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Approval Sheet

Association of Mother's Decision-Making Autonomy and Presence of Grandparents in the Household with Child Growth in India

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Abstract

Association of Mother's Decision-Making Autonomy and Presence of Grandparents in the Household with Child Growth in India

By Karmjeet Kaur

Introduction: Low height-for-age in childhood, or stunting, is a form of growth failure that leads to several short and long-term adverse consequences including poor mental development, physical morbidities, and mortality. Using recent national survey data, we investigated the interplay between mother's autonomy in decision-making and the presence of grandparents in the household on child height-for-age in India, a setting with disproportionate levels of stunting. As a secondary objective, we also sought to identify household socio-demographic correlates of child height.

Methods: We conducted a secondary analysis of the India Human Development Survey 2011-12 (IHDS-II). A total of 9202 children ages zero to five with complete covariates were analyzed. Decision-making autonomy was a composite of 8 indicators categorized as "high" or "low." Co-residing grandparents were classified as being maternal grandparent(s) only, paternal grandparent(s) only, or both maternal and grandparents; no co-residing grandparents served as the reference. Linear regression was used to assess the associations of maternal decision-making, presence of grandparents, and other socio-demographic factors with child height-for-age z-scores (HAZ). All analyses accounted for the complex survey design.

Results: Children were an average age of 2.6 years and had mean HAZ of -2.2. About 77% of their mothers reported high decision-making autonomy, 54% of children lived with at least one grandparent in the household. There was no statistically significant association between decision-making autonomy and child HAZ before (-0.08; 95% CI: -0.25, 0.095) or after (-0.04; 95% CI: -0.21, 0.14) adjustment. Relative to no grandparents, the presence of paternal grandparent(s) only was positively associated with child HAZ in unadjusted models (0.33; 95%CI: 0.21, 0.45), but this association was attenuated and not statistically significant after socio-demographic adjustment (0.15; 95%CI: -0.05, 0.35). Household income and parental education were the most salient socio-demographic correlates of child height. Findings were robust to treating child weight-for-age, an alternative child growth measure, as the outcome.

Conclusion: Although mother's decision-making autonomy was not associated with child height-for-age, children who co-resided with paternal grandparents tended towards higher attainment of height-for-age. The findings beg further investigation of the role of grandparents in child growth in Indian households.

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Chapter 1: Introduction and Literature Review

1.1 Child growth failure: a global public health problem

Despite progress towards global goals for child nutrition, such as 60% of countries reaching the Sustainable Development Goals (SDGs) targets for decreasing under-five mortality and about 58% reaching the targets for neonatal mortality (Lim et al., 2016), growth failure in childhood remains a major public health problem (Shroff, Griffiths, Adair, Suchindran, & Bentley, 2009). Child growth failure is defined in population health studies as a deficit in an array of anthropometric and body weight measures, including stunting, wasting, underweight, and low birth weight, for example. Only 16.5% of 188 countries assessed in 2015 were able to achieve the SDG target of eliminating stunting in children under age five (Lim et al., 2016). Nearly half of all deaths for children under the age of five is due to undernutrition equaling to a loss of about three million lives per year (UNICEF, 2017). In addition to mortality, undernutrition undermines child wellbeing by negatively impacting brain development and physical health, with consequences tracking well beyond childhood (Black et al., 2013; de Onis & Branca, 2016). Undernutrition, including stunting, wasting, and vitamin deficiencies, for example, causes 45% of child deaths, which is about 3 million lives lost annually (Black et al., 2013).

1.2 Child height-for-age: An informative indicator of child growth

Stunting, or being short for one's age, is defined as being two standard deviations from the World Health Organization's (WHO) Child Growth Standards median (WHO, 2014). About 25% of children under five had stunted growth in 2015 (UNICEF, WHO, & WBG, 2015). Due to fairly consistent findings in the literature regarding the adverse impacts of stunting, some irreversible, stunting is the most significant overall indicator of child well-being and most significant indicator of childhood undernutrition (Black et al., 2013; de Onis & Branca, 2016).

India is a country that has long struggled with child growth failure and stunting specifically. In India, 48% of children under five are stunted, accounting for 33% of stunted children across the globe (UNICEF). On a scale of 1 (worst) to 100 (best), India received a score of nine relative to other countries regarding the status of stunting in children under age five (Lim et al., 2016).

Stunting has several short-term and long-term consequences that has individual, household and societal implications (Stewart, Iannotti, Dewey, Michaelsen, & Onyango, 2013). Short term consequences include poor psychomotor and mental development (Black et al., 2013; Stewart et al., 2013; WHO, 2014) which can lead to late enrollment in school, lower grades, and poorer cognitive ability compared to children who are not stunted (de Onis & Branca, 2016). Children also face increased morbidity and mortality from infections such as pneumonia and diarrheal illness but also sepsis, meningitis, tuberculosis, and hepatitis which suggests a general poor and altered immune response (Black et al., 2013; de Onis & Branca, 2016). Frequent infection impairs nutritional status through a variety of pathways such as reduced appetite, impaired intestinal absorption, increased catabolism, and nutrients being used for immune response instead of growth (de Onis & Branca, 2016). Poor nutrition then leads to increased susceptibility of infection due to negative impact on epithelial barrier function and altered immune response (de Onis & Branca, 2016; Stewart et al., 2013). The cyclic nature of infection and poor nutrition influences poor nutritional outcomes and worsening nutritional status.

1.2.1 Impact of childhood stunting on later life health

Failure to reach growth potential, especially in the first two years, is associated with reduced stature in adulthood (de Onis & Branca, 2016; Stewart et al., 2013), which in turn is associated with a myriad of negative health outcomes. For example, women of short stature are at a higher risk for perinatal mortality, having stunted and/or wasted children (de Onis & Branca, 2016; Stewart et al., 2013; Vir, 2016), anemia in reproductive age and having low birth weight infants (WHO, 2014). Thus, stunting has inter-generational effects that are passed from mothers to their children. Evidence also suggests that stunting in childhood predisposes individuals to elevated risk of chronic diseases in adulthood (de Onis & Branca, 2016; Stewart et al., 2013). Children who were stunted and experience rapid weight gain after two years of age have increased risk of becoming overweight or obese as adults (WHO, 2014). Obesity is associated with various chronic diseases such as diabetes, hypertension, and coronary heart disease, for example (WHO, 2014). In addition to direct health impacts, stunting is associated with lower economic productivity. According to the World Bank, 1% of loss in adult height due to stunting is associated with 1.4% loss of economic productivity (de Onis & Branca, 2016). These long-term consequences can further contribute to the problem of stunting, for example, individuals with chronic diseases may have difficulties in caring for young children and economic implications over time could influence household resource allocation or even healthcare. Thus, the implications of childhood stunting are widespread, with ample area for intervention and prevention.

1.3 Causes of child growth failure

Several factors have been associated with stunted growth including maternal health and nutrition, inadequate infant/young child feeding practices, and infection (Vir, 2016; WHO, 2014). These factors result from various household, environmental, socio-economic and cultural contributors, therefore nutrition-sensitive and nutrition-specific interventions need to be integrated in order to reduce child growth failure including stunting (WHO, 2014). The WHO conceptual framework (Stewart et al., 2013) (see Appendix), modeled after the UNICEF malnutrition framework (UNICEF, 1990), provides key contextual factors which lead to household and nutritional factors that cause childhood stunting.

As discussed previously, infections are not only caused by childhood stunting, but are crucial risk factors (Black et al., 2013; de Onis & Branca, 2016). Many of these infections stem from contaminated water and poor sanitation (otherwise known as WASH), especially open defecation as young children begin to learn to feed themselves or begin exploring their environment, often putting objects into their mouths which may be contaminated (Stewart et al., 2013). WASH can also be linked to feeding practices, which are another risk factor for stunting. Almost all stunting takes places in the first 1000 days after conception, and there is strong evidence that appropriate feeding practices reduce stunting incidence (Black et al., 2013). Feeding practices can be conceptualized as poor quality of food which can stem from low food diversity, food and water safety through improper household hygiene, and inadequate practices such as infrequent feeding (Stewart et al., 2013).

Feeding practices and hygienic practices can in turn be associated with education, both of healthcare workers and caregivers on proper procedures and diet necessary for child growth (Stewart et al., 2013); education also empowers women and can contribute to higher decision-making power, especially in household resource allocation, such as provision of quality food (Vir, 2016). Feeding practices can also be thought of in terms of access to resources, which includes food prices, availability, and even household decisions for resource allocation (Brunson, Shell-Duncan, & Steele, 2009; Stewart et al., 2013). According to UN data, stunting prevalence for children under five was 2.47 times higher in the poorest quintile than the richest quintile and 1.45 times higher in rural versus urban areas (Black et al., 2013). Mother's nutrition has also been shown to have an influence on childhood stunting as mother's poor nutritional status can result in poor childhood nutritional outcomes, because mothers are likely not getting adequate nutrients during pregnancy (Vir, 2016) and also poor pregnancy outcomes due to difficulties in labor that result from poor nutritional status (Black et al., 2013).

1.4 Women's empowerment as a potential leverage point to reduce childhood growth failure

Many of the proximal risk factors for stunting are related to maternal nutritional status or maternal caregiving practices, both of which are shaped in part by women's empowerment. In particular, the ability of a mother to engage in recommended caregiving practices hinges on her decision-making power, which in turn stems from her level of empowerment and status in the household. Empowerment is defined as "the process of increasing capacity of individuals or groups to make choices and to transform those choices into desired actions and outcomes" (Alsop, 2005). Key terms used in conceptualizing empowerment have been discussed in the literature such as 'autonomy', 'agency', 'status', and 'gender equality' to name a few (Malhotra, Schuler, & Boender, 2002). According to the World Health Organization, empowerment is "a multidimensional social process that enables people to gain control over their lives" and specifically for women's empowerment this often encompasses making decisions about their health, increased self-esteem and communication or negotiation skills (WHO, 2011).

1.5 Measuring empowerment: Women's decision-making autonomy

Empowerment can be difficult to measure however, common indicators include decision-making, freedom of movement, control over income, and self-confidence among many others (Alsop, 2005; Kim et al., 2007; Malhotra et al., 2002). Several studies have tried to measure and understand the association of women's decision-making autonomy on various health outcomes. The table below provides a minimal list of some of these studies and how they conceptualized and operationalized this indicator. These studies were chosen to depict a world-wide representation of the utilization of decision-making autonomy.

Table 1. Conceptualization and Operationalization of Women's Decision-Making Autonomy

Conceptual definition of decision-making power	Operationalization	Country/Setting	Reference
Autonomy in decision-making	Low, medium and high decision-making based on questionnaire responses of: 'respondent alone', 'joint decision' and 'husband's decision'	Ethiopia Demographic and Health Survey (EDHS), 2005	(Tebekaw, 2011)
Autonomy in decision-making for various activities as well as freedom of movement, financial autonomy and attitudes towards domestic violence	Binary response for each, '0' indicating high autonomy	National Family Health Survey (NFHS) 2, Andra Pradesh	(Shroff et al., 2009)
Autonomy in decisions regarding child feeding and household expenditure	'Yes/No' to involvement in these decision-making variables	Rural households in Mao, Chad	(Begin, Frongillo, & Delisle, 1999)
Maternal decision-making regarding purchase of food items	Mother 'does/does not' make decisions regarding purchase of food items	Comprehensive Nutrition Survey in Maharashtra (CNSM)	(Aguayo, Nair, Badgaiyan, & Krishna, 2016)
Autonomy in decision-making around money, food procurement, livestock, medical care for self and child and child schooling	Four-part scale ranging from minimal autonomy (1) to complete autonomy (4)	Rendille population in Northern Kenya	(Brunson et al., 2009)
Autonomy in relation to child health and nutrition	Scores categorized into low, medium, and high tertiles	Los Cuatro Santos, Nicaragua	(Ziaei et al., 2015)
Decision-making autonomy from six decision-making questions ranging from own healthcare to household purchases	Low, medium, and high decision-making based on three-point scoring: 1 (little influence), 2 (joint), 3 (women)	Maternal and Infant Nutritional Intervention in Matlab, Bangladesh (MINIMat Study)	(Sharma & Kader, 2013)
Maternal autonomy as having final say in own healthcare,	Low, medium, high decision-making based on five-point scoring	NFHS 3, India	(Chakraborty & Anderson, 2011)

visits to family, and household purchases	

The findings reveal that decision-making autonomy has been widely used as an indicator of empowerment and derived from representative surveys such as national Demographic and Health Surveys (DHS) and NFHS. There is no singular, consistent definition of this indicator, yet it has been explored throughout the literature with varying results on health outcomes.

1.6 Literature regarding decision-making power and nutrition

Due to the complexity of defining and assessing decision-making and the fact that decision-making is only one aspect of a mother's full autonomy, it is not surprising that authors report varied results both in the items used to define decision-making and the impact those specific decision-making measures have on childhood nutritional status. The reason mother's decision-making autonomy can influence childhood nutritional status and child growth may be due to the differing priorities men and women have on resource allocation, with women, being primary caregivers, more likely to invest in food and care of their children (Brunson et al., 2009). A mother's autonomy allows her the ability to control and access these resources which affect the nutrition children receive and impacts their growth (Shroff et al., 2009).

Since decision-making is essential for the mother's ability to provide care, her nutritional status is also an important contributor to child nutritional outcomes as depicted in the WHO framework (see Supplemental Figure 1), as it can serve as a reflection of her decision-making power and ability to fully invest in the care of her child(ren). For example, a study in Ethiopia, using EDHS data, aimed to observe the link between woman's empowerment and her own nutritional status. They grouped women into low, medium, and high decision-making autonomy based on questionnaire responses (Tebekaw, 2011). When comparing the percentage of chronic energy deficit (CED) to the number of decisions women have a final say in, the researchers observed the highest percentage of CED in women (35.7%) when husbands had final say in all decisions compared to 6.6% CED when women had final say in all decisions (Tebekaw, 2011).

Another study, using DHS data from Zambia, Zimbabwe, and Malawi found a significant association between decision-making autonomy and CED in Malawi. Women in areas where HIV/AIDS and drought have constrained household resources were asked a series of decision-making questions (Hindin, 2006). Researchers found that with each additional decision made by the partner, women would have higher odds of CED (1.08, CI 1.02, 1.15) and when women made all decisions the odds of CED was even greater (2.88, CI 1.42, 5.83) which could be due the possibility of women taking care of multiple family members as this is an HIV/AIDS prevalent area among other reasons (Hindin, 2006).

Several studies also explore the association between maternal decision-making autonomy with various child nutritional outcomes such as birthweight, wasting, and stunting, often with conflicting results. For example, researchers in rural Bangladesh, utilizing a short questionnaire to assess mother's decision-making ranging from household to her own healthcare as part of the MINIMat study, found an association between women's decision-making autonomy and low birth weight in children (Sharma & Kader, 2013). Decision-making autonomy was scored and categorized into low, medium, and high (Sharma & Kader, 2013). They found that women with the lowest decision-making autonomy had significantly lower birthweight for children both in the adjusted and unadjusted models when compared to women with the highest autonomy, lower by 88 g ($p<0.01$) and by 69 g ($p<0.05$), respectively (Sharma & Kader, 2013). The odds of low birth weight children among women with the lowest autonomy was 1.46 (1.1 – 1.8) times the odds of low birth weight children among women with the highest autonomy (Sharma & Kader, 2013). The findings supported their hypothesis and they reasoned that women's decision-making autonomy can affect birthweight through women's health, nutritional status, and fetal growth (Sharma & Kader, 2013). A lack of decision-making, especially on food choices, can lead to unequal food sharing, improper dietary intake during pregnancy and thus lead to maternal undernutrition and low birth weight for her child(ren) (Sharma & Kader, 2013). A similar study, also looking at the association between maternal decision-making and low birth weight but conceptualizing maternal autonomy as having final say in own healthcare, visits to family, and household purchases in India from NFHS 2005-06, found that mothers with low autonomy were more likely to have children with low birth weight, OR 1.28 (1.07-1.53, p = 0.007) (Chakraborty & Anderson, 2011). This provides further evidence of the impact maternal decision-making can have on child nutritional status and outcomes.

A study in Kenya, where decision-making autonomy was categorized as a range from minimal autonomy (1) to complete autonomy (4) assessed maternal autonomy on child wasting (Brunson et al., 2009). Researchers only found a significant association between maternal autonomy and wasting in children ages 3-10 years (0.23, p< 0.05) but not for children ages three and younger (0.11, p> 0.6) (Brunson et al., 2009). Their findings were significant in areas of resource constraint, suggesting that the effect of women's autonomy on child nutrition may be influenced by such conditions (Brunson et al., 2009).

A study in Nicaragua, assessing women's autonomy on infant and young child feeding practices and child nutritional status, using a questionnaire based off of DHS women's questionnaire, categorized women's autonomy into low, medium and high (Ziaei et al., 2015). They found level of autonomy significantly associated with height-for-age and weight-for-height z-scores for children 6-35 months in the unadjusted models: high (-0.77, p= 0.02), medium (-0.99, p= 0.02), low (-1.07, p =0.02) and high (-0.18, p< 0.01), medium (-0.40, p< 0.01) low (-

0.46, p< 0.01), respectively. They found no significant association with stunting (-0.17, CI -0.39, 0.04), wasting (-0.04, CI -0.21, 0.14), and underweight (-0.15, CI -0.31, 0.02) when adjusting for all other variables for children 6 -35 months with mothers with medium autonomy compared to those with low autonomy (Ziaei et al., 2015). Similarly, no significant associations were found for children 6-35 months with mothers with high autonomy, and children less than 6 months in all autonomy groups when adjusted for confounders and compared to low autonomy (Ziaei et al., 2015). Even though results were not significant, the direction of the association shows higher autonomy resulting in better nutritional status of children older than 6 months; since Latin America has higher status of women compared to countries like Bangladesh and India, this factor and lower prevalence of malnutrition in the study sample may have prevented finding significant associations (Ziaei et al., 2015).

Other studies, specifically in India, found an association between decision-making autonomy and stunting in at least one decision-making domain or category. For example, a study in Andhra Pradesh, utilizing NFHS 2 data, observed the association between maternal autonomy and child stunting. They looked at four different domains related to autonomy including decision-making power in various activities, freedom of movement, financial autonomy, and attitudes towards domestic violence (Shroff et al., 2009). They found that mothers with high financial autonomy and mothers with higher physical autonomy were less likely to have a stunted child, OR= 0.731 (95% CI: 0.546, 0.981) and OR= 0.593 (95% CI: 0.376, 0.933, respectively (Shroff et al., 2009). Decision-making autonomy, however, had no significant association with childhood stunting with the authors referencing the survey as focusing more on questions about the woman's healthcare and not the child(ren)'s.

On the other hand, a study using data from CNSM in Maharashtra, evaluated decision-making around purchasing food items- mother either made or did not make these decisions (Aguayo et al., 2016). Researchers found that the odds of severe stunting were about two times higher in children of mothers with no decision-making power over purchase of food items (OR= 1.98, CI 1.31, 2.99) (Aguayo et al., 2016).

These studies reveal varying results in regards to the association between maternal decision-making autonomy and child nutritional status, often due to the multidimensionality and complexity of defining and assessing decision-making itself. Multiple researchers make this argument in their studies (Brunson et al., 2009; Sharma & Kader, 2013), thus no single index can capture the true effect of each dimension (Shroff et al., 2009). However, mothers are generally the primary caregivers, especially in India (Shroff et al., 2009), and thus their nutritional status and autonomy influences their child's nutritional status, therefore, it is essential to study the effects of decision-making autonomy on childhood nutritional status further.

1.7 Presence of grandparents and influences on decision-making

There is a high degree of heterogeneity in decision-making autonomy by country and context. Factors influencing a mother's decision-making autonomy must be studied alongside direct impacts of mother's decision-making autonomy on child health to more fully understand the role of decision-making in health outcomes. In India, as elsewhere, women's decision-making can be influenced by culture, household, socio-economic status, and religion, among other socio-demographic factors. There has been much discussion in the literature regarding the extended family system, which includes living in households with children's grandparents in India, and a married woman's decision-making ability, her nutritional status, and in turn influences on the nutritional status of her child(ren) (Allendorf, 2013; Borooah, 2004; Dasgupta, 1995; Osamor & Grady, 2016). Traditional marriages in India are usually exogamous, with the woman’s family paying a dowry and the women leaving her familial home and town to live with her husband’s family (Borooah, 2004; Sumner, 2009). These circumstances make it easy for subservience to be enforced, resulting in total loss of autonomy for the woman (Dasgupta, 1995). This is further fueled by a greater emphasis on the joint household because of power transfer to the son and greater loyalty to his mother than his wife (Dasgupta, 1995). In the context of these traditional patriarchal systems, a woman’s opinion is expected to be devalued or discounted by household members who have higher social position within the household and this devaluation leads to limited or low ability to make decisions (S. J. Jejeebhoy, 2002; Shireen J. Jejeebhoy & Sathar, 2001).

As described above, low decision-making of the mother can then impact her ability to enact decisions regarding her child’s health. The loss of autonomy coupled with other traditions, such as women eating after the men and their in-laws have eaten first, is also argued to impact the nutritional status of women themselves (Chorghade, Barker, Kanade, & Fall, 2006). However, living in extended families, specifically the presence of grandparent(s) in the household, has been shown to have a positive impact on child nutrition because grandparents are likely to invest in their kin and often take on the role of secondary caregivers, however, there can be instances where grandparents compete with grandchildren, especially under conditions of limited resources (Sear & Mace, 2008; Sheppard & Sear, 2016).

The literature is still conflicting in whether these implications are positive or negative. While young married women may now seek to live in nuclear families, the older generation of in-laws are reluctant to let go of the extended family system (Chorghade et al., 2006). Many argue that there has been a definite shift towards nuclear families in India, however, the extended family persists. NFHS data shows that there has been an increase in nuclear families especially in urban versus rural regions of India (Niranjan, Nair, & Roy, 2005). However, the percentage of young women living in extended families is still relatively high. Percentage of young women living in extended families decreased from 64.3% in 1998-1999 to 56.5% in 2005-2006 while the percentage of young women living in nuclear families increased from 35.7% to 43.5%, respectively (Allendorf, 2013). Regardless of family members, men are typically household heads (Niranjan et al., 2005) and thus have more decision-making power in the household.

For example, a study in Ghana found that for 49.2% of women interviewed, the husband made the final decision the last time they were unable to access or use skilled post-delivery care, while the next highest decision maker was mother-in-laws at 16.2% (Ganle et al., 2015). A literature review on women's autonomy in healthcare decision-making in various developing countries revealed that 28.1% of ever-married women in the reproductive age group in India made sole decisions regarding their healthcare, however, in 48.5% of households in India, healthcare decisions were made without women's participation (Osamor & Grady, 2016). In rural India, 55.6% of women in India weren't involved in decision-making regarding their healthcare (Osamor & Grady, 2016). These results can be reflective of women's decision-making in the context of their familial structure, where others in the household, particularly the in-laws, hold most of the decision-making power in the household, including healthcare access.

However, decreased or lack of autonomy does not always lead to negative health outcomes. In-laws and parents may provide social, material, informational or other support during pregnancy and during the child-rearing process. For example, a study in India revealed that young women living in extended families were more likely to use antenatal care, delivery assistance, and dairy consumption and were less likely to experience physical violence and meat consumption (Allendorf, 2013). A study in Guatemala, found a significant positive impact (0.21,

$p < 0.05$) of regular contact with maternal grandmothers on child height-for-age z-scores for children between the ages of one and five (Sheppard & Sear, 2016). In China, a study found that children living with grandparent(s) were more likely to be overweight or obese than children who did not live with any grandparent (OR= 1.71, 95% CI 1.00, 2.94); although this is a negative outcome, the perception was that heavier children are better cared for and healthier (Li, Adab, & Cheng, 2015). Positive associations are also dependent on which grandparent is present in the household or in contact with the child.

For example, a study looking at birthweight of children and access to grandparents and fathers in South Africa, specifically observed the effects maternal grandmother can have on birthweight and then compared results across all maternal and paternal grandparents (Cunningham, Elo, Herbst, & Hosegood, 2010). In unadjusted models, newborns were lighter when living in same homesteads as maternal grandmothers (-88.1, $p < 0.01$) than those whose maternal grandmothers were alive but living elsewhere; in the adjusted model this relationship was no longer significant, however, newborns with maternal grandmothers who were alive but not co-residents were heavier by 46 grams ($p < 0.10$) which reveals positive associations between maternal grandmother and birthweight (Cunningham et al., 2010). They also found, when comparing all maternal and paternal grandparents, that newborns were heavier when they lived with paternal grandparents (grandmother: 129.40, $p < 0.01$; grandfather: 264.84, $p < 0.05$) in the unadjusted models, but insignificant results in the adjusted models (Cunningham et al., 2010). A literature review of kin relationships on child survival revealed positive effects of grandmothers, where 64% of statistically valid studies showed that maternal grandmothers and 60% of statistically valid studies showed paternal grandmothers improve child survival (Sear & Mace, 2008). Grandfathers, on the other hand, had much less of an impact, with 83% and 50% of studies revealing no effects of maternal and paternal grandfathers, respectively (Sear & Mace, 2008).

However, this review also mentioned several studies that showed presence of grandparents having negative impacts on child survival. Two studies revealed detrimental effects of maternal grandmothers, while one study revealed detrimental effects of paternal grandmothers on child survival (Sear & Mace, 2008). Of the studies reviewed, 25% also revealed negative effects of paternal grandfathers on child survival (Sear & Mace, 2008). Another review of literature, mainly taken from qualitative studies, conducted by Pulgaron and colleagues found a negative effect of grandparents involvement on children's weight (Pulgaron, Marchante, Agosto, Lebron, & Delamater, 2016). Older data in India indicate that children born to mothers who resided with their mother's in-laws had about double the infant mortality rate (86/1000) as compared to those born in the mother's parental home (37/1000) (Dasgupta, 1995).

Therefore, it is not clear whether living in an extended family with one's in-laws or children's grandparents has a negative or positive impact on maternal and child nutrition. The differing effects by maternal and paternal grandparents may be due the fact that maternal and paternal grandparents, especially grandmothers, often have differing roles and investment at different stages of childhood (Sear & Mace, 2008). Paternal grandmothers tend to affect the condition of mothers during pregnancy; these can be beneficial if, for example, they help the mother with domestic chores or detrimental if they harass and stress the mother, while maternal grandmothers help with direct child-care (Sear & Mace, 2008). Many of these results could also be due to other socio-cultural factors. As the familial structure of India is varied and heads in the direction of mostly nuclear families, it will be interesting to see the relation living with grandparents has on health outcomes versus living in nuclear families.

1.7 Summary

Levels of child growth failure, maternal decision-making autonomy, familial influence on decisions, and their inter-relationships vary by context. The emerging narrative from the Indian literature suggests that first, maternal decision-making autonomy is a positive influence on child health; second, mother's residing with her in-laws may have lower ability to make decisions regarding her own or her child's health; and third, the presence of a mother's in-laws (that is, the child's grandparents) may benefit child health outcomes. To our knowledge, however, there are no recent data testing the association between maternal decision-making autonomy and child growth, nor examining the influence of grandparents in the household on maternal autonomy or child growth, across India. Given the changing socio-cultural dynamics in India, it will be important to investigate the influence of these factors on current child health at the national-level.

1.8 Problem Statement

Child growth is still a relevant and persistent public health problem around the world, particularly, in India, where nearly 50% of children under five are stunted (UNICEF). Stunting, or poor attainment of height-for-age, is a salient indicator of child well-being and can lead to irreversible loss of physical and cognitive potential (de Onis & Branca, 2016; Vir, 2016). Factors contributing to height-for-age include maternal nutrition, infant/young child feeding practices, and infection (Vir, 2016; WHO, 2014). These, in turn, are influenced by factors which effect mother's empowerment such as education, control over household resources, and decision-making (UNICEF, 1990). Since women tend to be primary caregivers in society, targeting their decision-making autonomy is expected to be crucial in impacting the health of their children. According to UNICEF, "eliminating gender discrimination and empowering women will have profound and positive impact on survival and well-being of children" (UNICEF, 2007).

The presence of grandparents in the household, may influence the impact maternal decision-making has on child nutrition. Presence of grandparents has been studied in various contexts, and given India's unique familial structures as well as culture, the effect of grandparents on child nutrition in India may vary compared to the impact of grandparents in the household in other countries. It will be beneficial to study the impact of both of these factors on child nutrition in order to develop successful, targeted interventions for child growth in India.

1.7 Purpose Statement

The purpose of this project was to determine the association between a mother's decision-making autonomy and presence of grandparents in the household with child growth, as defined by height-for-age z-score (HAZ) per WHO Child and Growth Standards.

1.8 Objectives

Figure 1 represents the focus of this paper, with mother's decision-making autonomy and the presence of grandparent(s) in the household as indicators of childhood height-for-age, as well as the various household socio-demographic characteristics which may also be associated with this relationship. The specific objectives include:

1. To assess the association between autonomy in mother's decision-making and child growth.

a. To determine whether the presence of grandparents in the household is related to autonomy in mother's decision-making.

b. To assess the association between presence of grandparents in the household on child growth.

c. To assess whether presence of grandparents in the household modify the association between autonomy in mother's decision-making and child growth.

2. To identify household socio-demographic correlates of child height-for-age in this population.

Chapter 2: Project Contents

Methods

2.1 Introduction

The purpose of this project was to assess the associations of maternal decision-making autonomy and presence of grandparents in the household with child height-for-age z-score. Analysis of secondary data from a nationally representative survey in India was used to meet these objectives.

2.2 Data Source and Sample

Data were from the second wave of the India Human Development Survey (IHDS-II), conducted in 2011-2012. The IHDS was designed to be a nationally representative survey, comprised of thirty-three states and union territories of India except for small populations living in island states of Andaman Nicobar and Lakshadweep (Desai & Vanneman, 2015). It was carried out by the University of Maryland and National Council of Applied Economic Research. Adult respondents were interviewed regarding health, education, employment, economic status, marriage, fertility, social capital, and gender relations (Desai & Vanneman, 2015) (Desai et al., 2010). The first wave of the survey was conducted in 2004-2005 with a sample of 41,554 households from 1503 villages and 971 urban neighborhoods in 383 of the 602 districts in India (Desai & Vanneman). Approximately 83% of those interviewed in IHDS-I were resurveyed for IHDS-II, which consisted of 42,152 households and 204,568 individuals. Up to two ever-married women ages 15-49 were eligible for interview; a total of 39,523 meeting these criteria were interviewed in IHDS II (Desai & Vanneman, 2015).

Among mothers in the sample of ever-married women ages 15-49 years, data for 19,489 children were recorded. Of these, 14,458 were 0-5 years old and were eligible to provide data on growth status, the primary outcome of this study. Therefore, we began by creating a dataset of children ages 0 to 5 years with anthropometric data. Data from the women's questionnaire, household questionnaire, and child anthropometry module were compiled and linked to each child aged 0 to 5. Child, maternal, and household characteristics were merged with the child-level anthropometric data using a combination of household, child, and maternal identification variables to create an analytic dataset. We excluded from analysis children with missing data for covariates of interest (see Supplemental Figure 2). A total of 26% were excluded due to missing anthropometry, and another 10% were excluded due to missing demographic (n= 12) or parental variables (n= 1429). The final analytic sample size was 9202 children ages 0-5 years with complete covariates of interest. The children in the analytic sample came from 7,017 households (average of ~1.3 children per household).

2. 3 Study Measures

2.3.1 Study Outcomes

Child growth status was measured through height-for-age z-score (HAZ) based on the World Health Organization child growth standards (WHO, 2010). Z-scores are computed as the number of standard deviations between a child's height and the reference age- and sex-specific mean height. Z-scores are used to describe child growth because standardization renders the scores comparable across age and sex, which is especially important while children are still growing (Wang & Chen, 2012). HAZ was assigned using the World Health Organization package igrowup_sas. The outcome variable of interest, height-for-age had skewness of 0.72 and kurtosis of 4.8, even though kurtosis was a bit high, the outcome was determined to be fairly normally distributed.

2.3.2 Household caregiving environment

Two dimensions of the caregiving environment were considered: maternal decision-making autonomy and the presence of grandparents in the household. Mother's decision-making autonomy was calculated from a women's responses to a series of eight questions regarding her decision-making ability, such as whether she has the ability to decide what to cook on a daily basis, to purchase expensive item, the number of children you have, what to do when she falls sick, whether to buy land/property, wedding expenses, what to do if a child falls sick, and whom your children should marry. Decision-making scores were calculated as the sum of the number of questions to which a woman provided a positive response; women were categorized as having high decision-making autonomy if her score was five or above and low decision-making autonomy otherwise.

Presence of grandparents in the household was determined from the woman's questionnaire. Two aspects of presence of grandparents in the household were considered: (1) as co-resident(s) of the household and (2) as household head. Having grandparents in the household, or grandparents as co-residents, was defined as a child's mother reporting that at least one of her parents or her parents-in-law resided in the same household as her. Using this information, a four-level grandparent variable was created for no grandparent(s) in the household, only maternal grandparent(s) (i.e., with no paternal grandparents) living in the household, only paternal grandparent(s) (i.e., with no maternal grandparents) living in the household, or both maternal and paternal grandparent(s) living in the household. Maternal grandparents were grouped together, as were paternal grandparents, since they yielded similar results when each of maternal and paternal grandfathers and grandmothers were examined separately in relate to child height-for-age z-score. Grandparents as head of the household was also considered therefore, we also created a three-level indicator of whether the father, a grandparent, or other family member (including mother) was head of household for analysis.

2.3.3 Socio-demographic covariates

Past studies indicate a strong socio-demographic patterning of child growth, though these relationships have been examined at the national level using data after 2005. We therefore sought to examine an array of potential socio-demographic correlates of child growth. In addition to being likely correlates of child growth, these socio-demographic factors are also associated with maternal decision-making, making them potential confounders of the primary associations of interest. Covariates of interest included: household income rank, religion, family caste, urban/rural, father's education, mother's education, mother's BMI, mother's age, mother's age at marriage, and child age, sex, weight, and height. Mother's and father's education variables were categorized as none, 1-9th standard, 10-12th standard, and all education post-secondary or above. Religion was categorized into Hindu, Muslim, and all other minority groups such as Sikhism and Jainism were combined. Caste was categorized as general caste which included Brahmin, forward and other castes, other backward castes, scheduled castes, and scheduled tribes. Household income was categorized into quintiles for the analysis.

Child age was normally distributed with a skewness of 0.15 and kurtosis of -1.05. Mother's age, her age at marriage, and BMI were also fairly normally distributed with skewness of 0.92, kurtosis of 1.2, skewness of 0.39, kurtosis of 1.8, and skewness of 1.3, kurtosis of 4.8, respectively. We therefore treated these as continuous variables in the analysis.

2.3.4 Statistical analysis

Data from the women's questionnaire, household questionnaire, and child anthropometry module were checked for data entry errors, distribution shapes using univariate analysis, and any implausible or missing values. Variables of interest in each dataset were categorized as described above before being sorted and merged into a final dataset. First a table of descriptive characteristics was created before regression analysis.

A table was created to understand the relation of presence of grandparents and head of household had with high or low mother's decision-making autonomy. This analysis also depicted each maternal autonomy indicator by high or low mother's decision-making autonomy. To estimate the unadjusted associations of each variable with height-for-age z-score specified as a continuous variable, we used simple linear regression. Coefficients can be interpreted as the mean difference in height-for-age z-score (i.e., number of standard deviations above or below the reference height-for-age by sex) associated with one unit of the predictor variable. Then a final, full model was run to determine associations of variables with height-for-age, accounting for all other covariates.

Several supplemental analyses were also conducted to further examine the study sample, exposure variables, and model results to assess how the study results may be impacted by key limitations. First, we compared the characteristics of children analyzed versus those not analyzed. Next, the association of each maternal autonomy indicator with HAZ was analyzed to determine which indicators may be more strongly associated with HAZ. This is important because, as we have mentioned, mother's decision-making autonomy can be significantly associated with child health outcomes and is often dependent on the type of the decision-making indicator. Similarly, the association of each grandparent type with HAZ was analyzed to determine if specific grandparent types have more impact on child growth, as many studies mentioned in this paper have discovered such associations.

Because HAZ may suffer from measurement error due to difficulty in measuring recumbent length in young children (de Onis & Branca, 2016), we conducted two sensitivity analyses. We repeated the above unadjusted and adjusted models by (1) modeling weight-for-age z-scores as the outcome; and (2) modeling height-for-age by restricting to children with standing height available (children ages two to five). Both of these set of models provide a robustness check to investigate the extent to which the height-for-age coefficients are biased due to measurement error in the height for younger children.

All analyses were performed using SAS software 9.4, while accounting for the clustered survey design, survey weights, and restriction to the analytic subpopulation.

2.4 Ethical considerations

Since the datasets used for this project were publicly available, the Emory Institutional Review Board deemed this study exempt from review.

Results

2.5 Findings

2.5.1 Description of child socio-demographic characteristics and anthropometry

Table 1 describes characteristics, household socio-demographic background, and caregiving environment of 9202 children, from 7017 households with an average of 1.3 children per household, included in this study. Mean age was 2.6 years (range: 0 to 5 years), with a slightly higher proportion of boys (52.6%) than girls (47.4%). On average, children weighed 11.6 kg and were 85.0 cm tall. Mean height-for-age z-score was -2.2, reflecting a high proportion of growth failure due to stunting in this population. Average age of mothers at the time of the survey was about 28 years, while average age at marriage was about 18 years old. Mother’s BMI was 20.8 indicating that most mothers are within the underweight-normal weight range. Overall, father’s education was higher than mother’s with fewer fathers receiving no education (20.9%) compared to mothers (37.6%). A greater proportion of children included in this analysis were from the lowest income quintile (27.6%) than the highest quintile (13.5%), relative to the full sample of households. The majority of children were from households that were Hindu (80.9%), belong to the historically disadvantaged other backward caste group (43.4%), and rural (74.4%).

The other 5256 children from ages zero to five that were excluded due to missing values for certain variables of interest had similar results in all categories (see Supplemental Table 1). The average age for children was 2.6 years, 51.2% were boys, average height was 77.7 cm and average weight was 12.2 kg. Height-for-age z-score was the worst anthropometric indicator at -4.1, which is two points worse than stunting in the sample population. Mean age of mothers was 27 years, while average BMI was 21.0, and average age at marriage is about 18 years. The majority of mothers did not have schooling beyond the 9th standard (73%) while 46.3% of fathers had received some education up to the 9th standard and 25.2% had schooling up until the 10-12th standard range. Household income was more evenly divided amongst the population with about 20% in each quintile. The majority of this population were from other backward castes (43.7%), Hindu (74.8%) and lived in rural residences (71.5%). In other respects, analyzed and excluded children resembled one another.

2.5.2 Mother's decision-making autonomy and grandparent(s) in the household

Mother's high decision-making autonomy was 77.2% in the study population and 81.5% among mothers of children excluded from this analysis. Roughly half of children from both the study population (54.3%) and those excluded (54.7%) lived with paternal grandparent(s) in the household, where 38.3% and 41.9% of household heads were a grandparent, respectively. High decision-making autonomy was higher among mothers who lived in households with no grandparents present (84%) than mothers who lived in households with any type of grandparent (e.g., 67%-74% for mothers who lived with a child's grandparent) (Table 2).

Table 3 presents the unadjusted and adjusted associations of maternal decision-making autonomy, the presence of grandparents in the household as (1) co-residents of the household and (2) head of the household, as well as other socio-demographic factors with child HAZ. In the unadjusted analysis, we observed no statically significant association between high decision-making autonomy and child HAZ in comparison to low decision-making autonomy (unadjusted: -0.08 [-0.25, 0.095]; adjusted: 0.04 [-0.21, 0.14]). Relative to children with no grandparents in the home, children with paternal grandparent(s) only in the household had 0.33 SD higher height-for-age. This association remained positive but was weaker and no longer statistically significant in the adjusted model, suggesting that the value of grandparents may be mediated through the socio-demographic variables. No other types of grandparents were statistically significantly associated with child HAZ. Children from households where a grandparent was the household head had higher HAZ scores (0.36, 95% CI: 0.22, 0.49) in comparison to children from households where their father was the head. This association was positive but not statistically significant in the adjusted model (0.10, 95% CI: -0.15, 0.35).

When individual maternal autonomy indicators were observed separately in relation to HAZ (see Supplemental Table 2), only action taken when the mother herself falls sick was significantly, but negatively, associated with height-for-age in the unadjusted models (-0.13, 95% CI: -0.25, -0.01). When adjusted for all other variables and covariates, the indicator was still negatively and significantly associated with height-for-age (-0.34, 95% CI: -0.50, -0.17). Two other indicators were also significant, but positively: decisions to buy land or property (0.25, 95% CI: 0.11, 0.40) and deciding what to do when child(ren) fall sick (0.38 (0.03, 0.73).

Specific grandparent type in the household was also analyzed separately to determine the association each has with HAZ (see Supplemental Table 3). In the unadjusted model, paternal grandmother in the household (0.29, 95% CI: 0.09, 0.49) and paternal grandfather in the household (0.32, 95% CI: 0.19, 0.46) were positively and significantly associated in comparison to no grandparents in the household. Maternal grandmother in the household and maternal grandfather in the household were also positively associated with HAZ in comparison to no grandparents in the household, but the results were not significant. The adjusted model showed positive associations between all grandparent types and HAZ in comparison to no grandparents in the household, however, the results were not significant.

The sensitivity analyses modeling weight-for-age z-scores as the outcome and restricting children with standing height available (children ages two to five) revealed similar findings (see Supplemental Tables 4 and 5). Specifically, high decision-making autonomy of mothers was not significant in comparison to mothers with low autonomy for either model or outcome. In the unadjusted models, having paternal grandparent(s) in the house in comparison to no grandparents was positively and statistically associated with weight-for-age z-score in children ages 0-5 years (0.31, 95% CI: 0.18, 0.44) and was also positively associated with height-for-age z-score in children ages two to five (0.18, 95% CI: 0.07, 0.29). These associations were positive but not statistically significant when adjusted for all other variables. In the WAZ model, grandparent(s) as household head was positively and significantly associated with weight-for-age (0.53, 95% CI: 0.31, 0.76) and this association was significant when adjusted for all other variables as well (0.35, 95% CI: 0.08, 0.61). For children ages two to five, grandparent(s) as household head was also positively associated with height-for-age, but only in the unadjusted model (0.23, 95% CI: 0.10, 0.37).

2.5.3 Relationship of socio-demographic characteristics with child growth

In addition to maternal decision-making autonomy, we examined an array of socio-demographic factors that are expected to be related to child height-for-age (Table 3). In the unadjusted models, child age was positively associated with height-for-age such that each year of child age was associated with a 0.17 (95% CI: 0.13,0.22) higher HAZ score. We did not observe a statistically significant difference between mean HAZ of boys and girls. HAZ was statistically significantly higher in children residing in households classified in the third through highest quintile of household wealth relative to the lowest, with a 0.73 unit (95% CI: 0.39, 1.08) difference in HAZ between children in the highest relative to lowest income quintiles. Relative to the Hindu majority, non-Muslim minority religions (comprised mostly of Christians) had on average 0.51 (0.075, 0.95) unit higher HAZ scores. With respect to family caste, children not belonging to the general caste category had substantially lower HAZ scores relative to this "higher" caste; these differences were statistically significant for other backwards castes (-0.20, 95% CI: -0.38, -0.025) and scheduled castes (-0.41, 95% CI: -0.67, -0.14), but not scheduled tribes. HAZ was higher among children living in urban compared to rural areas (0.36, 95% CI: 0.18, 0.54).

Of the parental characteristics examined, mother's BMI (0.089, 95% CI: 0.016, 0.062), higher levels of mother's education, and higher levels of father's education were positively associated with child height-for-age. For parental education, the largest difference in child height-for-age z-scores was between children whose mother's and father's attained up to class 10 to 12 – the middle educated group - relative to no education (mothers: 0.69, 95% CI: 0.49, 0.89; father's: 0.70, 95%CI: 0.38,1.02).

When adjusted for all child, household and parental characteristics, several variables were still significant predictors while others were no longer statistically significant. In the adjusted model, child age was positively associated with height-for-age such that each year of child age was associated with a (0.16, 95% CI: 0.11, 0.21), higher HAZ score. We did not observe a statistically significant difference between mean HAZ of boys and girls. HAZ was statistically significantly higher in children residing in households classified in the third through highest quintile of household wealth relative to the lowest. However, in this model, the greatest difference in HAZ was between children in the fourth quintile (0.42, 95% CI: 0.14, 0.70), relative to the lowest income quintile instead of the highest relative to lowest as observed in the unadjusted model. Findings for non-Muslim minority religions compared to the Hindu majority were still positive, but not significant in the adjusted model. With respect to family caste, children not belonging to the general caste or scheduled tribes had lower HAZ scores relative to the "highest" or general caste; these differences were not statistically significant however. Urban compared to rural areas, were no longer statistically significantly associated with HAZ.

Of the parental characteristics examined, mother's BMI (0.01, 95% CI: -0.02, 0.04) was no longer statistically significantly associated with HAZ. And only higher levels of mother's education, up until class 10-12, were still positively associated with child height-for-age, while only the middle-educated group for fathers, 10-12 class, was associated with height-for-age relative to no education. Education up until class 10-12 still had the largest difference in child height-for-age z-scores for both parents (mothers: 0.34, 95% CI: 0.11, 0.56; fathers: 0.35, 95% CI: 0.03, 0.67). The only variable which was not statistically significant in the unadjusted models but was significant after adjusting for all variables was mother's age, such that each year of mother's age was associated with a 0.02 (0.01, 0.03), higher HAZ score.

Chapter 3: Discussion and Recommendations

3.1 Discussion

The objectives of this study were to first investigate the interplay between mother's autonomy in decision-making and grandparents in the household in influencing child height; and second, to identify household socio-demographic correlates of child height. We found that the majority of mothers reported high decision-making autonomy, as measured by 8 indicators, regardless of whether grandparents were present in the household or her relationship with the household head. We also found that slightly over half of children co-reside with at least one grandparent. We observed no association between mother's decision-making autonomy and her child's height-for-age, but we observed some indication that the presence of grandparents – particularly paternal grandparents – was correlated with higher attainment of height-for-age. Similarly, children residing in households where the paternal grandfather was the household head had higher attainment of height-for-age. The positive associations between grandparents in the household and as the household head were not independent of socio-demographic variables, however. Household income and parental education were the most salient socio-demographic correlates of child height.

The null association between mother's autonomy and child growth may be due to very high decision-making autonomy in the study population overall. Prevalence of individual indicators was also high, ranging from 65% (decision over whether to buy land) to 89% (ability to decide the number of children she wants). Since decision-making is multidimensional, difficult to define and operationalize, there is no single indicator for it (Brunson et al., 2009; Sharma & Kader, 2013; Shroff et al., 2009), which results in some decision-making indicators as having a significant association with child health outcomes while others do not. Particularly, in our study, decisions about purchasing land or property, what to do when children fall sick, and decisions when the mother herself falls sick were all significantly associated with child growth, however decisions about what to do when the mother falls sick was negatively associated with child health outcomes. This result is surprising because about 93% of women had high autonomy for this indicator. Lack of decision-making regarding own healthcare can have a negative effect on child health outcomes as women are less likely to go in for check-ups, which is especially crucial during pregnancy (Sharma & Kader, 2013). Mothers with high financial autonomy and purchasing power, particularly over food items have been shown to have positive impacts on child health outcomes such as stunting and birthweight (Aguayo et al., 2016; Shroff et al., 2009), which is consistent with our results.

On the other hand, presence of grandparent(s), especially paternal grandparents, had significant positive associations with height-for-age. The studies discussed throughout this paper emphasize the fact that grandparent type is important in determining child health outcomes and survival (Cunningham et al., 2010; Sear & Mace, 2008). Studies show varied results according to grandparent type, and even which grandparent is most beneficial is not universally accepted, however, most studies show positive associations between maternal grandmothers and child outcomes in particular (Sear & Mace, 2008; Sheppard & Sear, 2016). Our study shows positive but insignificant associations of maternal grandmothers and maternal grandfathers in the household, but positive and significant associations of paternal grandmothers and paternal grandfathers on height-for-age in the unadjusted model. This may be because there were too few households with maternal grandparents as co-residents. However, when we looked at maternal grandparents together and paternal grandparents together both showed positive associations with height-for-age in comparison to households without grandparents, with paternal grandparents having significant results in the unadjusted model. Grandparents as head of household also had positive associations with height-for-age in comparison to fathers as household head in the unadjusted model only. The association of paternal grandparents on child health outcomes also varies in the literature, but given the high decision-making autonomy of mothers in the presence of all grandparent types and without grandparents in the household in our study, we can conclude that on average, co-residing paternal grandparents in the home and a grandparent as household head do not detrimentally impact mother's autonomy. Given the significance of these findings only in the unadjusted model, we can also conclude that the value of grandparents may be mediated through the socio-demographic variables.

We also found that child age, higher income quintiles, higher education levels up until the 10-12 class for both parents, and mother's age were also significant, positive correlates of height-for-age. Of these variables, parental education, especially maternal education, can have significant positive effects on child outcomes. For example, in a study in India, the proportion of children in rural households who had nutritious diets was 32% when mothers were literate compared to 18% when mothers were illiterate (Borooah, 2004). The reason the 10-12 class had the strongest association with height-for-age may be because this was often the highest level of education achieved for each parent, with very few parents seeking further education in the study population. Income has also been shown to have significant implications on child nutritional outcomes, as it is reflective of dietary options and resource allocation in the household because it enables access to higher-quality foods, healthcare and other determinants of growth (Stewart et al., 2013).

3.2 Strengths and Limitations

A possible limitation posed in this study includes only eight questions to assess decision-making autonomy, however the data and questionnaire come from a credible and nationally represented survey, with more questions to assess decision-making autonomy compared to other studies. As discussed previously, decision-making is complex and many studies have operationalized it in various forms with some forms showing an association between the outcome and others having no significant association. The data was collected through a survey which could lead to potential recall bias or misinformation by the respondents, influencing the overall results. There is also potential for measurement error in collection of height and weight data of either mother or child. Another limitation of this study is the exclusion of 36% of the eligible sample due to missing data for one or more covariates included. While there is concern that may introduce bias in the results due to selective inclusion of children, our analyses show that the study population resembled the excluded children (and therefore the full eligible sample) with respect to most study variables. The greatest strength of this study lies in the data itself, which comes from a nationally representative and credible survey with objectively-assessed height and weight data.

3.3 Conclusion

While mother's decision-making autonomy was not associated with child height-for-age, children who co-resided with paternal grandparents tended towards higher attainment of height-for-age, which may be mediated through the socio-demographic variables. The findings beg further investigation of the role of grandparents in child growth in Indian households. Household income and parental education were the most salient socio-demographic correlates of child height.

3.4 Recommendations

Null findings for the high decision-making autonomy of mothers does not imply the findings are irrelevant. Many sources in the literature, describe the importance of creating interventions that aim to address women's empowerment in order to improve her child(ren)'s nutritional outcomes, and many have also seen positive results (Kraft, Wilkins, Morales, Widyono, & Middlestadt, 2014; Taukobong et al., 2016). A review of the literature on interventions targeting women found that interventions which seek to empower women, through access to resources such as education and community networks for decision-making, have the strongest effectiveness to improve health behaviors and outcomes for both mother and child (Kraft et al., 2014). They provided a specific example for an intervention to decrease childhood stunting which involved empowering women with nutritional support, sanitation, food insecurity alleviation, etc. and found the intervention to be associated with a sharper decline in stunting for children up to 24 months (Kraft et al., 2014).

Findings in regards to the association of decision-making autonomy on child outcomes vary by study, questions asked, and culture, therefore, it is important to consider the potential positive effect higher decision-making autonomy of mothers can have on nutritional outcomes. Regardless of culture, religion, and country, mothers remain the primary caregivers in most settings, thus, allowing them to have control of their child(ren)'s nutrition can lead to positive nutritional outcomes and positive long-term developmental results for the child and over time positive outcomes in the population as a whole. It will also be beneficial to further study the associations of maternal decision-making autonomy on child outcomes in regards to cultural factors that may affect the association. Each culture's specific societal/cultural norms are the underlying factors behind women's status and thus their decision-making autonomy (Stewart et al., 2013), so understanding the impact of these factors on her autonomy can provide insight into the effects it may have on her children.

The presence of grandparents, especially by type of grandparent, can have positive or negative outcomes on child nutritional outcomes. These results vary across the literature, therefore, further study, especially in the context of culture, social/traditional norms, and family structure could provide more insight on these associations. In our study, presence of grandparents did not have negative impacts on women's autonomy as most women who lived in households with their in-laws still had high autonomy. This fact paired with the positive effects, especially paternal grandparents, seem to have on this population reveal that grandparents do indeed have a generally positive influence on child growth. Therefore, grandparents could prove to be an important target group for interventions aimed at improving child outcomes. Future investigation may focus on whether observed relationships at the national-level vary by regionally within India or among special sub-populations.

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Tables and Figures

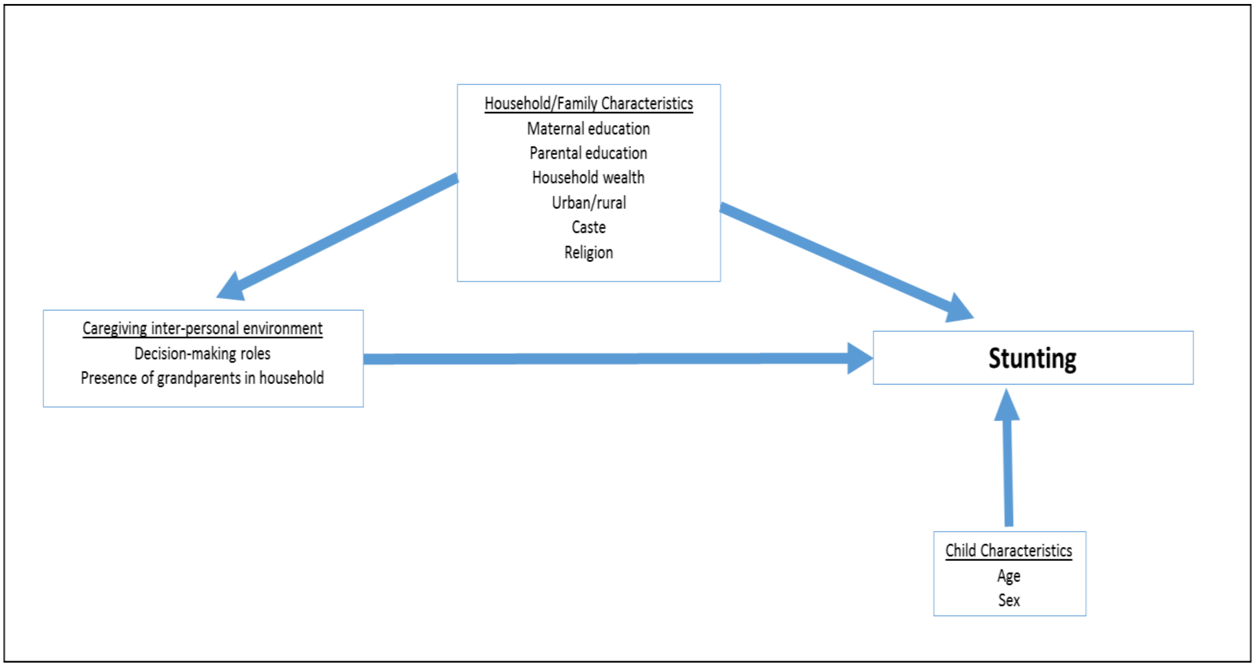


Figure 1. Conceptual framework for child growth as pertaining to this paper

Table 1. Distribution of characteristics for children ages 0 to 5 years (n = 9202)

Primary exposures of interest	
Maternal decision-making autonomy, n (%)	
Low	1974 (22.8%)
High	7228 (77.2%)
Grandparent(s) reside in household, n (%)	
No grandparents in household	3796 (41.8%)
Maternal grandparent(s) in household	225 (2.3%)
Paternal grandparent(s) in household	5019 (54.3%)
Both maternal and paternal grandparent(s) in household	162 (1.6%)
Household head, n (%)	
Father	4879 (54.0%)
Grandparent	3717 (38.3%)
Other (including mother)	606 (7.7%)
Child characteristics	
Child age, years, mean (SD)	2.6 (0.02)
Gender, n (%)	
Girl	4363 (47.4%)
Boy	4839 (52.6%)
Height, cm, mean (SD)	85.0 (0.17)
Weight, kg, mean (SD)	11.6 (0.09)
Height-for-age Z-score, mean (SD)	-2.2 (0.05)
Household Characteristics	
Household income quintile, n (%)	
Lowest Quintile	2168 (27.6%)
2nd Quintile	2036 (23.8%)
3rd Quintile	1880 (18.5%)
4th Quintile	1634 (16.5%)
Highest Quintile	1484 (13.5%)
Religion, n (%)	
Hindu	7323 (80.9%)
Muslim	1445 (15.4%)
All Other Religions	434 (3.7%)
Family caste, n (%)	
General Caste	2305 (22.9%)
Other Backward Castes	3806 (43.4%)
Scheduled Castes	2288 (25.3%)
Scheduled Tribes	803 (8.4%)
Residence, n (%)	
Rural	6621 (74.4%)
Urban	2581 (25.6%)
Parental characteristics	
Mother's age, years, mean (SD)	27.9 (0.07)
Mother's BMI, mean (SD)	20.8 (0.12)
Mother's Age at Marriage, years, mean (SD)	17.9 (0.14)
Mother's Education, n (%)	
None	3187 (37.6%)
1-9th Standard	3666 (38.8%)
10-12th Standard	1694 (16.8%)
Post Secondary and Above	655 (6.8%)
Father's Education, n (%)	
None	1766 (20.9%)

Table 1. Distribution of characteristics for children ages 0 to 5 years (n = 9202)	
1-9th Standard	4372 (47.2%)
10-12th Standard	2095 (21.8%)
Post Secondary and Above	969 (10.2%)

[a] India Human Development Survey 2011-12 (IHDS-II), children ages 0 to 5 years
b Estimates were weighted using survey weights and standard errors account for clustering

Table 2. Maternal autonomy indicators and type of grandparent in the home by autonomy

		Decision-making autonomy [d]	
	Prevalence	High autonomy	Low autonomy
Maternal Decision-making indicators [b]			
What to cook daily	86.5%	87.3%	12.7%
Purchase of expensive item	68.8%	97.8%	2.2%
Number of children	89.4%	85.6%	14.4%
Action taken when she (mother) falls sick	78.3%	93.1%	6.9%
Buy land/property	64.5%	99.5%	0.5%
Wedding expense	70.2%	98.0%	2.0%
What to do when child(ren) fall sick	84.1%	90.6%	9.4%
Whom child(ren) should marry	82.6%	91.5%	8.5%
Grandparent Co-residents in the home			
No grandparents in the household	41.8%	84.7%	15.3%
Maternal grandparent(s) in household	2.3%	74.4%	25.6%
Paternal grandparent(s) in household	54.3%	71.8%	28.2%
Both maternal and paternal grandparent(s) in household	1.6%	67.4%	32.6%
Household head			
Father	54.0%	84.1%	15.9%
Grandparent	38.3%	66.7%	33.3%
Other (including mother)	7.7%	81.1%	18.9%

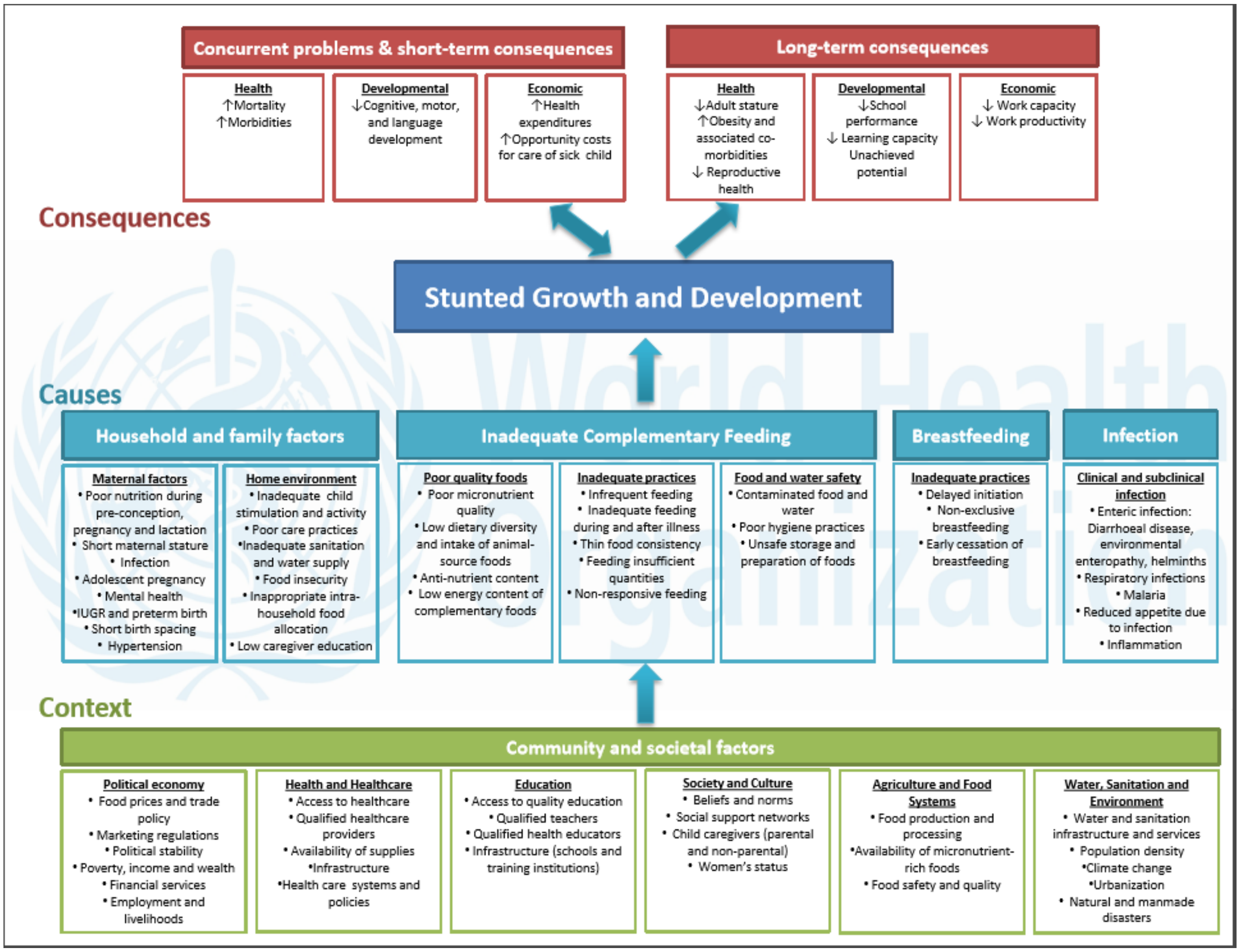
[a] India Human Development Survey 2011-12 (IHDS-II), children ages 0 to 5 years
[b] Estimates were weighted using survey weights and standard errors account for clustering
[c] Each indicator describes whether a woman reported having the ability to make decisions about this domain
[d] Row percent of those classified in the high versus low decision-making autonomy group for each indicator

Table 3. Unadjusted and adjusted variable associations with HAZ for children ages 0 to 5 years		
	Height-for-Age Z-score	
	Unadjusted coefficient (95% CL)	**Adjusted Coefficient (95% CL)**
Primary exposures of interest		
Maternal decision-making autonomy		
Low	Reference	Reference
High	-0.08 (-0.25, 0.095)	-0.04 (-0.21, 0.14)
Grandparent(s) reside in household		
No grandparents in household	Reference	Reference
Maternal grandparent(s) in household	0.17 (-0.26, 0.61)	0.09 (-0.42, 0.61)
Paternal grandparent(s) in household	0.33 (0.21, 0.45)	0.15 (-0.05, 0.35)
Both maternal and parental grandparent(s) in household	-0.21 (-1.10, 0.68)	-0.25 (-1.15, 0.66)
Household head		
Father	Reference	Reference
Grandparent	0.36 (0.22, 0.49)	0.10 (-0.15, 0.35)
Other (including mother)	0.06 (-0.26, 0.39)	-0.01 (-0.36, 0.34)
Child Characteristics		
Age	0.17 (0.13, 0.22)	0.16 (0.11, 0.21)
Gender		
Girl	Reference	Reference
Boy	-0.097 (-0.23, 0.034)	-0.12 (-0.26, 0.02)
Household Characteristics		
Household income quintile		
Lowest Quintile	Reference	Reference
2nd Quintile	0.0058 (-0.17, 0.18)	-0.03 (-0.20, 0.15)
3rd Quintile	0.28 (0.084, 0.48)	0.15 (-0.04, 0.33)
4th Quintile	0.67 (0.44, 0.9)	0.42 (0.14, 0.70)
Highest Quintile	0.73 (0.39, 1.08)	0.37 (0.05, 0.69)
Religion		
Hindu	Reference	Reference
Muslim	-0.08 (-0.23, 0.070)	-0.09 (-0.25, 0.07)
All Other Religions	0.51 (0.075, 0.95)	0.37 (-0.06, 0.80)
Caste		
General Caste	Reference	Reference
Other Backward Castes	-0.20 (-0.38, -0.025)	-0.07 (-0.23, 0.09)
Scheduled Castes	-0.41 (-0.67, -0.14)	-0.23 (-0.49, 0.03)
Scheduled Tribes	-0.19 (-0.53, 0.14)	0.11 (-0.23, 0.45)
Residence		
Rural	Reference	Reference
Urban	0.36 (0.18, 0.54)	0.15 (-0.11, 0.41)
Parental characteristics		
Mother's age, years	0.12 (-0.01, 0.03)	0.02 (0.01, 0.03)
Mother's BMI	0.039 (0.02, 0.06)	0.01 (-0.02, 0.04)
Mother's Age at Marriage, years	0.031 (-0.01, 0.07)	-0.02 (-0.06, 0.02)
Mother's Education		
None	Reference	Reference
1-9th Standard	0.33 (0.21, 0.46)	0.22 (0.12, 0.32)
10-12th Standard	0.69 (0.49, 0.89)	0.34 (0.11, 0.56)
Post Secondary and Above	0.59 (0.13, 1.06)	0.16 (-0.27, 0.59)
Father's Education		
None	Reference	Reference
1-9th Standard	0.24 (0.05, 0.43)	0.10 (-0.11, 0.32)

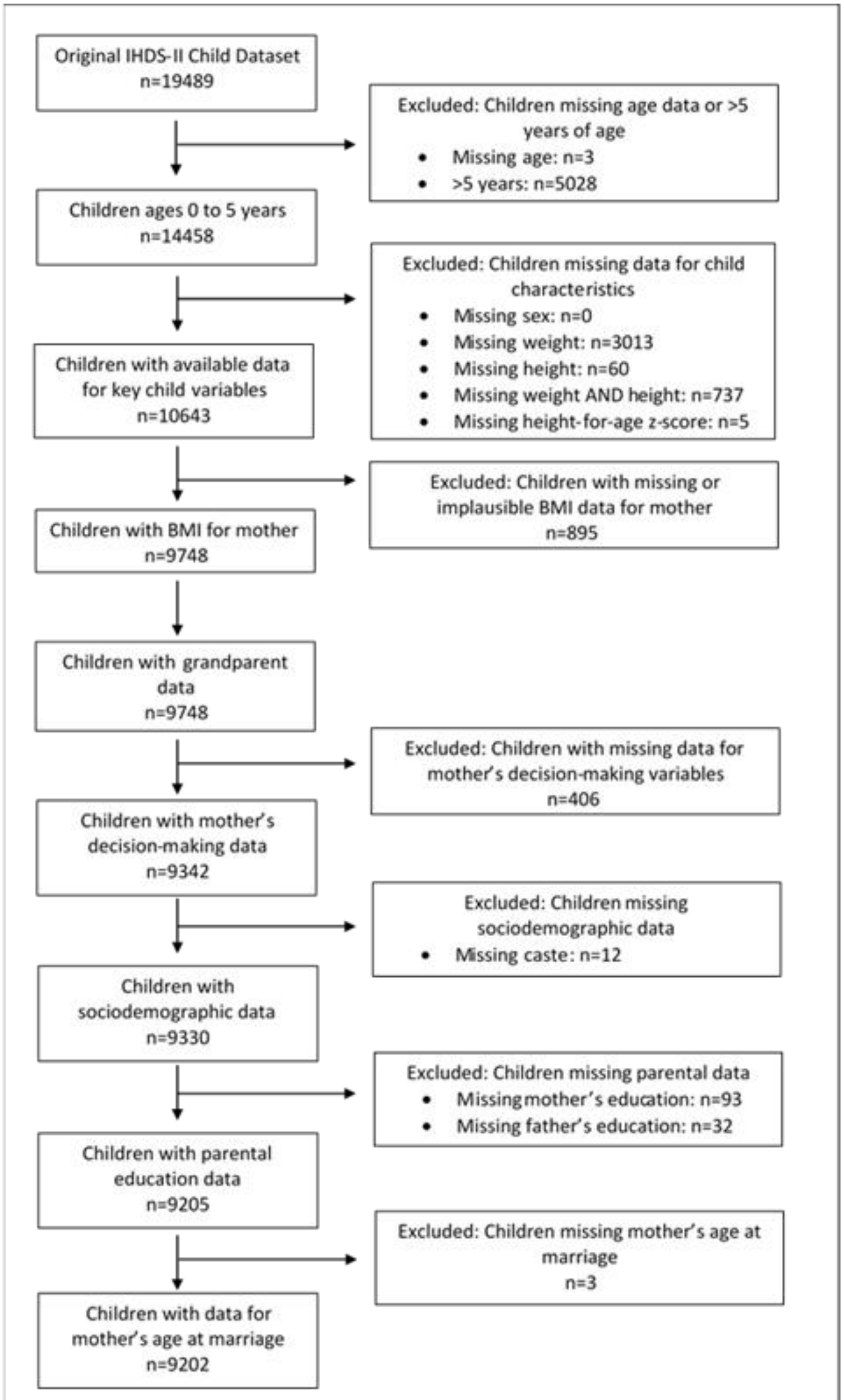
Table 3. Unadjusted and adjusted variable associations with HAZ for children ages 0 to 5 years		
	Height-for-Age Z-score	
	Unadjusted coefficient (95% CL)	**Adjusted Coefficient (95% CL)**
10-12th Standard	0.7 (0.38, 1.02)	0.35 (0.03, 0.67)
Post Secondary and Above	0.63 (0.31, 0.95)	0.18 (-0.09,0.45)

[a] India Human Development Survey 2011-12 (IHDS-II), children ages 0 to 5 years
[b] Estimates were weighted using survey weights and standard errors account for clustering

Appendix A: Supplemental Tables and Figures



Supplemental Figure 1. WHO conceptual framework for stunting



Supplemental Figure 2. Exclusion criteria and sample size after each restriction. India Human Development Survey 2011-11 (IHDS-II)

Supplemental Table 1. Distribution of characteristics for children by inclusion and exclusion		
	Analytic Sample	**Excluded Children**
Primary exposures of interest		
Maternal decision-making autonomy, n (%)		
Low	1974 (22.8%)	361 (18.5%)
High	7228 (77.2%)	1904 (81.5%)
Grandparent(s) reside in household, n (%)		
No grandparents in household	3796 (41.8%)	958 (35.1%)
Maternal grandparent(s) in household	225 (2.3%)	211 (8.3%)
Paternal grandparent(s) in household	5019 (54.3%)	1562 (54.7%)
Both maternal and paternal grandparent(s) in household	162 (1.6%)	57 (1.8%)
Household head, n (%)		
Father	4879 (54.0%)	1204 (44.2%)
Grandparent	3717 (38.3%)	1229 (41.9%)
Other (including mother)	606 (7.7%)	355 (13.8%)
Child characteristics		
Child age, years, n	9202	5256
Mean (SD)	2.6 (0.02)	2.6 (0.02)
Gender, n (%)		
Girl	4363 (47.4%)	2554 (48.8%)
Boy	4839 (52.6%)	2702 (51.2%)
Height, cm, n	9202	2197
Mean (SD)	85.0 (0.17)	77.7 (0.77)
Weight, kg, n	9202	2243
Mean (SD)	11.6 (0.09)	12.2 (0.25)
Height-for-age Z-score, n	9202	2189
Mean (SD)	-2.2 (0.05)	-4.1 (0.22)
Household Characteristics		
Household income quintile, n (%)		
Lowest Quintile	2168 (27.6%)	868 (20.0%)
2nd Quintile	2036 (23.8%)	955 (20.3%)
3rd Quintile	1880 (18.5%)	1052 (20.6%)
4th Quintile	1634 (16.5%)	1192 (20.3%)
Highest Quintile	1484 (13.5%)	1189 (18.8%)
Religion, n (%)		
Hindu	7323 (80.9%)	2049 (74.8%)
Muslim	1445 (15.4%)	573 (19.5%)
All Other Religions	434 (3.7%)	166 (5.7%)
Family caste, n (%)		
General Caste	2305 (22.9%)	1402 (26.4%)
Other Backward Castes	3806 (43.4%)	2219 (43.7%)
Scheduled Castes	2288 (25.3%)	1042 (20.1%)
Scheduled Tribes	803 (8.4%)	554 (9.9%)
Residence, n (%)		
Rural	6621 (74.4%)	3679 (71.5%)
Urban	2581 (25.6%)	1577 (28.5%)
Parental characteristics		
Mother's age, years	9202	2788
Mean (SD)	27.9 (0.07)	27.4 (0.16)
Mother's BMI	9202	2423
Mean (SD)	20.8 (0.12)	21.0 (0.10)
Mother's Age at Marriage, years	9202	2783
Mean (SD)	17.9 (0.14)	18.4 (0.12)
Mother's Education, n (%)		

Supplemental Table 1. Distribution of characteristics for children by inclusion and exclusion

	Analytic Sample	**Excluded Children**
None	3187 (37.6%)	742 (30.5%)
1-9th Standard	3666 (38.8%)	1223 (42.5%)
10-12th Standard	1694 (16.8%)	598 (19.4%)
Post Secondary and Above	655 (6.8%)	220 (7.6%)
Father's Education, n (%)		
None	1766 (20.9%)	448 (18.3%)
1-9th Standard	4372 (47.2%)	1196 (46.3%)
10-12th Standard	2095 (21.8%)	678 (25.2%)
Post Secondary and Above	969 (10.2%)	273 (10.2%)

[a] India Human Development Survey 2011-12 (IHDS-II), children ages 0 to 5 years
[b] Estimates were weighted using survey weights and standard errors account for clustering
[c] Comparing distribution of characteristics from children excluded in sample to those included in sample to determine if characteristics are similar throughout entire cohort and possibility of any loss of information due to exclusion criteria

Supplemental Table 2. Association of decision-making autonomy indicators with HAZ

	Height-for-Age Z-score	
	Unadjusted Coefficient (95% CI)	**Adjusted Coefficient (95% CI)***
Decision-making indicators [c]		
What to cook daily	-0.12 (-0.29, 0.04)	-0.09 (-0.29, 0.10)
Purchase of expensive item	-0.09 (-0.21, 0.02)	-0.05 (-0.25, 0.15)
Number of children	0.01 (-0.30, 0.31)	0.02 (-0.33, 0.37)
Action taken when she (mother) falls sick	**-0.13 (-0.25, -0.01)**	**-0.34 (-0.50, -0.17)**
Buy land/property	-0.01 (-0.13, 0.11)	**0.25 (0.11, 0.40)**
Wedding expense	-0.06 (-0.18, 0.06)	-0.06 (-0.22, 0.10)
What to do when child(ren) fall sick	0.06 (-0.15, 0.28)	**0.38 (0.03, 0.73)**
Whom child(ren) should marry	-0.05 (-0.24, 0.14)	-0.18 (-0.43, 0.07)

[a] India Human Development Survey 2011-12 (IHDS-II), children ages 0 to 5 years
[b] Estimates were weighted using survey weights and standard errors account for clustering
[c] Each indicator describes whether a woman reported having the ability to make decisions about this domain
* Adjusted for child age, male child, mother's age, BMI, age at marriage, and education levels, father's education levels, income quintiles, caste groups, religion categories, urban residence, household head, and maternal grandparent(s), paternal grandparent(s) and both maternal and paternal grandparent(s) in household

Supplemental Table 3. Association of specific grandparent type in household with HAZ

	Height-for-Age Z-score	
	Unadjusted Coefficient (95% CI)	**Adjusted Coefficient (95% CI)***
Grandparent(s) reside in household		
No grandparent(s) reside in household	Reference	Reference
Maternal grandmother resides in household	0.08 (-0.50, 0.65)	0.02 (-0.37, 0.42)
Maternal grandfather resides in household	0.22 (-0.40,0.84)	0.12 (-0.58,0.83))
Paternal grandmother resides in household	**0.29 (0.09,0.49)**	0.15 (-0.07,0.38)
Paternal grandfather resides in household	**0.32 (0.19,0.46)**	0.11 (-0.18,0.39)

[a] India Human Development Survey 2011-12 (IHDS-II), children ages 0 to 5 years
[b] Estimates were weighted using survey weights and standard errors account for clustering
* Adjusted for child age, male child, mother's age, BMI, age at marriage, and education levels, father's education levels, income quintiles, caste groups, religion categories, urban residence, high autonomy, and household head

Supplemental Table 4. Unadjusted and adjusted variable associations with WAZ for children ages 0 to 5 years		
	Weight-for-Age Z-score	
	Unadjusted coefficient (95% CL)	Adjusted Coefficient (95% CL)
Primary exposures of interest		
Maternal decision-making autonomy		
Low	Reference	Reference
High	-0.23 (-0.62, 0.16)	-0.12 (-0.49, 0.25)
Grandparent(s) reside in household		
No grandparents in household	Reference	Reference
Maternal grandparent(s) in household	0.23 (-0.05, 0-.51)	0.07 (-0.21, 0.36)
Paternal grandparent(s) in household	0.31 (0.18, 0.44)	-0.13 (-0.29, 0.03)
Both maternal and paternal grandparent(s) in household	-0.05 (-0.36, 0.25)	-0.33 (-0.78, 0.11)
Household head		
Father	Reference	Reference
Grandparent	0.53 (0.31, 0.76)	0.35 (0.08, 0.61)
Other (including mother)	0.03 (-0.12, 0.19)	-0.05 (-0.18, 0.07)
Child Characteristics		
Age	-0.04 (-0.14, 0.05)	-0.04 (-0.13, 0.04)
Gender		
Girl	Reference	Reference
Boy	0.11 (-0.070, 0.30)	0.10 (-0.10, 0.31)
Household Characteristics		
Household income quintile		
Lowest Quintile	Reference	Reference
2nd Quintile	0.19 (-0.03, 0.41)	0.10 (-0.10, 0.30)
3rd Quintile	0.56 (0.20, 0.92)	0.32 (-0.02, 0.66)
4th Quintile	0.60 (0.41, 0.80)	0.17 (-0.08, 0.42)
Highest Quintile	0.91 (0.75, 1.07)	0.27 (0.05, 0.50)
Religion		
Hindu	Reference	Reference
Muslim	-0.02 (-0.20, 0.15)	-0.11 (-0.28, 0.05)
All Other Religions	0.40 (0.27, 0.52)	0.25 (0.07, 0.44)
Caste		
General Caste	Reference	Reference
Other Backward Castes	-0.26 (-0.51, -0.02)	-0.10 (-0.29, 0.10)
Scheduled Castes	-0.54(-0.78, -0.30)	-0.30 (-0.52, -0.07)
Scheduled Tribes	-0.87 (-1.05, -0.68)	-0.50 (-0.71, -0.29)
Residence		
Rural	Reference	Reference
Urban	0.40 (0.28, 0.53)	0.08 (-0.04, 0.19)
Parental characteristics		
Mother's age, years	-0.02 (-0.04, -0.001)	-0.01 (-0.02, 0.01)
Mother's BMI	0.08 (0.04, 0.11)	0.05 (0.01, 0.09)
Mother's Age at Marriage, years	0.05 (0.04, 0.06)	-0.01 (-0.02,0.01)
Mother's Education		
None	Reference	Reference
1-9th Standard	0.46 (0.26, 0.65)	0.22 (0.04, 0.39)
10-12th Standard	0.79 (0.64, 0.95)	0.20 (-0.07, 0.48)

Supplemental Table 4. Unadjusted and adjusted variable associations with WAZ for children ages 0 to 5 years

	Weight-for-Age Z-score	
	Unadjusted coefficient (95% CL)	Adjusted Coefficient (95% CL)
Post Secondary and Above	0.90 (0.70, 1.11)	0.10 (-0.06, 0.26)
Father's Education		
None	Reference	Reference
1-9th Standard	0.11 (-0.02, 0.24)	-0.13 (-0.31, 0.05)
10-12th Standard	0.82 (0.50, 1.14)	0.38 (-0.03, 0.78)
Post Secondary and Above	0.87 (0.69, 1.05)	0.29 (0.05, 0.53)

[a] India Human Development Survey 2011-12 (IHDS-II), children ages 0 to 5 years
[b] Estimates were weighted using survey weights and standard errors account for clustering
[c] Sensitivity analysis to determine potential bias in height-for-age z-score coefficients due to measurement error in height of young children

Supplemental Table 5. Unadjusted and adjusted variable associations with HAZ for children ages 2 to 5 years

	Height-for-Age Z-score	
	Unadjusted coefficient (95% CL)	Adjusted Coefficient (95% CL)
Primary exposures of interest		
Maternal decision-making autonomy		
Low	Reference	Reference
High	-0.05 (-0.21, 0.11)	-0.05 (-0.23, 0.13)
Grandparent(s) reside in household		
No grandparents in household	Reference	Reference
Maternal grandparent(s) in household	-0.08 (-0.56, 0.41)	-0.15 (-0.62, 0.31)
Paternal grandparent(s) in household	0.18 (0.07, 0.29)	0.05 (-0.15, 0.24)
Both maternal and paternal grandparent(s) in household	-0.21 (-0.97, 0.54)	-0.23 (-1.05, 0.59)
Household head		
Father	Reference	Reference
Grandparent	0.23 (0.10, 0.37)	0.07 (-0.21, 0.36)
Other (including mother)	0.11 (-0.25, 0.48)	0.08 (-0.26, 0.42)
Child Characteristics		
Age	0.24 (0.16, 0.32)	0.22 (0.14, 0.30)
Gender		
Girl	Reference	Reference
Boy	-0.05 (-0.20, 0.11)	-0.07 (-0.22, 0.09)
Household Characteristics		
Household income quintile		
Lowest Quintile	Reference	Reference
2nd Quintile	0.04 (-0.12, 0.21)	0.01 (-0.19, 0.20)
3rd Quintile	0.24 (0.02, 0.45)	0.13 (-0.06, 0.33)
4th Quintile	0.58 (0.35, 0.80)	0.33 (0.05, 0.62)
Highest Quintile	0.61 (0.24, 0.98)	0.29 (-0.05, 0.63)
Religion		
Hindu	Reference	Reference
Muslim	-0.08 (-0.19, 0.04)	-0.15 (-0.30, 0.003)
All Other Religions	0.35 (-0.13, 0.83)	0.21 (-0.23, 0.65)
Caste		
General Caste	Reference	Reference
Other Backward Castes	-0.24 (-0.46, -0.02)	-0.16 (-0.32, -0.003)
Scheduled Castes	-0.49 (-0.79, -0.20)	-0.39 (-0.65, -0.12)
Scheduled Tribes	-0.31 (-0.73, 0.12)	-0.08 (-0.50, 0.35)
Residence		
Rural	Reference	Reference
Urban	0.38 (0.21, 0.54)	0.20 (-0.06, 0.46)
Parental characteristics		
Mother's age, years	0.02 (-0.001, 0.04)	0.03 (0.01, 0.04)
Mother's BMI	0.03 (0.01, 0.06)	0.005 (-0.02, 0.03)
Mother's Age at Marriage, years	0.04 (-0.01, 0.08)	-0.01 (-0.05, 0.03)

Supplemental Table 5. Unadjusted and adjusted variable associations with HAZ for children ages 2 to 5 years

	Height-for-Age Z-score	
	Unadjusted coefficient (95% CL)	Adjusted Coefficient (95% CL)
Mother's Education		
None	Reference	Reference
1-9th Standard	0.26 (0.13, 0.39)	0.10 (-0.04, 0.23)
10-12th Standard	0.58 (0.37, 0.79)	0.17 (-0.07, 0.42)
Post Secondary and Above	0.40 (-0.24, 1.03)	-0.15 (-0.66, 0.36)
Father's Education		
None	Reference	Reference
1-9th Standard	0.32 (0.084, 0.56)	0.24 (-0.04, 0.51)
10-12th Standard	0.71 (0.42, 1.00)	0.47 (0.18, 0.77)
Post Secondary and Above	0.57 (0.18, 0.96)	0.26 (-0.01, 0.53)

[a] India Human Development Survey 2011-12 (IHDS-II), children ages 0 to 5 years
[b] Estimates were weighted using survey weights and standard errors account for clustering
[c] Sensitivity analysis to determine potential bias in height-for-age z-score coefficients due to measurement error in height of young children