Factors Associated With Feeding And Caregiving Practices For Children Under Five In Lowland Nepal: A Community-Based Cross-Sectional Survey

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Abstract

Background: While nurturing care, including adequate nutrition and responsive caregiving and early learning, is critical to early childhood development, national surveys in Nepal highlight inequalities in feeding and parental caregiving practices. This study aimed to document and analyse infant and young child feeding (IYCF) and cognitive and socio-emotional caregiving practices among caregivers of children under age five in Dhanusha district, Nepal.

Methods: We used a subset of data from the MIRA Dhanusha cluster randomised controlled trial, including mother-child dyads (N=1360) when children were aged 0-12 months and a follow-up survey of the same mother-child dyads (N=1352) when children were 7-59 months. We used World Health Organization IYCF indicators and questions from the Multiple Indicator Cluster Survey-4 tool to obtain information on IYCF and cognitive and socio-emotional caregiving practices, respectively. We collected data on breastfeeding practices in a postpartum 6-week questionnaire and on complementary feeding and caregiving practices in the follow-up survey. Using multivariable logistic regression models, potential explanatory household, parental and child-level variables were tested to determine their independent associations with IYCF and caregiving indicators.

Results: The prevalence of feeding indicators varied. Ever breastfed (99%), exclusive breastfeeding in past 24-hours at 0-12 months (89%), and vegetable or fruit consumption (84%) were common, and minimum dietary diversity reached 63%. Problem areas were early initiation of breastfeeding (16%), feeding of colostrum (67%), no pre-lacteal feeding (53%), timely introduction of complementary feeding (56%), and animal-source food consumption (29%). Amongst caregiving indicators, access to books (7%), early stimulation and responsive caregiving (11%), and access to early childhood education (27%) were of particular concern, while 64% had access to toys and 71% received adequate care. Only 38% of children were developmentally on track. Younger children from poor households with young mothers who had not received antenatal visits and delivered at home were at risk of poor IYCF and caregiving practices.

Conclusions: Poor IYCF and cognitive and socio-emotional caregiving practices are widely prevalent in lowland Nepal, which highlights the importance of improved integrated nutrition and caregiving interventions in resource-constrained settings.

Background

Early Childhood Development (ECD) provides a critical foundation for long-term health, well-being, and productivity [1, 2]. Fostering nurturing care is a priority as it enhances the development of young children [3]. Nurturing care is characterised as a stable environment established by parents and other caregivers to promote aspects of ECD. These include children's good health and adequate nutrition, safety and security, early learning through interaction opportunities, and emotional support and responsive caregiving [2, 3]. Our study looks at three components of nurturing care: nutrition, responsive caregiving, and early learning.

A global commitment to promote ECD advocates the integration of nutrition and caregiving (including responsive caregiving and early learning) interventions to establish a holistic early childhood care programme to enhance children's development [2, 3, 4, 5]. Current recommendations for Infant and Young Child Feeding (IYCF) practices include breastfeeding within the first hour of birth, exclusive breastfeeding of infants under six months, and after that, providing nutritionally adequate and safe complementary foods at sufficient frequency while breastfeeding up to two years of age [6]. Likewise, caregiving is a multidimensional construct. Two critical dimensions are cognitive and socio-emotional caregiving [7]. Cognitive caregiving refers to the strategies parents can use to help children engage with their environment; for example, describing objects, demonstrating activities, and offering learning opportunities [7]. In contrast, socio-emotional caregiving includes physical and verbal actions that stimulate children's attention, performance, and experiences [7, 8].

Recent systematic reviews have emphasised the benefits of integrated nutrition and caregiving interventions for children's development in early life [5, 9, 10]. In Nepal, large-scale nutrition programmes led by the government and non-governmental organisations are already in place to address undernutrition in children under five years [11, 12, 13]. On the other hand, caregiving interventions primarily focus on increasing education access for children aged 3 to 5 years through Early Childhood Education (ECE) [12]. Nepal does not have any caregiving interventions focusing on children below age three [12], which is a critical phase for child development [3]. Could caregiving interventions be scaled up if they were integrated with the current nutrition programmes? A deeper understanding of the common underlying factors impeding both IYCF and cognitive and socio-emotional caregiving practices for young children is imperative to inform improved integrated nutrition and caregiving interventions in resource-constrained settings.

In 2019, Nepal's nationally representative Multiple Indicator Cluster Survey (MICS) showed inequalities in the nutritional intake, parental caregiving practices, and early learning opportunities of young children, particularly among disadvantaged groups [14]. We know that children in Province 2 have the greatest disadvantages in terms of IYCF and caregiving practices [14, 15], but we do not know which socio-demographic and economic factors are driving these practices or how factors affecting poor IYCF and caregiving practices interact. To address this gap, we aimed to (1) document practices related to IYCF, and cognitive and socio-emotional caregiving among caregivers of children under age five in

Dhanusha district, Nepal, and (2) examine socio-demographic and economic factors at household, parental, and child-level associated with both practices.

Methods

Study setting

We conducted our study in the Dhanusha district in Province 2 in the *Terai* (lowland) region of Nepal. The district covers 1180 km^2 and has a population of 754,777 [15]. According to the 2011 census, most live in rural areas (89%); 40% of women are illiterate, and for over 50%, agriculture is the main occupation [16]. The average household size is 5.5 people, 35% have access to toilet facilities, and 13% have access to clean drinking water. The common language is Maithili, and the main religion is Hinduism (89%), followed by Islam (9%).

The MIRA Dhanusha cluster Randomised Controlled Trial (cRCT)

Between 2006 and 2011, the MIRA Dhanusha Trial, a community-based factorial cRCT, was implemented in Dhanusha district by a Nepalese non-government organisation, Mother and Infant Research Activities (MIRA) and University College London in 60 Village Development Committees (VDCs) (now restructured into eleven urban- and six rural-municipalities). The main aim of the trial was to test the effect of community mobilisation through women's groups following a Participatory Learning and Action (PLA) cycle and of community-based neonatal sepsis management on neonatal mortality, home care practices and health care seeking, maternal and infant nutrition-related behaviour and anthropometric status [17]. Between September 2006 and June 2011, data on mother-child dyads who participated in the trial were collected by a team of 39 trained interviewers, using a questionnaire at six weeks postpartum (6-week questionnaire).

A cross-sectional follow-up survey of children born to mothers participating in the cRCT

A random sample of 1365 mother-child dyads was drawn from the trial dataset and followed by seven female interviewers between 16 September and 15 December 2011, when the children were between 7 and 62 months old.

Study population

For this study, we used a subset of data obtained from the 6-week questionnaire (N = 1360) between 21 February 2007 and 10 July 2008 and a follow-up survey of the same mother-child dyads (N = 1352). The median age of children was 45 days at the 6-week questionnaire and 37 months at follow-up. We excluded five children above 12 months from the 6-week postpartum interview because they did not meet the age range criteria for inclusion (n = 2) or had missing age data (n = 3). For similar reasons, we removed 13 children above 59 months from the follow-up survey (did not meet the inclusion criteria (n = 12) and had missing age data (n = 1)). Supplementary Figure 1 shows the participant flow diagram.

Selection of outcome variables

We used World Health Organization (WHO) indicators to obtain information on IYCF practices [18] and questions from the United Nations Children Fund's (UNICEF) MICS-4 survey tools to obtain information on cognitive and socio-emotional caregiving practices [19]. Supplementary Table 1 summarises the indicators available. At the postpartum 6-week questionnaire, we gathered information about breastfeeding immediately after birth (time of initiation, colostrum feeding and pre-lacteal feeding) and feeding behaviours in the past 24-hours when children were 0-12 months. In addition, we obtained data on complementary feeding practices (recall) and cognitive and socio-emotional caregiving practices from the follow-up survey when children were 7-59 months. For both the 6-week and follow-up surveys, mothers were interviewed, and verbal informed consent was obtained from all adults and minors. Both guardians and minors gave verbal informed consent when mothers were under 18 years age. Trained, experienced interviewers conducted the interviews in participants' homes, using a structured pre-coded questionnaire. Almost all (98.7%) interviews were conducted in Maithili. This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (see Supplementary Table 2 for details) [20].

Outcome Variables

IYCF indicators

We constructed IYCF indicators according to WHO 2021 recommendations [6], except for Minimum Dietary Diversity (MDD). The eight food groups in the recent WHO recommendation include i) breast milk, ii) grains, roots, tubers, and plantains, iii) pulses, nuts and seeds, iv) dairy products (milk, yoghurt cheese), v) flesh foods, (meat, fish, poultry, and liver/organ meats), vi) eggs, vii) vitamin-A rich fruits and vegetables and viii) other fruits and vegetables. The new group "breastfed in recall period" was not available in our dataset. We used the following definitions of IYCF indicators: (1) Ever breastfed: the proportion of children aged 0-12 months who were ever breastfed at the time of the 6-

week questionnaire; (2) Early initiation of breastfeeding: the proportion of newborns who were put to the breast within one hour of birth; (3) exclusive breastfeeding for last 24-hours: proportion of children aged 0-5 months who were exclusively breastfed for the past 24-hours in the 6-week questionnaire; (4) timing of introduction of solid, semi-solid or soft foods: proportion of children aged 7-59 months who received solid, semi-solid or soft foods within 6–8 months of age; (5) MDD: proportion of children 7-59 months of age who received foods from at least four out of seven food groups in the past 24-hours; (6) consumption of animal-source foods: proportion of children aged 7-59 months who had consumed eggs or flesh foods (meat and fish) in the past 24-hours, and (7) consumption of fruits and vegetables: proportion of children aged 7-59 months who had consumed any fruits or vegetables in the past 24-hours. We also included, from the 6-week questionnaire, colostrum feeding (feeding child with the first yellowish human breast milk) and not giving pre-lacteal feeds (not providing any food except mother's milk to a newborn before initiating breastfeeding) because these are significant barriers to exclusive breastfeeding in Nepal [21, 22]. We have summarised the timing of data collection for each indicator and the age range over which we present results in Supplementary Table 3.

Cognitive and socio-emotional caregiving indicators

We compiled indicators of ECD using questions derived from the UNICEF MICS-4 survey [19], including: (1) access to learning materials, defined as the proportion of children under age five who had (a) three or more children's books and (b) two or more types of playthings at home; (2) early stimulation and responsive care, defined as the proportion of children aged 24-59 months with whom mother/father/other adults had engaged in four or more activities such as reading, storytelling, singing, taking the child outside, playing or counting and drawing at home in the past three days; (3) adequate supervision, defined as the proportion of children under age five who were not left alone or in the company of another child younger than 10 years for more than an hour at least once in the last week; (4) attendance of ECE, defined as the proportion of children aged 36-59 months who attended some form of ECE programme outside the home; and (5) Early Child Development Index (ECDI) score, defined as the proportion of children aged 36-59 months who were developmentally on track in three of the four domains described in Table 1.

Table 1
Definitions of developmental domains for 36-59 months children

Developmental domains	Definition
Literacy and numeracy	A child can read at least four simple, well-known words; and know the name and recognise the symbols of all numbers from 1 to 5.
Physical	A child can pick up a small object with two fingers, like a stick or stone, from the ground, and the mother/caregiver does not indicate that the child is sometimes too sick to play.
Socio-emotional	A child gets along well with other children, does not kick, bite, or hit other children, and does not get distracted easily.
Learning	Ability to follow the simple direction to do something correctly, and when instructed to do something, a child can perform independently.

Explanatory variables

We categorised explanatory variables collected in the 6-week questionnaire into household, parental, and child-level. Their selection was informed by the literature and factors that have been shown or hypothesised to be associated with IYCF and cognitive and socio-emotional caregiving practices. Household-level variables included wealth quintiles, months of adequate household food provisioning (MAHFP), migration of any household member, household size (adult family members), access to health care, ethnicity, and religion. We derived a household wealth index using principal component analysis from household characteristics and ownership of household assets and then divided the wealth score into five equal quintiles [23]. Parental level variables included mother's education, father's education, mother's age (in years), parity, antenatal visits (none, 1-3, 4+), and place of delivery (home, health facility). Individual child-level variables included age (in months) and sex.

Statistical analyses

We adapted the *Nurturing Care Framework* published in the Lancet series "Advancing ECD: from science to scale" [3], limited to factors available in our data, to develop an analytical framework to structure the variables selected for the analysis (Figure 1). We did not have data on two elements of nurturing care: good health and safety and security. The conceptual framework consisted of household-, parental- and child-level explanatory variables, which were assumed to influence IYCF and cognitive and socio-emotional caregiving practices directly or indirectly. The age and sex of the child were also considered to independently affect the developmental outcome (ECDI score). Groups of explanatory variables were entered in hierarchical order into a multivariable modelling procedure as shown in Supplementary Figure 2 and described below.

We used descriptive statistics to assess household, parental, and child characteristics and the prevalence of feeding and caregiving practices across the sample. First, we assessed the association between variables within the three categories with the outcome variables using

univariable analyses. Then, we examined the role of factors using multivariable mixed-effects logistic regression. All multivariable models were adjusted for study design by adding cluster (VDC) as a random effect, trial arm as a fixed effect, and for non-modifiable explanatory variables child age and sex. Similarly, we also pre-identified essential predictors of feeding practices (mother's age and education) [22, 24] and caregiving (mother's education and household wealth index) [25–27] and included them in all multivariable models.

We ran three different multivariable logistic regression models separately for each outcome variable (except the ever breastfed indicator since almost all children were breastfed). Model 1 included household-level variables with a *p*-value < 0.2 in univariable analyses. We retained household variables with a *p*-value < 0.05 in Model 1 in the second set of multivariable models (Model 2). Model 2 included household variables kept from Model 1 and parental-level variables with a *p*-value < 0.2 in univariable analyses. The final fully adjusted model (Model 3) included household and parental-level variables with a *p*-value < 0.05 in Model 2. We report the Adjusted Odds Ratio (AOR) for variables retained in Model 3 with 95% Confidence Interval (CI). A *p*-value < 0.05 was considered statistically significant in all models. Finally, we used a Venn diagram to present the cluster of factors associated with both optimal feeding and cognitive and socio-emotional caregiving practices. We conducted the statistical analysis using STATA 16.1.

Results

Participant characteristics

There was no refusal to participate in the follow-up survey. Participant characteristics are summarised in Table 2. In the preceding year of the 6-week questionnaire, 64% of mothers reported adequate household food provisioning for up to 12 months. Over half (51%) had a family member working away, and most lived in households with more than six members (77%). Only 14% of mothers and children had access to health care. Almost a third (31%) were from the most disadvantaged groups (Dalits/Muslims), and nearly all were Hindu (88%). Mothers' mean age was 26.5 years. Only 19% of mothers had attended school, and 82% of them could not read or read with some difficulty. Nearly two-thirds of fathers (64%) had not attended school. Around a third of mothers were primiparous (32%); over a third had not received antenatal visits, and home delivery was common (78%). In our sample, there were more boys (54%) than girls (47%).

Table 2
Participant characteristics

Variables	n (%)
Household characteristics[#]	
Wealth Quintile (N= 1299)	
Lowest	243 (18.7)
Second	260 (20.0)
Middle	292 (22.5)
Fourth	243 (18.7)
Highest	261 (20.1)
Months of adequate food provisioning (MAHFP) (N=1347)	
For up to 7 months	169 (12.5)
For 8 to 11 months	312 (23.2)
For 12 months	866 (64.3)
Migration of at least one household member (N=1343)	
No	654 (48.7)
Yes	689 (51.3)
Household size (N=1340)	
1-5 members	311 (23.2)
6-10 members	806 (60.1)
≥11 members	223 (16.6)
Health care access (N=1250)	
No	1077 (86.2)
Yes	173 (13.8)
Ethnicity/Caste (N=1352)	
Dalit/Muslim (most disadvantaged group)	418 (30.9)
Janajati/other terai caste (Sudi/Teli)	639 (47.3)
Yadav/Brahmin (least disadvantaged group)	295 (21.8)
Religion (N=1352)	
Hindu	1194 (88.3)
Non-Hindu (mostly Muslim)	158 (11.7)
Parental characteristics[#]	
Maternal age, mean (SD) (N=1351)	26.5 (5.0)
15-24 years	521 (38.6)
25-34 years	729 (54.0)
35- 45 years	101 (7.5)

[#] Collected in the post-neonatal period when the index child was median 46 days old.

[¶] Collected in the follow-up cross-sectional survey questionnaire when the child was median age 37.9 months.

* IQR Interquartile Range

Variables	n (%)
No of previous pregnancies (N=1351)	
One	430 (31.8)
Two	366 (27.1)
Three	256 (18.9)
Four or more	299 (22.1)
Maternal education (N=1352)	
Never went to school	1097 (81.1)
Primary	98 (7.2)
Secondary and above	157 (11.6)
Mother's literacy (N=1345)	
Cannot read or with some difficulty	1107 (82.3)
Can read easily	238 (17.7)
Father's education (N=1352)	
Never went to school	867 (64.1)
Primary	161 (11.9)
Secondary and above	324 (24.0)
Antenatal visits (N=1352)	
None	435 (32.2)
1-3 visits	642 (47.5)
4 +	275 (20.3)
Place of delivery (N=1326)	
Home	1038 (78.3)
Health facility	288 (21.7)
Child characteristics	
Child sex (N=1352)	
Male	723 (53.5)
Female	629 (46.5)
Child age group in days at 6-week interview [#], median (IQR) (N=1360)	46 (34)
<46 days	678 (49.9)
46 to 91 days	503 (37.0)
92 to 182 days (3–5 months)	135 (9.9)
183 to 366 days (6 – 12 months)	44 (3.2)
Children age in months at follow-up[¶], median (IQR) (N=1352)	37.9 (29.7)
7 –11	124 (9.2)
12 –23	288 (21.3)
[#] Collected in the post-neonatal period when the index child was median 46 days old.	
[¶] Collected in the follow-up cross-sectional survey questionnaire when the child was median age 37.9 months.	
* IQR Interquartile Range	

Variables	n (%)
24 – 35	219 (16.2)
36 – 47	300 (22.2)
48 –59	421 (31.1)
Trial allocation (N=1352)	
Control	459 (34.0)
Women's group only	372 (28.0)
Women's group and sepsis	320 (23.7)
Sepsis only	201 (14.9)
[#] Collected in the post-neonatal period when the index child was median 46 days old.	
[¶] Collected in the follow-up cross-sectional survey questionnaire when the child was median age 37.9 months.	
* IQR Interquartile Range	

IYCF practices

Table 3 describes breastfeeding practices for children under 12 months collected in the 6-week questionnaire and complementary feeding practices for children 7-59 months at follow-up. Almost all (99%) children aged 0-12 months were ever breastfed; however, only 16% were breastfed within one hour of birth; 67% of children were fed colostrum, and more than half (53%) were not given pre-lacteal feeding. The majority (89%) of children aged 0-5 months were exclusively breastfed for the past 24-hours preceding the survey. Slightly more than half of children aged 7-59 months (56%) received solid, semi-solid and soft foods between 6-8 months. The median number of food groups consumed by children aged 7-59 months in the last 24-hours was 3.8, and nearly two-thirds (63%) had achieved 24-hours MDD (≥4 items). Consumption of vegetables and fruits was higher (84%) than animal-source foods (29%). Consumption of fruits and vegetables increased from 44% at 7-11 to 80% at 12-23 months. Consumption of animal-source foods increased from 13–27%. After 24 months, a small gradual increase in consumption with age was found (see Supplementary Figure 3).

Table 3
Infant and young child feeding practices for children under 59 months in Dhanusha district

Indicators collected when children were 0-12 months	n (%)
Ever breastfed for children at 0-12 months (N=1358)	
No	8 (0.6)
Yes	1350 (99.3)
Breastfeeding initiation for children at 0-12 months (N= 1350)	
Within 1 hour of birth	215 (15.9)
1 to 24-hours	348 (25.8)
After 24-hours	787 (58.3)
Colostrum feeding for children at 0-12 months (N=1343)	
No	449 (33.4)
Yes	894 (66.6)
No pre-lacteal feeding for children at 0-12 months (N=1342)	
No	627 (46.7)
Yes	715 (53.3)
Exclusive breastfeeding for past 24-hours amongst children birth to 183 days at interview (N=1314)	
No	141(10.7)
Yes	1173 (89.3)
Indicators were collected when children were 7-59 months	
Timing of introduction of solid-semi-solid or soft foods (recall for all children sampled), median (IQR) (N=1313)	8 (4)
Before six months	53 (4.0)
6-8 months	731 (55.7)
At nine months and after	529 (40.3)
Minimum dietary diversity achieved in past 24-hours	
mean (SD) (N= 1352)	3.8 (1.2)
No	506 (37.4)
Yes	846 (62.6)
Consumption of animal foods (eggs and flesh food) in the past 24-hours (N=1352)	
No	961 (71.1)
Yes	391 (28.9)
Consumption of fruits and vegetables in past 24-hours (N=1352)	
No	214 (15.8)
Yes	1138 (84.2)
* IQR Interquartile Range	

Cognitive and socio-emotional caregiving practices

Table 4 and Supplementary Figure 4 describe cognitive and socio-emotional caregiving practices for children aged 7-59 months. Most children (91%) used household objects like toys, and 69% had toys from shops. Fewer children (12%) had homemade toys, and very few (7%) had three or more children's books. The absence of books and low literacy rates meant that few children aged 7-59 months were read to (14%). Reading (2%), storytelling (8%) and counting and drawing (5%) by caregivers were uncommon in the 7-23 months age group but slightly common in the 24-59 months age group (19%, 31%, and 27%, respectively). More than two-thirds (69%) of children were never played with, and most (72%)

were never sung to by caregivers. Taking children outside (65%) was the most common activity and was primarily done by mothers; other activities such as reading (7%), playing (15%), counting, and drawing (13%) for children were done chiefly by their older siblings and storytelling and singing were done mainly by other adults (including grandparents) (13%). Only 11% of children aged 7-59 months received any kind of early stimulation or responsive care from any caregiver in the three days preceding the survey, and three-quarters of children (71%) received adequate supervision.

Table 4
Cognitive and socio-emotional caregiving practices for children under 59 months in Dhanusha district

Indicators	7 -23 months	24-59 months	7-59 months
	n (%)	n (%)	n (%)
Availability of children's books	**412**	**940**	**1352**
Has less than three children's books	376 (91.3)	833 (93.9)	1259 (93.1)
Has three or more children's books	36 (8.7)	57 (6.1)	93 (6.9)
Types of playthings	**412**	**940**	**1352**
Homemade toys	17 (4.5)	134 (14.6)	151 (11.6)
Toys from shop	277 (73.5)	623 (67.7)	900 (69.4)
Household objects used as toys	322 (85.4)	852 (92.6)	1174 (90.5)
Availability of playthings	**412**	**940**	**1352**
Has less than two playthings	181 (43.9)	306 (32.6)	487 (36.0)
Has two or more playthings	231 (56.1)	634 (67.5)	865 (64.0)
Support for learning			
Child read to	**378**	**921**	**1299**
No	370 (98)	750 (81.4)	1120 (86.2)
Yes	8 (2.1)	171 (18.6)	179 (13.8)
Child told stories	**378**	**919**	**1297**
No	349 (92.3)	634 (69)	983 (75.8)
Yes	29 (7.7)	285 (31)	314 (24.2)
Child sung to	**378**	**921**	**1299**
No	321 (84.9)	619 (67.2)	940 (72.4)
Yes	57 (15.1)	302 (32.8)	359 (27.6)
Child taken outside	**377**	**920**	**1297**
No	163 (43.2)	291 (31.6)	454 (35)
Yes	214 (56.8)	629 (68.4)	843 (65)
Child engaged in playing	**378**	**920**	**1298**
No	302 (79.9)	587 (63.8)	889 (68.5)
Yes	76 (20.1)	333 (36.2)	409 (31.5)
Child engaged in counting or drawing	**378**	**921**	**1299**
No	361 (95.5)	672 (73)	1033 (79.5)
Yes	17 (4.5)	249 (27)	266 (20.5)
Stimulation and responsive care [a]			
By mother/father/adults*	**412**	**940**	**1352**
No	401 (97.3)	804 (85.3)	1205 (89.1)
Yes	11 (2.7)	136 (14.5)	147 (10.9)

* Other adults include maternal and paternal grandparents. [a] Mother/Father/Adult has engaged with children in four or more support for learning activities in the last three days. [b] Children were not left alone or in the company of another child younger than 10 years for more than one hour at least once in the previous week.

Indicators	7 -23 months	24-59 months	7-59 months
Adequate supervision [b]	**378**	**921**	**1299**
No	83 (22)	300 (32.6)	383 (29.5)
Yes	295 (78)	621 (67.4)	916 (70.5)

* Other adults include maternal and paternal grandparents. [a] Mother/Father/Adult has engaged with children in four or more support for learning activities in the last three days. [b] Children were not left alone or in the company of another child younger than 10 years for more than one hour at least once in the previous week.

About three quarters (74%) of children aged 36-59 months did not participate in ECE, and over half (62%) were not on developmental track according to the ECDI score (Table 5). Supplementary Figure 5 shows differences in ECDI scores by wealth quintile disaggregated by sex. A higher proportion of girls were on track than boys in the lowest (39% vs 30%), second (39% vs 29%), and fourth (48% vs 30%) wealth quintiles.

Table 5
Early childhood development index score for children aged 36-59 months in Dhanusha district

Indicators	n (%)
Early childhood education (attending playgroup/ community childcare) (N=717)	
No	527 (73.5)
Yes	190 (26.5)
Early childhood development index (ECDI)	
Children on track in (N=721)	
Literacy-numeracy domain (can count to 5 and say four simple words)	
No	346 (48)
Yes	375 (52)
Physical domain (pick up a small object with two fingers and is not too sick to play)	
No	363 (50.4)
Yes	358 (49.7)
Socioemotional domain (gets along with others/ does not kick or bite/ not distracted)	
No	520 (72.1)
Yes	201 (27.9)
Learning domain (follows simple directions and can do something independently)	
No	42 (5.8)
Yes	679 (94.2)
On track in at least 3 of 4 domains	
No	444 (61.6)
Yes	277 (38.4)

Factors associated with IYCF indicators

Figures 2 and 3 present the variables' independent association with each IYCF indicator. See Supplementary Tables 4-11 for numerical details of regression output.

The odds of breastfeeding initiation within one hour of birth was higher in children whose mothers had four or more previous births (AOR 2.78; 95% CI 1.42, 5.45, ref: one) and who were born in a health facility (AOR 4.44; 95% CI 3.03, 6.49, ref: home). The odds of feeding colostrum were higher in children from the fourth quintile (AOR 1.72; 95% CI 1.12, 2.63, ref: lowest quintile) and those born in a health facility (AOR 2.64; 95% CI 1.82, 3.82, ref: home). The odds of not giving pre-lacteal feeding were higher in those born in a health facility (AOR 2.94; 95% CI 2.15, 4.02, ref: home) and lower in children of older mothers (35-45 years, AOR 0.51; 95% CI 0.32, 0.83, ref: 15-24 years). The odds of exclusive breastfeeding

in the past 24-hours before the survey when children were 0-5 months was higher in the highest wealth quintile (AOR 2.58; 95% CI 1.23, 5.39, ref: lowest quintile) and, unexpectedly, lower for children who had access to health care (AOR 0.49; 95% CI 0.29, 0.85, ref: no access).

The odds of children receiving solid, semi-solid and soft foods at 6-8 months age were higher in girls (AOR 1.29; 95% CI 1.01, 1.64, ref: boys), in children of older mothers (35-45 years, AOR 1.95; 95% CI 1.18, 3.22, ref: 15-24 years), whose mothers had antenatal visits (1-3 visits, AOR 1.45; 95% CI 1.09, 1.91; 4 or more visits, AOR 1.58; 95% CI 1.11, 2.24, ref: none) or came from smaller households (1-5 members, AOR 1.54; 95% CI 1.15, 2.06, ref: 6-10 members).

The odds of achieving MDD among children aged 7-59 months increased with wealth to a maximum of 2.12 in the highest quintile. Younger children (7-24 months, AOR 0.36; 95% CI 0.27, 0.48; 25-42 months, AOR 0.70; 95% CI 0.52, 0.95, ref: 43-59 months) and whose mothers were aged 35-45 years (AOR 0.60; 95% CI 0.38, 0.97, ref: 15-24 months) were less likely to achieve MDD. The odds of consumption of animal-source foods were lower in younger children (7-24 months, AOR 0.55; 95% CI 0.40, 0.75, ref: 43-59 months), and amongst those whose mothers were aged 35-45 years (AOR 0.52; 95% CI 0.30, 0.90, ref: 15-24 years), whose fathers had higher education (primary, AOR 0.66; 95% CI 0.43, 1.00; secondary and above, AOR 0.63; 95% CI 0.45, 0.87; ref: none) and were from relatively advantaged caste groups (Janjati/other terai, AOR 0.58; 95% CI 0.43, 0.78; Yadav/Brahmin, AOR 0.49 95% CI 0.33, 0.71, ref: Dalit/Muslim). The odds of consuming fruits and vegetables were much lower in younger children (AOR 0.20; 95% CI 0.13, 0.29, ref: 43-59 months) than in the oldest age group.

Factors associated with cognitive and socio-emotional caregiving practices

Figures 4 and 5 present the variables' independent association with each cognitive and socio-emotional caregiving practice indicator. See Supplementary Tables 12-17 for numerical details of regression output.

The odds of having access to three or more books were 2.6 times higher among children whose mothers had higher education and three times higher in those whose mothers had four or more antenatal visits. The odds of having access to books were lower for younger children (AOR 0.24; 95% CI 0.10, 0.55, ref: 43-59 months). The odds of access to two or more toys were two times higher for children in all the wealth quintiles relative to the poorest and whose mothers had 1-3 antenatal visits (AOR 1.38; 95% CI 1.02, 1.88, ref: none). Girls (AOR 0.72; 95% CI 0.55, 0.94, ref: boys) and younger children (AOR 0.49; 95% CI 0.36, 0.66; ref: 43-59 months) were less likely to have access to toys.

Children whose mothers were aged 25-34 years (AOR 1.82; 95% CI 1.03, 3.21, ref: 15-24 years) had received at least primary education (AOR 3.12; 95% CI 1.34, 7.27, ref: none), had access to health care (AOR 2.04; 95% CI 1.01, 4.13, ref: no access) and were aged between 48-59 months (AOR 2.76; 95% CI 1.40, 5.45, ref: 24-35 months) were more likely to receive early stimulation and responsive caregiving. Children from large households with 11 or more members (AOR 0.41; 95% CI 0.18, 0.94, ref: 6-10 members) and where at least one member had migrated (AOR 0.52; 95% CI 0.31, 0.90, ref: none) had lower odds of receiving early stimulation and responsive caregiving.

Younger children aged 7-24 months (AOR 1.94, 95% CI 1.39, 2.70; ref: 43-59 months) and those whose mothers had higher education (AOR 1.67; 95% CI 1.02, 2.75, ref: none) had higher odds of receiving adequate supervision. Children whose mothers had three (AOR 0.60; 95% CI 0.40, 0.89) or more (AOR 0.38; 95% CI 0.26, 0.55, ref: one) previous births and were from households with 1-5 members (AOR 0.57; 95% CI 0.40, 0.79, ref: 6-10 members) had lower odds of receiving adequate supervision.

Children from wealthier households (highest quintile AOR 2.93; 95% CI 1.39, 6.19, ref: lowest quintile), born in a health facility (AOR 1.95; 95% CI 1.10, 3.46, ref: home) and aged 48-59 months (AOR 3.87; 95% CI 2.40, 6.24, ref: 36-47 months) were more likely to participate in ECE. Similarly, children aged 48-59 months had higher odds of being developmentally on track according to the ECDI score (AOR 1.46; 95% CI 1.02, 2.08, ref: 36-47 months).

Factors affecting both optimal feeding and caregiving practices

Figure 6 maps the common risk factors associated with IYCF and caregiving outcomes in multivariable regression analysis Model 3. The common risk factors affect both indicators in the same direction, indicating an overlapping risk group (see Supplementary Table 18). Children with a higher risk of poor feeding and caregiving practices were younger, from poor households, and were born of adolescent and young mothers (15-24 years), received few or no antenatal visits, and delivered at home.

Discussion

Our study profiled the prevalence of IYCF and cognitive and socio-emotional caregiving practices among children below five years of age in a highly disadvantaged area of the Nepal plains and examined a range of socio-demographic and economic factors associated with IYCF and caregiving practices. Our findings highlighted relatively good adherence to IYCF practices for exclusive breastfeeding and complementary feeding in the Dhanusha district. However, the prevalence of appropriate cognitive and socio-emotional caregiving practices was lower for all indicators, including access to learning materials, early stimulation and responsive care, adequate supervision, access to ECE and ECDI scores.

Younger children from poor households whose mothers were younger, had not made antenatal visits and were delivered at home were the most at risk of poor feeding and caregiving practices.

We compared our findings to regional and national estimates in the NDHS in 2011 and 2016. The prevalence of mothers initiating breastfeeding within one hour of birth was extremely low (16% vs 31% & 45%), and no pre-lacteal feeding was slightly higher (53% vs 47% & 52%) in our sample relative to regional and provincial estimates in NDHS 2011 and 2016, respectively [15, 16]. Colostrum feeding was marginally lower (67% vs 84%) than the national estimates reported by Bhandari et al. [22]. These findings corroborate prior research indicating that optimal breastfeeding practices were less prevalent in the Terai [22, 28]. Similarly, we found that the prevalence of children receiving solid, semi-solid or soft foods between 6-8 months was lower (56% vs 66% & 84%) than NDHS 2011 and 2016 national estimates [15, 16], whilst MDD was higher (63% vs 12% & 30%) than the regional average in NDHS 2011 and 2016, respectively [15, 16]. Although the PLA group intervention tested in the trial could have increased dietary diversity among older children, we controlled for trial arms and found no effect. The low prevalence of recommended feeding behaviours relative to national and regional averages highlights the limited progress in improving IYCF practices in the Terai, indicating inadequate coverage or ineffectiveness of IYCF programmes, as highlighted by Cunningham et al. [29].

Concerning caregiving practices, the regional estimate for access to books was lower in MICS 2014 and 2019 (2% & 1%) than in the Dhanusha district (7%) [14, 30]. However, for all other indicators, Dhanusha district was behind, with fewer children receiving early stimulation and responsive caregiving (11% vs 64% & 68%), adequate supervision (71% vs 84% & 82%), access to ECE (27% vs 29% & 39%) and developmentally on track according to ECDI score (38% vs 46% & 56%) than in regional and provisional estimates in MICS 2014 and 2019, respectively [14, 30].

Improved feeding and caregiving practices were associated with wealth in our setting. Children from wealthier households were more likely to receive colostrum, be exclusively breastfed, achieve MDD (≥4), have access to two or more toys, and participate in ECE. These findings are consistent with other studies that have reported that children from the poorest wealth quintile were not fed colostrum [22, 31], non-exclusively breastfed, [32] and did not meet the MDD [33–37]. Low-income families tend to have limited access to education resources and poor utilisation of health services, affecting IYCF practices. Poverty has been associated with poor child development indicators in low- and middle-income countries (LMICs) [26, 27, 38, 39]. Similarly, previous studies in Nepal have found household wealth to be a strong predictor of ECD [25, 40]. However, the adverse effects of poverty on child development can be mitigated through parents' engagement with their children in cognitive and socio-emotional caregiving practices [41, 42]. Therefore, ensuring parents' awareness and engagement in IYCF and caregiving activities should be a programmatic priority [3, 41].

Our study highlights that lack of antenatal visits and home delivery among young mothers were associated with poor feeding and caregiving practices. Children of adolescent and young mothers were more likely to have delayed or early introduction of complementary foods, which was consistent with a previous study from Nepal [33]. Adolescent and young mothers are physiologically and socioeconomically disadvantaged because of early marriage and childbearing, with lower education levels, high financial dependency, low self-esteem, and low decision-making autonomy [43]. Despite efforts to reduce child marriage in Nepal, it remains a pervasive public health issue [44], with more than half (52%) of women aged 25-49 having married before the age of 18 and nearly a quarter of them (17%) becoming mothers before the age of 18 [15]. The problem is pronounced in Dhanusha district and other areas of Province 2, where 88% of women aged 20-30 years are married before 18 [45]. Many adolescent mothers have restricted access to maternal health services, impacting their knowledge and awareness about nutrition and caregiving practices. Programmes and policies to strengthen efforts to prevent early marriage and childbearing and improve knowledge and practice about optimal IYCF and caregiving practices among adolescent and young mothers should be prioritised in this context.

We found that antenatal visits were associated with the timely introduction of complementary feeding, and this is supported by previous studies from Nepal [33, 46], Sri Lanka [47] and Pakistan [48]. More antenatal visits were associated with greater access to books and toys, suggesting that mothers receive information and counselling about their value for ECD during antenatal visits. Alternatively, wealthier, more educated women living in more accessible areas who are more likely to access antenatal visits may be able to afford books and toys for their children. Our finding that delivering in a health facility was associated with better breastfeeding practices is similar to prior studies from Nepal [24, 49] and India [50]. Improved access to community health care services may enable the transfer of nutrition and caregiving information, especially to young mothers. Hence, existing antenatal, delivery, and postnatal contact points with mothers provide an opportunity to reach out to this vulnerable group at scale and counsel them on optimal feeding and caregiving practices.

As previously found in studies from Ethiopia [37] and India [50], younger children were more likely to fail to achieve MDD and consumed fewer animal-source foods, vegetables, and fruits. One possible reason for this is the widespread cultural belief in Nepal that cereal foods are sufficient for young children [51]. Furthermore, cultural taboos dictate that children are not offered eggs and flesh foods until they have their first tooth, usually at the age of one year [52]. Further, compared with children 43-59 months, younger children were at higher risk of poor access to children's books, toys, ECE, early stimulation and responsive caregiving, and at higher risk of poor development. This highlights the

lack of awareness among parents and caregivers that most development occurs in the early years of life and that optimal feeding and caregiving play a key role. Prior research from Burkina Faso and Malawi found a lack of knowledge and awareness among caregivers about the relationship between caregiving practices for younger children and child development [53, 54].

The association of feeding and caregiving practices with the sex of the child was not in the same direction. Boys were less likely to receive complementary feeding at 6-8 months of age and girls were less likely to have access to toys. Boys, on average, are at a higher risk of undernutrition than girls [55, 56]. Lower respiratory infections, diarrhoeal disease, malaria, and preterm birth are all observed to occur more frequently in boys than in girls [57]. These conditions increase boys' susceptibility to undernutrition, which may impact the initiation of complementary feeding. Girls' low access to toys may be explained by their greater engagement in household chores from an early age and parents' preferential treatment of boys. These issues are worthy of investigation in Nepal. Other studies showed inconsistent gender differences: Bornstein et al. (2012) found no difference in caregiving practices between genders in 38 LMICs [8], while data across 35 LMICs using the ECDI scores showed that boys scored lower than girls [58]. Further exploration of gender-based feeding and caregiving practices is warranted to reduce disparity.

Prior research has consistently shown that maternal education is a strong predictor of optimal feeding [33, 35, 50, 59] and caregiving practices [26, 60–62]. The underlying mechanism explaining the association between maternal education and improved child developmental outcomes in LMICs is responsive caregiving behaviour, including early stimulation and learning support [63]. Furthermore, higher educated mothers can foster an enabling environment at home to promote child development [26, 64]. Our finding that maternal education was not a common factor affecting both practices may be explained by the lack of variability in the level of education in our sample, with only 12% having secondary schooling or beyond.

Our study has some limitations. First, the cross-sectional design precludes causal inferences. Second, while our results shed light on the factors affecting IYCF and caregiving practices in lowland Nepal, findings may not be generalisable to other areas of Nepal due to cultural and geographical variation. Third, the information on feeding and caregiving practices was self-reported by mothers, which may be liable to recall bias and social desirability bias. Fourth, the developmental potential of children at 36-59 months of age was assessed using the ECDI score, which has limited coverage of cognition and culturally specific developmental milestones [58]. Fifth, we did not collect separate data on maternal and paternal caregiving practices. Mothers and fathers both play critical but distinct roles in a child's development. Studies have found fathers' engagement in stimulating activities is more influential to child development than mothers' engagement in similar activities [25, 63]. Sixth, while we used a wide range of indicators embedded within the *Nurturing Care Framework*, we missed health and safety and security. Future studies should use age-appropriate and culture-sensitive population measures to gauge child development, examine separately the potential factors influencing the parenting practices of both mothers and fathers at different levels in the surrounding environment and explore all aspects of nurturing care to inform a holistic approach to child development. Finally, whilst our data dates to 2012, the pattern noted shows that the gap in IYCF and caregiving practices may still exist given that no significant intervention, particularly on responsive caregiving and early learning for children under three years, has been implemented in the area since then.

Our findings provide context-based evidence to guide the Government of Nepal, international agencies, non-governmental organisations, and public health experts to inform the design of interventions to improve ECD. Young children of adolescent and young mothers with limited access to health services during pregnancy and those from low-income families should be targeted for interventions to reduce the gap in child development in rural Nepal. This strategy must be strengthened at the local level, given the country's recent transition to a decentralised federal structure. Identifying those at risk of poor feeding and caregiving practices has further highlighted the need for an integrated approach to reduce the adverse consequences of poor practices on ECD. Existing interventions to enhance ECD are delivered in silos or with only partial integration of health and nutrition or nutrition and caregiving interventions [65, 66]. Local, state, and federal governments need to focus on bringing different sectors together and designing interventions that incorporate all aspects of nurturing care for a child's holistic development. Further, governments should increase investment in parenting programmes to support parents and caregivers to improve their feeding and caregiving practices for young children is required to reduce the inequality in child development [4, 67]. Likewise, the Government of Nepal and other key stakeholders should engage in social, and behaviour change communication at the household and community level to increase awareness of the optimal feeding and caregiving practices that could support ECD.

Conclusions

Our study demonstrates that optimal IYCF and caregiving practices remain a challenge in rural Nepal and that the Dhanusha district in Province 2 is even more behind than other areas, suggesting that more needs to be done to support parents and caregivers to improve feeding and caregiving practices. Moreover, a holistic approach to child development, focusing on young children, to address poverty and improve health services for adolescents and young mothers should be prioritised to optimise feeding and caregiving practices in rural Nepal.

Abbreviations

AOR: Adjusted Odds Ratio; cRCT: cluster Randomised Controlled Trial; CI: Confidence Interval; ECD: Early Childhood Development; ECDI: Early Child Development Index; ECE: Early Childhood Education; IYCF: Infant and Young Child Feeding; LMIC: Low- and Middle-Income Countries; MDD: Minimum Dietary Diversity; PLA: Participatory Learning and Action; MAHFP: Months of Adequate Household Food Provisioning; MICS: Multiple Indicator Cluster Survey; MIRA: Mother and Infant Research Activities; NDHS: Nepal Demographic Health Survey; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology; UNICEF: United Nations Children Fund's; VDC: Village Development Committees; WHO: World Health Organization

Declarations

Ethics approval and consent to participate

Prior to the start of data collection, in compliance with the Declaration of Helsinki on research involving human subjects, ethical approval was obtained for use of verbal informed consent. Verbal informed consent was obtained from all participants and both guardians and minors gave verbal informed consent when mothers were under 18 years age. The verbal informed consent procedure was approved by the ethics committee of the Institute of Child Health and Great Ormond Street Hospital for Children (04PC01/2005) and the Nepal Health Research Council (269/2004). Additional ethical approval for this analysis was obtained from the Western Sydney University Human Research Ethics Committee (H13494) and The Nepal Health Research Council (822/2019 PhD).

Consent for publication

Not applicable

Availability of data and materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare no competing interests.

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Authors' contributions

SD and AP conceptualised the paper. SD analysed data with inputs from NMS and SK. SD interpreted results and wrote the first draft of the paper for publication. NMS, DO and AC designed the original trial and NMS led the trial and the follow-up survey on the ground. DSM, BPS, BB managed the field data collection team in Nepal. NMS, AP, SK, DM, DO, AC reviewed the paper and provided inputs. All authors read and approved the submission of this paper.

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Figures

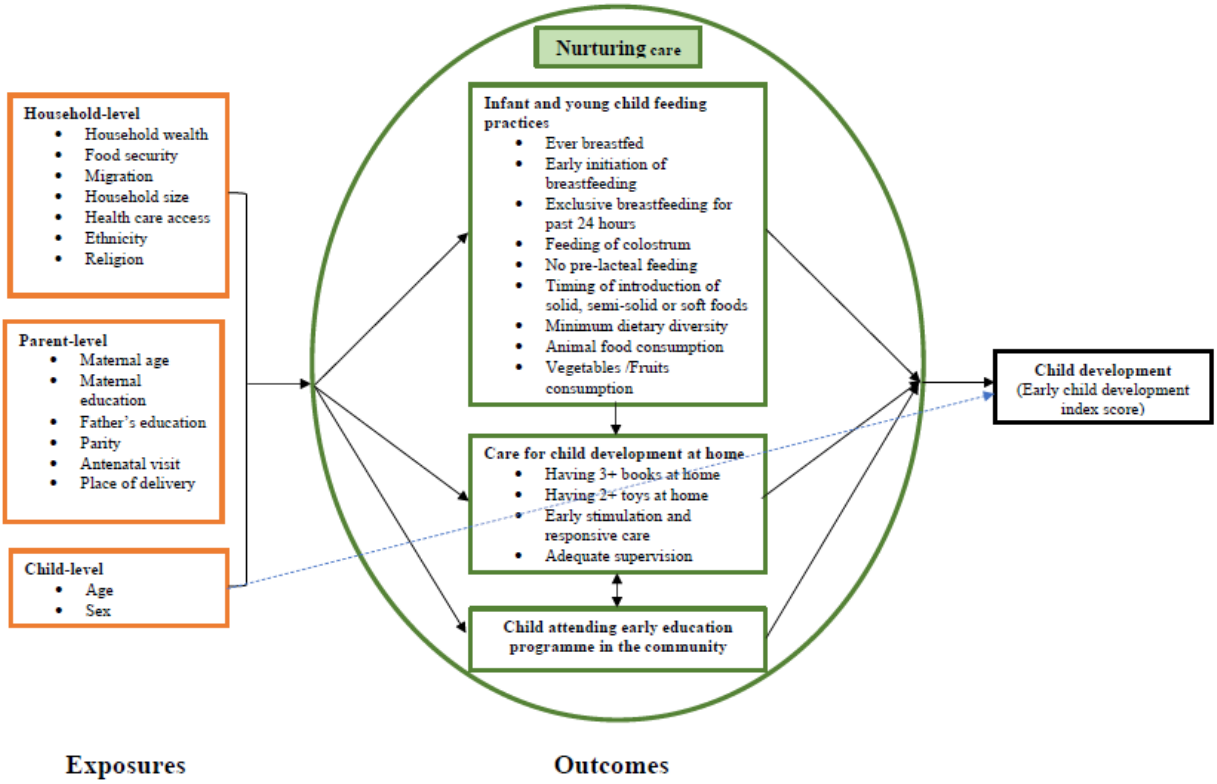

Figure 1

Conceptual framework for determinants of feeding and caregiving practices. Single-headed solid black and dotted blue arrows represent directional paths, and double-headed arrows indicate the variables that are assumed to be correlated.

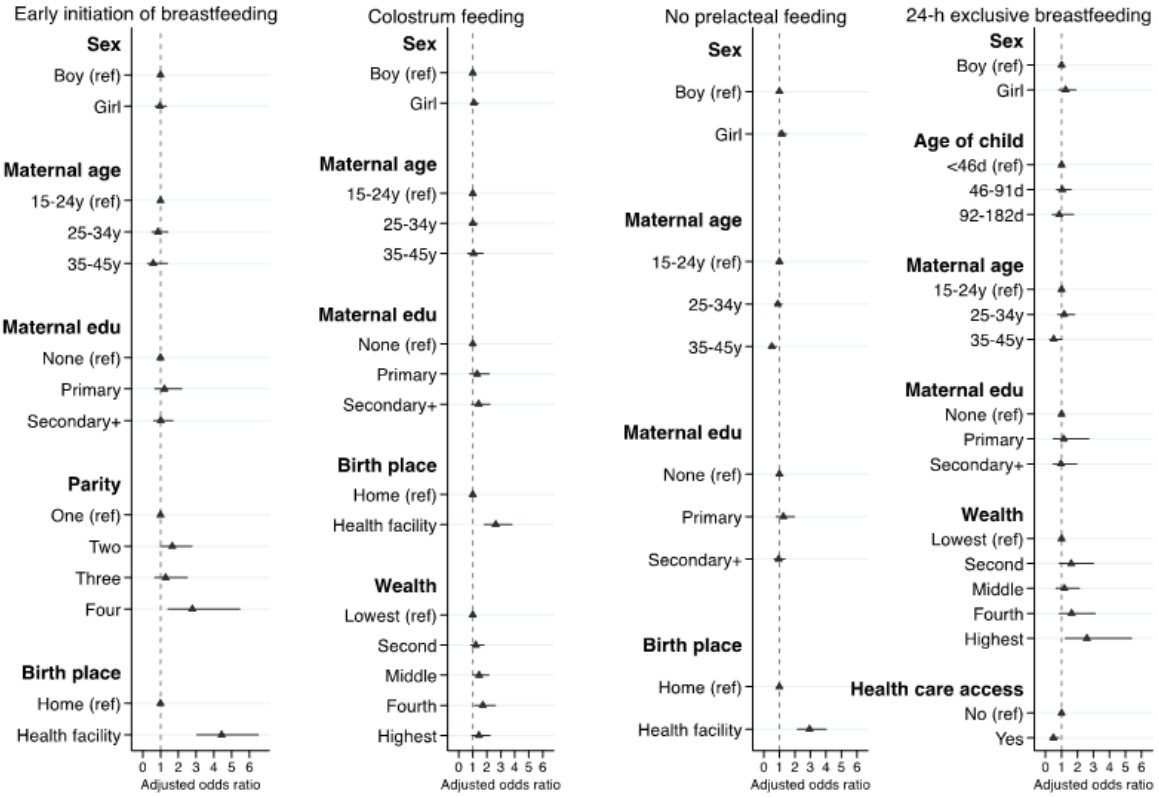

Figure 2

Final adjusted model showing factors affecting breastfeeding practices among children aged 0-12 months Each model was adjusted for the effect of clustering using cluster sites as a random effect and study trial arms as a fixed effect.

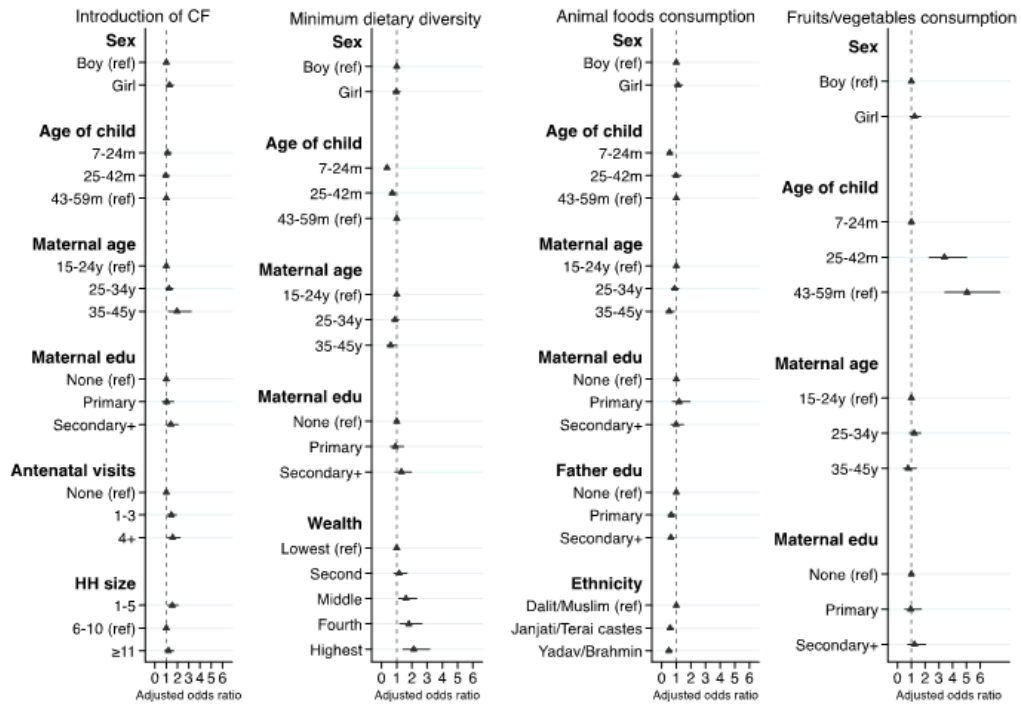

Figure 3

Final adjusted model showing factors affecting complementary feeding practices among children aged 7-59 months Each model was adjusted for the effect of clustering using cluster sites as a random effect and study trial arms as a fixed effect. CF: Complementary feeding.

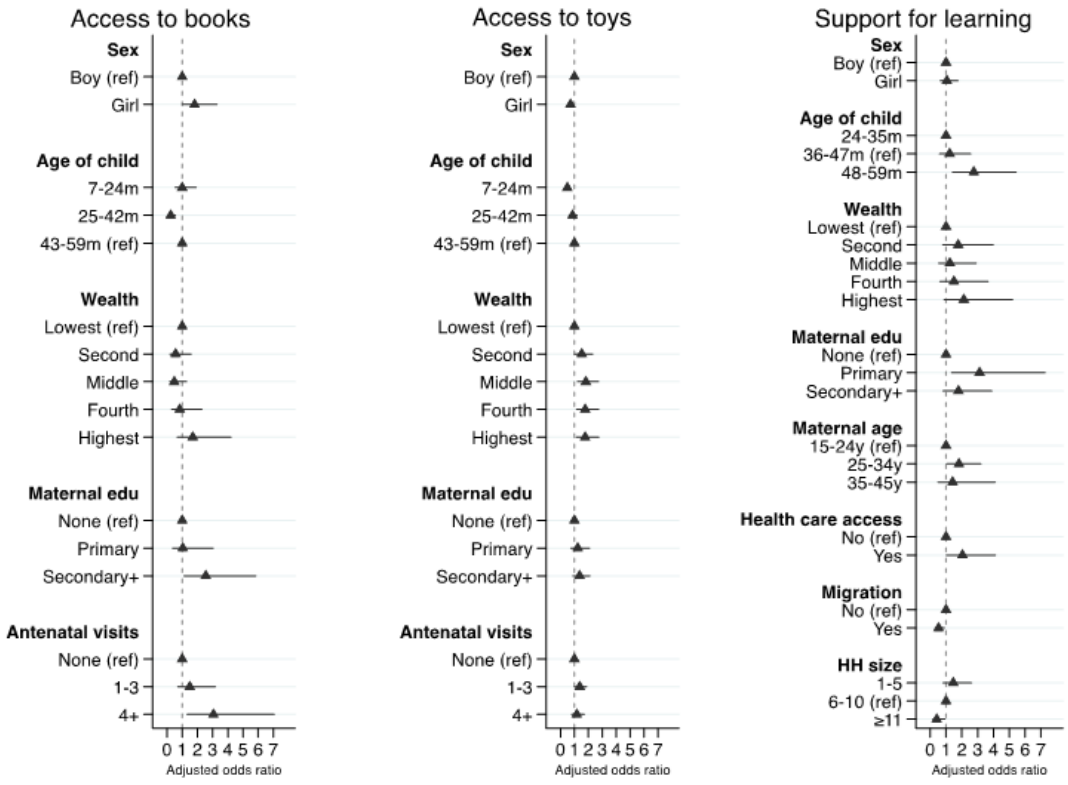

Figure 4

Final adjusted model showing factors affecting caregiving practices among children aged 7-59 months Each model was adjusted for the effect of clustering using cluster sites as a random effect and study trial arms as a fixed effect. The age denominator for access to books and toys is 7-59 months; for support for learning is 24-59 months.

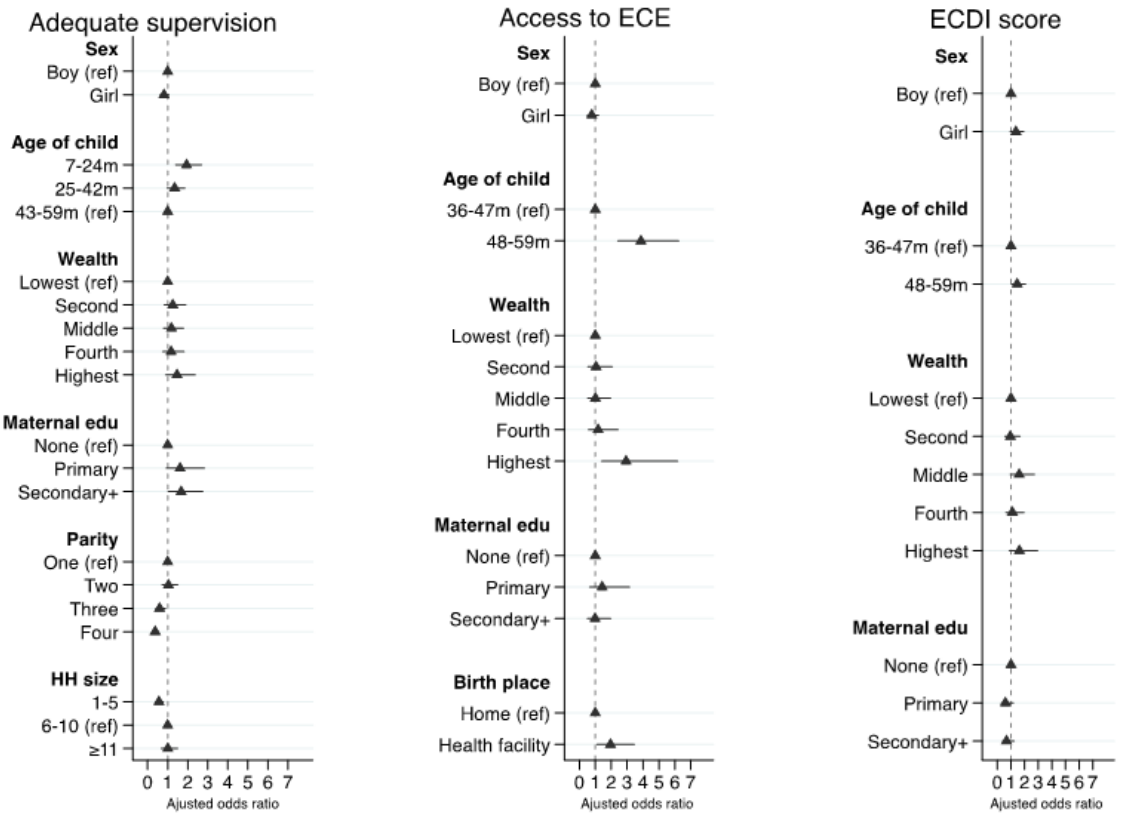

Figure 5

Final adjusted model showing factors affecting caregiving practices among children aged 7-59 months Each model was adjusted for the effect of clustering using cluster sites as a random effect and study trial arms as a fixed effect. ECE: Early Childhood Education; ECDI: Early Childhood Development Index. The age denominator for adequate supervision is 7-59 months; for access to ECE and ECDI score is 36-59 months.

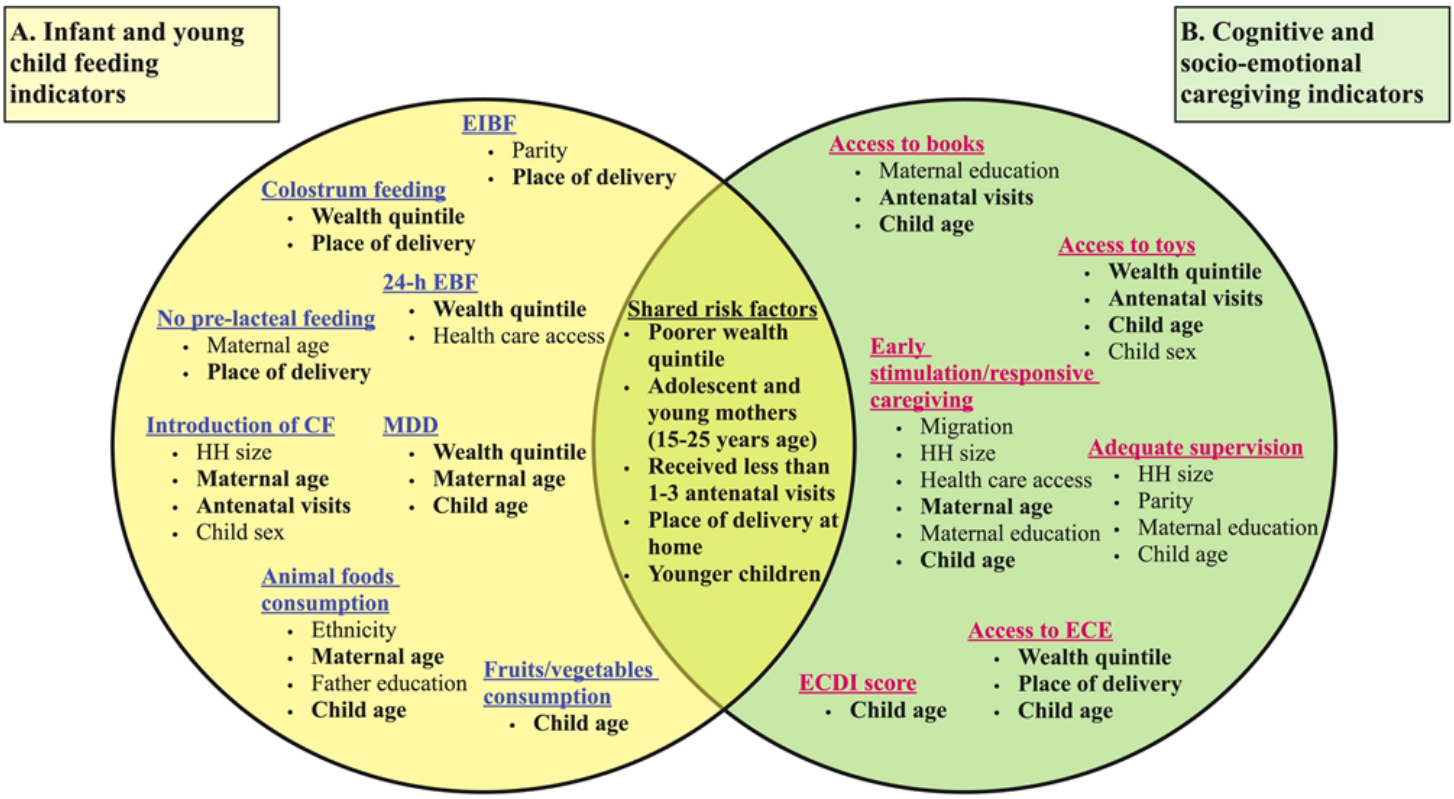

Figure 6

Venn diagram showing shared risk factors between feeding and caregiving indicators Legend: The area where the circles overlap denote factors commonly identified as significant factors for each infant and young child feeding and cognitive and socio-emotional caregiving indicator showing the same direction of association for each outcome in multivariable regression analysis Model 3. EIBF Early initiation of breastfeeding, EBF Exclusive breastfeeding, CF Complementary feeding, HH Household, MDD Minimum Dietary Diversity, ECE Early Childhood Education, ECDI Early Childhood Development Index.

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