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The contribution of grandmother involvement to child growth and development: an observational study in rural Pakistan

Esther O Chung [1,2] Ashley Hagaman [2,3,4] Katherine LeMasters [1,2]
Nafeesa Andrabi,[2,5] Victoria Baranov [6] Lisa M Bates,[7] John A Gallis [8,9]
Karen O'Donnell,[8,10] Atif Rahman,[11] Siham Sikander,[12,13] Elizabeth L Turner [8,9]
Joanna Maselko[1,2]

ABSTRACT

Introduction Early childhood interventions primarily focus on the mother–child relationship, but grandmothers are often critical in childcare in low-resource settings. Prior research is mixed on how grandmother involvement influences child outcomes and there is a paucity of research on grandmother caregiving in low-income and middle-income countries. We examined the role of grandmother involvement on child growth and development in the first 2 years of life cross sectionally and longitudinally in rural Pakistan.

Methods We used data from the Bachpan Cohort, a longitudinal birth cohort in rural Pakistan. Maternally reported grandmother involvement in daily instrumental and non-instrumental caregiving was collected at 3 and 12 months. A summed score was created and categorised into non-involved, low and high. Outcomes included 12-month and 24-month child growth, 12-month Bayley Scales of Infant and Toddler Development and 24-month Ages and Stages Questionnaire—Socioemotional. We used multivariable generalised linear models to estimate mean differences (MD) at 12 months (n=727) and 24 months (n=712). Inverse probability weighting was used to account for missingness and sampling.

Results In our sample, 68% of children lived with a grandmother, and most grandmothers were involved in caregiving. Greater 3-month grandmother involvement was positively associated with 12-month weight z-scores; however, greater involvement was associated with lower 24-month weight z-scores. High 12-month grandmother involvement was associated with improved 12-month cognitive (MD=0.38, 95% CI −0.01 to 0.76), fine motor skills (MD=0.45, 95% CI 0.08 to 0.83) and 24-month socioemotional development (MD=−17.83, 95% CI −31.47 to −4.19). No meaningful associations were found for length z-scores or language development.

Conclusion In rural Pakistan, grandmothers provide caregiving that influences early child development. Our findings highlight the complex relationship between grandmother involvement and child weight, and suggest that grandmothers may positively promote early child cognitive, fine motor and socioemotional development. Understanding how grandmother involvement affects child outcomes in early life is necessary to inform caregiving interventions.

Key questions

What is already known?
► Child health interventions in low-income and middle-income settings typically focus on mothers; however, grandmothers are often key, and potentially final, decision-makers on issues related to pregnancy and child caregiving across cultures.
► Existing research is mixed, rarely examined in relation to early child development, and typically do not operationalise the type, frequency or developmental timing of grandmother involvement.

What are the new findings?
► Using a measure of maternally reported participation in child caregiving activities, we find that grandmothers are often involved in providing caregiving support in early life.
► Using longitudinal data from the Bachpan Cohort in rural Pakistan, we provide evidence of cross-sectional and longitudinal relationships between grandmother involvement and child weight, cognitive, fine motor and socioemotional development in the first two years of life.
► We found no association between grandmother involvement and child length and language development.

What do the new findings imply?
► Together with previous studies, our findings underscore the complex role of grandmothers on early child growth and development.
► Given the role grandmothers have in childcare, programmes should incorporate a family-centered approach to child health by engaging all key actors, including parents and grandmothers.
► Future research should interview or observe grandmothers and their interactions with young children to identify caregiving activities related to child growth and development.

INTRODUCTION

Globally, it is estimated that 250 million children under the age of 5 are at risk of not achieving their full developmental potential.[1] Early life stress can lead to detrimental

changes in the brain that may affect later adult health and lead to loss of economic productivity.[2 3] Caregivers, such as parents, grandparents and extended family members, can have large influences on these trajectories. Therefore, identifying how important actors shape this critical period is key to developing interventions to improve child health.

Early childhood interventions have primarily focused on the mother–child relationship.[4] However, non-maternal care and investment are important contributors to well-being in early childhood, and are evident around the world and throughout human history.[5] In low-income and middle-income countries (LMIC), where the burden of risk for poor developmental outcomes is concentrated,[1] most children live in multigenerational households with other family members who are often involved in the feeding and caregiving of young children.[6] There is a growing body of research examining the contribution of other family members, such as fathers, to child health and development.[7–11] However, grandmothers are often key, and potentially final, decision-makers on issues related to pregnant mothers and young children in low-resource settings.[12–14] Specifically, grandmother knowledge of maternal and child nutrition recommendations, infant feeding practices and their decision-making power have been demonstrated to not only affect maternal practices, but also child health and development.[12 15–17] In many contexts, grandmothers are perceived as wise and experienced, serving as teachers for young mothers and passing down cultural traditions and knowledge.[6 18]

Grandmother involvement in caregiving across the world is typically high; however, differences across cultural settings are important to consider.[6 19] In South Asia, qualitative studies have described how grandmothers in India and Pakistan are involved in daily childcare, such as feeding, bathing and engaging children in play, and even influence maternal caregiving behaviours.[20 21] In India and Nepal, grandmothers generally support exclusive breast feeding and complementary feeding, but such practices vary by child sex with complementary foods introduced earlier for female infants.[14 21 22] However, existing research in LMIC is mixed on whether grandmother impact is positive or negative, illuminating the need to untangle the type, timing and complex contextual factors involved.[23] Some studies found grandmothers are beneficial for child height[24 25] and educational participation,[26] while others found grandmothers have negative effects on child health,[27] feeding practices[21] and weight.[14 28]

With few exceptions,[29–33] the majority of quantitative studies in LMIC of grandmother caregiving on child outcomes operationalise grandmother involvement crudely as household coresidence with the grandchild[13 14 21 22 26 34 35] or use proxies such as whether the grandmother is still alive.[25 36 37] Though studies have illuminated the impacts of grandmother presence[36–38] these crude measures do not operationalise the type, frequency or temporality of a grandmother's involvement with child

caregiving activities. Moreover, the current literature focuses on early life survival and early child and adolescent nutritional outcomes[24 25 27 28 36–40] or educational participation[26 41–44]; however, with some exceptions,[31 33 35] early child development from 0 to 2 years has rarely been investigated as a primary outcome. Therefore, the present study described grandmother involvement in caregiving and examined the role of grandmother involvement on child growth and development in rural Pakistan, cross sectionally and longitudinally in the first 2 years of life.

METHODS

Study design and participants

Data for this observational study come from the Bachpan Cohort, a cluster randomised perinatal depression trial nested in a birth cohort in Pakistan. A detailed description of the study design and sampling is available elsewhere.[45 46] Briefly, all pregnant women in the third trimester living in the 40 village clusters of the study area were screened for depression using the Patient Health Questionnaire (PHQ-9).[45 47 48] Every woman who screened positive (PHQ-9 ≥10) was invited to participate in the trial portion (n=570) and the next woman in the same village who screened negative (PHQ-9 <10) was asked to participate in the cohort only portion (n=584) to create a non-depressed comparison. Given the unequal probabilities of selection into the study, sampling weights were created to represent the underlying population of pregnant women in the area. Cluster-specific weights for non-depressed women were generated based on their sampling fraction (ie, the inverse of the proportion of non-depressed women screened and then enrolled in the study). All non-depressed women in a cluster were assigned the same weight. Depressed women were all invited to participate and therefore received a weight of 1. Women were interviewed at baseline in the third trimester (n=1154) and followed up at 3, 6, 12 and 24 months post partum. There was no differential loss to follow-up by treatment arm. We used data on participants with 3-month and 12-month grandmother involvement and outcome data collected at 12-month and 24-month interviews.

Outcomes

Child weight for length (WLZ), weight for age (WAZ) and length for age (LAZ) were collected at 12 and 24 months.[49] Extreme anthropometric measurements, as defined by the WHO, were excluded from analysis (WLZ <−5 or WLZ>5; WAZ<−6 or WAZ>5; LAZ <−6 or LAZ>6).[49] At 12 months, child development was assessed using the Bayley Scales of Infant and Toddler Development-III (BSITD).[50] Cognitive, receptive and expressive language, and fine and gross motor domains were collected by trained assessors. For each domain, standard BSITD scaled scores were generated using child age.[50] At 24 months, socioemotional development was measured using the 25-item caregiver-reported Ages and

Stages Questionnaire Socioemotional Scale (ASQ-SE).[51] Responses were summed to create an overall ASQ-SE score, where a higher score indicates more socioemotional difficulties.

Grandmother involvement

Grandmother involvement was maternally reported using an 11-item 'Day in the Life' measure at 3 and 12 months post partum (online supplementary table 1; O'Donnell *et al*, unpublished data, 2020). This newly developed measure involved a semistructured interview designed to indirectly capture the extent to which the mother performs child caregiving tasks alone or with the help of other specified family members on a typical day. Mothers were asked to report in the previous 24 hours household members that were involved in 11 various activities related to instrumental care (eg, feeding and changing diapers), non-instrumental care (eg, playing with and soothing the child) and other support (eg, when the mother was unwell or busy).

Of the 11 activities, 5 items were asked about in the morning, afternoon and evening: sleep routine, feeding, snacks (only afternoon and evening), changing diapers or clothes, and caring for the child when the mother is occupied with other chores. We weighted each activity equally and therefore only counted participation in these five activities once. We summed the number of times grandmothers (paternal and/or maternal) were reported for each activity. We aimed to capture the global caregiving and stimulation provided by grandmothers, regardless of origin and coresidence, and therefore created one overall grandmother score, combining reports of both grandmothers. The total theoretical score ranges from 0 to 22; our analytical data ranged from 0 to 15 at 3 months and 0 to 20 at 12 months. As these variables were highly right skewed, we categorised the measure using a data-driven approach to assist with fit to the data and interpretability. After labelling all zero values as non-involved, we selected the median value of both timepoints to define low and high involvement, thus categorising the overall score into three groups: non-involved (0); low (1–5); high (6 and higher).

Statistical analysis

We described grandmother involvement with child caregiving tasks at 3 and 12 months post partum and examined separate effects of 3-month and 12-month grandmother involvement on child growth and development at 12 and 24 months of age (BSITD at 12 months and ASQ-SE at 24 months). We calculated mean differences in scores using multivariable generalised linear models with cluster robust standard errors to account for clustering by village. We included the following potential confounders determined a priori: maternal and paternal education (none, primary or middle, secondary, higher secondary or tertiary), family structure (nuclear family vs extended or multiple families), household asset-index quintiles,[52] treatment arm, child sex, reported child

diarrhoea, 3-month and 12-month maternal depression using the Structured Clinical Interview for DSM (SCID),[53] 12-month and 24-month maternal report of any intimate partner violence in the past year,[54] and 3-month and 12-month father absence. Confounders with multiple timepoints were included according to appropriate time ordering with respect to exposure timing (eg, 12-month SCID was included in models examining 12-month grandmother involvement, but not in 3-month models). Child growth models accounted for prior growth measurements.

We used stabilised inverse probability weighting (IPW)[55] to account for informative missingness between the baseline sample (n=1154) and the sample with grandmother involvement data at 3 and 12 months (n=783; figure 1). The weight is the inverse probability that an observation is not missing at 3, 12, or 24 months based on observed characteristics. IPW were stabilised by including the marginal probability of being observed in the numerator. Using IPW, non-missing observations with characteristics most similar to characteristics of the missing will be weighted more heavily in the estimation. We included in the IPW model baseline variables associated with missingness and baseline variables associated with grandmother involvement and outcomes, as suggested by Seaman *et al*.[55] We examined baseline characteristics associated with missingness and included those with a p value <0.10 in the IPW model: PHQ-9,[47 48] maternal disability,[56] maternal perceived stress,[57] number of living children (first pregnancy, one to three children, or four or more) and crowding (people per room), grandmother coresidence with grandchild, and whether the husband works. The following baseline confounders were also included in the IPW model: maternal age, maternal and paternal education, family structure (nuclear family vs extended or multiple families), household asset quintiles and treatment arm. Sampling weights and IPW were multiplied to create the final weight used in all models.[58] Analyses were conducted using Stata V.14 and R V.3.6.1.

Role of funding source

The funders had no role in study design, data collection, analysis, interpretation of results or writing of the report. The authors had access to all the data and had full responsibility to submit for publication.

Patient and public involvement

There has been no patient and/or public involvement in the study design, data collection, data analysis and writing of this research.

RESULTS

Figure 1 presents the flow chart for our two final analytic samples (n=727 for 12 months and n=712 for 24 months). Of the 1154 women at baseline, 783 had available data on grandmother involvement at 3 and 12 months. For 12-month outcomes, 39 had missing outcome data and an additional 25 were excluded
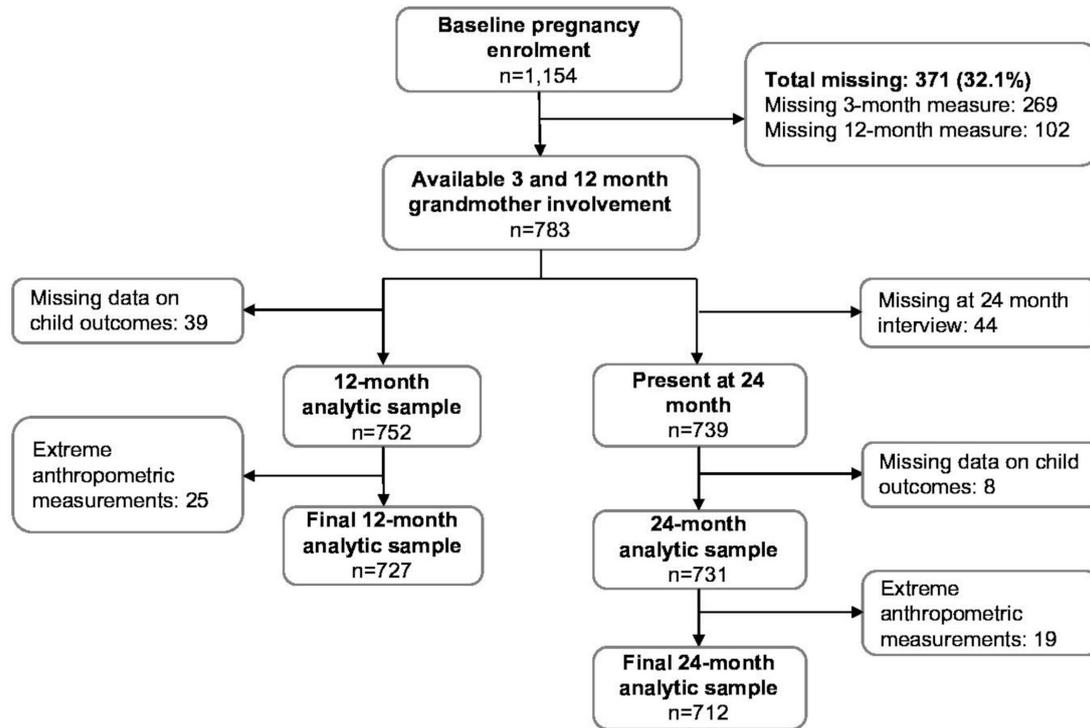
Figure 1 Study sample flow chart, Bachpan Cohort, Pakistan.

due to extreme anthropometric measurements.[49] For 24-month outcomes, 44 observations were missing at the 24-month interview, 8 had missing outcome data and an additional 19 were excluded due to extreme anthropometric measurements.

Using the total weighted sample present at either 12 months or 24 months, mothers were, on average, 27 years old and 32% were pregnant with their first child at baseline (table 1). Unweighted sample characteristics are presented in online supplementary table 2. Approximately 13% of the sample lived in nuclear families and 68% of mothers reported grandmothers living with the target child. Mean (SD) LAZ at 12 and 24 months was −0.73 (1.21) and −1.19 (1.20), and mean (SD) WAZ at 12 and 24 months was −0.77 (1.12) and −0.89 (0.99).

The majority of mothers reported at least some grandmother involvement in child caregiving at 3 and 12 months post partum (table 2). At 3 months, 48% of grandmothers engaged in 1–5 caregiving activities (characterised as low involvement) and 23% engaged in 6 or more (characterised as high involvement). At 12 months, 28% had low involvement and 30% had high involvement. Mothers commonly reported grandmothers providing support when the mother was busy with other chores (3 months: 58.29%; 12 months: 49.34%), unwell (3 months: 49.92%; 12 months: 47.12%), or working (3 months: 48.04%; 12 months: 46.86%). Grandmothers were frequently reported playing and interacting with the child (3 months: 42.88%; 12 months: 42.52%). Mothers reported paternal grandmothers more often than maternal grandmothers on all caregiving items (online supplementary table 3).

We found no differences in grandmother involvement by child sex (results not shown).

We assessed the relationship between grandmother involvement and child outcomes using mean differences and highlight findings below. Full estimates for growth outcomes are presented in online supplementary table 4 and estimates for development outcomes are presented in online supplementary table 5.

Twelve-month growth outcomes
In adjusted models, high 3-month grandmother involvement was associated with a 0.21 SD greater 12-month WLZ compared with non-involvement (figure 2A, 95% CI −0.02 to 0.45). We found similar results for 12-month WAZ (figure 2B, MD=0.25, 95% CI 0.07 to 0.43). Grandmother involvement at 3 months had a positive relationship with 12-month LAZ, while 12-month involvement had largely no associations (figure 2C).

Twenty-four-month growth outcomes
Three-month grandmother involvement was negatively associated with child WLZ and WAZ at 24 months (figure 2D,E). Children with high 12-month grandmother involvement had, on average, 0.22 SD lower 24-month WLZ (figure 2D, 95% CI −0.42 to −0.01) and 0.09 SD lower 24-month WAZ (figure 2E, 95% CI −0.22 to 0.04) compared with children with non-involved grandmothers. We found no substantial relationships between grandmother involvement and 24-month LAZ (figure 2F).

Table 1 Sample characteristics and child outcomes over time, Bachpan Cohort, Pakistan

	Mean or N	SD or %	Min	Max
Demographic characteristics				
Maternal characteristics				
Age	26.70	4.37	18	40
Number of living children				
Pregnant with first child	219	31.52		
1–3	489	60.65		
4 or more	64	7.83		
Educational attainment				
None	105	13.34		
Primary or middle	299	36.57		
Secondary	191	26.00		
Higher secondary or tertiary	177	24.08		
Depressive symptoms (PHQ-9; baseline)	6.65	6.26	0	25
Depression diagnosis (SCID; baseline)	277	25.34		
Depression diagnosis (SCID; 3 months)	112	12.88		
Depression diagnosis (SCID; 12 months)	145	15.93		
Disability (WHO-DAS)	9.10	8.88	0	44
Perceived stress (PSS-10)	15.74	8.75	0	40
Any self-reported IPV in the past year (12 months)				
Yes	289	34.80		
Did not report	19	1.94		
Any self-reported IPV in the past year (24 months)				
Yes	356	44.75		
Did not report	99	11.29		
Paternal characteristics				
Educational attainment				
None	60	7.42		
Primary or middle	226	28.13		
Secondary	353	47.09		
Higher secondary or tertiary	133	17.37		
Absent in household (3 months)	136	17.79		
Absent in household (12 months)	157	20.93		
Currently working (baseline)	706	92.26		
Grandmother characteristics				
Coresidence with grandchild	535	67.97		
Household characteristics				
People per room	2.35	1.88	0	23
Nuclear family	97	12.58		
Wealth quintiles				
Lowest	142	17.19		
Lower middle	151	18.70		
Middle	161	20.36		
Upper middle	154	21.54		
Highest	164	22.21		
Child sex: female	399	51.03		

Continued

Table 1 Continued				
	Mean or N	**SD or %**	**Min**	**Max**
Child diarrhoea (12 months)				
At least once weekly	102	12.43		
Every 2 weeks	45	5.71		
Every month	91	11.91		
Less often than every month	534	69.95		
Child outcomes				
Growth (3 months, n=772)				
WLZ	−1.36	1.49	−4.96	4.55
WAZ	−1.09	1.19	−5.32	3.22
LAZ	−0.05	1.61	−5.80	5.20
Growth (12 months, n=727)				
WLZ	−0.56	1.26	−4.78	3.65
WAZ	−0.77	1.12	−4.16	3.66
LAZ	−0.73	1.21	−4.91	3.99
Growth (24 months, n=712)				
WLZ	−0.41	1.13	−4.76	2.55
WAZ	−0.89	0.99	−3.87	2.46
LAZ	−1.19	1.20	−4.86	3.13
BSITD scaled scores (12 months, n=759)*				
Cognitive	9.47	2.12	1	14
Receptive language	8.02	1.39	1	12
Expressive language	9.18	1.47	1	13
Fine motor	9.16	1.68	1	15
Gross motor	8.27	2.21	1	14
Socioemotional development (24 months, n=723)*				
ASQ-SE total score	14.32	29.02	0	180

Calculations were based on the total sample of participants present at either 12 months or 24 months (n=772). Means, SD and percentages were based on weighted data to account for both the sampling design in which one in every three non-depressed pregnant women and the inverse probability of missingness.

*Higher Bayley Scales of Infant and Toddler Development (BSITD) scores indicate better development and higher Ages and Stages Questionnaire-Socioemotional (ASQ-SE) scores indicate worse development.

IPV, Intimate Partner Violence; LAZ, length-for-age z-score; PHQ-9, Patient Health Questionnaire; PSS-10, Perceived Stress Scale; SCID, Structured Clinical Interview for DSM; WAZ, weight-for-age z-score; WHO-DAS, World Health Organization-Disability Assessment Scale; WLZ, weight-for-length z-score.

Twelve-month developmental outcomes

Compared with non-involvement, 3-month low and high grandmother involvement was largely unassociated with developmental outcomes, whereas 12-month grandmother involvement was concurrently associated with higher fine motor and cognitive development. Children with high 3-month grandmother involvement had higher receptive language scores on the BSITD at 12 months than children with non-involved grandmothers (figure 3B, MD=0.22, 95% CI −0.09 to 0.53). High 3-month involvement was associated with higher fine motor scores compared with non-involvement (figure 3D, MD=0.23, 95% CI −0.13 to 0.60). Moreover, high 12-month grandmother involvement versus non-involved was associated with improved child cognitive and fine motor skills.

Children with highly involved grandmothers scored, on average, 0.38 points higher on the cognitive subscale (figure 3A, 95% CI −0.01 to 0.76) and 0.45 points higher on the fine motor subscale (figure 3D, 95% CI 0.08 to 0.83) than children with non-involved grandmothers.

Twenty-four-month developmental outcomes

Compared with non-involvement, low and high grandmother involvement at 3 months was not strongly associated with child socioemotional development; however, grandmother involvement at 12 months was longitudinally associated with socioemotional development. Low and high 3-month grandmother involvement was not associated with ASQ-SE scores (figure 4, MD=0.25, 95% CI −6.21 to 6.72; MD=2.39, 95% CI −8.28 to 13.07,

Table 2 Grandmother caregiving at 3 and 12 months post partum, Bachpan Cohort, Pakistan

	Overall			
	3 months		12 months	
	N	%	N	%
Grandmother involvement score				
Non-involved (0)	241	30.24	327	42.07
Low (1–5)	364	47.30	226	28.12
High (6+)	167	22.46	219	29.81
Instrumental care				
Sleep/naps	127	17.06	140	18.71
Feeding meals	29	3.99	85	11.51
Providing snacks to the child	57	7.73	198	26.04
Changing diapers/clothes, washing/cleaning	111	14.78	119	15.81
Giving a bath	200	27.43	93	13.24
Non-instrumental care				
Playing or interacting with child	327	42.88	323	42.52
Who does the child like to be held by the most?	107	14.11	178	23.70
Soothing child when restless/crying	140	18.30	194	26.42
Other support (care for the child)				
When mother is occupied with other tasks/chores	443	58.29	375	49.34
When mother is unwell	379	49.92	361	47.12
When mother is working	364	48.04	362	46.86

Calculations were based on the total sample of participants present at either 12 months or 24 months (n=772). Percentages were based on weighted data to account for both the sampling design in which one in every three non-depressed pregnant women was eligible for study inclusion and the inverse probability of missingness.

Figure 2 Grandmother involvement on child growth outcomes, Bachpan cohort, Pakistan. Mean differences are presented with the non-involved category as the referent. Generalised linear models accounted for clustering with robust standard errors. Inverse probability weighting was used to account for missingness and sampling. Twelve-month outcomes accounted for 3-month measures and 24-month outcomes accounted for 3-month and 12-month measures. + A priori controls included sex, number of living children, maternal age, maternal education, maternal depression at 3 months, father absence at 3 months, paternal education, crowding, nuclear family, assets and treatment arm. Additional baseline covariates that predicted missingness at 12 months included depressive symptoms, maternal disability measure and perceived social support. ++Additional a priori controls included 3-month grandmother involvement, 12-month child diarrhoea, 12-month father absence and any self-reported interpersonal violence in the past year. LAZ, length-for-age z-score; WAZ, weight-for-age z-score; WLZ, weight-for-length z-score.

respectively). Yet, low 12-month grandmother involvement was associated with better development (lower ASQ-SE scores; figure 4, MD=-15.70, 95% CI −28.68 to −2.72). Children with high grandmother involvement had better socioemotional development (figure 4, MD= −17.83, 95% CI −31.47 to −4.19).

We conducted a sensitivity analysis to examine whether there were any differences in findings when we excluded maternal grandmothers and did not find any substantial differences (online supplementary tables 6 and 7).

DISCUSSION
In rural Pakistan, mothers often reported grandmothers being involved in child caregiving activities in the first year of life. Mothers commonly reported grandmothers providing support to the mother when she was busy or unwell and playing and interacting with the child.
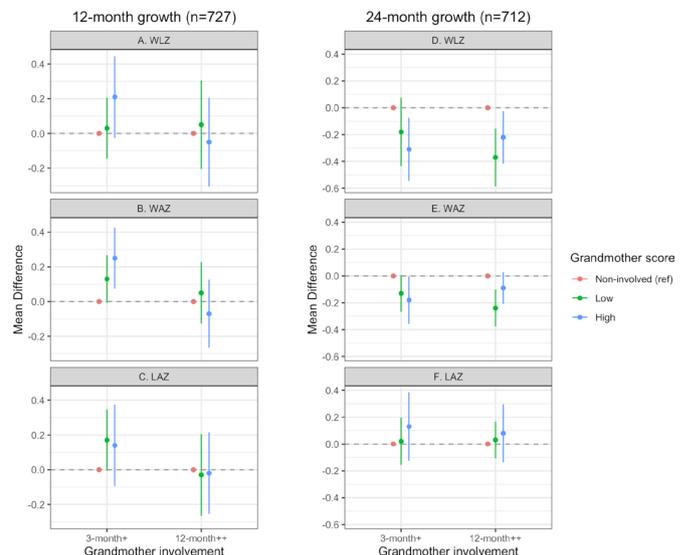
We found cross-sectional and longitudinal associations between grandmother involvement and child growth and development. Specifically, early grandmother involvement had positive relationships with child weight, but this association became negative as the child grew older. Grandmother involvement was positively associated with cognitive, fine motor and socioemotional development cross sectionally and longitudinally, but was not associated with language skills. Our findings demonstrate the important contribution grandmothers have early in life and highlights the need to better understand how grandmothers influence child growth and development.

Grandmother involvement in the first year of life was associated with several indicators of better early child development. Twelve-month grandmother involvement was associated with greater child cognitive and motor development at 12 months and better socioemotional development at 24 months. While we did not find studies examining grandmother involvement and developmental outcomes in LMIC, evidence from high-income countries corroborate our findings.[59–62] We speculate that the
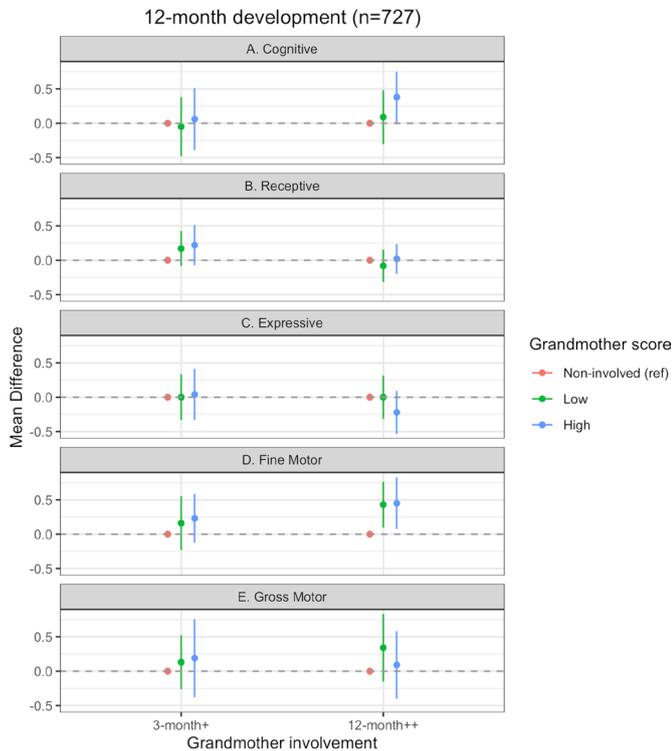
Figure 3 Grandmother involvement on child development at 12 months, Bachpan cohort, Pakistan. Mean differences are presented with the non-involved category as the referent. Generalised linear models accounted for clustering with robust standard errors. Inverse probability weighting was used to account for missingness and sampling. +A priori controls included sex, number of living children, maternal age, maternal education, maternal depression at 3-month father absence at 3 months, paternal education, crowding, nuclear family, assets and treatment arm. Additional baseline covariates that predicted missingness at 12 months included depressive symptoms, maternal disability measure and perceived social support. ++Additional a priori controls included 3-month grandmother involvement, 12-month child diarrhoea, 12-month father absence and any self-reported interpersonal violence in the past year. Bayley Scales of Infant and Toddler Development scaled scores are presented where higher scores indicate better development.

positive associations are driven by grandmothers reportedly playing and interacting with children. Grandmother involvement may also improve child development through indirect pathways. For example, grandmother involvement may decrease family stress by allowing mothers to work or perform chores in the household. Grandmother participation in household chores may also free up time for the mother to engage in responsive caregiving with her child. Yet another hypothesis is that the type of caregiver may not be salient, but rather the frequency with which the child receives stimulation. Further research examining such pathways is needed to inform the development and delivery of caregiving interventions in low-resource settings. Our findings highlight the significant role of grandmothers for children early in life and suggest the need to consider the larger family context to understand early childhood outcomes. Research from
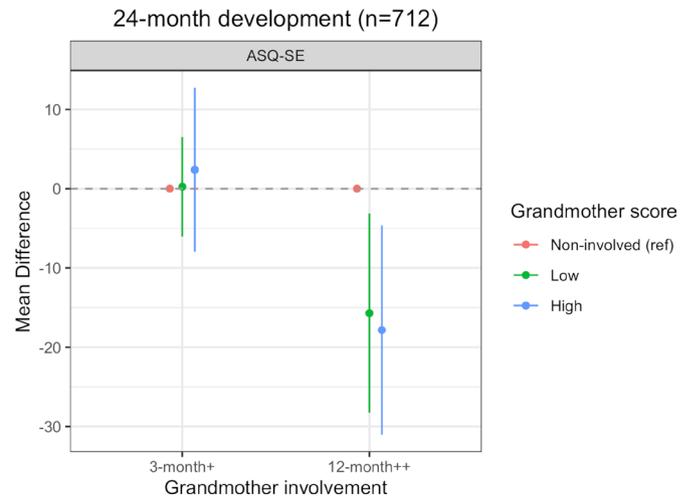

Figure 4 Grandmother involvement on child socioemotional development at 24 months, Bachpan cohort, Pakistan. Mean differences are presented with the non-involved category as the referent. Lower Ages and Stages Questionnaire Socioemotional Scale (ASQ-SE) scores indicate better socioemotional development. Generalised linear models accounted for clustering with robust standard errors. Inverse probability weighting was used to account for missingness and sampling. +A priori controls included sex, number of living children, maternal age, maternal education, maternal depression at 3 months, father absence at 3 months, paternal education, crowding, nuclear family, assets and treatment arm. Additional baseline covariates that predicted missingness at 12 months included depressive symptoms, maternal disability measure and perceived social support. ++Additional a priori controls included 3-month grandmother involvement, 12-month child diarrhoea, 12-month father absence and any self-reported interpersonal violence in the past year.

Burkina Faso demonstrate the unique opportunities grandmothers could play in providing low-cost, interactive play for children.[63] Moreover, while early childhood interventions in LMIC largely focus on the mother–child dyad, our results suggest grandmothers can have positive impacts for children and should be included in addition to mothers in parenting programmes in order to optimise caregiving and promote healthy development.

In contrast to the findings with cognitive, motor and socioemotional developmental indicators, we found largely null results for the language domains across 3-month and 12-month grandmother involvement. It may be that grandmothers in our study do not interact with young children in ways that are specific for the development of language skills, such as talking or singing to the child. This points to the need for further research into the specific types of play and interactions grandmothers have with young children that influence different domains of development.

Three-month grandmother involvement was associated with improved child weight at 12 months; however, 12-month grandmother involvement was associated with poorer child weight at 24 months. This conflicting finding has been documented in other LMIC. Prior work

in Mali found that grandmother involvement was associated with poorer child weight[28] and in rural Gambia, children living with their grandmother were significantly heavier in the first year of life; however, this effect disappeared later in childhood.[36] Related, the grandmother hypothesis proposes that grandmothers past reproductive age invest time and resources to their daughter's fertility and their grandchildren's care in order to increase the chances of the next generation's survival.[64 65] This hypothesis suggests while grandmothers can increase the survival chances of the grandchild, they can also decrease the weaning age of the grandchild so her daughter can have more children.[65] Earlier weaning without the introduction of healthy and nutritionally dense foods can lead to poorer weight. Our measure of grandmother involvement describes the presence of grandmother caregiving at 3 and 12 months; while we did not have data on the types of food and snacks grandmothers fed children, grandmother involvement with respect to feeding meals and snacks increased over time (feeding: 4.1% at 3 months and 11.9% at 12 months; snacks: 8.5% at 3 months and 26.3% at 12 months). It is also plausible that child temperament and health affect grandmother involvement; for example, a grandmother may participate in feeding if a child is not gaining weight, or she may not if a child is fussy or difficult to feed. Child temperament has been linked to caregiver stress, parenting styles and subsequent child development in the USA.[66 67] In Bangladesh, child temperament moderated the relationship between maternal depressive symptoms and child development.[68] Further research is needed to characterise child temperament and how it may influence caregiving and child development in low-resource contexts. Additionally, our finding may be partially due to the beliefs of grandmothers surrounding infant and young child feeding practices and their decision-making power within the household. Previous research has identified grandmothers as significant influencers when it comes to early cessation of exclusive breast feeding and early introduction of complementary foods.[12 17 21 69–72] In South Asia, grandmothers can exert strong influence on issues related to child care and rearing and maternal knowledge and practices of optimal infant and young child feeding practices.[71–74] It may be that grandmothers in our sample begin feeding children more often at 12 months, but potentially not nutrient-dense foods. Future research examining the impact of grandmother involvement on child nutritional status should include measures that capture the types and quantities of food grandmothers provide to grandchildren, which can inform behaviour change interventions. Research from sub-Saharan Africa countries and China highlights when grandmothers are engaged in infant feeding and child interventions; they not only change their beliefs and behaviours, but can also influence maternal caregiving to promote such practices.[15 16 70 75 76]

The key strength of our study was a detailed assessment of caregiving activities routinely performed by the child's grandmother(s). Moreover, this measure encompassed involvement independent of grandmother–grandchild coresidence, which extends beyond the current literature that largely uses household coresidence as proxy for involvement. Additional strengths include the population-representative sample, validated child outcome measures and the longitudinal study design. Our measure of grandmother involvement incorporated both instrumental and non-instrumental childcare and included specific activities such as playing and soothing the child. This allowed us to examine how early grandmother involvement affected future child outcomes.

However, some limitations warrant discussion. First, our measure of grandmother involvement was maternally reported. Maternal report may not capture all caregiving activities grandmothers are involved in and may be vulnerable to social desirability bias, interpersonal relationships and maternal depression status. Future research should incorporate grandmother-reported caregiving and direct observation. Second, we combined all caregiving activities into a summed score in order to categorise grandmother involvement; however, this may mask the effects of specific activities on child outcomes (eg, instrumental vs non-instrumental care). Since this score is independent of coresidence status, the non-involved category included coresident, non-resident and absent grandmothers. However, this may not be particularly important for the child given both situations suggest non-involvement. Third, we acknowledge that biases can result from missing data, including loss to follow-up.[77 78] Our analytic samples were substantially smaller than the baseline sample (figure 1). However, we employed stabilised IPW to account for missingness. Importantly, excluding these weights did not change estimates or precision, suggesting that our results were not sensitive to the weighting procedure (online supplementary tables 8 and 9). Fourth, we were unable to capture the age or morbidity status of grandmothers. Prior research suggests varying levels of impact by grandmother age.[24 26] The parabolic age hypothesis suggests that very young grandmothers are still taking care of their own households and may not be as involved while older grandmothers may not be capable of contributing to caregiving. A recent study in Brazil found that grandmother mental health symptoms were associated with more emotional and behavioural problems in grandchildren.[79] Future work should examine effect measure modification of grandmother involvement on child outcomes by grandmother age and morbidity. Additionally, other factors such as child sex and maternal depression can have strong influences on caregiving behaviours and child outcomes. We conducted preliminary examinations of modification by child sex and maternal depression and found some evidence of modification by child sex, but this varied based on outcome and grandmother involvement timepoint (online supplementary tables 10–12). Ongoing work is exploring the potential impact of child sex on caregiving and developmental outcomes. We were

unable to assess modification by maternal depression given reductions in the prevalence of maternal depression over time. Future research is needed to determine whether and how grandmother involvement varies by maternal depression and the impacts on child outcomes.

We add to the literature by describing the types of grandmother child caregiving activities in a LMIC. Our findings highlight the beneficial roles grandmothers have on early child cognitive, motor and socioemotional development. Our results on child weight demonstrate the complex relationship between grandmothers and child weight and underscore the need to understand the role of grandmothers on infant and young child feeding practices in rural Pakistan. Future research should focus on characterising the caregiving activities of grandmothers and examining grandmother beliefs surrounding child nutrition, such as breast feeding, introduction of complementary foods and types of nutritious foods, as well as child stimulation and parenting practices. Forthcoming research will examine the relationship between grandmother involvement and maternal mental health and perceived stress. This research can inform how other caregiver support impacts maternal well-being, which may subsequently affect maternal caregiving and early child development. In addition to potential benefits to mothers, research from high-income settings highlight the possible contributions of child caregiving to grandmother health.[80–82] Programmes and future interventions may benefit by engaging all key actors within a household, including parents and grandmothers, in order to promote optimal early child growth and development.

Author affiliations
[1]Epidemiology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA
[2]Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA
[3]Department of Social and Behavioral Sciences, Yale University, New Haven, Connecticut, USA
[4]Center for Methods in Implementation and Prevention Science, Yale University, New Haven, CT, United States
[5]Department of Sociology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA
[6]Department of Economics, The University of Melbourne, Melbourne, Victoria, Australia
[7]Department of Epidemiology, Columbia University, New York, New York, USA
[8]Duke Global Health Institute, Duke University, Durham, North Carolina, USA
[9]Department of Biostatistics and Bioinformatics, Duke University, Durham, North Carolina, USA
[10]Center for Child and Family Health, Durham, North Carolina, USA
[11]Department of Primary Care and Mental Health, University of Liverpool, Liverpool, UK
[12]Human Development Foundation Pakistan, Islamabad, Pakistan
[13]Health Services Academy, Islamabad, Pakistan

ORCID iDs
Esther O Chung http://orcid.org/0000-0002-2866-949X
Ashley Hagaman http://orcid.org/0000-0002-8016-1036
Katherine LeMasters http://orcid.org/0000-0002-1754-1730
Victoria Baranov http://orcid.org/0000-0003-4777-6466
John A Gallis http://orcid.org/0000-0003-1921-8424
Elizabeth L Turner http://orcid.org/0000-0002-7638-5942

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