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Maternal depression is associated with less dietary diversity among rural Nepali children

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Abstract

Maternal depression has been associated with adverse child growth and development; less is known about its relation to children's diet. In a cross-sectional study embedded at endline of a longitudinal community development intervention, mothers of 629 children (age 23–66 months) in rural Nepal responded to household and children's diet questionnaires and were screened for depression. Child anthropometry and development (Ages and Stages Questionnaire) were assessed. Regression models examined children's diet, growth and development, adjusting for household, child and maternal characteristics. The prevalence of maternal depression was 21%. Maternal depression was associated with 11% lower likelihood that the child consumed one additional food group [Poisson regression, adjusted relative risk (aRR) 0.89, 95% confidence intervals (95% CI 0.81, 0.99), $p = 0.024$] and 13% lower likelihood that the child consumed one additional animal source food (ASF) [aRR 0.87, (95% CI 0.76, 1.01), $p = 0.061$] compared with children of nondepressed mothers. However, maternal depression was not associated with either child anthropometry or development: these outcomes were strongly associated with better home child-rearing quality. Stunting also related to child age and intervention group; child development related to mother's education and household wealth. This study suggests a correlation between maternal depression and child dietary diversity. This association could be due to unmeasured confounders, and therefore, further research is warranted. Understanding the relationship of depression to child outcomes—and the role of other potentially compensatory household factors—could help address some of the earliest, modifiable influences in a child's life and contribute to innovative approaches to improve child well-being.

1 | INTRODUCTION

The prevalence of maternal depression in low- and middle-income countries (LMICs) ranges from 16% to 20%, according to several recent meta-analyses (Atif et al., 2015; Halbreich & Karkun, 2006; Wachs et al., 2009; Wolf et al., 2002). Maternal depression has been widely considered a risk factor for poor child growth and development (Atif et al., 2015; Bennett et al., 2016; Gelaye et al., 2016; Kingston & Tough, 2014; Ruel et al., 2013; Smith Fawzi et al., 2019; Surkan et al., 2011; Wachs et al., 2009), especially in LMICs. Children in resource-poor settings face multiple challenges associated with poverty, including food insecurity, limited access to medical care, frequent infections, poor hygiene and sanitation, and lower levels of maternal education (Ruel et al., 2013; Shonkoff et al., 2012; Walker et al., 2011). When combined with the insidious effects of poverty on the growth and development of young children, maternal depression represents an important additional risk factor for poor outcomes (Herba et al., 2016; Lovejoy et al., 2000). However, results of existing studies of the relationship of maternal depression to children's diet are inconclusive (World Health Organization, 2008), with some (Anato et al., 2020; Barker et al., 2013; Emerson et al., 2017; Henderson et al., 2003; Patel et al., 2004; Rahman et al., 2004) but not all studies (Adhikari et al., 2020; Lima et al., 2017; Wemakor & Iddrisu, 2018) showing a relationship. Thus, poor diet has not been established as one of the risk factors for worse growth and development in children of depressed mothers.

Research suggests several possible relationships between maternal depression and children's diet. Depressed mothers may lack energy and motivation to seek and prepare varied and nutrient-rich foods. Depression has been linked to reduced attunement between mother and child: the mood of depressed mothers may interfere with their awareness of their child's nutritional needs (Beck, 1995; Herba et al., 2016). Depressed mothers may also be less inclined to engage in 'responsive feeding' (Berkes et al., 2019), one of the fundamental behaviours associated with better child nutrition (Beck, 1995; Herba et al., 2016). Moreover, maternal depression may impact child outcomes at any age. Although infants and very young children are more dependent on their mothers than older children, maternal depression may be even more problematic for older children (Lovejoy et al., 2000). Maternal depression noted at preschool age or older often represents a recurrence or continuation—rather than an initial episode (Herba et al., 2016; Lovejoy et al., 2000): multiple episodes of depression (and 'inter-episodic subsyndromal symptoms') are likely to compromise mother–child interaction patterns (Herba et al., 2016; Lovejoy et al., 2000) related to feeding and other behaviours.

Thus, understanding how maternal depression relates to other household factors to influence child nutrition, growth and development remains incomplete (Berkes et al., 2019). Identification and disaggregation of these environmental factors may offer additional targets for interventions. Several reports have recently described the feasibility of addressing maternal depression at the village as well as at the household level in LMICs (Atif et al., 2015; Chowdhary et al., 2014; Rahman et al., 2013; Walker et al., 2011); examination of other household characteristics may suggest alternate ways to promote or protect child growth and development if the child's mother is depressed. To explore these issues, we assessed the relation of maternal depression, and other household variables, to children's diet, growth and development in rural Nepal.

Key messages

- The prevalence of maternal depression in rural Nepal was 21%.
- Children of these depressed mothers consumed less diverse diets than children of nondepressed mothers.
- Growth and development of the children of depressed mothers did not differ from that of children of nondepressed mothers.
- Home child-rearing quality was associated with growth and development among these rural Nepali children.

2 | METHODS

2.1 | Ethics

The investigation was approved by the Nepal Health Research Council (#1369), as well as the Human Investigation Review Board of Tufts University (#1305009), and was registered at ClinicalTrials.gov (NCT03516396). Data are available on request due to privacy/ethical restrictions.

2.2 | Study design

This study of maternal depression was a cross-sectional observational study, embedded at endline among participants in a longitudinal community development intervention. The larger study evaluated the impact of a community mobilization intervention trial implemented by the non-governmental organization, Heifer Nepal. The aim of this longitudinal controlled impact evaluation (Habicht et al., 1999) was to assess the contributions of community mobilization activities plus training in family nutrition and livestock management on household socio-demographic outcomes, as well as children's diet and growth (see Miller et al., 2020, for details on the intervention and its implementation). Notably, the intervention did not address child development nor maternal depression. The study took place in Banke district in western Nepal, an area largely populated by low-income subsistence farmers. Eighteen villages in this district were matched for sociodemographic characteristics including geographic location, altitude, population size, local natural resources, employment opportunities, availability of health care and type of agriculture practiced. Three groups of six villages each were randomly assigned to the three treatment arms: (1) full Heifer intervention package, including community development, livestock training and nutrition education (Full Package); (2) livestock training and nutrition education only (Partial Package); or (3) Control (no inputs). Due to logistic considerations in delivery of this community-based intervention, the six villages in each arm were adjacent to each other but geographically separate from the two other groups of villages to avoid contamination across arms.

2.3 | Field practices

The results described in this study were derived from cross-sectional data obtained at the sixth household visit of this longitudinal trial. Only previously enrolled households with a child between ages 23 and 66 months old were eligible to participate in this sixth visit. This visit occurred 16 months after the end of the trial and after both the Partial Package and Control groups received intervention inputs similar to what the Full Package intervention group had received (Figure 1). Field enumerators administered a 145-item questionnaire to the mother of each enrolled child. The core of the questionnaire was based on the Nepal Demographic and Health Survey (Nepal Ministry of Health, et al., 2017), and included household demographics and diet information. Two modules not previously included during the first 5 rounds of data collection were added to the questionnaire at the 6th round: maternal depression and home child-rearing quality (described below). In addition, child anthropometry was performed, and developmental status was assessed (described below).

The conceptual framework and measures are shown in Figure 2. Child outcomes related to growth, development, and diet were assessed in relation to maternal mental health status, and child, maternal, and household characteristics.

2.4 | Participants

Eligibility for this cross-sectional study was limited to children age 23–66 months in families which had previously been enrolled in the longitudinal study. At the time this study was done (16 months after the previous survey), 637 children who met these criteria were identified (Figure 1). Child age was determined by inspection of the birth or the vaccine certificate; either or both of these documents were available for all children. Exclusion criteria were child physical or neurologic handicaps that prevented ingestion of a normal diet for age or children with severe inter-current illnesses at the time of survey; however, no children met these criteria. Two of these 637 children could not be located; and for 6 children, developmental testing results were recorded incorrectly. Thus, diet, growth, and developmental testing results were available on 629 children. The mothers of these 629 children were screened for depression at the time of the final household visit (described below).

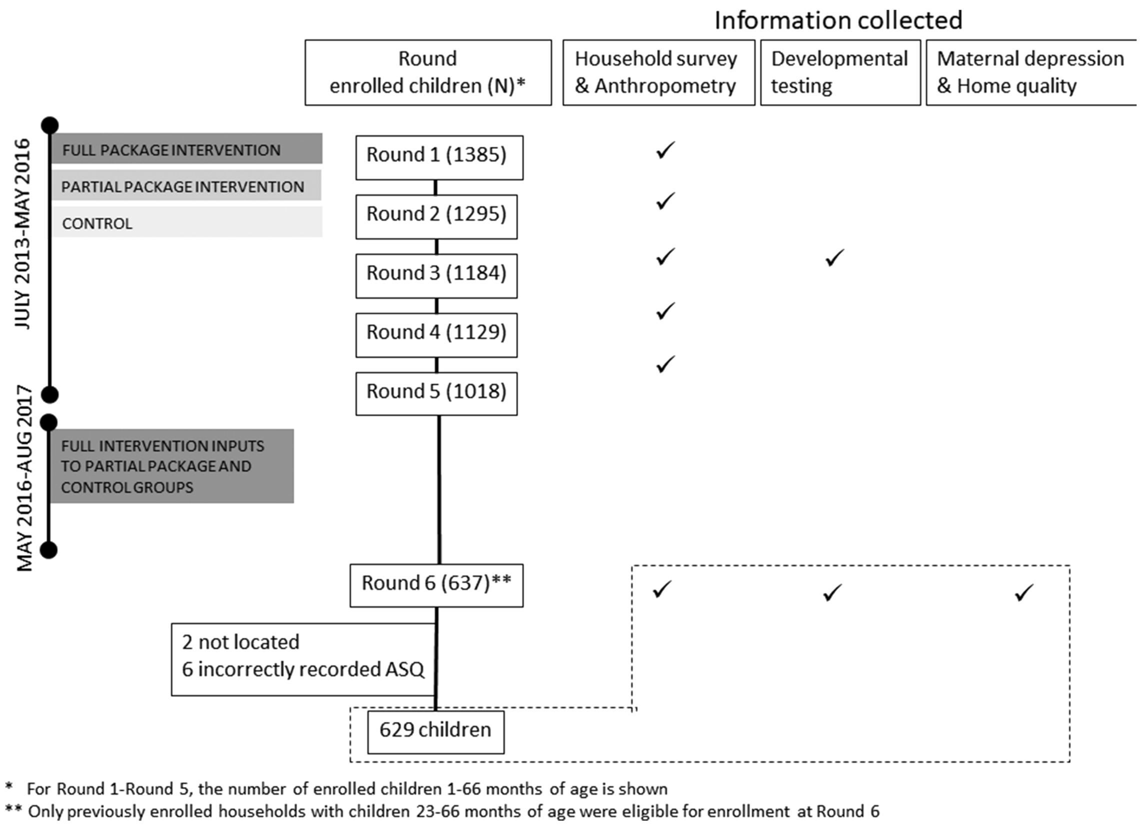

FIGURE 1 The intervention group assignments are shown in the grey-shaded areas on the left of the diagram. After Round 5, the Partial Package and Control groups received the Full Intervention. Household surveys (including diet recall), and child anthropometry were collected at all six rounds of data collection. Developmental testing was completed on a small subset of children at Round 3. Round 6 enrollment was limited to previously enrolled households with a child between the ages of 23 and 66 months ($n = 637$). At Round 6, developmental testing was completed on these children, and maternal depression and home quality were assessed. The dotted lines show the cross-sectional data that were used in the current study

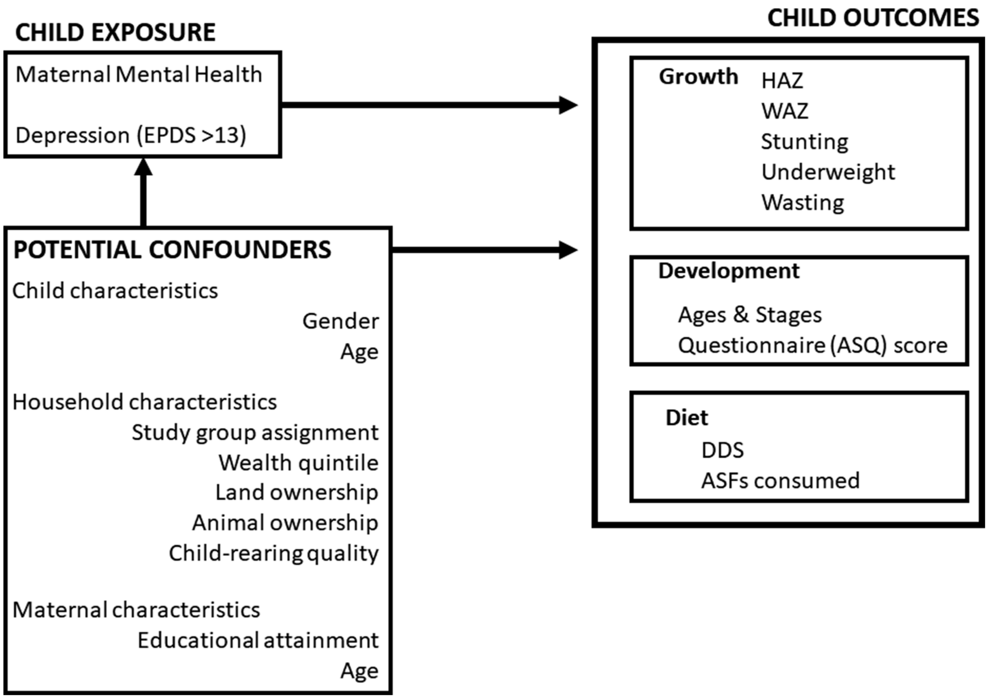

FIGURE 2 Conceptual framework and measures used for the analysis. Potential confounders of the relationship between maternal depression and child growth, developmental and diet outcomes were considered. EPDS, Edinburgh Post-Partum Depression Scale

2.5 | Household and maternal characteristics

2.5.1 | Socio-economic status

Multiple indicators of socio-economic status (SES) were collected including animal ownership (converted to a standardized score using FAO Global Livestock Units (Food and Agricultural Organization, 2003) and amount of land owned (square meters). Annual income, including foreign remittances, was calculated based on reports of the household's monthly expenditures and savings (NPR, Nepali rupees). Wealth scores were based on household possessions and quality of housing (including toilet and water) using principal components analysis following DHS-Nepal guidelines (Ministry of Health and Population Nepal et al., 2012) and treated as quintiles for modelling purposes.

2.5.2 | Maternal education

The educational status of the mothers was classified as follows: (1) none or simple literacy classes, (2) some or completed primary school, and (3) some or completed secondary school (or beyond).

2.5.3 | Maternal depression

The Edinburgh Post-Partum Depression Scale (EPDS) was administered by field enumerators to the mothers of the 629 enrolled children. This 10-item measure has been validated in LMICs (Shrestha et al., 2016) including Nepal (Bhusal et al., 2016; Gibson et al., 2009; Nepal et al., 1999; Regmi et al., 2002), and also for use in women outside of the post-partum period (Cox et al., 1996; Matijasevich et al., 2014). Responses are scored as 0, 1, 2 and 3 according to the increasing severity of the symptoms. Total score is calculated by adding the scores of each of the 10 items. The value of score can range from 0 to 30. Based on prior work in Nepal validating the EPDS against psychiatric interview using the International Classification of Diseases 10th revision, the cut-off 12/13 was used to construct a dichotomous variable of 'depressed' (≥13) or 'not depressed' (<13), which was used in modelling. Cronbach's alpha ranged from 0.814 to 0.844 for each of the 10 items, the sensitivity of the screening overall was 92% (positive predictive value 77%) and the specificity was 95.6% (negative predictive value was 99.3%) (Bhusal et al., 2016). Training in the use of the EPDS was included in the 7-day preparation of field enumerators who conducted the study. Detailed discussion of each item, role-playing exercises, and inter-rater reliability exercises were conducted using 'mock subjects'. In the field setting, supervisors readministered this questionnaire to 10% of enrolled mothers ($k = 0.93$).

2.5.4 | Home child-rearing quality

The home child-rearing quality was assessed using the Early Childhood Development component of the Nepali version of the UNICEF Multiple Indicator Cluster Survey questionnaire (Nepal Central Bureau of Statistics & UNICEF Nepal, 2015). This section included items such as availability of (homemade or purchased) toys, dolls and books (verified by field enumerator); interactive activities with an adult family member, such as reading together, telling stories, singing together, naming objects and playing (parent report); and child supervision (number of days per week that the child was left alone or under the supervision of another child, parent report) (Kariger et al., 2012). Responses to these items were scored using the method adapted from Jeong et al. (2018). Scores were normally distributed (median 4, range −2 to 11) and treated as a continuous variable in models.

The home child-rearing quality variable was included in our adjusted model as a way to incorporate the unusual conjoint family structure in these households. Typically, the households are composed of several adult male siblings, their wives, children and parents. All the adults attend more-or-less to all the children. Although the mother–child relationship remains primordial, other adults are available to provide for the child in case of need. Thus, a measure of home child-rearing quality—which assessed adult involvement with the child (and not just that of the mother)—was an important adjustment in evaluating the relationship of maternal depression to child outcomes.

2.6 | Child characteristics

2.6.1 | Child anthropometry

Child growth was assessed at each field visit. Weight was measured with Seca 835 electronic scales (Hamburg, Germany), calibrated before each measurement. Standing height (≥2 years) was measured with a portable Seca 213 stadiometer. Head circumference was assessed with disposable paper tapes at the maximum occipitofrontal measurement. Mid-upper arm circumference (MUAC) was measured with disposable insertion tapes (Harlow Ltd, South Shields, UK). Each measurement was obtained twice, and results averaged. If results were >5% discrepant, then a third measurement was obtained. Results were converted to *z* scores using World Health Organization (WHO) Anthro (World Health Organization, 2011). The prevalence of underweight, stunting and wasting was defined as < −2 *z* scores using WHO standards (World Health Organization, 2011).

2.6.2 | Child developmental assessment

Child development was assessed using the Ages & Stages questionnaire-3 (ASQ-3). This standardized screening instrument is used worldwide (including Nepal) to assess child development (Kerstjens et al., 2009; Kvestad et al., 2017; Shrestha et al., 2019; Strand et al., 2017; Thorne-Lyman et al., 2019). It is scored by observation (or parent report), and consists of 30 age-specific items within the domains of communication, gross motor, fine motor, problem-solving and personal-social skills. The instrument was translated from English to Nepali, then back-translated; minor changes were made to adapt to local conditions. The instrument was then pilot-tested for clarity. The test was administered by field enumerators who received 7 days didactic and practical training; the training was conducted by a Nepali child development paediatrician specialist. Inter-rater reliability exercises were conducted as part of the training for the four enumerators and two supervisors. At the end of the training period, seven children were assessed by each trainee (30 items per child); their results were compared with the results obtained by the child development expert. Agreement between the assessments of the trainees and the expert was 96%. In addition, a child development nurse-specialist accompanied the field enumerators to the study area and remained with them as an on-site supervisor for the first 2 weeks of the 4-week period of data collection and by phone for the remainder of data collection.

2.6.3 | ASQ scoring

The Ages and Stages Questionnaire (ASQ) total score was used in these analyses. Standard methods were used to score the ASQ (Squires et al., 1995). A score of 10 was assigned if the child was observed/reported to 'always' practice the behaviour, 5 if the child sometimes practiced the behaviour and 0 if the child could not/did not practice it. Contributing variables for each subdomain were evaluated, and those showing no variance were removed from the score, and the relative contribution of other items for that subdomain was weighted accordingly. Total ASQ scores < 50 (found in six children) were omitted as these were felt to represent implausible results.

2.6.4 | Children's diet

Field enumerators received 4 days of didactic and practical training on administering the dietary questionnaire. Each food item was carefully discussed to be certain it was well understood in the local context. Possible responses were also thoroughly reviewed to verify that coding would be done correctly and consistently. After didactic training, the enumerators visited a field site unrelated to the research site for 2 days of practical training. Extensive debriefing sessions were conducted after each day of practical training. Field supervisors closely monitored the enumerators' activities in the research households, accompanying the enumerators for at least one third of each visit. At the household visit, the mothers reported their child's consumption in the past 24 h of 12 specific foods/food groups (Kennedy et al., 2013). The 24-h diet recall information was aggregated into eight categories based on the Food and Agriculture Organization/Food and Technical Assistance (FAO/FANTA) dietary diversity scores: starchy staples (grains and white potatoes); vitamin A-rich fruits and vegetables; other fruits and vegetables; offal, meat and fish; eggs; legumes, nuts and seeds; milk and dairy products; oils (Swindale & Bilinsky, 2006). Oil was included as one of the food categories (Swindale & Bilinsky, 2006), as it was frequently consumed in the project area, and represents an energy-dense source of nutrients for children ages 23–66 months. The number of categories consumed in the prior 24 h comprised the child's diet diversity score (DDS) (range 0–8). Additionally, the food categories of milk, dairy products, offal, meat, fish and eggs were summed to determine the number of animal source foods (ASF) consumed in the prior 24 h (range 0–6).

2.7 | Statistical analysis

Data were entered and analysed with JMP 13.1, SAS version 9.4 and STATA 15.0. A descriptive analysis of the variables was performed, including *t* tests, analysis of variance, chi-square tests and correlations to assess collinearity. Continuous dependent variables were evaluated with histograms to verify normal distribution. Regression analyses were performed, assessing the relationship of maternal, child and household variables to child growth, development and diet. Linear regressions were used to analyse continuous variables (e.g., HAZ and ASQ score), logistic regressions were used to analyse nominal variables (e.g., stunting), and Poisson regressions were used to analyse count variables (e.g., number of food groups or ASFs consumed). In an attempt to control for confounding of the relationship between maternal depression, children's diet and development, we performed adjustment using a set of covariates that were chosen a priori, including child gender and age, maternal age and education, and household wealth quintile, intervention group assignment, land and livestock ownership, and home child-rearing quality. These were included in the adjusted model if they were associated ($p \leq 0.10$) with the anthropometric, developmental and dietary outcomes. Home child-rearing quality was included due to the particular nature of the conjoint family structure in these households. Although it is possible that home child-rearing quality is on the pathway from maternal depression to child outcomes, the availability of other adults in the household to meet the child's needs suggested that alternative pathways should be considered. To examine this further, the regressions were run with and without adjusting for this variable.

3 | RESULTS

3.1 | Characteristics of the study population

The characteristics of the study population of the households, mothers and children are shown in Table 1. Most families owned their homes (93%). In general, family members and mothers were poorly educated (77% with no education or simple literacy classes only). At the time of the survey round (Round 6), the prevalence of stunting was 32%, underweight 30%, wasting 13% and microcephaly 21% [*z* scores < −2 respectively for height-for-age (HAZ), weight-for-age (WAZ), weight-for-height (WHZ) and head circumference-for-age (HCZ)]; mean *z* scores were < −1 for HAZ, WAZ and HCZ. Children's diets, as assessed using 24-h recall, were suboptimal. Mean dietary diversity score was (mean ± SD) 4.68 ± 1.14 (maximum possible 8), and mean number of ASFs consumed was 0.82 ± 0.84 (maximum possible 6). Children's total developmental score (measured using the ASQ) was (mean ± SD) 201 ± 51 (out of a maximum possible of 300).

3.2 | Child growth, development and diet in relation to maternal depression

Next, we assessed child growth, development and diet in relation to maternal depression (Table 2). (Stunting is shown as an indicator of growth in Table 2; other growth parameters are shown in Table S1.) In the unadjusted model, children of depressed mothers were 1.49 times more likely to be stunted [95% confidence interval (95% CI) 1, 2.21, $p < 0.10$], have lower scores for developmental performance (−12.6 points) (95% CI −22.35, −3.01, $p < 0.10$), and consume 14% fewer food groups (RR 0.86, 95% CI 0.79, 0.95, $p < 0.05$) and 31% fewer ASFs (RR 0.69, 95% CI 0.6, 0.79 $p < 0.01$) (Table 2). After adjustment for mother's age and education, child age and gender, and household characteristics [intervention group assignment (Full Package, Partial Package and Control group), wealth, livestock and land ownership, and home child-rearing quality], the relationships between maternal depression and child stunting (and other growth measurements) or developmental performance were attenuated. However, the relationship between maternal depression and children's diet remained significant. Maternal depression was associated with 11% lower likelihood that the child would eat one additional food group [Poisson regression, relative risk (RR) 0.89, 95% CI 0.81, 0.99, $p = 0.024$] and 13% lower likelihood that the child would consume one additional ASF [RR 0.87, (95% CI 0.76, 1.01), $p = 0.061$], compared with children of nondepressed mothers. When the analysis was conducted omitting the variable for home child-rearing quality, the most notable change was that the relationships between maternal depression and *both* measures of diet quality were significant: child ASF consumption [RR 0.850 (95% CI 0.74, 0.98), $p = 0.026$], and child diet diversity [RR 0.890 (95% CI 0.81, 0.98), $p = 0.019$] (Table S2). There was no relation between maternal depression and child growth without adjustment for home child-rearing quality (Table S3).

The relation of household, child and other maternal factors to child growth, development and diet was further explored. In the adjusted analysis, assignment to either intervention group (Full or Partial Package) was associated with lower likelihood of stunting than being in a Control household. Younger children were less likely to be stunted. Better home child-rearing quality was associated with an 11% reduced likelihood of stunting. Child development (ASQ score) remained strongly related to maternal education: having a mother who had some or completed primary education was associated with an increase of 10.6 points in the child's ASQ total score; for mothers who had some or completed secondary education, the increase was 21.2 points. Being in the upper two wealth quintiles (respectively, by 16.0 and 20.2 points) and having a favourable home child-rearing quality also related to better ASQ scores (by 5.2 points). Assignment to the Full Package or Partial Package intervention groups, wealth quintile, household livestock ownership and home child-rearing

TABLE 1 Household, maternal and child characteristics

	(% or mean ± SD)
Household characteristics (*N* = 629)	
Intervention group assignment	
Control	35%
Full intervention	26%
Partial intervention	39%
Demographics	
Homeowner	93%
Number of household members (m ± SD)	8.8 ± 4.4
Amount of land owned m^2 (m ± SD)	8474 ± 9861
HH wealth score (m ± SD)	0.02 ± 0.99
Annual income per HH member NPR (m ± SD)	28,806 ± 20,950
Annual income (m ± SD)	217,864 ± 130,176
Animal score (m ± SD)	1.83 ± 1.87
Other household characteristics	
Household has migrants	37%
Home child rearing quality(m ± SD)	4.19 ± 2.14
Most educated adult in HH	
None or basic only	77%
Some or completed primary	19%
Some or completed secondary	4%
Mothers' characteristics (*N* = 525)	
Mother's ages (m ± SD)	29.15 ± 7.11
Pregnant	5%
Lactating	51%
Age of youngest child (months) (m ± SD)	33.35 ± 18.27
Educational level	
None or basic only	77%
Some or completed primary	18%
Some or completed secondary	5%
Child characteristics (*N* = 629) (range 23–66 months)	
M:F	317:312
Age (m ± SD)	43.90 ± 13.56
Education	
Ever attended school	34%
Anthropometry (*N* = 629)	
HAZ (m ± SD)	−1.55 ± 1.02
Stunted	32%
WAZ (m ± SD)	−1.55 ± 0.87
Underweight	30%
WHZ (m ± SD)	−0.93 ± 0.92
Wasted	13%
HCZ (m ± SD)	−1.22 ± 0.95
Microcephalic	21%
MUACZ (m ± SD)[a]	−0.50 ± 0.70

(Continues)

TABLE 1 (Continued)

	(% or mean ± SD)
24-hr diet recall (m ± SD)	
Dietary diversity score (range 0–8)	4.68 ± 1.14
#ASFs consumed (range 0–6)	0.82 ± 0.84
Developmental performance (ASQ) (m ± SD)	
ASQ total (maximum possible 300)	201 ± 51
ASQ subdomains (maximum possible 60 for each)	
Gross motor	48.9 ± 13.7
Communication	45.5 ± 12.1
Fine motor	31.0 ± 16.5
Personal-social	39.2 ± 14.7
Problem-solving	36.2 ± 14.5

Abbreviation: MUAC, mid-upper arm circumference.
[a]For MUAC measurements, $N = 535$. Household, mother, and child characteristics are shown for the 629 children included in the study. The % or mean +SD of each variable at the time of this cross-sectional study is shown.

quality all related positively to child ASF consumption. In contrast, boys were 12% less likely to consume one additional ASF, compared with girls.

4 | DISCUSSION

Maternal depression has been linked to many adverse child outcomes, including poor growth, worse health (more episodes of diarrhoea, fever), delayed development (especially cognitive) and behavioural problems (internalizing and externalizing disorders, disordered attachment and later mental health disorders (Atif et al., 2015; Gelaye et al., 2016; Herba et al., 2016; Kingston & Tough, 2014; Ruel et al., 2013; Wachs et al., 2009). Maternal depression is a strong determinant of caregiving, which can directly influence child growth and development (Atif et al., 2015; Black et al., 2009; Gelaye et al., 2016; Herba et al., 2016; Ruel et al., 2013; Wachs et al., 2009); even short periods of depression may have long-lasting repercussions (Hammen & Brennan, 2003). Multiple reports confirm the negative effects of maternal depression on children regardless of their age (Goodman et al., 2011; Herba et al., 2016; Lovejoy et al., 2000; Pizeta et al., 2018; Priel et al., 2019). Although infants and very young children are more dependent on maternal interactions and cannot easily seek support elsewhere, preschool and older children are also vulnerable to the adverse effects of maternal depression (Lovejoy et al., 2000). Maternal depression documented in these older children often represents a recurrence or continuation of pre-existing depression, rather than an initial episode (Herba et al., 2016; Lovejoy et al., 2000). Multiple episodes of depression (and 'inter-episodic subsyndromal symptoms') compromise dyadic adjustment and child mental health and behavioural outcomes (Herba et al., 2016; Lovejoy et al., 2000). Several meta-analyses have documented these negative relationships in children at preschool age or older (Goodman et al., 2011; Lovejoy et al., 2000). Moreover, maternal depression can affect other family members, not just the child (Lovejoy et al., 2000). Consequently, maternal depression is said to be the mental disorder with the highest public health impact (Atif et al., 2015).

In this cross-sectional study, we found that maternal depression was present in about 20% of mothers of young children in several rural Nepali communities. Maternal depression was associated with 11% lower likelihood that the child would eat one additional food group (Poisson regression, RR 0.89, (95% CI 0.81, 0.99), $p = 0.024$) and 13% lower likelihood that the child would consume one additional ASF [RR 0.87, (95% CI 0.76, 1.01), $p = 0.061$). The presence of depression was associated with many other household characteristics, including older maternal age, less education, poverty and lower home child-rearing quality. Each of these factors may also contribute independently to less favourable child growth, developmental and diet outcomes that we observed. Consistent with the findings of other studies, we found that household wealth and maternal education appeared to attenuate the negative associations between depression and adverse child outcomes (Anato et al., 2020; Berkes et al., 2019; Black et al., 2009; Gelaye et al., 2016; Harpham et al., 2005; Johnson et al., 2016; McCoy et al., 2016; Patel et al., 2004; Rahman et al., 2004; Ruel et al., 2013; Sania et al., 2019; Smith Fawzi et al., 2019; Walker et al., 2011; Wemakor & Mensah, 2016). Wealth may have provided additional resources to care for the children (preschools, paid caregiver, etc.) if a depressed mother was unable to provide the usual care for her child.

Household child-rearing quality also related strongly to growth and developmental outcomes, irrespective of the presence of maternal depression. In these typical conjoint family households in Nepal, multiple adults were available to provide care for the children and contribute to the household's child-rearing quality. The 'older' children in our study (vs. newborns and young infants included in many studies of maternal depression and child outcomes) may have been able to readily access these other adults as caregivers. These extra adults may have compensated for any deficiencies in care on

TABLE 2 Relationship of maternal depression to child growth, development and diet

	Child growth (logistic regression)		Child development (linear regression)	
	Stunting OR (95% CI)		ASQ, β (95% CI)	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Mother's characteristics				
Mother EPDS ≥ 13	1.491* (1, 2.21)	1.262[a] (0.82, 1.95)	−12.679* (−22.35, −3.01)	0.516[b] (−8.87, 9.91)
Mother's age	0.998 (0.97, 1.02)	0.997 (0.97, 1.02)	−1.194*** (−1.74, −0.65)	−0.866*** (−1.39, −0.34)
Mothers' education				
Some or completed primary (ref = no education	0.73 (0.52, 1.03)	0.807 (0.55, 1.18)	18.471*** (10.53, 26.41)	10.675*** (2.77, 18.58)
Some or completed secondary (ref = no education	0.724 (0.31, 1.69)	1.324 (0.49, 3.56)	55.115*** (36.15, 74.08)	21.224** (1.25, 41.20)
Child's characteristics				
Child age (months)	0.979** (0.97, 0.99)	0.978*** (0.96, 0.99)	0.559*** (0.27, 0.85)	0.405*** (0.13, 0.68)
Male gender (ref = female)	0.904 (0.65, 1.26)	0.882 (0.62, 1.25)	−0.99 (−8.95, 6.97)	−0.224 (−7.54, 7.09)
Household's characteristics				
Intervention group (ref = control)				
Full package intervention	0.51** (0.33, 0.79)	0.440*** (0.27, 0.71)	1.4 (−8.8, 11.61)	2.783 (−7.05, 12.61)
Partial package intervention	0.59** (0.4, 0.87)	0.483*** (0.32, 0.74)	−10.965* (−20.23, −1.7)	−1.573 (−10.52, 7.38)
Wealth quintile (ref = poorest)				
Second	1.124 (0.67, 1.88)	1.151 (0.67, 1.97)	2.46 (−9.78, 14.7)	2.644 (−8.99, 14.28)
Third	0.821 (0.49, 1.37)	0.908 (0.53, 1.57)	13.249* (1.29, 25.21)	8.002 (−3.58, 19.58)
Fourth	0.702 (0.41, 1.2)	0.709 (0.39, 1.28)	26.089*** (13.92, 38.26)	16.023** (3.82, 28.23)
Richest	0.631 (0.37, 1.09)	0.731 (0.39, 1.38)	37.322*** (25.03, 49.61)	20.269*** (7.10, 33.44)
Land owned (m2)	1 (1.00, 1.00)	1 (1.00, 1.00)	0.001** (0, 0)	0 (−0.00, 0.00)
Household livestock score (FAO units)	1.037 (0.95, 1.13)	1.05 (0.95, 1.16)	2.7* (0.59, 4.81)	1.24 (−0.78, 3.26)
Home child-rearing quality	0.877*** (0.81, 0.95)	0.893** (0.81, 0.98)	7.704*** (5.94, 9.46)	5.227*** (3.35, 7.11)

Note: For each outcome (growth, development, diet diversity and consumption of animal source foods (ASF), both unadjusted and adjusted results are shown. Analyses adjusted for mothers' age and education, child age and gender, household intervention group assignment, wealth quintile, land and livestock ownership, and home child-rearing quality. For child growth, the relationship of maternal depression to child stunting was assessed by logistic regression (results of other growth parameters are shown in Table S1). Results are shown as odds ratio (OR) and 95% confidence intervals (95% CI). For child development, the relationship of maternal depression to child's total score on the Ages and Stages Questionnaire (ASQ) was assessed by linear regression. Results are shown as β coefficients and 95% CI. For child diet, diet diversity and ASF consumption were each assessed by Poisson regression. Results are shown as relative risk (RR) and 95% CI. Asterisks are used to indicate significance level: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Superscripts are used to indicate the exact p values for the adjusted results for the relationship between maternal depression and child growth, development and diet (95% confidence intervals in parenthesis).

*$p < 0.10$.

**$p < 0.05$.

***$p < 0.01$.

[a]$p = 0.294$. [b]$p = 0.914$. [c]$p = 0.024$. [d]$p = 0.061$.

TABLE 2 Continued

	Child diet (Poisson regression)			
	Count food groups consumed, RR (95% CI)		Count ASF consumed, RR (95% CI)	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Mother's characteristics				
Mother EPDS ≥ 13	0.864** (0.79, 0.95)	0.894**[c] (0.81, 0.99)	0.693*** (0.6, 0.79)	0.872*[d] (0.76, 1.01)
Mother's age	1 (0.99, 1)	0.998 (0.99, 1.00)	0.992* (0.98, 1)	0.996 (0.99, 1.00)
Mothers' education				
Some or completed primary (ref = no education	1.05 (0.98, 1.13)	1.009 (0.93, 1.09)	1.247*** (1.13, 1.38)	1.107* (0.99, 1.23)
Some or completed secondary (ref = no education	1.1 (0.92, 1.3)	0.967 (0.80, 1.17)	1.658*** (1.35, 2.04)	1.027 (0.81, 1.31)
Child's characteristics				
Child age (months)	1 (1, 1)	1 (1.00, 1.00)	1.006** (1, 1.01)	1.004** (1.00, 1.01)
Male gender (ref = female)	0.97 (0.9, 1.04)	0.966 (0.90, 1.04)	0.859** (0.78, 0.95)	0.881** (0.80, 0.97)
Household's characteristics				
Intervention group (ref = control)				
Full package intervention	0.95 (0.86, 1.04)	0.977 (0.89, 1.08)	1.338*** (1.17, 1.52)	1.350*** (1.17, 1.55)
Partial package intervention	0.93 (0.85, 1.01)	0.931 (0.85, 1.02)	1.308*** (1.16, 1.48)	1.492*** (1.32, 1.69)
Wealth quintile (ref = poorest)				
Second	1.08 (0.96, 1.22)	1.07 (0.95, 1.21)	1.346** (1.13, 1.61)	1.349*** (1.13, 1.61)
Third	1.11 (0.99, 1.24)	1.061 (0.94, 1.19)	1.278** (1.07, 1.52)	1.204** (1.01, 1.44)
Fourth	1.152* (1.02, 1.29)	1.074 (0.95, 1.22)	1.611*** (1.36, 1.91)	1.509*** (1.26, 1.81)
Richest	1.219** (1.08, 1.37)	1.103 (0.97, 1.26)	2.064*** (1.75, 2.43)	1.816*** (1.51, 2.18)
Land owned (m2)	1 (0.01, 1)	1 (1.00, 1.00)	1 (0.01, 1)	1 (1.00, 1.00)
Household livestock score (FAO units)	1.01 (0.99, 1.03)	1.004 (0.98, 1.02)	1.045** (1.02, 1.07)	1.034** (1.01, 1.06)
Home child-rearing quality	1.021* (1, 1.04)	1.012 (0.99, 1.03)	1.09*** (1.07, 1.11)	1.064*** (1.04, 1.09)

Note: For each outcome (growth, development, diet diversity and consumption of animal source foods (ASF), both unadjusted and adjusted results are shown. Analyses adjusted for mothers' age and education, child age and gender, household intervention group assignment, wealth quintile, land and livestock ownership, and home child-rearing quality. For child growth, the relationship of maternal depression to child stunting was assessed by logistic regression (results of other growth parameters are shown in Table S1). Results are shown as odds ratio (OR) and 95% confidence intervals (95% CI). For child development, the relationship of maternal depression to child's total score on the Ages and Stages Questionnaire (ASQ) was assessed by linear regression. Results are shown as β coefficients and 95% CI. For child diet, diet diversity and ASF consumption were each assessed by Poisson regression. Results are shown as relative risk (RR) and 95% CI. Asterisks are used to indicate significance level: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. Superscripts are used to indicate the exact p values for the adjusted results for the relationship between maternal depression and child growth, development and diet (95% confidence intervals in parenthesis).
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$. [a]$p = 0.294$. [b]$p = 0.914$. [c]$p = 0.024$. [d]$p = 0.061$.

the part of the depressed mother. This suggests the possibility that empowering and deploying additional family members to provide care for children of depressed mothers might have favourable results on child outcomes (Cuartas et al., 2020; Jeong et al., 2018; Jeong et al., 2019). When analyses were conducted without accounting for this variable, maternal depression related significantly to child ASF consumption [RR 0.850 (95% CI 0.74, 0.98), $p = 0.026$] as well as diet diversity [RR 0.890 (95% CI 0.81, 0.98), $p = 0.019$]. This suggests that indeed other family members may have played a role in monitoring and assuring the child's dietary intake. However, this was not measured directly and remains speculative. A recent study in Nepal (Adhikari et al., 2020) found no association of maternal depression with child growth or intake of minimum dietary diversity; this may provide additional support for our suggestion that the conjoint family households may compensate to some degree for the mother's condition.

The relationships between maternal depression and child growth, development and diet are complex: unravelling the many factors which influence child outcomes is enormously challenging. Although the relationship between adverse child outcomes and maternal depression in LMICs has been characterized as 'consistent and strong' (Herba et al., 2016), this relationship is complicated. The same factor 'might act as a moderator of the risk of depression, as a potential confounder, and could also lie on the causal pathway between maternal depression and child outcome' (Herba et al., 2016). Therefore, poor child outcomes could also contribute to maternal depression. For example, children's failure to thrive may cause mental distress to their mothers and has been associated with postnatal depression (Harpham et al., 2005). Most study designs—including our own—are unable to establish causality, that is, whether the maternal depression preceded or resulted from factors of adversity (Herba et al., 2016). Additionally, various risk factors for maternal depression, such as family adversity, low social support and financial stress, may also contribute to adverse child outcomes in the absence of depression (Bernard-Bonnin & Canadian Paediatric Society Mental Health Developmental Disabilities Committee, 2004). On the other hand, some household characteristics may buffer the negative impact of maternal depression. Finally, inconsistencies among studies of depression on child outcomes could relate to the measure of depression used, the age of children and of their mothers, the study site (country, urban vs. rural, etc.) and which other (if any) household, child and maternal factors were considered in analyses.

4.1 | Strengths and limitations

Our study had several limitations. We used a self-reported screening tool, the EPDS, to assess depression. Self-report questionnaires, especially for sensitive topics, are subject to bias. Women may overestimate or underestimate their responses, according to their beliefs and the level of mental health stigma they perceived (Apter-Levy et al., 2013; Arifin et al., 2018; Halbreich & Karkun, 2006). The EPDS was originally developed for postnatal women and excludes somatic symptoms of the perinatal period. However, it was subsequently validated for non-postnatal women (Cox et al., 1996; Matijasevich et al., 2014) and has been used in mixed populations (including men, Matthey et al., 2001) when the benefits of comparability outweigh the population-specific attributes of various screening tools (Areias et al., 1996; Sparling et al., 2020). The original EPDS validation in a group of non-perinatal women using a cut off of 12/13 showed sensitivity (88%) and specificity (80%) for major depression similar to other validation studies (Cox et al., 1996). Although this measure has been validated in Nepal (Bhusal et al., 2016; Regmi et al., 2002), it has not previously been used in a rural population at the household level. However, the measure has been used in both rural and urban household surveys in Bangladesh, China, Brazil, South Africa, Hong Kong, Indonesia, Pakistan and Turkey (Halbreich & Karkun, 2006). The prevalence of depression found in our survey, 21%, was comparable with that found in similar settings in other countries (Atif et al., 2015; Wachs et al., 2009; Wolf et al., 2002) imparting credence to our results. Experienced supervisors also oversaw the administration of this test in the field, and no problems were identified in the 10% of questionnaires that were readministered. However, we only measured maternal depression at a single time point in this cross-sectional survey. As a result, there was no way to determine the duration of these symptoms or to differentiate mothers who were acutely distressed versus those with chronic or recurrent depression. It is important to emphasize that both anthropometry and child developmental skills reflect cumulative effects of many environmental inputs over a longer period of time. In this cross-sectional study, the causal direction of the associations found in this study cannot be determined. Assumptions about causality of depression on these outcomes are dependent on current depression being associated with chronic or prior episodes of depression. Further, we were unable to assess if the mood of the mothers may have interfered with their ability to respond accurately to the food recall questionnaire. However, the responses to the items in the diet intake questionnaire did not differ between depressed and nondepressed mothers, suggesting that this was not the case. It is plausible to speculate that children's poor diet, if sustained over time, could negatively affect child growth and development. Although we measured home child-rearing quality as a possible proxy measure for the expanded caregiving network available in these conjoint family households, we did not specifically measure other resilience factors that might have contributed to our findings. Finally, our study was limited to women in households that had participated in an intervention, who consented to respond to our survey, and who remained in the same location over the 4 years from the baseline to the endline survey. Given these many limitations, our findings may not be generalizable to other populations within Nepal or elsewhere.

As strengths, we collected comprehensive household information on a group of 629 young children and their mothers. Detailed household demographics allowed us to relate these characteristics to the presence or absence of depression and to adjust for these factors in our analysis. We used a conservative cut off for the EPDS (≥13), in accordance with prior work in Nepal, although a wide range of cut offs are used for this test in other developing countries (between 9 and 13) (Halbreich & Karkun, 2006). Lastly, our study provides a detailed description in of children's diet and other child outcomes in a LMIC, in relation to the depression status of their mothers as well as other important household characteristics.

5 | CONCLUSIONS

Our results suggest a relationship between maternal depression and children's diet quality. This association could be due to unmeasured confounders and therefore further research is warranted. Understanding the relationship of depression to child outcomes—and the role of other potentially compensatory household factors—could help address some of the earliest, modifiable influences in a child's life and contribute to innovative approaches to improve child well-being. Disentangling the interactions between environmental influences, social experiences, nutrition and genetic predispositions, and their influence on child outcomes is complex (Shonkoff et al., 2012). The evidence base for the determinants and effects of maternal depression must be strengthened particularly in LMIC (Engle et al., 2007; Nepal Health Research Council (NHRC) et al., 2019). For example, a recent comparative risk assessment analysis of 137 LMIC identified maternal depression as the leading psychosocial risk factor for stunting (Smith Fawzi et al., 2019). However, identifying depression is only a first step. Understanding the relationship of depression to child outcomes—and the role of other household factors as potential compensatory mechanisms—could help address some of the earliest, modifiable influences in a child's life. Incorporating approaches that protect and enhance the growth, development and diet of young children would be an important component of nutrition interventions (Kingston & Tough, 2014) and nutrition-sensitive programmes (Ruel et al., 2013) aimed at improving child well-being.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONTRIBUTIONS

LCM designed the study, supervised data collection, performed initial statistical analysis and wrote the initial draft of the manuscript. SN supervised the statistical analysis and interpretation and critically reviewed the manuscript. TS contributed to the concept and design of the work and critically reviewed the manuscript. MS contributed to the training of field enumerators and critically reviewed the manuscript. NJ made substantial contributions to the concept and design of the work and the acquisition of the data. ML made substantial contributions to the concept and design of the work and the acquisition of the data. AT-L contributed substantially to the design of the study and data analysis and critically reviewed the manuscript.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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