulation on cognition were persistent at 12 years [54].
3. Child schooling: The effects for academic performance and psychological functioning were noticed by 17 years [55,56] and 22 years [57].

Parenting Interventions for Improving Maternal Mental Health

Emotional availability of a parent affects parenting capability. Maternal depression is related with early termination of breastfeeding [58], growth [59], health-related outcomes [60] and an overall poor ECD [61]. Interventions aimed at reducing maternal depression may improve emotional availability. Parenting programs in LMICs indicates mixed results on maternal depression [41,62,63]. Combined intervention in an RCT found small benefit on maternal depression [31].

Numerous parenting programs have evaluated the outcome of stimulation on mental health of mothers [41,62,63]. Most interventions failed to ease depression or did so in particular settings. For instance, a trial eased depression in mothers only after 25 home visits [63]. Other interventions did not demonstrate favourable benefits when mothers received individual home visits, but did so when they met in groups [62]. One more parenting

programme in South Africa directed on mother-child interactions improved maternal depression at six months, nevertheless results were not sustained at 12 months [41]. Thus, although it is likely that encouraging interactions with children may perhaps promote mother's self-esteem, however these interactions individually seem inadequate to tackle maternal depression. Combination of maternal programmes and child health programmes helps children as well as their mothers [52,64]. Current evidences backs

a encouraging direction to focus mothers as well as their children as an integrated intervention in low-resource, community-based settings [52]. Three systematic reviews have reported the effect of psychosocial stimulation, nutrition, or both, to enhance ECD in developing nations [13,49,50]. None of the systematic reviews precisely studied maternal mental health. Total 17 studies in the characteristics of the study on ECD is shown in [Table/Fig-3] [21,27,31,34,35,41,52,56,63,65-72].

Author year	Country	Type of study	Intervention	Outcome
			Type of intervention	Outcomes reported
Chang SM et al., 2015 [21]	West Indies (Caribbean)	Cluster RCT	Total N=501 mother-child pair randomly assigned to 1. IG: 14 centers (n=251 mother-child pairs): 5 routine visits, short films, discussion and demonstration and mothers' practice of activities by CHW 2. CG: 15 centers (n=250 mother-child pairs)	1. Primary outcomes: Child cognition, language, and hand-eye coordination 2. Secondary outcomes: Caregiver knowledge, practices, maternal depression, and child growth
About FE and Akhter S, 2011 [27]	Rural Bangladesh	Cluster RCT	1. IG1: Sessions on Responsive Feeding and Stimulation (RFS) 2. IG2: Sessions on RFS + 6 months of a food powder fortified with minerals and vitamins (RFS+) 3. CG: 12 informational sessions on health and nutrition	1. Developmental outcomes: Child responsive talk, and language development 2. Nutritional outcomes: Weight, height, self-feeding, and mouthfuls eaten
Yousafzai AK et al., 2015 [31]	Pakistan	Cluster randomised effectiveness trial with a 2 * 2 factorial design	1489 mother-infant 1. IG1: Responsive stimulation (n=383) 2. IG2: Enhanced nutrition (n=364) 3. IG3: Combined (n=374) 4. CG: Control (n=368)	1. Primary outcomes: Child development and child growth 2. Secondary outcomes: Parenting skills and emotional availability
Rahman A et al., 2013 [34]	Rural Pakistan	Cluster randomised controlled trial	1. IG: Half-day workshop on second birth month stage of development in which each mother was given a "Learning Through Play" calendar to take home 2. CG: Routine care including monthly visits by LHWs in which they educate mothers on health, hygiene, and basic nutrition education	1. Primary outcome: Mothers' knowledge and attitudes about the second birth month stage of development 2. Secondary outcomes: Mental distress in mothers
Nahar B et al., 2012 [35]	Urban Bangladesh	Community-based RCT	Total N=322 severely underweight hospitalised children randomly assigned to: 1. IG1: Psychosocial stimulation comprising of Play Sessions (PS) 2. IG2: Food Supplementation (FS) 3. IG3: PS along with FS (PS+FS) 4. CG1: Clinic-Control (CC) 5. CG2: Hospital control (CH) Food supplements or routine clinical management of the hospital comprising growth monitoring, health education, and micronutrient supplementation	1. Primary outcomes: MDI and PDI 2. Secondary outcomes: Children's growth in weight and length
Cooper PJ et al., 2009 [41]	South Africa	RCT	Total N=449 pregnant women >32 randomly assigned to: 1. IG: 16 sessions in total, ending at five months postpartum (n=220) 2. CG: No therapeutic input from research team (n=229)	1. Primary outcomes: Quality of mother-infant interactions at 6 and 12 months postpartum, infant attachment security at 18 months. 2. Secondary outcome: Maternal depression at 6 and 12 months.
Singla DR et al., 2015 [52]	Uganda (Lira)	Community-based cluster RCT	291 dyads randomly assigned to: 1. IG: Session integrated intervention programme (n=160) 2. CG: (n=131)	1. Primary outcomes: Cognitive and receptive language development 2. Secondary outcomes: Self-reported maternal depressive symptoms and child growth
Walker SP et al., 2006 [56]	Kingston, Jamaica	RCT	Total N=129 stunted children randomly assigned to 1. CG: (n=27) 2. IG1: Supplementation (n=21) 3. IG 2: Stimulation (n=28) 4. IG3: Supplementation + Stimulation (n=27)	Anxiety, depression, self esteem, and anti-social behaviour
Baker-Henningham H. 2005 [63]	Urban Jamaica	Cluster RCT	1. IG: Home visits delivered by community health aids 2. CG: Health clinics provide education on health and nutrition for mothers and monitor their children's growth	Improving child development which has significant benefits for maternal depression.
Yousafzai AK et al., 2016 [65]	Pakistan	Community-based, cluster RCT	1. IG: Caretakers/Mothers were taught how to interpret and respond to children's signals while engaging in developmentally appropriate play and communication activities. 2. CG: Expand on existing health, hygiene, and basic nutrition education.	1. Maternal scaffolding 2. Parenting Intervention exposure 3. Early Cognitive Development 4. Executive function 5. Home stimulation quality 6. Intelligence
Tofail F et al., 2013 [66]	Rural Bangladesh	Cluster Randomised Controlled trial	1. IG 1 of NANI and IG2 of IDA: a. Iron syrup: 30 mg daily b. Psychosocial stimulation: Mothers were shown how to play with toys and interact with their children in a way to promote their development 2. CG 1 of NANI and CG2 of IDA: CGs were visited weekly, and mothers were asked about their child's health status.	1. Mental and motor development. 2. Behaviour 3. Family care indicators. 4. Anthropometric measurements
Black MM et al., 2004 [67]	Bangladesh	Double-blind RCT	1. IG: Weekly supplement of iron (20 mg), zinc (20 mg), iron zinc, MM (16 vitamins and minerals, including iron and zinc), or riboflavin weekly from 6 to 12 months 2. CG: 1 mg riboflavin	Mental, motor, and behavioral development from 6 to 12 months
Murray L et al., 2016 [68]	South Africa	RCT	1. IG: Session for mothers from third trimester of pregnancy until 6 months postpartum 2. CG: No treatment	Infant cognitive outcome and attachment security

Obradović J et al., 2016 [69]	Pakistan	Community-based, Cluster RCT	1. IG: Early Responsive Stimulation (RS) 2. CG: Enhanced Nutrition (EN) interventions	1. Children's cognitive outcomes 2. Children's verbal intelligence, performance intelligence, and executive functioning
Gelli A et al., 2015 [70]	Malawi	Protocol: Community-based Cluster RCT	60 communities randomly assigned to one of two treatment arms: 1. IG: Communities with CBCCs supported by Save the Children's ECD programme with additional nutritional and agricultural support 2. CG: Communities with CBCCs supported by Save the Children's ECD programme with no additional nutritional or agricultural support	1. Primary outcomes: Dietary intake 2. Secondary outcomes a. Child development b. Nutritional status
Garcia D et al., 2015 [71]	Not reported	RCT	1. IG: Blended Communication and Behavior Support program, Success in Parenting Preschoolers (SIP2) 2. CG	1. Child language production 2. Child behaviour problems
Rodríguez GM et al., 2014 [72]	Not reported	Pilot RCT	1. IG: Parent-child Interaction Therapy (PCIT) 2. CG	1. Child Externalising Behaviour 2. Emotion Regulation

[Table/Fig-3]: Characteristics of the study on Early Childhood Development (ECD) [21,27,31,34,35,41,52,56,63,65-72].

IG: Intervention group; CG: Control group; CHW: Community Health Worker; LHW: Lady Health Worker; MDI: Mental development index; PDI: Psychomotor development index; NANI: Neither anemic nor iron deficient; IDA: Iron deficiency anemia

Protecting cognitive and socio-emotional development of young children stands utmost priority for the sake of raising healthy children worldwide. The concern of poor child development in LMICs will continue unless a substantial effort is undertaken to encourage appropriate programs. Current evidences advocate that interventions for improving ECD can help in preventing the loss of development in disadvantaged children and that amendments can ensue quickly. The health sector can play a crucial role as it has the potential to reach families and can provide efficient interventions for optimum child development. Looking at the high cost of dealing with the issue of poor child development in LMICs, financially as well as in terms of equity, and the accessibility of efficient interventions, we cannot excuse or defend dormancy.

CONCLUSION(S)

The evidence in hand indicates that early stimulation interventions are beneficial in improving child and maternal outcomes and these effects tend to sustain over a long term. ECD Programmes should target younger and more disadvantaged children and their families and should also encourage wellbeing of families as a whole, particularly the mothers or care-givers. More research is also required to identify the comparative effectiveness of different modes of delivery and cost-benefit of early stimulation interventions. Finally, more long-term follow-up studies of ECD stimulation interventions are needed.

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