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

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**Abbreviations**: Ages and Stages Questionnaire Socioemotional Scale (ASQ-SE); Bayley Scales of Infant and Toddler Development-III (BSITD); Confidence Interval (CI); Length-for-age z-score (LAZ); Low- and middle-income country (LMIC); Mean difference (MD); Weight-for-age z-score (WAZ); Weight-for-length (WLZ); Patient Health Questionnaire (PHQ-9); Structured Clinical Interview for DSM (SCID)

**What is already known?**

* Child health interventions in low- 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 operationalize 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 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, programs 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.

**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- and middle-income countries. We examined the role of grandmother involvement on child growth and development in the first two years of life cross-sectionally and longitudinally in rural Pakistan.

**Methods**: We utilized 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 categorized into non-involved, low, and high. Outcomes included 12- 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 generalized 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, 0·76), fine motor skills (MD=0·45, 95% CI: 0·08, 0·83), and 24-month socioemotional development (MD=-17·83, 95% CI: -31·47, -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 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.

**INTRODUCTION**

Globally, it is estimated 250 million children under the age of five 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- 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 behaviors.20,21 In India and Nepal, grandmothers generally support exclusive breastfeeding 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 height24,25 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 operationalize grandmother involvement crudely as household co-residence with the grandchild13,14,21,22,26,34,35 or use proxies such as whether the grandmother is still alive.25,36,37 Though studies have illuminated the impacts of grandmother presence,6,15,36-38 these crude measures do not operationalize 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 outcomes6,25,27,28,36,37,39-41 or educational participation;26,42-45 however, with some exceptions,31,33,35 early child development from 0-2 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 two years of life.

**METHODS**

*Study design and participants*

Data for this observational study come from the Bachpan Cohort, a cluster randomized perinatal depression trial nested in a birth cohort in Pakistan. A detailed description of the study design and sampling is available elsewhere.46,47 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).46,48,49 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 (i.e. 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=1,154) and followed up at 3, 6, 12, and 24 months postpartum. There was no differential loss-to-follow-up by treatment arm. We utilized data on participants with 3- and 12-month grandmother involvement and outcome data collected at 12- 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.50 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).50 At 12 months, child development was assessed using the Bayley Scales of Infant and Toddler Development-III (BSITD).51 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.51 At 24 months, socioemotional development was measured using the 25-item caregiver-reported Ages and Stages Questionnaire Socioemotional Scale (ASQ-SE).52 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 postpartum (Appendix Table 1).53 This newly developed measure involved a semi-structured 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. Mothers were asked to report in the previous 24 hours household members that were involved in 11 various activities related to instrumental care (e.g. feeding and changing diapers), non-instrumental care (e.g. playing with and soothing the child) and other support (e.g. when the mother was unwell or busy).

Of the 11 activities, five 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 co-residence, and therefore created one overall grandmother score, combining reports of both grandmothers. The total theoretical score ranges from 0 to 22; our analytic data ranged from 0 to 15 at 3 months and 0 to 20 at 12 months. As these variables were highly right skewed, we categorized the measure using a data-driven approach to assist with fit to the data and interpretability. After labeling all zero values as non-involved, we selected the median value of both timepoints to define low and high involvement, thus categorizing 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 postpartum and examined separate effects of 3- 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 generalized 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,54 treatment arm, child sex, reported child diarrhea, 3- and 12-month maternal depression using the Structured Clinical Interview for DSM (SCID),55 12- and 24-month maternal report of any intimate partner violence in the past year,56 and 3- and 12-month father absence. Confounders with multiple timepoints were included according to appropriate time ordering with respect to exposure timing (e.g. 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 stabilized inverse probability weighting (IPW)57 to account for informative missingness between the baseline sample (n=1,154) 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 stabilized 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.57 We examined baseline characteristics associated with missingness and included those with a p-value <0.10 in the IPW model: PHQ-9,48,49 maternal disability,58 maternal perceived stress,59 number of living children (first pregnancy, one to three children, or four or more) and crowding (people per room), grandmother co-residence 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.60 Analyses were conducted using Stata 14 and R version 3.6.1.

*Ethics approval*

Written informed consent (or witnessed consent, if the participant was illiterate) was obtained from mothers before study participation. This study was approved by institutional review boards at the Human Development Research Foundation (HDRF), the University of North Carolina at Chapel Hill, and Duke University.

*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 flowchart for our two final analytic samples (n=727 for 12-months and n=712 for 24-months). Of the 1,154 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 due to extreme anthropometric measurements.50 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 Appendix 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 postpartum (Table 2). At 3 months, 48% of grandmothers engaged in 1 to 5 caregiving activities (characterized as low involvement) and 23% engaged in 6 or more (characterized 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 (Appendix 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 are presented in Appendix Tables 4-5.

*Twelve-month growth outcomes*

In adjusted models, high 3-month grandmother involvement was associated with a 0·21 standard deviation greater 12-month WLZ compared to non-involvement, (Figure 2A, 95% CI: -0·02, 0·45). We found similar results for 12-month WAZ (Figure 2B, MD=0·25, 95% CI: 0·07, 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 (Figures 2D and 2E). Children with high 12-month grandmother involvement had, on average, 0·22 standard deviations lower 24-month WLZ (Figure 2D, 95% CI: -0·42, -0·01) and 0·09 standard deviations lower 24-month WAZ (Figure 2E, 95% CI: -0·22, 0·04) compared to children with non-involved grandmothers. We found no substantial relationships between grandmother involvement and 24-month LAZ (Figure 2F).

*Twelve-month developmental outcomes*

Compared to 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, 0·53). High 3-month involvement was associated with higher fine motor scores compared to non-involvement (Figure 3D, MD=0·23, 95% CI: -0·13, 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, 0·76) and 0·45 points higher on the fine motor subscale (Figure 3D, 95% CI: 0·08, 0·83) than children with non-involved grandmothers.

*Twenty-four-month developmental outcomes*

Compared to 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, 6·72; MD=2·39, 95% CI: -8·28, 13·07, 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, -2·72). Children with high grandmother involvement had better socioemotional development (Figure 4, MD= -17·83, 95% CI: -31·47, -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 (Appendix Tables 6-7).

**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.61-64 We speculate that the 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 Burkina Faso demonstrate the unique opportunities grandmothers could play in providing low-cost, interactive play for children.65 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 programs in order to optimize 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 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 grandmother involvement was associated with poorer child weight28 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.66,67 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.67 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 U.S.68,69 In Bangladesh, child temperament moderated the relationship between maternal depressive symptoms and child development.70 Further research is needed to characterize 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 breastfeeding and early introduction of complementary foods.12,17,21,71-74 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.73-76 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 behavior 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 behaviors, but can also influence maternal caregiving to promote such practices.15,16,72,77,78

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 co-residence, which extends beyond the current literature that largely uses household co-residence 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 categorize grandmother involvement; however, this may mask the effects of specific activities on child outcomes (e.g. instrumental vs. non-instrumental care). Since this score is independent of co-residence status, the non-involved category included co-resident, 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.79,80 Our analytic samples were substantially smaller than the baseline sample (Figure 1). However, we employed stabilized inverse probability weighting to account for missingness. Importantly, excluding these weights did not change estimates or precision, suggesting our results were not sensitive to the weighting procedure (Appendix Tables 8-9). Fourth, we were unable to capture the age or morbidity status of grandmothers. Prior research suggests varying levels of impact by grandmother age.26,41 The parabolic age hypothesis suggests 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 grandmother mental health symptoms were associated with more emotional and behavioral problems in grandchildren.81 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 behaviors 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 (Appendix 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 characterizing the caregiving activities of grandmothers and examining grandmother beliefs surrounding child nutrition, such as breastfeeding, 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.82-84 Programs 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.

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**Contributors’ Statements:**

Esther Chung conceptualized the research question, analyzed the data, interpreted results, drafted the initial manuscript, and reviewed and revised the manuscript.

Ashley Hagaman, Katherine LeMasters, Nafeesa Andrabi, and Joanna Maselko assisted in the analytic study design, interpretations of results, and reviewed and revised the manuscript.

Karen O’Donnell, Ashley Hagaman, Siham Sikander, and Joanna Maselko developed the grandmother involvement measure.

Victoria Baranov, Lisa Bates, John Gallis, Karen O’Donnell, Atif Rahman, Siham Sikander, Elizabeth Turner, and Joanna Maselko designed the Bachpan cohort study, contributed to the interpretation of results, and reviewed and revised the manuscript.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

**Declarations of Interest**:

The authors have no conflicts of interest to disclose.

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**Clinical Trials Registration:**

NCT02111915 (https://clinicaltrials.gov/ct2/show/NCT02111915); NCT02658994 (https://clinicaltrials.gov/ct2/show/NCT02658994). Trials were prospectively registered.

**Data Sharing Statement**:

Data are not publicly available due to ongoing data collection; however, data will be released when the Bachpan cohort study is completed. Data are available upon reasonable request from the senior author, Joanna Maselko.

**References:**

1. Black MM, Walker SP, Fernald LCH, et al. Early childhood development coming of age: science through the life course. *Lancet* 2017; **389**(10064): 77-90.

2. Shonkoff JP, Garner AS, Committee on Psychosocial Aspects of C, et al. The lifelong effects of early childhood adversity and toxic stress. *Pediatrics* 2012; **129**(1): e232-46.

3. Walker SP, Wachs TD, Grantham-McGregor S, et al. Inequality in early childhood: risk and protective factors for early child development. *The Lancet* 2011; **378**(9799): 1325-38.

4. Jeong J, Pitchik HO, Yousafzai AK. Stimulation Interventions and Parenting in Low- and Middle-Income Countries: A Meta-analysis. *Pediatrics* 2018; **141**(4).

5. Meehan CL. Allomothers and Child Well-Being. In: Ben-Arieh A, Casas F, Frønes I, Korbin JE, eds. Handbook of Child Well-Being: Theories, Methods and Policies in Global Perspective. Dordrecht: Springer Netherlands; 2014: 1787-816.

6. Aubel J. The role and influence of grandmothers on child nutrition: culturally designated advisors and caregivers. *Matern Child Nutr* 2012; **8**(1): 19-35.

7. Jeong J, McCoy DC, Fink G. Pathways between paternal and maternal education, caregivers’ support for learning, and early child development in 44 low- and middle-income countries. *Early Childhood Res Q* 2017; **41**: 136-48.

8. Jeong J, McCoy DC, Yousafzai AK, Salhi C, Fink G. Paternal Stimulation and Early Child Development in Low- and Middle-Income Countries. *Pediatrics* 2016; **138**(4).

9. Urke HB, Contreras M, Matanda DJ. The Influence of Maternal and Household Resources, and Parental Psychosocial Child Stimulation on Early Childhood Development: A Cross-Sectional Study of Children 36-59 Months in Honduras. *International journal of environmental research and public health* 2018; **15**(5).

10. Vazir S, Naidu AN, Vidyasagar P. Nutritional status, psychosocial development and the home environment of Indian rural children. *Indian Pediatr* 1998; **35**(10): 959-66.

11. Maselko J, Hagaman AK, Bates LM, et al. Father involvement in the first year of life: Associations with maternal mental health and child development outcomes in rural Pakistan. *Soc Sci Med* 2019; **237**: 112421.

12. Kerr RB, Dakishoni L, Shumba L, Msachi R, Chirwa M. “We grandmothers know plenty”: breastfeeding, complementary feeding and the multifaceted role of grandmothers in Malawi. *Soc Sci Med* 2008; **66**(5): 1095-105.

13. Pulgaron ER, Marchante AN, Agosto Y, Lebron CN, Delamater AM. Grandparent involvement and children's health outcomes: The current state of the literature. *Fam Syst Health* 2016; **34**(3): 260-9.

14. Griffiths P, Matthews Z, Hinde A. Gender, family, and the nutritional status of children in three culturally contrasting states of India. *Soc Sci Med* 2002; **55**(5): 775-90.

15. Aubel J, Touré I, Diagne M, et al. Strengthening grandmother networks to improve community nutrition: Experience from Senegal. *Gender & Development* 2010; **9**(2): 62-73.

16. Aubel J, Toure I, Diagne M. Senegalese grandmothers promote improved maternal and child nutrition practices: the guardians of tradition are not averse to change. *Soc Sci Med* 2004; **59**(5): 945-59.

17. Kerr RB, Berti PR, Chirwa M. Breastfeeding and Mixed Feeding Practices in Malawi: Timing, Reasons, Decision Makers, and Child Health Consequences. *Food and Nutrition Bulletin* 2007; **28**(1): 90-9.

18. Mumtaz Z, Salway SM. Gender, pregnancy and the uptake of antenatal care services in Pakistan. *Sociol Health Illn* 2007; **29**(1): 1-26.

19. Hank K, Buber I. Grandparents caring for their grandchildren: Findings from the 2004 Survey of Health, Ageing, and Retirement in Europe. *Journal of Family Issues* 2009; **30**(1): 53-73.

20. Lingam R, Gupta P, Zafar S, et al. Understanding care and feeding practices: building blocks for a sustainable intervention in India and Pakistan. *Annals of the New York Academy of Sciences* 2014; **1308**(1): 204-17.

21. Sharma M, Kanani S. Grandmothers’ influence on child care. *The Indian Journal of Pediatrics* 2006; **73**(4): 295-8.

22. Masvie H. The role of Tamang mothers-in-law in promoting breast feeding in Makwanpur District, Nepal. *Midwifery* 2006; **22**(1): 23-31.

23. Sadruddin AF, Ponguta LA, Zonderman AL, Wiley KS, Grimshaw A, Panter-Brick C. How do grandparents influence child health and development? A systematic review. *Soc Sci Med* 2019: 112476.

24. Schrijner S, Smits J. Grandparents and Children's stunting in sub-Saharan Africa. *Soc Sci Med* 2018; **205**: 90-8.

25. Gibson MA, Mace R. Helpful grandmothers in rural Ethiopia: A study of the effect of kin on child survival and growth. *Evolution and Human Behavior* 2005; **26**(6): 469-82.

26. Schrijner S, Smits J. Grandmothers and Children's Schooling in Sub-Saharan Africa. *Hum Nat* 2018; **29**(1): 65-89.

27. Nanthamongkolchai S, Munsawaengsub C, Nanthamongkolchai C. Comparison of the health status of children aged between 6 and 12 years reared by grandparents and parents. *Asia Pac J Public Health* 2011; **23**(5): 766-73.

28. Simon D, Adams AM, Madhavan S. Women’s Social Power, Child Nutrition and Poverty in Mali. *Journal of Biosocial Science* 2002; **34**(02).

29. Sichimba F, Mooya H, Mesman J. Predicting Zambian Grandmothers' Sensitivity Toward Their Grandchildren. *Int J Aging Hum Dev* 2017; **85**(2): 185-203.

30. Sheppard P, Sear R. Do grandparents compete with or support their grandchildren? In Guatemala, paternal grandmothers may compete, and maternal grandmothers may cooperate. *Royal Society open science* 2016; **3**(4): 160069.

31. Yue A, Shi Y, Luo R, et al. Stimulation and Early Child Development in China: Caregiving at Arm's Length. *Journal of Developmental & Behavioral Pediatrics* 2019.

32. Yue A, Zhang N, Liu X, et al. Do Infant Feeding Practices Differ Between Grandmothers and Mothers in Rural China? Evidence From Rural Shaanxi Province. *Family & community health* 2018; **41**(4): 233-43.

33. Liu L, Fan L, Hou X-Y, et al. Family Childcare Types and Conduct Problem Behaviors in Young Children: The Mediation Role of Caregiver-Child Interaction. *Front Pediatr* 2018; **6**: 217-.

34. Doan RM, Bisharat L. Female autonomy and child nutritional status: the extended-family residential unit in Amman, Jordan. *Soc Sci Med* 1990; **31**(7): 783-9.

35. Reynolds SA, Fernald LCH, Deardorff J, Behrman JR. Family structure and child development in Chile: A longitudinal analysis of household transitions involving fathers and grandparents. *Demogr Res* 2018; **38**: 1777-814.

36. Sear R, Mace R, McGregor IA. Maternal grandmothers improve nutritional status and survival of children in rural Gambia. *Proc Biol Sci* 2000; **267**(1453): 1641-7.

37. Scott M, Malde B, King C, et al. Family networks and infant health promotion: a mixed-methods evaluation from a cluster randomised controlled trial in rural Malawi. *BMJ Open* 2018; **8**(6): e019380.

38. Ice GH, Heh V, Yogo J, Juma E. Caregiving, gender, and nutritional status in Nyanza Province, Kenya: grandmothers gain, grandfathers lose. *Am J Hum Biol* 2011; **23**(4): 498-508.

39. Ikeda N, Fuse K, Nishi N. Changes in the effects of living with no siblings or living with grandparents on overweight and obesity in children: Results from a national cohort study in Japan. *PLoS One* 2017; **12**(4): e0175726.

40. Jiang J, Rosenqvist U, Wang H, Greiner T, Lian G, Sarkadi A. Influence of grandparents on eating behaviors of young children in Chinese three-generation families. *Appetite* 2007; **48**(3): 377-83.

41. Schrijner S, Smits J. Grandparents and Children's stunting in sub-Saharan Africa. *Soc Sci Med* 2018; **205**: 90-8.

42. Parker EM, Short SE. Grandmother Co-Residence and School Enrollment in sub-Saharan Africa. *J Fam Issues* 2009; **30**(6): 813-36.

43. Arenas E. Abuelos at home: Differential impact on children’s education by family structure. *Research in Social Stratification and Mobility* 2017; **52**: 36-48.

44. Chiang YL, Park H. Do grandparents matter? A multigenerational perspective on educational attainment in Taiwan. *Soc Sci Res* 2015; **51**: 163-73.

45. Pilkauskas NV. Living with a grandparent and parent in early childhood: associations with school readiness and differences by demographic characteristics. *Dev Psychol* 2014; **50**(12): 2587-99.

46. Turner EL, Sikander S, Bangash O, et al. The effectiveness of the peer-delivered Thinking Healthy PLUS (THPP+) Program for maternal depression and child socioemotional development in Pakistan: study protocol for a randomized controlled trial. *Trials* 2016; **17**(1): 442.

47. Sikander S, Ahmad I, Bates LM, et al. Cohort Profile: Perinatal depression and child socioemotional development; the Bachpan cohort study from rural Pakistan. *BMJ Open* 2019; **9**(5): e025644.

48. Kroenke K, Spitzer RL, Williams JB. The PHQ‐9: validity of a brief depression severity measure. *J Gen Intern Med* 2001; **16**(9): 606-13.

49. Gallis JA, Maselko J, O’Donnell K, et al. Criterion-related validity and reliability of the Urdu version of the patient health questionnaire in a sample of community-based pregnant women in Pakistan. *PeerJ* 2018; **6**: e5185.

50. WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards based on length/height, weight and age. *Acta Paediatr Suppl* 2006; **450**: 76-85.

51. Bayley N. Bayley Scales of Infant Development-III. San Antonio, Texas, USA: Psychological Corporation; 2006.

52. Squires J, Bricker D, Twombly E. Ages and Stages Questionnaires: Social-Emotional (ASQ: SE): apparent completed, child-monitoring system for social-emotional behaviors. *Baltimore: Paul H Brookes* 2002.

53. O’Donnell K, Gallis J, Turner EL, Hagaman A, Sikander S, Maselko J. The Day in the Life Interview: Assessing Infant Caregiving Practice in Rural Pakistan [Under Review]. *Field Methods* 2019.

54. Maselko J, Bates L, Bhalotra S, et al. Socioeconomic status indicators and common mental disorders: Evidence from a study of prenatal depression in Pakistan. *SSM-Population Health* 2018; **4**: 1-9.

55. Spitzer RL, Williams JB, Gibbon M, First MB. The structured clinical interview for DSM-III-R (SCID): I: history, rationale, and description. *Archives of general psychiatry* 1992; **49**(8): 624-9.

56. World Health Organization. WHO multi-country study on women's health and domestic violence against women: initial results on prevalence, health outcomes and women's responses. 2005.

57. Seaman SR, White IR. Review of inverse probability weighting for dealing with missing data. *Statistical methods in medical research* 2013; **22**(3): 278-95.

58. Chisolm TH, Abrams HB, McArdle R, Wilson RH, Doyle PJ. The WHO-DAS II: psychometric properties in the measurement of functional health status in adults with acquired hearing loss. *Trends in amplification* 2005; **9**(3): 111-26.

59. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav* 1983: 385-96.

60. Dugoff EH, Schuler M, Stuart EA. Generalizing observational study results: applying propensity score methods to complex surveys. *Health Serv Res* 2014; **49**(1): 284-303.

61. Black MM, Nitz K. Grandmother co-residence, parenting, and child development among low income, urban teen mothers. *J Adolesc Health* 1996; **18**(3): 218-26.

62. N’zi AM, Stevens ML, Eyberg SM. Child directed interaction training for young children in kinship care: A pilot study. *Child abuse & neglect* 2016; **55**: 81-91.

63. Kirby JN, Sanders MR. A randomized controlled trial evaluating a parenting program designed specifically for grandparents. *Behaviour Research and Therapy* 2014; **52**: 35-44.

64. Sherr L, Roberts KJ, Hothi S, Balchin N. Never too old to learn-Parenting interventions for grandparents–A systematic review. *Cogent Social Sciences* 2018; **4**(1): 1-22.

65. Hollowell J, Dumbaugh M, Belem M, et al. 'Grandmother, aren't you going to sing for us?' Current childcare practices and caregivers' perceptions of and receptivity to early childhood development activities in rural Burkina Faso. *BMJ Glob Health* 2019; **4**(2): e001233-e.

66. Hawkes K, O'Connell JF, Blurton Jones NG. Hadza women's time allocation, offspring provisioning, and the evolution of long postmenopausal life spans. *Current Anthropology* 1997; **38**(4): 551-77.

67. Kachel AF, Premo LS, Hublin J-J. Grandmothering and natural selection. *Proceedings of the Royal Society B: Biological Sciences* 2011; **278**(1704): 384-91.

68. Stright AD, Gallagher KC, Kelley K. Infant Temperament Moderates Relations Between Maternal Parenting in Early Childhood and Children’s Adjustment in First Grade. *Child Development* 2008; **79**(1): 186-200.

69. Dalimonte-Merckling DM, Brophy-Herb HE. A Person-Centered Approach to Child Temperament and Parenting. *Child Development* 2019; **90**(5): 1702-17.

70. Black MM, Baqui AH, Zaman K, et al. Depressive symptoms among rural Bangladeshi mothers: implications for infant development. *Journal of Child Psychology and Psychiatry* 2007; **48**(8): 764-72.

71. Agunbiade OM, Ogunleye OV. Constraints to exclusive breastfeeding practice among breastfeeding mothers in Southwest Nigeria: implications for scaling up. *Int Breastfeed J* 2012; **7**: 5.

72. Martin SL, Muhomah T, Thuita F, Bingham A, Mukuria AG. What motivates maternal and child nutrition peer educators? Experiences of fathers and grandmothers in western Kenya. *Soc Sci Med* 2015; **143**: 45-53.

73. Sarma H, Uddin MF, Harbour C, Ahmed T. Factors Influencing Child Feeding Practices Related to Home Fortification With Micronutrient Powder Among Caregivers of Under-5 Children in Bangladesh. *Food Nutr Bull* 2016; **37**(3): 340-52.

74. Zakar R, Zakar MZ, Zaheer L, Fischer F. Exploring parental perceptions and knowledge regarding breastfeeding practices in Rajanpur, Punjab Province, Pakistan. *International breastfeeding journal* 2018; **13**: 24-.

75. Aubel J. Grandmothers: A learning institution: United States Agency for International Development, 2005.

76. Karmacharya C, Cunningham K, Choufani J, Kadiyala S. Grandmothers’ knowledge positively influences maternal knowledge and infant and young child feeding practices. *Public Health Nutrition* 2017; **20**(12): 2114-23.

77. Mukuria AG, Martin SL, Egondi T, Bingham A, Thuita FM. Role of social support in improving infant feeding practices in Western Kenya: a quasi-experimental study. *Global Health: Science and Practice* 2016; **4**(1): 55-72.

78. Zhang Y, Ji M, Zou J, et al. Effect of a Conditional Cash Transfer Program on Nutritional Knowledge and Food Practices among Caregivers of 3-5-Year-Old Left-Behind Children in the Rural Hunan Province. *International journal of environmental research and public health* 2018; **15**(3).

79. Hernan MA, Hernandez-Diaz S, Robins JM. A structural approach to selection bias. *Epidemiology* 2004; **15**(5): 615-25.

80. Howe CJ, Cole SR, Lau B, Napravnik S, Eron Jr JJ. Selection bias due to loss to follow up in cohort studies. *Epidemiology (Cambridge, Mass)* 2016; **27**(1): 91.

81. Pearson R, Culpin I, de Mola CL, et al. Grandmothers’ mental health is associated with grandchildren’s emotional and behavioral development: a three-generation prospective study in Brazil. *BMC psychiatry* 2019; **19**(1): 184.

82. Ku LJ, Stearns SC, Van Houtven CH, Lee SY, Dilworth-Anderson P, Konrad TR. Impact of caring for grandchildren on the health of grandparents in Taiwan. *J Gerontol B Psychol Sci Soc Sci* 2013; **68**(6): 1009-21.

83. Xu L, Tang F, Li LW, Dong XQ. Grandparent Caregiving and Psychological Well-Being Among Chinese American Older Adults-The Roles of Caregiving Burden and Pressure. *J Gerontol A Biol Sci Med Sci* 2017; **72**(suppl\_1): S56-S62.

84. Hughes ME, Waite LJ, LaPierre TA, Luo Y. All in the family: The impact of caring for grandchildren on grandparents' health. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 2007; **62**(2): S108-S19.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | | **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** | | |  |  |  |  |
| Co-residence 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 |  |  |
| Child diarrhea (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 |  |  |
| **Table 1. Sample characteristics and child outcomes over time, Bachpan Cohort, Pakistan** | | | | | | |
| **Child Outcomes** | | | **Mean** | **SD** | **Min** | **Max** |
| **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, standard deviations, and percentages were based on weighted data to account for both the sampling design in which 1 in every 3 non-depressed pregnant women and the inverse probability of missingness. | | | | | | |
| ∮Higher BSITD scores indicate better development and higher ASQ-SE scores indicate worse development | | | | | | |
| Abbreviations: Patient Health Questionnaire (PHQ-9); Structured Clinical Interview for DSM (SCID); Intimate Partner Violence (IPV); World Health Organization-Disability Assessment Scale (WHO-DAS); Perceived stress scale (PSS-10); Weight-for-length z-score (WLZ); Weight-for-age z-score (WAZ); Length-for-age z-score (LAZ); Bayley Scales of Infant and Toddler Development (BSITD); Ages and Stages Questionnaire-Socioemotional (ASQ-SE) | | | | | | |
| **Table 1. Sample characteristics and child outcomes over time, 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 1 in every 3 non-depressed pregnant women were eligible for study inclusion and the inverse probability of missingness. | | | | |
| **Table 2. Grandmother caregiving at 3 and 12 months postpartum, Bachpan Cohort, Pakistan** | | | | |