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Approval Sheet

Influence of women's empowerment on child nutritional status in Bihar, India

By

Yu Wang
Degree to be awarded: Master of Science in Public Health

Global Health

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Abstract Cover Page

Influence of women's empowerment on child nutritional status in Bihar, India

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Bachelor of Medicine
Peking University Health Science Center
2011

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An abstract of
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Abstract

Influence of women's empowerment on child nutritional status in Bihar, India

By Yu Wang

Increasing evidence indicates that maternal empowerment may be an important determinant of child nutritional status. However, little is known about this relationship in Bihar, India. This study is designed to examine the relationship between women's empowerment, represented by single and summary indicators, and child nutritional status in Bihar. Cross-sectional data from the National Family Health Survey 2005-2006 are used for the analysis. Women's empowerment is measured in five dimensions: decision making autonomy, freedom of mobility, tolerance of abuse and attitude towards domestic violence, maternal employment, and husband-wife differences in age/education. Polychoric Principle Component Analysis and factor analysis are employed to generate summary indicators or factor scores Nutritional status among children under five are measured by dichotomous variables as stunting, wasting, and underweight, and continuous variables as height-for-age, weight-for-height, and weight-for-age Z-scores. Logistic and linear regression models are built to test associations between women's empowerment and child nutritional status. After adjusting for the social context, household socio-economic status, and maternal and child characteristics, women with higher power {have jointly say in own cash income with husbands [OR=0.6, 95% CI (0.3, 0.9)]; allowed to go to health facility with someone else [OR=0.6, 95% CI (0.3, 1.0)]; employed during past year [OR=0.7, 95% CI (0.5, 1.0)]} are significantly less likely to have wasted children. Parents with greater age differences are more likely to have stunted children [OR=1.03, 95% CI (1.00, 1.05)]. However, opposite effects are also found; women with higher power {have jointly say in daily household purchases [OR=1.3, 95% CI (1.0, 1.7)]; allowed to go to the market alone [OR=1.4, 95% CI (1.1, 2.0)]; think it is unjustified to be beaten by their husbands if they don't cook properly [OR=1.4, 95% CI (1.0, 1.9)]} are more likely to have wasted children. Little of the variances in child nutritional status Z-scores is explained by the five summary indicators or factor scores that were generated. Thus, in this population, the results do not support the hypothesis that maternal empowerment is an important determinant of child nutritionals status. Further surveys with more sensitive and detailed questions are needed to measure women's empowerment, and further research uncovering the pathways between women's empowerment and child nutritional status is necessary.

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Chapter 1: Introduction

1. Introduction and rationale

Women's empowerment

Over the past decade, gender equality and women's empowerment have been explicitly recognized as key not only to the health of nations, but also to social and economic development. India's National Population Policy 2000 has "empowering women for health and nutrition" as one of its cross-cutting strategic themes. Additionally, the promotion of gender equality and empowering of women is one of the eight Millennium Development Goals (MDG) to which India is a signatory.

Gender-based inequalities translate into greater value being placed on the health and survival of males than of females; for example, ultrasound tests are being widely used for sex selection in India (Kishor & Gupta, 2009). The sex ratio at birth, which is defined as the number of girls born per 1,000 boys born, for all children born in the five calendar years preceding each of three National Family and Health Survey (NFHS) shows a slight decline from 941 (NFHS-1, 1992-93) to 938 (NFHS-2, 1998-99), but an accelerated decline from 938 (NFHS-2, 1998-99) to 919 (NFHS-3, 2005-06). The child mortality rate is 61% higher for girls than for boys. The median age at first marriage for women age 25-49 is low and has increased very slowly in the past decades. For NFHS-1, it is 16.1, for NFHS-2, it is 16.4, and for NFHS-3, it is 16.8 (Kishor & Gupta, 2009). Further, at the household level, disempowerment of women results in decreased access to resources such as education, employment, and income, and limits their power over

decision making and freedom of movement (Kishor & Gupta, 2009). This lack of power also constrains their ability to take care of their children. Women may not have the ability to exclusively breastfeed their newborns, provide nutritionally balanced food to their children, or bring them to a healthcare facility when needed, because of lack of knowledge and mobility. This may further affect their children's nutritional status.

Child nutritional status

Malnutrition affects one out of every three preschool-age children living in developing countries. This disturbing, yet preventable, state of affair causes untold suffering and, given its wide scale, presents a major obstacle to the development process. Global data show that the worst affected region is Southeast Asia, where more than 50% children are malnourished (Ray, Haldar, Biswas, Misra, & Kumar, 2001). The NFHS-3 2005-06 shows the prevalence of stunting, wasting, and underweight among children 0-59 months in India is 48.0%, 19.8%, and 42.5%, respectively. In Bihar, as one of the states with the worst situation, the figures are 55.6%, 27.1%, and 55.9%, respectively. Although there has been significant economic progress in India in recent decades, and agricultural progress has made India self-sufficient in major food grains, it remains one of the most impoverished countries in terms of undernutrition, especially in rural populations (Rao, 2001).

Relationship between women's empowerment and child nutritional status

Volumes have been written about the causes of child malnutrition and the means of reducing it. But the role of women's social status in determining their children's nutritional health has gone largely unnoticed until recently. In a seminal paper, "The Asian Enigma," written more than a

decade ago, Ramalingaswami et al. (Ramalingaswami, Jonsson, & Rohde, 1996) proposed that the extremely low status of women is a key factor responsible for high rates of child undernutrition in South Asia compared with Africa. The authors suggested that if women's status were improved, there would be improvements in the nutritional status of their children (Ramalingaswami, Jonsson, & Rodhe, 1996; Shroff et al.. 2009). Women's status affect their ability to control household time and income, to get enough social support to relieve time and resource constraints, to have appropriate knowledge and beliefs about taking care of themselves and their children, and further to gain mental health, self-confidence and self-esteem. Therefore, women's status affects children's health not only directly by affecting care given to children, but also indirectly through the health and nutritional status of caregivers (Engle, Menon, & Haddad, 1999; Smith, 2003). The NFHS-3 2005-06 reported on gender equality and women's empowerment in India (Kishor & Gupta, 2009), showing that children are more likely to be fully immunized and less likely to be underweight if mothers have more power at home.

2. Problem statement

Undernutrition jeopardizes children's survival, health, growth and development, and it slows national progress towards development goals. The status of growth, especially in early childhood, is not only the most important determinant of health of a child, but also a reflection of the well-being of the entire society.

Bihar is one of the worst affected states in India for the health condition of children (MacroInternational, 2007). Moreover, Bihar is one of the poorest states in India, with a large rural and tribal population, very high child mortality rates, and low women's status (Pandey, Lin,

Collier-Tenison, & Bodden, 2012). Thus, given the high rates of child malnutrition, low women's status, and the fact that women's status can be an important determinant of child malnutrition, we plan to explore the relationship between mother's empowerment and child (0-59 mo) nutritional status in Bihar by using the NFHS-3 (2005-06) data set.

3. Purpose statement

This study is designed to explore the relationship between women's empowerment and nutritional status of children under five in Bihar, India.

4. Research question

Research hypothesis: Women's empowerment may be an important determinant of nutritional status of children under five in Bihar, India.

There are two aims in this study:

(1) Calculate to what extent the various dimensions of women's empowerment impact nutritional status of children under five in Bihar, India.

(2) Use reduced factors representing women's empowerment to predict nutritional status of children under five.

5. Significance statement

The low status of women is considered one of the primary determinants of children malnutrition, especially in South Asia (Ramalingaswami et al., 1996; Smith, 2003). However, results of studies have often shown regional variation (MacroInternational, 2007; Mogford, 2011; Smith, 2003). Bihar, one of the poorest and most highly patriarchal states, has the highest malnutrition

status. Whether women's status plays an important role in determining the child nutritional status in Bihar is an urgent issue to be studied to guide local intervention programs and policies. Though Shroff et al. (2009) found that women with higher autonomy and freedom to choose to go to the market were significantly less likely to have a stunted child in Andhra Pradesh, a south Indian state, we may expect alternative results due to the economic and cultural differences among states of India. Moreover, no thorough analysis exists about the relationships between indicators of women's empowerment and all three indices of child nutritional status. This study is designed to examine the extent of influence of women's empowerment on nutritional status of children under five in Bihar, India.

Chapter 2: Comprehensive Review of the Literature

1. Current situation and trends of the child nutritional status of India and Bihar State

India is the home of more than three out of every ten stunted children in the world, and more than one third of the world's wasted children live in India. It is notable that 23.7% are severely stunted and 15.8% are severely underweight (MacroInternational, 2007). The proportion of children under three years of age who are underweight decreased from 43% in NFHS-2 to 40% in NFHS-3, and the proportion of severely underweight decreased from 18% to 16%. Stunting decreased from 51% to 45% while severe stunting decreased from 28% to 22%. However, wasting increased from 20% to 23% while severe wasting increased from 7% to 8% (MacroInternational, 2007; Sciences & ORCMacro, 2000). Unlike the national data, Bihar has worsened in the seven years since NFHS-2, except that the percentage of stunting of children under three years dropped from 58% to 50% , wasted children increased from 25% to 33%, and children who were underweight increased from 52% to 55% (MacroInternational, 2007).

2. Underlying factors of child nutritional status

In developing countries, children are vulnerable to malnutrition because of low dietary intakes, infectious diseases, lack of appropriate care, and inequitable distribution of food within the household (MacroInternational, 2007). However, there are also many underlying factors affecting these determinants.

Data presented in the NFHS-3 national report showed that children 18-23 months had the highest stunting and underweight prevalence, which was 57.8% and 45.9, respectively, and children less

than six months had the highest wasting prevalence, which was 30.3% (MacroInternational, 2007). Boys and girls were about equally undernourished. Undernutrition was generally lower for the first birth and increased with birth order (MacroInternational, 2007). The prevalence of undernutrition was much higher in residents of rural areas than urban areas, 50.7% vs. 39.6% for stunting, 20.7% vs. 16.9% for wasting, and 45.6% vs. 32.7% for underweight (MacroInternational, 2007). Undernutrition prevalence decreased with increasing years of mother's education and household wealth index. Hindu and Muslim children were about equally likely to be undernourished, while Christian, Sikh, and Jain children were considerably better nourished. Children belonging to scheduled caste and scheduled tribes had higher levels of undernutrition (MacroInternational, 2007).

- *Socio-economic status*

Socio-economic status was an important determinant of child nutrition across many different contexts. The risk of underweight and stunting was significantly higher among children from household with the lowest and middle wealth index (Meshram et al., 2012; Meshram et al., 2011; Mondal, Biswas, & Bose, 2012; von Laer Tschudin et al., 2009). Child feeding practices may also vary by household SES, for example, in India, the richest households were less likely to delay the introduction of complementary foods than other households (Patel et al., 2012).

Most studies found that higher socioeconomic status, lower prevalence of undernutrition; however, Indian Muslims, who were considered having lower socioeconomic status than upper-caste Hindus, had exhibited higher child survival rates for decades (Bhalotra, Valente, & van Soest, 2010). After controlling for age and sex, children belonging to the scheduled caste group

had lower body fat (Mandal, Bose, & Koziel, 2011). The gap in child malnutrition between the scheduled tribe/scheduled caste (ST/SC) and the remaining Indian population was found to be primarily caused by the ST/SC's lower wealth, education and use of health care services (Van de Poel & Speybroeck, 2009).

- *Maternal characteristics*

Maternal education level tended to have a protective effect towards child nutrition. Studies done by Rajaram and colleagues (2007) found that children whose mothers were illiterate had a higher prevalence of stunting, wasting, and underweight, and children whose mothers obtained high school or more education had the lowest prevalence. Meshram et al. (2011) also found that women's literacy was a strong factor affecting malnutrition. In regard to receiving nutritional diets, whether the mothers were literate highly affected the treatment of female children. There was no gender difference among literate mothers, while girls were 5% less likely to be well-fed compared to their brothers when the mother was illiterate (Shaikh et al., 2003). Moestue & Huttly (2008) found that besides mother's education, child nutrition was also positively and independently associated with fathers' and grandmothers' education.

Maternal health, mother's behavior, and maternal socio-economic status, were also found to be positively related to child nutrition. Studies have shown a link between high maternal common mental disorders and poor child nutritional status in India (Harpham, Huttly, De Silva, & Abramsky, 2005). The severity of malnutrition was significantly associated with major depression during the postpartum period (Anoop, 2004). A multilevel model that was conducted using data from the NFHS-2 1998-99 showed that maternal characteristics, such as mother's

height and mass media exposure; maternal socio-economic status, such as religion and caste; and maternal behavioral factors, such as mothers consuming tobacco and/or alcohol, were significantly related to child weight-for-height, height-for-age, and weight-for-age Z-scores (Rajaram et al., 2007).

- *Region*

Children in northern and western geographical regions of India had higher odds for inappropriate complementary feeding indicators than in other geographical regions (Patel et al., 2012). Children living in rural areas were more likely to be malnourished compared to children living in urban areas (Bharati, Pal, & Bharati, 2008). However, rural areas were often not fully reachable by nutrition interventions. A study by Pasricha et al (2011) showed that public distribution of iron to children was inadequate and disparities existed, resulting in higher prevalence of anemia in rural India.

- *Family structure*

Number of household members and number of live siblings in a household showed to be related to child nutrition in previous studies. In a study conducted by Kuman & Ram (2013), nuclear/non-nuclear family had only a small crude effect on child underweight and full immunization. However, the number of siblings was significantly and negatively associated with nutritional status of children and full immunization coverage, even after adjusting for other socio-demographic and geographic factors (Kumar & Ram, 2013).

- *National economic growth*

India has had stable economic growth during the past three decades. But economic growth alone was not sufficient for substantially reducing malnutrition (Bharati et al., 2008). Subramanyam et al. (2010) analyzed data from the three NFHS cycles and found that the absolute rates of undernutrition decreased for everyone regardless of their social status. Results showed that social disparities in childhood undernutrition in India either widened or stayed the same during a time of major economic growth. Data from the three survey cycles also showed there was no consistent evidence that economic growth led to reduction in childhood undernutrition in India (Subramanyam, Kawachi, Berkman, & Subramanian, 2011).

3. Definition and measurement of women's empowerment

Mason (1986) noted that status is difficult to confine to a single concept because of its multidimensionality. There is still no general agreement on the definition of women's empowerment; terms such as "status," "empowerment" and "autonomy" are sometimes used interchangeably. Likewise, detailed definitions of the underlying concept varied among studies and authors. Dyson and Moore (1983) defined status as "the capacity to manipulate one's personal environment," including the ability "to obtain information and to use it as the basis for making decisions about one's private concerns and those of one's intimates." Hobcraft (2000) defined female autonomy as "increasing the means and ability of females to choose and control outcomes, implying a shift towards greater individual agency". Malhortra and colleagues (2005) defined status as "the expansion in people's ability to make strategic life choices in a context where this ability was previously denied to them." Basu and Koolwal (2005) differentiated two

types of empowerment, one that was based on women's autonomy used for "relatively altruistic or instrumental purposes (such as childcare)" and the other empowerment used for self-interest.

Jejeebhoy (2002) and others distinguished between empowerment and autonomy, suggesting that "empowerment is a more dynamic term because it encompasses both a process and an end-product." Thus, Jejeebhoy (2002) chose to use the static concept autonomy, defining it as "the extent to which women exert control over their own lives within the families in which they live, and at a given point in time." Also, since it is difficult to quantitatively measure a process, authors studying women's empowerment usually measure the end-product, such as a woman's freedom of mobility, her decision-making authority, and so on.

Although women's status has been variously defined, common quantitative measurement themes have arisen in the international research. Women's status was initially measured through proxy variables, such as women's employment, education, and the age difference between spouses (Cain, 1984; Presser & Sen, 2000), or women's economic independence from men (Cain, 1984). In addition to proxy measures, direct measures are also now commonly utilized. The indices developed by Jejeebhoy (2000) are among the most replicated in literature. Her measures represented "separate end-product dimensions of autonomy, namely, decision making autonomy, which is subdivided into economic and child related; freedom of mobility; freedom from threat; access to economic resources; and control over economic resources".

4. Relationship between women's empowerment and child nutritional status in India

- *Women's empowerment*

Sethuraman (2006) designed a study to explore the relationship between women's empowerment and child (aged 6 to 24 months) nutritional status in rural Karnataka, India. Structured interview was performed to collect information on mothers to measure their empowerment, and anthropometric measurements were done to obtain child nutritional status. Eight hundred and twenty mother-child pairs were included in this study. Results showed that women's empowerment variables (measured by decision-making, mobility, employment and income, and psychological abuse and sexual coercion) were significantly related to child nutritional status and explained 5.6% of the variance. Thirty-four percent of mothers had experienced domestic violence. Children whose mothers had experience psychological abuse and sexual coercion were1.43 times more likely to be malnourished compared to others ($p<0.05$).

Bose (2011) used data from NFHS-3 (2005–06) in India to investigate the association between mother's status (measured by mother's education, mother's work, local exogamy, and autonomy), and the gender difference of nutrition allocation among children under five years old. Results indicated that children (both female and male children) whose mothers were more educated were five percent less likely to be malnourished ($p<0.01$), and children whose mothers were not working were 13% less likely to be malnourished compared to those whose mothers were working for pay ($p<0.01$). In general, higher women's status, especially at community level, had beneficial effects on female children's nutritional status.

- *Domestic violence*

An experience of domestic violence is thought to be an indicator of women's status in the household. To investigate the relationship between mother's experience of domestic violence and child nutritional status, Ackerson & Subramanian (2008) analyzed data from NFHS-2 (1998-99). Experiences of physical domestic violence were self-reported by the mothers. Child nutritional status was calculated from anthropometric measurements. Results indicated that mothers who had experienced multiple incidents of domestic violence in the previous year were 1.18 times more likely to have wasted children [OR=1.18, 95% CI: (1.03, 1.35)] and 1.34 times more likely to have severely underweight children [OR=1.34, 95% CI: (1.05, 1.70)] compared to mothers who had never experienced domestic violence since married after adjusting for demographic characteristics, which reduced the strength of the association.

- *Maternal autonomy*

Maternal autonomy (defined as a woman's personal power in the household and her ability to influence and change her environment) is believed to indicate mother's status in the household. It affects the mother's decision-making power with respect to mobility, finance, healthcare use, and other household activities. Evidence suggests that autonomy of the mother is significantly associated with child nutritional status (Chakraborty & Anderson, 2011; Shroff et al., 2009; Shroff et al., 2011).

Shroff and colleagues (2009) analyzed data from NFHS-2 (1998-99) to examine the relationship between maternal autonomy and child (0-36 months) stunting in Andhra Pradesh, India. Maternal autonomy was measured four dimensions – decision making, permission to travel,

attitude towards domestic violence, and financial autonomy. Results showed that children whose mothers had some money set aside that they could use as they wished were 27% less likely to be stunting compared to those whose mothers did not have [OR=0.73, 95% CI (0.55, 0.98)]. Children whose mothers didn't need permission to go to the market were 41% less likely to be stunting compared to those whose mothers needed permission [OR=0.59, 95% CI (0.38, 0.93)].

Shroff et al. (2011) also studied the relationship between maternal autonomy breastfeeding rate and infant growth in infants 3-5 months of age in rural Andhra Pradesh, India. Maternal autonomy was measured by four different dimensions, which were decision-making, freedom of movement, financial autonomy, and acceptance of domestic violence. Six hundred mother-infant pairs were included in this study. Results indicated that mothers with higher financial autonomy were 1.26 times more likely to be breastfeeding exclusively [OR=1.26, 95% CI (1.00, 1.58)], and mothers with higher participation in decision-making were less likely to have underweight or wasted infants [β=0.167, 95%CI (0.037, 0.297); β=0.263, 95%CI (0.106, 0.421), respectively].

Chakraborty & Anderson (2011) examined the association between mother's autonomy and child birth weight. Maternal autonomy was measured by their decision making power in this study and data came from NFHS-3 (2005-06). Child's birth weight was obtained from health cards or mother's recall. Principle Component Analysis (PCA) was performed to construct a composite score, and this score was further categorized as high, medium, and low to represent maternal autonomy. Results showed that low maternal autonomy was an independent predictor of low birth weight (LBW). Children whose mothers had low autonomy were 1.28 times more likely to

have LBW compared to those whose mothers had high autonomy [OR=1.28, 95% CI: (1.07-1.53)] after adjusting for other factors. Medium autonomy level didn't show significant effect.

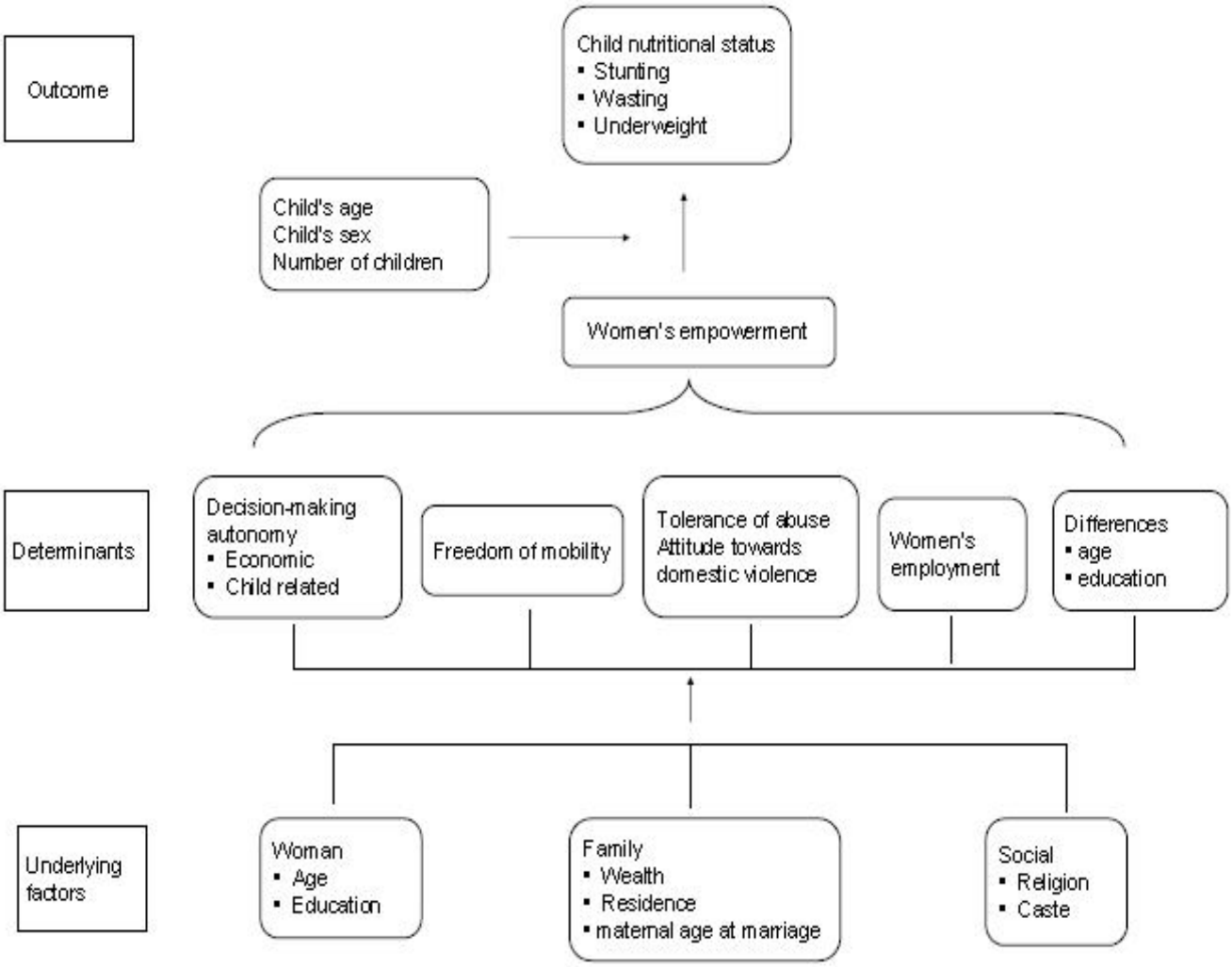
Smith and colleagues (Smith et al., 2003) analyzed Demographic and Health Survey (DHS) data of 36 developing countries and found higher women's status had a significant, positive effect on children's (under three years of age) nutritional status in South Asia, Sub-Saharan Africa and Latin America/Caribbean. In South Asia, increases in women's status had a strong and positive influence on both the long- and short-term nutritional status of children. Also, the Gender Equality and Women's Empowerment in India report showed, at the national level, that among children (0-35 months) of mothers who were employed, children whose mothers earned cash and alone had the main say on the use of their earnings had the lowest underweight prevalence. However, children of mothers who were not employed were less likely to be underweight compared to children of mothers who were employed (MacroInternational, 2007).

5. Conceptual Framework

Based on the literature review, a conceptual framework has been developed to examine the relationship between maternal empowerment and child malnutrition. As illustrated in Figure 1, the outcomes are three indices of child nutritional status, which is stunting, wasting, and underweight. Women's empowerment, which is measured by five dimensions and described in detail below, is hypothesized to be a determinant of child nutritional status. Control variables are child's age, child's sex, and number of other children living together with the target child, and three levels of other underlying factors: a) woman's characteristics, including woman's age and

education, b) family characteristics, including household wealth, place of residence, and mother's age at marriage, and 3) the social context, including mother's religion and caste.

Figure 1 Conceptual framework of this research project



In this study, women's empowerment is measured primarily by taking full account of the end-product dimensions developed by Jejeebhoy (2000) and variables available in the NFHS data set. As the conceptual framework shows in Figure 1, measurement of women's empowerment is

divided into five parts: decision making autonomy; freedom of mobility; tolerance of abuse and attitude towards domestic violence; women's employment; and differences between husbands and wives.

The first component of indicators to measure women's empowerment is their decision making autonomy. It is believed that a woman who has greater control over household economic resources is more able to care for her children because she has the ability to weigh the costs and benefits of alternative uses of resources (Smith, 1995; Smith et al., 2003). For example, the more control a woman has over her own income, her husband's income, or household purchases, the more likely she is to spend the money to purchase special food for her children or medical products to take care of her sick children. And the more likely she is to have a well-nourished child.

The second component is women's freedom of mobility. Women with low status are often restricted in their freedom of mobility and therefore are less likely to go out and interact with people in their community. Thus, they are less likely to either take their sick children to healthcare services or to be exposed to new health and nutrition knowledge. Additionally, women who are less likely to engage in social interactions with people outside their family are less likely to question culturally based beliefs, such as inappropriate food taboos and consumption of high-calorie sugar sweetened but not protein-energy balanced food, which are deleterious to child's nutritional status (Smith et al., 2003).

The third component is women's tolerance of abuse and attitude towards domestic violence. A woman with lower status is more dependent on her husband and thus more likely to accept her inferior state and believe it is justified for a husband to beat his wife. Therefore, she is more likely to experience physical violence and disrespect from her husband or even other household members. All of these factors lead to poor mental health, low self-esteem, and a lack of confidence (Engle et al., 1999; Smith, 1995). In this context, a woman would be less likely to adopt new feeding practices, receive knew information and knowledge, or provide timely health care to her children.

Working women are theorized to have greater decision-making power in financial and household matters (Caldwell, 1982; Mason, 1986). However, women's employment may expose them to more domestic violence, which is often regarded as a measure of a woman's lack of empowerment, in patriarchal societies (Kishor, 2000; Mogford, 2011). Therefore, women's employment is listed as a separate component of women's empowerment.

Indicators of gender equality/inequality and empowerment/disempowerment are considered not to be relevant by definition. "Indicators of equity are designed to compare the status of women and men, while indicators of empowerment are designed to measure roles, attitudes, and rights of women and sometimes men" (Kishor & Gupta, 2009). However, the pairing of the two concepts into one Millennium Development Goal (MDG) shows their mutually dependent relationship; "progress toward gender equality requires women‘s empowerment and women‘s empowerment requires increases in gender equality" (Kishor & Gupta, 2009). Therefore, this study also includes inequality status, such as age and education differences between husband and wife, into

the measurement of women's empowerment. Age difference between spouses is included as an indicator, because it is believed that a wife has less ability to exert power when she is much younger than her husband. Education is also included because more educated mothers tend to have more knowledge and skills to take care of the entire household and have more power at home (Kishor, 2000).

3. Summary

The literature review showed that the definition and measurement of women's empowerment have been widely discussed, many studies have been done to explore the causes of child malnutrition and the ways in which women's empowerment plays a role in child malnutrition, especially in South Asia. However, in Bihar, which has some of the highest levels of child malnutrition in India, not much research has been done on the relationship between women's empowerment and child malnutrition. NFHS-3 questionnaires include more questions that can measure women's empowerment than ever before; therefore, in this study, we use both single indicators and factors representing each dimension to examine the association between women's empowerment and child nutritional status. Additionally, there is no study thoroughly exploring the association between single indicators of women's empowerment and all three indices of child nutritional status (wasting, stunting, underweight). This study aims to fill these research gaps.

Chapter 3: Data and Methods

The data in this study are drawn from the 2005-2006 India National Family Health Survey (NFHS-3), which is also known as the Demographic and Health Survey (DHS). The worldwide DHS project was initiated in 1984 to provide data and analysis on population, health, nutrition, and other issues of concern in developing countries.

"The 2005-2006 National Family Health Survey (NFHS-3) is the third in the NFHS series of surveys. The first (NFHS-1) was conducted in 1992-93 and the second (NFHS-2) was in 1998-99. All three NFHS surveys were conducted under the stewardship of the Ministry of Health and Family Welfare (MOHFW), Government of India. The MOHFW designated the International Institute for Population Sciences (IIPS), Mumbai, as the nodal agency for the surveys. Funding for NFHS-3 was provided by the United States Agency for International Development (USAID), the United Kingdom Department for International Development (DFID), the Bill and Melinda Gates Foundation, UNICEF, UNFPA, and the Government of India. Technical assistance for NFHS-3 was provided by ICF Macro, Calverton, Maryland, USA" (MacroInternational, 2007).

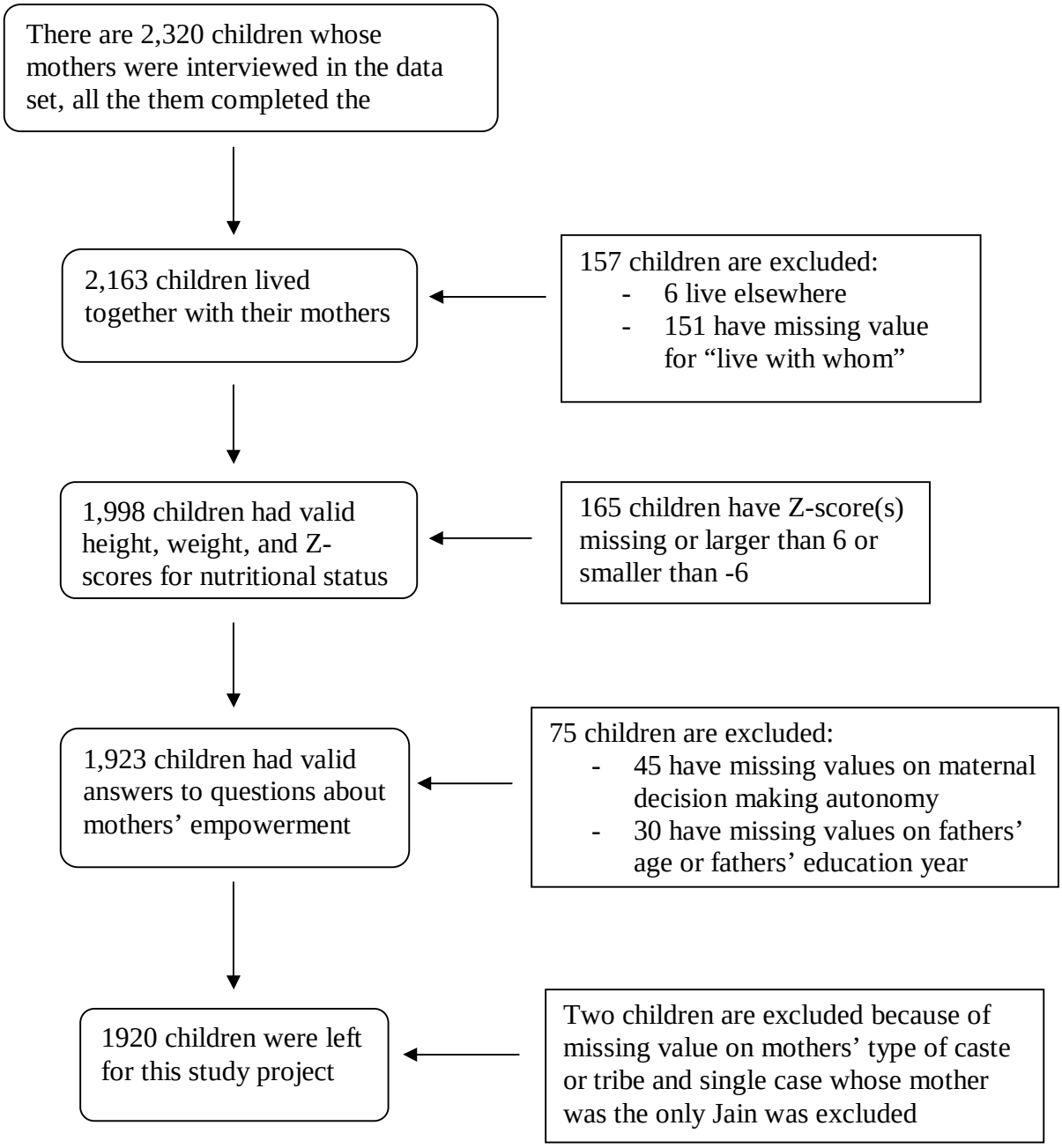
"NFHS-3 collected information from a nationally representative sample of 124,385 women age 15-49 and 74,369 men age 15-54 in 109,041 households, and included questions on fertility, mortality, family planning, HIV-related knowledge, and important aspects of nutrition, health, and health care" (MacroInternational, 2007). Data collected were recoded into different files which are free to download online. Data did not contain any personal indefinable information and that informed consent was obtained from all participants; surveys were approved by the

International Institute for Population Sciences (IIPS) ethical review board. Therefore, this study did not require Emory IRB approval. The children's "recode" file, which was used in this study, contained the entire woman's questionnaire for each child born in the month of the interview and the 59 months preceding. There were 2,320 children under five years of age in Bihar State of India whose mothers were interviewed, of which 1,920 were used in this study. The sample was selected based on the study requirements and data quality (Figure 2)[1]. First, all mothers completed the interview. Second, all children not living with their mothers were excluded because maternal empowerment did not have a direct impact on the nutritional status of children who did not live with their mothers. Third, the marital status of the mothers was married, because most indicators used to measure women's empowerment in this study involved information about their husbands. Fourth, if one of the following values was missing or implausible, is was excluded from the sample: (1) Child nutritional status (children with any height-for-age, weight-for-height, or weight-for-age Z-scores larger than 6 or less than -6, or missing); (2) Indicators of women's status (children whose mothers didn't have a valid answer to any question used to measure women's empowerment); and (3) Control variables and underlying factors (including age and sex of the target child, number of children five years and under living in the same household with the target child, women's age and education level, maternal age at marriage, household wealth, place of residence, mother's religion and caste). 1,921 children were left after data cleaning process, however, for the question asking mother's religion, all mothers answered Hindu or Muslim except one Jain. It was not meaningful to include this one case and keep it as a separate religious category, nor was it appropriate to combine it with either group, so the child of this mother was also excluded from the analysis. Hence, there were 1,920 cases in

[1] Background information of samples excluded from the study is also explored to identify and difference from included samples. See Appendix A.

total for this study project. SAS ® Propriety Software 9.3 (Copyright (c) 2002-2010 by SAS Institute Inc., Cary, NC, USA.) and SAS-Callable SUDAAN Release 11.0.0 were used for the data analysis. Analytical methods to account for the complex sampling and sample weights are used.

Figure 2 Process of sample selection



Dependent variables

The dependent variables are the child nutritional status at the time of measurement. There are three standard indices of physical growth describing the nutritional status of children in this paper: height-for-age (stunting), weight-for-height (wasting), and weight-for-age (underweight). Each of the three nutritional status indices is expressed in standard deviation units (Z-scores) from the median of the reference population in the data set. The reference population used is the World Health Organization's 2006 child growth standards, derived from children around the world (Brazil, Ghana, India, Norway, Oman, and the United States) who were raised in healthy environments, whose mothers did not smoke, and who were fed according to recommended feeding practice (exclusive breastfeeding for the first six months and appropriate complementary feeding from 6 to 23 months) (De Onis, 2006) .

Stunting is an indicator of linear growth retardation and cumulative growth deficits; children whose height-for-age Z-score is below minus two standard deviation (-2SD) from the median of the reference population are considered short for their age (stunted) and are chronically malnourished. Wasting measures body mass in relation to body length to describe current nutritional status; children whose weight-for-age Z-score is below minus two standard deviation (-2SD) from the median of the reference population are considered thin for their height (wasted) and are acutely malnourished. Underweight is a composite index of height-for-age and weight-for-height; children whose weight-for-age Z-score is below minus two standard deviation (-2SD) from the median of the reference population are considered as underweight, taking both acute and chronic malnutrition into account.

Independent variables

Independent variables included five dimensions of indicators used to measure women's empowerment, as described in the conceptual framework. Age and education differences between mother and her husband/partner were measured by absolute years while others were categorical and recoded to different levels based on answers to specific questions.

- *Decision making autonomy*

Five variables were included to measure women's decision making autonomy: (1) who decides how the cash income the woman earns herself will be used; (2) who decides how the husband's earnings will be used; (3) who usually makes decisions about health care for the woman herself; (4) who usually makes decisions about making major household purchases; and (5) who usually makes decisions about making purchases for daily household needs. Answers available in the survey were "respondent alone", "respondent and husband/partner", "respondent and other person", "husband/partner alone", "someone else", and "other", except there was no "other" as an answer for the first question. Since all respondents were married and nobody answered "respondent and other person" throughout the survey, mothers who answered "respondent alone" were considered having the main say on decision making. Mothers who answered "respondent and husband" were considered having a joint say on decision making. And mothers who answered "husband alone" or "someone else" were considered having no main say on decision making. They were grouped together because both reflect similar levels of maternal empowerment. Respondents with the answer "other" were excluded for the specific indicator only because they were less than five percent and this percentage was too low for meaningful interpretation.

Respondents with the answer "other" to "who decides how the husband's earnings will be used" were not excluded because they accounted for 15% of all cases. However, respondents whose husbands had no earnings were excluded for this question because there were less than 2% of respondents whose husbands have no earnings. Therefore, answers to question (1) were categorized in five levels: a) earns cash and has main say alone in earnings use, b) earns cash and has joint say in earnings use, c) earns cash, no main say in earnings use, d) employed but does not earn cash, and e) has not been employed. Answers to question (2) were categorized in four levels: a) mainly alone, b) joint, c) no main say, and d) other. For question (3) to (5), answers are recoded to three categories as "mainly alone", "jointly", and "no main say." The last level was interpreted as having the lowest decision making autonomy and was set to be the reference group.

- *Freedom of mobility*

Four variables were encompassed to measure women's freedom of mobility: (1) who usually makes decisions about visits to the woman's family or relatives; (2) whether the mother is allowed to go to the market alone, with someone else, or not at all; (3) whether the mother is allowed to go to the health facility alone, with someone else, or not at all; and (4) whether the mother is allowed to go to places outside the village alone, with someone else, or not at all. Answers to question (1) were the same as those for decision making autonomy questions[2] and were also recoded to three categories as "mainly alone", "jointly", and "no main say" while "other" was excluded. And answers to question (2) to (4) were "alone", "with someone else" and

[2] Association between these indicators and child nutritional status were also calculated with each answer as a separate level to provide data justification for the recoding, see Appendix B. Results indicate that respondents who answered "someone else" are less likely to have stunted children. In order to check if the nutritional status of children whose mothers answered "someone else" was different from others, dummy variables were created for "someone else" to examine the association between new variables and child nutritional status. There is no body answering 'someone else' for question "who usually decides how the husband's earning to be used", dummy variable for "other" is created to check the difference. See Appendix C.

"not at all" and kept without recoding. The women who had no main say on visiting family or relatives, or who were not allowed go out at all, were interpreted as having the least freedom of mobility and was set as the reference group.

- *Tolerance of abuse and attitude towards domestic violence*

Seven variables were used to measure women's tolerance of abuse and attitude towards domestic violence: in the woman's opinion, a husband is justified in hitting or beating his wife (1) if she goes out without telling him; (2) if she neglects the house or the children; (3) if she argues with him; (4) if she refuses to have sex with him; (5) if she doesn't cook properly; (6) if he suspects her of being unfaithful; and (7) if she shows disrespect for in-laws. The majority of women interviewed answered "yes" or "no", and respondents who answered "don't know" were excluded only when exploring the relationship between this specific indicator and children nutritional status, and factor analysis[3].

- *Maternal employment and husband-wife difference*

Mothers who were employed or had been employed for the past year were considered employed, while others were coded as unemployed. Husband-wife differences were indicated by age and education differences. Since women with lower empowerment were assigned larger values for former indicators (e.g., "1" for "main say alone, "2" for "jointly", and "3" for "no main say"), the age difference was husband's age minus wife's age, while the education difference was husband's education year minus wife's education year. It is believed that the larger the difference, the less power the mother has.

[3] Mothers who answered "don't know" didn't have similar effect on nutritional status of children with mothers who answered "yes" or "no", and this group is too small to be listed as a separate level, see Appendix D.

- *Control variables*

Child's age in month, mother's age, and maternal age at marriage age were continuous variables in the data set. In descriptive analysis, child's age was categorized to 0-11, 12-23, and 24-59 months, since prevalence of child chronic malnutrition became stable after two years old (Victora et al. 2010); mother's age was categorized to <=25, 26-30, 31-35, and 36+; and maternal age at marriage was categorized to <=16 and 17+ years old since early marriage was extremely common in Bihar. Child's sex was a dichotomous variable. Number of other children five years and under who were living in the same household was used because it was believed that only those children competed for resources and the mother's care of the target child. Mother's education level was recoded as "no education", "primary", "secondary and higher" instead of "no education", "primary", "secondary" and "higher" in the original data set because there were few mothers who had an education level higher than secondary in Bihar. Place of residence was a dichotomous variable with "urban" and "rural". Mothers' religion was Hindu or Muslim. Caste or tribe was recoded as scheduled and not scheduled.

Household wealth, which was calculated from the wealth index factor score, was an ordinal variable including five levels: poorest, poorer, middle, richer, and richest. The wealth index score was constructed from the household-level data collected from the survey using Principle Components Analysis (PCA). Household-level data included "ownership of items ranging from furniture and vehicles; to dwelling characteristics such as water source, sanitation facilities, and the home's construction materials; and to whether a household member had a bank or post office account." (MacroInternational, 2007) Each asset was assigned a standardized scoring coefficient obtained from PCA, and the resulting asset scores were standardized to a standard normal

distribution. The sum of the scores of the assets possessed by each household resulted in that household's wealth index factor score. The sample was then divided into population quintiles and the distribution represents the national household population.

Survey procedures in SAS and SAS-Callable SUDAAN were used to calculate mean and standard error of children's anthropometric Z-scores, children's age in months, number of children under five living together with the target child, mothers' age, mothers' age at marriage, and wealth level. The percentages of children who were, or severely stunting, wasting, or underweight, distribution of child's age, sex, number of children five years or under living in the same household, women's age, education level, household wealth, place of residence, maternal age at marriage, religion, and caste, and women's empowerment indicators were calculated. The distribution of child nutritional status by baseline characteristics was calculated and Rao-Scott chi-square tests were applied to check whether there is an association between each variable and nutritional status.[4] Logistic regression was performed to calculate the crude and adjusted odds ratios between women's empowerment and child nutritional status and linear regression[5] was also used to check if there are linear relationships between women's empowerment indicators and child nutritional status Z-scores. Finally, factor analysis was done to pick up reduced factors representing women's empowerment to predict child nutritional status.

[4] Rao-Scott chi-square tests are also applied to check whether there is a gender difference in child nutritional status by level of maternal empowerment. There is no consistent gender difference so the results are presented pooled in Appendix E.

[5] For the linear regression, base model including all covariates as independent variables were built first, then each indicator of women's empowerment was added separately to see how much more variance it explained. Then all indicators were added into the base model, and backward elimination process was done to eliminate the least significant indicator one at a time to see which indicator explained more variance of child nutritional status Z-scores. Examining these relationships did not provide any additional insight compared to just examining dummy variables in the logistic regression, results are presented at Appendix F.

Most of the indicators of women's empowerment were categorical (ordinal or dichotomous). Pearson or Spearman correlations tends to under estimate the true correlation between a set of observed categorical variables as correlation coefficients are calculated as if the variables were continuous. An analytic approach that could generate unbiased correlations among a set of categorical variables was therefore needed. This problem was remedied by using polychoric Principle Component Analysis (PCA). This technique proceeds by first estimating the polychoric correlation between theorized normally distributed continuous latent variables generated from observed ordinal variables (Jöreskog, 1994). The resultant polychoric correlation matrix is then analyzed using factor analysis with SAS® System's PROC FACTOR procedure, utilizing the VARIMAX rotation. The polychoric PCA was very appropriate for the current investigation as all Polychoric coefficients were stronger than both the Pearson and or Spearman correlation coefficients for all variables considered in the study sample, examples are shown in Appendix G.

Factor analysis is a statistical method used to describe variability among observed or correlated variables with the aim reducing the number of measure variables into unobserved variables called factors (Kline, 1993). The objective of factor analysis in this study was to determine the minimum number of factors that will adequately explain the variance of all 19 variables used to measure women's empowerment and to study variable aggregation patterns that exist in the data. The factors retained are then used as independent variables to predict child nutritional status. The elements of the Factor Pattern reflect the unique variance each factor contributes to the variance of an observed variable (Kline, 1993). Because of the rotated factor aggregation patterns captured by the factor analyses, a set of aggregated variables that load equally provide the identical variance information and can thus be represented by one variable in subsequent

multivariate analyses. Linear and logistic regression models are built to examine the crude and adjusted relationship between reduced factors together and child nutritional status.

Chapter 4 Results

Table 1 presents descriptive statistics of the sample, including information on child, mother and household demographic characteristics. The mean Z-score of height-for-age, weight-for-height, and weight-for-age is -2.2, -1.4, and -2.2, respectively. The prevalence of stunting, wasting, underweight is 55.7%, 27.2%, and 56.2, respectively. It is also notable that 29.6% children are severely stunting and 24.5% are severely underweight (Z-score < -3SD). Forty-seven percent of the sample is female and their average age is 30 months old. On average, there are two other children who are five years old or under living in the same household with the target child, and about 8% of children live together with four or more other children five years old or under. Mothers of 1,357 households are included in this study with an average age of 27 years, and nearly half of them are 25 years old or younger. Around 70% of them have no education, and more than 60% got married at 16 years old or younger. A little more than 80% of them are Hindu, and the rest are Muslim. Nearly 80% of them are in a scheduled caste. As for the households they live in, nearly 90% are located in rural areas and about 31% of the households are in the poorest wealth level.

Table 1 Baseline characteristics of mothers, children, and household in Bihar, India, NFHS-3 survey data, 2005-2006

Characteristics	n	Mean (SE) / Percentage
Children, n=1920		
Anthropometric		
Height-for-age Z-score		-2.2 (0.05)
Weight-for-height Z-score		-1.4 (0.03)
Weight-for-age Z-score		-2.2 (0.04)

Stunting		
<-2SD height-for-age Z-score	1041	55.8%
<-3SD height-for-age Z-score	534	29.6%
Wasting		
<-2SD weight-for-height Z-score	518	27.2%
<-3SD weight-for-height Z-score	154	8.2%
Underweight		
<-2SD weight-for-age Z-score	1048	56.2%
<-3SD weight-for-age Z-score	451	24.5%
Children's age in months		29.7 (0.36)
0-11	385	20.3%
12-23	398	20.7%
24-59	1138	59.0%
Children's sex		
Female	915	47.1%
Male	1005	52.9%
Number of children under 5 living together		2.0 (0.05)
0	148	7.4%
1	489	25.3%
2	732	38.5%
3	412	21.1%
4+	139	7.7%
Mothers, n=1357		
Mother's age		26.7 (0.18)
<=25	640	48.4%
26-30	392	28.0%
31-35	200	14.1%
36+	125	9.5%
Mother's education		
No education	860	67.7%
Primary	136	10.4%
Secondary and higher	361	21.9%
Maternal age at marriage		16.0 (0.10)
<=16	804	63.7%
17+	553	36.3%
Religion		

Hindu	1092	81.5%
Muslim	265	18.5%
Caste		
Scheduled	248	20.5%
Not scheduled	1109	79.5%
Household, n=1357		
Residence		
Urban	420	11.7%
Rural	937	88.3%
Wealth level		
1 (poorest)	365	30.7%
2 (poorer)	394	32.2%
3 (middle)	234	17.9%
4 (wealthier)	211	13.1%
5 (wealthiest)	153	6.3%

NFHS, National Family Health Survey; SE, standard error.

Table 2 describes the situation of women's status. Thirty-four percent women are employed, among which half have cash income and most play a role in deciding their own earnings use. Half of mothers have no main say in their own health care or making large household purchases. Even regarding making purchases for daily needs, the percentage of mothers who have no main say is still as high as 41%. Almost all (98%) husbands have earnings and about 60% of mothers have a say on the husbands' earnings use. Households in which husbands don't have earnings, wives are also not employed (not shown in the table). Above 90% mothers can not decide about making visits to their own family or relatives alone. A relatively smaller group of mothers are not allowed to go to the market, a health facility, or outside the village at all (14%, 4%, 16%, respectively); more than half of the rest are only allowed to go with someone else. Above 65% of mothers think it's not justified for a husband to beat his wife under certain circumstances. And

40% mothers think it is not justified for a husband to beat his wife under all seven scenarios (results not shown). On average, a husband is six years older than his wife and has three years more education.

Table 2 Distribution of maternal empowerment indicators in Bihar, India, NFHS-3 survey data, 2005-2006, n=1357*

Indicator of women's empowerment	n (%)
Decision making autonomy	
Mother's main say in earning use	
- Earns cash, has main say alone in earnings use	57 (4.4)
- Earns cash and has joint say in earnings use	119 (9.3)
- Earns cash, no main say in earning use	25 (2.2)
- Employed but doesn't earn cash	202 (18.2)
- Not employed	954 (65.9)
Mother's say in own health care n=1320	
- Mainly alone	277 (21.8)
- Jointly	423 (32.2)
- No main say	620 (46.0)
Mother's say in making large household purchase n=1298	
- Mainly alone	99 (8.7)
- Jointly	560 (42.4)
- No main say	639 (48.9)
Mother's say in making purchase for daily needs n=1296	
- Mainly alone	385 (30.2)
- Jointly	366 (28.6)
- No main say	545 (41.2)
Mother's say in husband's earnings n=1329	
- Mainly alone	145 (11.9)
- Jointly	702 (51.8)
- No main say	276 (20.3)
- Other	207 (16.0)
Freedom of mobility	

Mother's say in making visits to own family or relatives n=1308	
- Mainly alone	98 (7.9)
- Jointly	615 (45.8)
- No main say	595 (46.3)
Allowed to market	
- Alone	560 (37.6)
- With someone else	610 (48.1)
- Not at all	187 (14.3)
Allowed to go to health facility	
- Alone	530 (36.1)
- With someone else	780 (60.2)
- Not at all	47 (3.8)
Allowed to go outside village	
- Alone	417 (30.3)
- With someone else	744 (54.1)
- Not at all	196 (15.7)
Tolerance of abuse & Attitude towards domestic violence	
In respondent's opinion, it's justified for husband to beat his wife if	
she goes out without permission	
- Yes	328 (24.4)
- No	1027 (75.5)
- Don't know	2 (0.1)
she neglects the child	
- Yes	271 (21.2)
- No	1086 (78.8)
she argues with him	
- Yes	443 (33.9)
- No	911 (65.8)
- Don't know	3 (0.3)
she refuses to have sex with him	
- Yes	142 (11.6)
- No	1203 (87.6)
- Don't know	12 (0.8)
she burns the food	217(17.4)
- Yes	1138 (82.4)
- No	2 (0.2)

- Don't know	
wife is unfaithful	
- Yes	359 (27.2)
- No	985 (71.9)
- Don't know	13 (1.0)
wife is disrespect to in-laws	
- Yes	432 (32.0)
- No	914 (67.2)
- Don't know	11 (0.8)
Maternal employment	
Mother was employed during past year	403 (34.1)
Husband-wife differences	
Husband-wife age difference	5.7 (0.18)**
Husband-wife education year difference	3.10 (0.15)**

*There are cases excluded from specific question as described in the Method section;
**Husband-wife age and education year differences are described as mean (standard error).

Table 3 presents child nutritional status by control variables between women's empowerment and child nutritional status, as well as underlying factors of child nutritional status. Children's age is highly significantly related to stunting, wasting, and underweight. Prevalence of stunting in children 12-23 months are similar with that in children 24 months and older, but are much higher than children 0-11 months. There is no significant relationship between child's sex and nutritional status in the sample of this study. The number of children under five years living in the same household as the target child is associated with stunting but not wasting or underweight. Mother's age is related to all three indices, and the prevalence of stunting and underweight increases with the increasing of mother's age. The higher the mothers' education level, the lower the prevalence of children stunting, wasting, and underweight. The prevalence of stunting and underweight is lower in children whose mothers married at 17 or older compared to children whose mothers married at 16 or younger, while the prevalence difference of wasting is not

statistically significant. Mother's religion is not associated with child nutritional status. Children of mothers in non-scheduled castes or tribes have a lower prevalence of stunting, wasting, and underweight. For stunting and underweight, children living in an urban area have a lower prevalence than those in rural areas, and there is a clear trend showing that children that living in wealthier households have a lower prevalence. However, these relationships are not clear for wasting.

Table 3 Association between baseline characteristics and child nutritional status in Bihar, India, NFHS-3 survey data, 2005-2006, n=1920

Characteristics	Stunting (%)	Wasting (%)	Underweight (%)
Children's age in months			
0-11	28.5**	38.5**	44.9**
12-23	56.1	35.3	57.4
24-59	65.0	20.5	59.6
Children's sex			
Female	57.4	28.6	54.4
Male	54.3	25.8	58.1
Number of children under 5 living together			
0	50.0*	25.8	54.8
1	53.2	28.1	54.3
2	60.2	26.7	59.0
3	50.1	27.8	51.8
4+	62.7	27.0	61.6
Mother's age			
<=25	52.2**	30.5*	53.6*
26-30	57.4	23.6	54.9
31-35	57.1	27.1	60.4
36+	67.7	21.5	67.9
Mother's education			
No education	61.4**	29.5**	61.8**
Primary	48.1	22.6	49.9
Secondary and higher	40.9	22.0	40.7

Maternal age at marriage			
<=16	59.6**	28.1	59.4**
17+	49.0	25.7	50.6
Religion			
Hindu	54.9	27.7	55.3
Muslim	59.2	25.5	59.8
Caste			
Scheduled	67.9**	33.0*	68.7**
Not scheduled	52.8	25.8	53.1
Residence			
Urban	48.6*	26.0	48.8*
Rural	56.7	27.4	57.1
Wealth level			
1 (poorest)	63.9**	29.5	65.9**
2	59.3	28.9	58.6
3	56.4	25.7	53.1
4	40.4	24.0	44.5
5 (wealthiest)	24.4	17.3	25.2

*p<0.05 significant;
**p<0.01 significant

Association between mothers' decision making autonomy and children nutritional status

Before adjusting for other factors and as shown in Table 4, compared to mothers who are not employed, mothers who earn cash and have joint say in earnings use with their husbands are 1.5 times more likely to have stunted children [OR=1.5, 95% CI (1.1, 2.2)], and are 1.4 times more likely to have underweight children [OR=1.4, 95% CI (1.0, 2.1)], but are 40% less likely to have wasted children [OR=0.6, 95% CI (0.4, 1.0)]. Mothers who are employed but don't have cash income are 1.7 times more likely to have stunted children [OR=1.7, 95% CI (1.3, 2.2)], and 1.6 times more likely to have underweight children [OR=1.6, 95% CI (1.3, 2.0)], than mothers who are not employed. Mothers who decide their own health care jointly with their husbands are 1.3 times more likely to have stunted children [OR=1.3, 95% CI (1.1, 1.6)]. Mothers who have the

main say in making daily purchases are 1.5 times more likely to have stunted children compared to those who have no say[OR=1.5, 95% CI (1.2, 2.0)]. And mothers who play a role in making daily purchases are more likely to have underweight children [mainly alone vs. no main say: OR=1.4, 95% CI (1.1, 1.8); jointly with husband vs. no main say: OR=1.5, 95% CI (1.1, 1.9)]. Mothers whose husbands' earnings are decided by "other" are also 30% less likely to have stunted children [OR=0.7, 95% CI (0.5, 0.9)]. (Table 4)

After adjusting for other factors, mothers who earn cash and have joint say in earnings use with their husbands are still 40% less likely to have wasted children [OR=0.6, 95% CI (0.3, 0.9)]. And mothers who have joint say in making daily household purchases are 1.3 times more likely to have wasted children [OR=1.3, 95% CI (1.0, 1.7). (Table 4)

Association between mothers' freedom of mobility and children nutritional status

Before adjusting for other factors and as shown in Table 5, mothers who are allowed to go to a health facility alone or with someone else are less likely to have wasted children compared to mothers who are not allowed to go to a health facility at all [alone vs. not at all: OR=0.6, 95% CI (0.3, 1.0); with someone else vs. not at all: OR=0.5, 95% CI (0.3, 0.9)]. After adjusting for all factors, mothers who are allowed to go to a health facility with someone else are still significantly less likely to have wasted children compared to those who are not allowed at all [OR=0.6, 95% CI (0.3, 1.0)]. Mothers who are allowed to go to the market alone are 1.4 times more likely to have wasted children compared to those who are not allowed at all[OR=1.4, 95% CI (1.1, 2.0)]. (Table 5)

Association between indicators of mothers' tolerance of abuse & attitude towards domestic violence and children nutritional status

Before adjusting for other factors and as shown in Table 6, mothers who think it's unjustified for a husband to beat his wife if she goes out without telling are 30% less likely to have stunted children compared to those who think it's justified [OR=0.7, 95% CI (0.6, 1.0)]. Mothers who think it's unjustified to be beaten by their husbands if they don't cook food properly are also 30% less likely to have stunted children compared to those who think it's justified [OR=0.7, 95% CI (0.5, 1.0)]. Children whose mothers have no tolerance under all seven circumstances are 30% less likely to be underweight [OR=0.7, 95% CI (0.6, 1.0)] (results not shown in the table). After adjusting for other factors, mothers who think it's unjustified to be beaten by their husbands if they don't cook properly are 1.4 times more likely to have wasted children compared to those who think it's justified [OR=1.4, 95% CI (1.0, 1.9)]. (Table 6)

Association between other indicators of women's empowerment and children nutritional status

Before adjusting for other factors and as shown in Table 6, mothers who are employed during the past year are 1.6 times more likely to have stunted children [OR=1.6, 95% CI (1.3, 1.9)], and are 1.5 times more likely to have underweight children [OR=1.5, 95% CI (1.3, 1.8)], than mothers who are not employed. With one year increase of husband's age minus wife's age, their children are 1.04 times more likely to be stunted or underweight [for stunting: OR=1.04, 95% CI (1.01, 1.07); for wasting: OR=1.04, 95% CI (1.01, 1.06)]. After adjusting for other factors, with one year increase of husband's age minus wife's age, their children are 1.03 times more likely to be stunted [OR=1.03, 95% CI (1.00, 1.05)]. Mothers who are employed during the past year are 30% less likely to have wasted children [OR=0.7, 95% CI (0.5, 1.0)]. Education differences do

not show significant association with child nutritional status. Forty-one percent of mothers have the same education level as their husbands and 53.0% of mothers have lower education level than their husbands. Mothers who have the similar education as their husbands are 30% more likely to have stunted or underweight children compared to mothers who have less education than their husbands before adjusting for other factors [for both: OR=1.3, 95% CI (1.0, 1.6), results not shown in the table). (Table 7)

Table 4 Association between indicators of mothers' decision-making autonomy and nutritional status of children under five in Bihar, India, NFHS-3 survey data, 2005-2006, n=1920) ***

	Stunting		Wasting		Underweight	
	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Mother's employment and main say in earning use						
- Earns cash and has main say alone in earnings use	1.4 (0.9, 2.2)	0.9 (0.6, 1.5)	1.1 (0.7, 1.8)	0.9 (0.5, 1.6)	1.5 (0.9, 2.5)	1.0 (0.6, 1.7)
- Earns cash and has joint say in earnings use	1.5* (1.1, 2.2)	1.0 (0.7, 1.5)	0.6* (0.4, 1.0)	0.6* (0.3, 0.9)	1.4* (1.0, 2.1)	1.0 (0.6, 1.5)
- Earns cash, no main say in earnings use	1.0 (0.4, 2.3)	0.8 (0.3, 1.9)	0.6 (0.3, 1.5)	0.5 (0.2, 1.2)	1.0 (0.4, 2.3)	0.7 (0.3, 1.7)
- Does not earn cash	1.7** (1.3, 2.2)[b]	1.1 (0.8, 1.4)	0.9 (0.7, 1.3)	0.8 (0.6, 1.1)	1.6** (1.3, 2.0) [b]	1.1 (0.8, 1.4)
- Not employed	Reference	Reference	Reference	Reference	Reference	Reference
Mother's say in own health care n=1873						
- Mainly alone	1.2 (1.0, 1.6)	1.1 (0.8, 1.4)	1.0 (0.8, 1.4)	1.1 (0.8, 1.5)	1.1 (0.8, 1.4)	0.9 (0.7, 1.2)
- Jointly	1.3* (1.0, 1.6)	1.1 (0.9, 1.3)	1.0 (0.8, 1.3)	1.1 (0.8, 1.4)	1.1 (0.8, 1.3)	0.9 (0.7, 1.1)
- No main say	Reference	Reference	Reference	Reference	Reference	Reference
Mother's say in making large household purchases n=1841						
- Mainly alone	1.3 (0.9, 1.9)	1.0 (0.6, 1.6)	1.1 (0.7, 1.8)	1.3 (0.8, 2.0)	1.4 (0.9, 2.2)	1.2 (0.7, 1.9)
- Jointly	1.1 (0.9, 1.4)	0.9 (0.7, 1.2)	1.0 (0.8, 1.3)	1.1 (0.8, 1.4)	1.1 (0.9, 1.4)	0.9 (0.7, 1.2)
- No main say	Reference	Reference	Reference	Reference	Reference	Reference
Mother's say in making purchases for daily needs n=1839						
- Mainly alone	1.5** (1.2, 2.0)[b]	1.2 (0.9, 1.6)	1.1 (0.8, 1.4)	1.2 (0.9, 1.5)	1.4* (1.1, 1.8)	1.1 (0.8, 1.4)
- Jointly	1.3 (1.0, 1.7)	1.1 (0.8, 1.5)	1.2 (1.0, 1.6)	1.3* (1.0, 1.7)	1.5** (1.1, 1.9)	1.2 (0.9, 1.6)
- No main say	Reference	Reference	Reference	Reference	Reference	Reference
Mother has a say in husband's earnings n=1884						
- Mainly alone	1.5 (1.0, 2.3)	1.5 (0.9, 2.4)	1.4 (0.9, 2.2)	1.5 (0.9, 2.4)	1.5 (1.0, 2.3)	1.5 (0.9, 2.3)
- Jointly	1.1 (0.9, 1.5)	1.1 (0.8, 1.4)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)
- Other	0.7** (0.5, 0.9)	0.9 (0.7, 1.3)	1.2 (0.8, 2.0)	1.3 (0.8, 2.0)	0.8 (0.6, 1.2)	1.2 (0.8, 1.7)
- No main say	Reference	Reference	Reference	Reference	Reference	Reference

*p<0.05 significant;
**p<0.01 significant;
***Control variables: child age in months, number of other children five years or under living in the same household, mother's age, and maternal age at marriage as continuous variables; and child sex, mother's education level, mother's religion, mother's caste, household region, and household wealth level as categorical variables;
[b]: significant for Bonferroni tests (p< 0.0026).

Table 5 Association between indicators of mothers' freedom of mobility and nutritional status of children under five in Bihar, India, NFHS-3 survey data, 2005-2006, n=1920***

	Stunting		Wasting		Underweight	
	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Mother's say in making visits to own family or relatives n=1854						
- Mainly alone	1.4 (0.9, 2.1)	1.0 (0.7, 1.6)	1.0 (0.6, 1.7)	1.1 (0.7, 1.8)	1.3 (0.8, 2.0)	1.0 (0.6, 1.6)
- Jointly	1.1 (0.9, 1.4)	0.9 (0.7, 1.1)	1.1 (0.8, 1.4)	1.2 (0.9, 1.5)	1.1 (0.9, 1.4)	0.9 (0.7, 1.2)
- No main say	Reference	Reference	Reference	Reference	Reference	Reference
Allowed to go to market						
- Alone	1.1 (0.8, 1.5)	1.0 (0.7, 1.4)	1.3 (0.9, 1.9)	1.4* (1.1, 2.0)	1.3 (0.9, 1.7)	1.2 (0.8, 1.6)
- With someone else	1.2 (0.9, 1.7)	1.2 (0.9, 1.6)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)	1.2 (0.8, 1.7)	1.2 (0.8, 1.6)
- Not at all	Reference	Reference	Reference	Reference	Reference	Reference
Allowed to go to health facility						
- Alone	0.9 (0.5, 1.4)	0.8 (0.5, 1.2)	0.6* (0.3, 1.0)	0.7 (0.4, 1.1)	0.9 (0.5, 1.6)	0.9 (0.5, 1.5)
- With someone else	0.8 (0.5, 1.4)	0.8 (0.5, 1.2)	0.5* (0.3, 0.9)	0.6* (0.3, 1.0)	0.8 (0.5, 1.5)	0.9 (0.5, 1.5)
- Not at all	Reference	Reference	Reference	Reference	Reference	Reference
Allowed to go to places outside the village						
- Alone	1.0 (0.7, 1.4)	1.0 (0.7,1.4)	1.1 (0.8, 1.7)	1.2 (0.8, 1.8)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)
- With someone else	0.9 (0.7, 1.3)	1.0 (0.7, 1.4)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)
- Not at all	Reference	Reference	Reference	Reference	Reference	Reference

*p<0.05 significant;

***Control variables: child age in months, number of other children five years or under living in the same household, mother's age, and maternal age at marriage as continuous variables; and child sex, mother's education level, mother's religion, mother's caste, household region, and household wealth level as categorical variables.

Table 6 Association between indicators of mothers' tolerance of abuse & attitude towards domestic violence and nutritional status of children under five in Bihar, India, NFHS-3 survey data, 2005-2006, n=1920***

	Stunting		Wasting		Underweight	
	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Whether the mother think it's justified to be beaten by her husband if						
Go out without telling n=1918						
- No	0.7* (0.6, 1.0)	0.9 (0.7, 1.1)	1.0 (0.8, 1.2)	1.0 (0.8, 1.3)	0.8 (0.6, 1.1)	0.9 (0.7, 1.2)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Neglect the house or children						
- No	0.8 (0.6, 1.0)	0.9 (0.6, 1.2)	1.0 (0.8, 1.3)	1.1 (0.8, 1.4)	0.8 (0.6, 1.1)	0.9 (0.6, 1.2)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Argue with him n=1917						
- No	0.9 (0.7, 1.1)	1.0 (0.8, 1.2)	1.0 (0.8, 1.2)	1.1 (0.8, 1.3)	0.9 (0.7, 1.1)	0.9 (0.8, 1.2)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Refuse to have sex with him n=1906						
- No	0.8 (0.6, 1.1)	0.9 (0.7, 1.3)	1.0 (0.7, 1.5)	1.1 (0.8, 1.7)	0.9 (0.6, 1.2)	1.0 (0.7, 1.4)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Doesn't cook food properly n=1915						
- No	0.7* (0.5, 1.0)	0.8 (0.6, 1.1)	1.3 (0.9, 1.7)	1.4* (1.0, 1.9)	0.9 (0.7, 1.2)	1.1 (0.8, 1.5)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Wife is suspected unfaithful n=1900						
- No	1.0 (0.8, 1.3)	1.1 (0.9, 1.4)	1.1 (0.9, 1.3)	1.2 (1.0, 1.4)	1.0 (0.8, 1.2)	1.1 (0.9, 1.4)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Wife is disrespect for in-laws n=1903						
- No	0.8 (0.7, 1.1)	0.9 (0.7, 1.2)	1.0 (0.8, 1.2)	1.0 (0.8, 1.3)	0.8 (0.6, 1.0)	0.9 (0.7, 1.2)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference

*p<0.05 significant;

***Control variables: child age in months, number of other children five years or under living in the same household, mother's age, and maternal age at marriage as continuous variables; and child sex, mother's education level, mother's religion, mother's caste, household region, and household wealth level as categorical variables.

Table 7 Association between indicators of mothers' employment and husband-wife differences and nutritional status of children under five in Bihar, India, NFHS-3 survey data, 2005-2006, n=1920***

	Stunting		Wasting		Underweight	
	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Mother employed during past year						
Yes	1.6** (1.3, 1.9)[b]	1.0 (0.8, 1.3)	0.8 (0.6, 1.1)	0.7* (0.5, 1.0)	1.5** (1.3, 1.8)[b]	1.0 (0.8, 1.2)
No	Reference	Reference	Reference	Reference	Reference	Reference
Husband-wife age difference	1.04** (1.01, 1.07) [b]	1.03* (1.00, 1.05)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.04** (1.01, 1.06)	1.0 (1.0, 1.1)
Husband-wife education year difference	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)

*p<0.05 significant;
**p<0.01 significant;
***Control variables: child age in months, number of other children five years or under living in the same household, mother's age, and maternal age at marriage as continuous variables; and child sex, mother's education level, mother's religion, mother's caste, household region, and household wealth level as categorical variables;
[b]: significant for Bonferroni tests (p< 0.0026).

Factor Analysis

There are five eigenvalues greater than 1, therefore five factors are kept for further investigation. Over 70% of the variance was explained by the five factors (Table 8). Results of eigenvalues for all factors, the scree plot, and rotated factor pattern are shown in Appendix G. Variable aggregation patterns are similar to the five dimensions in the conceptual framework except (1) final say on mothers' own cash income is grouped together with mothers' employment instead of decision-making autonomy; (2) final say in visiting own family or relatives is grouped together with the four remaining indicators of decision-making autonomy; (3) for husband-wife education year difference, all loadings of the five factors are smaller than 0.5. The five dimensions based on the factor analysis are: a), mother's tolerance of domestic violence (including all seven questions in the data set); b), decision making power (including final say on visiting own family or relatives, making major household purchase, making daily household purchase, owning health care, and how to spend husband's earnings); c), freedom of mobility (including whether it's allowed to go to health facility, outside village, or market, alone, with someone else, or not at all); d), maternal employment and income (including whether the mother is employed and has final say on her own cash income if there is any); and e), husband-wife differences (husband-wife age difference).

Table 8 Eigenvalues and variance explained of all five factors retained

Factor	Eigenvalue	Proportion	Cumulative
1	4.53735890	0.2388	0.2388
2	3.84353110	0.2023	0.4411
3	2.27627585	0.1198	0.5609
4	1.70903528	0.0899	0.6509

Factor	Eigenvalue	Proportion	Cumulative
5	1.00491877	0.0529	0.7037

Variables grouped in each factor have similar loading and explain the most variance of a specific factor (i.e., having the largest loading value) of each group is selected to represent this factor. For example variables for "if the woman thinks a husband is justified in beating his wife if she doesn't cook properly" aggregated factor 1, which falls under the broad theme of *tolerance of domestic violence*. The other themes that emerged include: *decision making power* for variables capturing "who usually makes decisions about visits to the woman's family or relative" represent factor 2. Questions regarding "whether the woman is allowed to go to a health facility" represent factor 3 under the *freedom of mobility* theme; while responses to questions like "who decides how the cash income the woman earns herself will be used" represented factor 4 (*maternal employment and income*), and "husband-wife age difference" is selected to represent factor 5 (*husband-wife differences*).

Linear regression results show that the variances explained by all the five variables representing the corresponding themes of the 5 factors were 1.7%, 0.04% and 1.5% respectively for height-for-age Z-score (HAZ), weight-for-height Z-score (WHZ), and weight-for age Z-score (WAZ). When control variables are included in the prediction models, the amount of explained variance increases to 12.7%, 3.3% and 8.7% for HAZ, WHZ and WAZ respectively. In examining the observed associations denoted by the factor analyses themes, maternal decision making power and maternal employment and income (higher scores means less power) are positively related to child height-for-age and weight-for-age Z-scores, which indicates that higher power of these two dimensions lead to poorer nutritional status (lower height-for-age and weight-for-age Z-scores).

Bothe of these relationships are in the unexpected direction. On the other hand, larger husband-wife differences are negatively related to child nutritional status (lower height-for-age and weight-for-age Z-scores), as expected. However, after adjusting for other covariates, only husband-wife differences remain significantly negatively related to child nutritional status.

Logistic regression results show that the predictive effects (represented by area under the curve) of five factors together are 58.6%, 54.8%, and 58.3% for stunting, wasting, and underweight, respectively. The predictive abilities increased to 69.5%, 64.8%, and 65.3%, respectively after adjustment. After adjusting for control variables, mothers who are unemployed, and had parents closer in age were less likely to have stunted or underweight children. Mothers who have more freedom of mobility are less likely to have wasted children. After further adjusting for other covariates, mothers who have more freedom of mobility are still less likely to have wasted children. Mothers who have no tolerance of domestic violence are more likely to have wasted children. (Table 9)

Table 9 Results of linear relationship between height-for-age, weight-for-height, and weight-for-age Z-scores, and Factor Analyses reduced indicators of women's empowerment; and logistic relationship between stunting, wasting, and underweight, and reduced indicators of women's empowerment***

Linear regression						
	Height-for-age Z-score		Weight-for-height Z-score		Weight-for-age Z-score	
	Crude Coefficient	Adjusted Coefficient	Crude Coefficient	Adjusted Coefficient	Crude Coefficient	Adjusted Coefficient
If beaten justified if doesn't cook properly (tolerance of domestic violence)	-0.1311	-0.0502	0.0624	0.1122	-0.0167	0.0646
Final say on visiting her family or relatives (decision making power)	0.1398*	0.0061	0.0677	0.0579	0.1158*	0.0331
Allowed the go to a health facility (freedom of mobility)	0.0041	-0.0059	0.0045	0.0101	0.0009	0.0020
Final say on own cash income (Maternal employment and income)	0.1237**	0.0149	-0.0047	-0.0415	0.0765**	-0.0087
Husband-wife age difference (Husband-wife differences)	-0.02677**	-0.0186*	-0.0090	-0.0070	-0.0220**	-0.0158*
Adjusted R-square	0.01687	0.1273	0.000440	0.03300	0.01483	0.08716

Note: higher values of factors indicate lower women's empowerment in this study. Therefore, if a factor is positively related to Z-scores, it means that higher women's empowerment in this dimension is associated with worse child nutritional status. If a factor is negatively related to Z-scores, it means that higher women's empowerment in this dimension is associated with better child nutritional status.

Logistic regression

	Stunting		Wasting		Underweight	
	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Tolerance of domestic violence						
If beaten justified if doesn't cook properly						
- No	0.8 (0.6, 1.0)	0.9 (0.6, 1.1)	1.3 (0.9, 1.7)	1.4 (1.0, 1.8)*	0.9 (0.7, 1.3)	1.1 (0.8, 1.4)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Decision making power						
Final say on visiting her family or relatives						
- Mainly alone	1.3 (0.8, 2.1)	1.1 (0.6, 1.7)	1.0 (0.6, 1.7)	1.0 (0.6, 1.7)	1.3 (0.7, 2.1)	1.0 (0.6, 1.7)
- Jointly	1.1 (0.9, 1.3)	0.9 (0.7, 1.1)	1.1 (0.8, 1.4)	1.1 (0.8, 1.4)	1.1 (0.9, 1.4)	0.9 (0.7, 1.2)
- No main say	Reference	Reference	Reference	Reference	Reference	Reference
Freedom of mobility						
Allowed the go to a health facility						
- Alone	0.8 (0.5, 1.4)	0.8 (0.5, 1.3)	0.6 (0.3, 1.0)	0.7 (0.4, 1.2)	0.9 (0.5, 1.7)	0.9 (0.5, 1.7)
- With someone else	0.8 (0.5, 1.4)	0.8 (0.5, 1.3)	0.5 (0.3, 0.9)*	0.5 (0.3, 1.0)*	0.9 (0.5, 1.7)	0.9 (0.5, 1.6)
- Not at all	Reference	Reference	Reference	Reference	Reference	Reference
Maternal employment and income						
Final say on own cash income						
- Earns cash and has main say alone	1.3 (0.8, 2.1)	0.9 (0.5, 1.5)	1.2 (0.7, 1.9)	0.9 (0.5, 1.7)	1.4 (0.8, 2.5)	1.0 (0.6, 1.7)
- Earns cash and has jointly say	1.5 (1.0, 2.2)*	1.0 (0.7, 1.5)	0.6 (0.4, 1.0)*	0.5 (0.3, 1.0)*	1.5 (1.0, 2.2)*	1.0 (0.7, 1.5)
- Earns cash and has no main say	1.0 (0.4, 2.3)	0.8 (0.3, 1.8)	0.7 (0.3, 1.7)	0.6 (0.2, 1.4)	1.0 (0.4, 2.5)	0.8 (0.3, 1.7)
- Employed, not earn cash	1.7 (1.3, 2.1)**	1.1 (0.8, 1.4)	1.0 (0.7, 1.4)	0.8 (0.6, 1.1)	1.6 (1.3, 2.1)**	1.0 (0.8, 1.4)
- Not employed	Reference	Reference	Reference	Reference	Reference	Reference
Husband-wife differences	1.04	1.03	1.0 (1.0, 1.0)	1.0 (1.0, 1.0)	1.04	1.0 (1.0, 1.1)
Husband-wife age difference	(1.01, 1.07)**	(1.00, 1.06)*			(1.01, 1.06)**	
Area under curve	0.586	0.695	0.548	0.648	0.583	0.653

*p<0.05 significant;

**p<0.01 significant;

***Control variables: child age in months, number of other children five years or under living in the same household, mother's age, and maternal age at marriage as continuous variables; and child sex, mother's education level, mother's religion, mother's caste, household region, and household wealth level as categorical variables.

Chapter 5: Discussion, Conclusion and Recommendations

The results of this study do not support the hypothesis that lower women's empowerment is an important determinant of stunting, wasting, and underweight. There are a few exceptions where some single indicators show a protective effect on children malnutrition if their mothers have more power (final say in husband's earnings use, allowed to go to a health facility, employment, and husband-wife age difference). However, in other cases, indicators (final say in making daily household purchases, allowed to go to the market, think it's unjustified to be beaten by the husband if she doesn't cook properly) show results in the opposite direction than hypothesized. The reduced factors explain little of the variance in child growth (height-for-age, weight-for-height, and weight-for-age Z-scores,) and risk of child malnutrition (stunting, wasting, and underweight). It's believed that women's empowerment has long-term and cumulative effect on children's nutrition, so more significant association between women's empowerment and stunting or underweight compared to wasting was predicted. Previous studies also showed women's autonomy was strongly related to child stunting (Doan & Popkin, 1993; Hashemi, Schuler, & Riley, 1996; Shroff et al., 2009). However, our adjusted logistic regression results show that most significant effects are between single indicators of maternal empowerment and wasting. It may because wasting is a more sensitive indicator.

Indicators of women's empowerment showed different effects on child nutritional status across studies. In this study, mothers who have joint say in their own cash income with husbands (compared to no say), who are allowed to go to a health facility with someone else (compared to

not at all), who are employed during the past year (compared to unemployed), and who are closer in age to their husbands are less likely to have malnourished children; mothers who have joint say in daily household purchases (compared to no say), who are allowed to go to the market (compared to not at all), and who think it's unjustified to be beaten by husbands if they don't cook properly (compared to those who think it's justified) are more likely to have malnourished children; while other indicators showed no significant associations. Shroff et al. (2009) used eight indicators to measure women's empowerment and found that women who had freedom to go to market and had some money set aside to use as wished were less likely to have stunted children. Other indicators, including mother's decision making power, whether the mother needs permission to visit relatives or friends, and attitude towards domestic violence, didn't show significant effects. Shroff et al. (2011) used 57 indicators of seven dimensions to measure women's empowerment, and found that mothers who had more household decision making power were less likely to have underweight infants, and mothers who had more mobility autonomy and more household decision making power were less likely to have wasted infants. Other dimensions, including financial independence, mobility, child care decision making, acceptance of domestic violence, and experience of domestic violence didn't show significant effect. Sethuraman and colleagues (2006) found that psychological abuse and sexual coercion increased the risk of child underweight; other indicators, including mother's position in household and involvement in decision-making, and mobility within the village, didn't show significant effect.

Maternal employment and income have contradicting effects towards child nutritional status across studies. Sethuraman et al. (2006) found that maternal employment increased the risk of children's underweight significantly, Bose (2011) found that children whose mothers were not working were less likely to be malnourished, and Shroff et al. (2011) found that mothers who were financially independent were less likely to exclusively breastfeed their infants. While Smith et al. (2003) constructed in index, where mothers who were employed had more power, and found that higher women's status decreased the risk of children malnutrition. Negative associations between maternal empowerment and child nutritional status were not found in other studies.

The cause for the inconsistent results with maternal empowerment and child malnutrition is unclear. There may be different pathways between women's empowerment and child nutritional status in Bihar. For example, we believe that mothers who have access to money are more likely to allocate it to food or child care (Doan & Popkin, 1993; Hashemi, Schuler, & Riley, 1996). However, women get married extremely early in Bihar; they may have limited experience or knowledge on how to take care of their children in comparison to other household members. This makes sense when we analyzed the association between household decision making and child nutritional status when answers to household decision making questions were categorized to two levels as "husband, wife, or jointly" and "someone else". Results showed that children from households where decisions were made by "someone else" were less likely to be wasted (appendix C) after adjustment, which may because other members (mother-in-law, possibly) have more knowledge and experience about child care. The "someone else" also shows a protective effect for most decision-making indicators towards stunting and underweight before

adjustment. More detailed information about the household is necessary to understand the mechanisms.

Sethuraman (2006) used both quantitative (questionnaires) and qualitative (structured interviews) methods to collect information on women's empowerment and found it explained more than five percent of the variance of child nutrition; it only explains about one percent in this study. It is possible that we do not have good indicators for women's empowerment in this study. Qualitative methods, such as face-to-face interview and focused group discussion, usually probe more detailed relevant information. For example, we believed that mothers who usually made decisions on daily household purchases had more power. However, it may be an extra burden rather than power in the case of mothers in Bihar. In face-to-face interviews, information on why they made decisions on daily purchases, if they just made decisions or had to go shopping each day, what they bought, how they decided what to buy, how long it took them to make these purchases, and how they felt to have this decision making power could be collected at the same time, which would be helpful to decide whether this variable was a good indicator of women's empowerment. Thus, more detailed questions are necessary in future surveys. However, the weak association between maternal empowerment and child nutrition suggests it is not an important determinant of child nutrition. There may be other more important key driving factors, such as infection, agricultural development, and food insecurity and so on in Bihar.

In previous studies, Smith et al. (2003) constructed a decision-making index using four indicators including "whether the woman works for cash income, the woman's age at first

marriage, the percent difference in the woman's and her partner's age, and the difference in the woman's and her partner's years of education", and found higher women's decision making power was significantly positively related to child nutritional status Z-scores. Charkraborty & Anderson (2011) also created a maternal autonomy score using "final say on own healthcare, final say on making large household purchase, final say on making purchase for daily needs, and final say on visits to family or relatives", and found it was an independent predictor of low birth weight. However, in this study, factors reduced from the 19 indicators didn't show consistently significantly association between each factor and child nutritional status, nor did they have a good predictive effect when placed together in the models.

There are several strengths in this study. First, the data set used in this study was well designed, state representative, and included a large sample size. The complex survey design was taken into account for all analysis. Second, a comprehensive literature review was done to obtain a better understanding of the development of definition and measurement of women's empowerment, determinants to child nutrition, and the existing studies exploring relationship between women's empowerment and child nutritional status. A conceptual framework including five dimensions to measure women's empowerment and control variables between women's empowerment and child nutrition was built. Third, this study thoroughly tested the association between each indicator of women's empowerment and child nutritional status, including logistic regression to obtain odds ratios between different levels of these indicators and stunting, wasting, and underweight, and linear regression with height-for-age, weight-for-height, and weight-for-age Z-scores to check how much more variance they explained compared to the base model. Forth,

factor analysis was performed to reduce the number of variables observed and examine the association between all factors retained together and child nutritional status.

There are several limitations in this study. First, the possible pathways between women's empowerment and child nutritional status were not explored. Earlier studies showed possible mechanisms through which women's empowerment affected child nutrition. For example, increasing women's power had a positive effect on prenatal and birthing care for women, infant birth weight, timely initiation and duration of breast feeding, good complementary feeding practice of children, children illness treatment and immunization (Chakraborty & Anderson, 2011; Shroff et al., 2011; Smith et al., 2003). However, this is beyond the scope of this study project. Second, there are limited variables in the data set used in this study. Previous studies showed that maternal experience of psychological abuse and sexual coercion increased the risk of malnutrition in children (Ackerson & Subramanian, 2008; Sethuraman et al., 2006). However, NFHS-3 included the experience of domestic violence variables in a different data set with a different sample module. Therefore, this paper only included mothers' tolerance of domestic violence but not the experience of domestic violence as one dimension. Third, this data set only includes cases from Bihar, India, where have a different background compared to other regions, such as climate, agricultural development, education, and other socio-economic contexts. Therefore, results of this study can not be generalized to other populations. Fourth, statistic tests with significant level of 0.05 were performed throughout the analysis. However, 19 indicators were analyzed separately to examine the relationship with child nutritional status. To avoid the bias inherent in multiple testing, Bonferroni method uses a lower significant level (for this study 0.05/19); after the Bonferroni tests were applied, fewer results remained significant (Table 4, 5,

6, and 7). Fifth, 400 cases in the original data set were excluded from this study. Compared to children included in the study, there is a larger proportion of children whose mothers are scheduled caste, have no education, or come from the poorest households in the excluded cases. Thus, mothers of excluded cases possibly have less power. Non-inclusion of those cases may underestimate the association between women's empowerment and child nutritional status.

Based on the results of this study, interventions are needed to increase women's age at marriage, discourage the marriage of adult man and female adolescents. A study done by Kadir et al. (2003) found that education of mothers has an effect on marriage age, especially in traditional South Asian settings, where decision about age at marriage are often made by parents. Bates et al. (2007) found that daughters of women with more education married later. However, due to limitation of this study, more knowledge about the effect of women's status on child nutrition and its underlying determinants must be acquired before policy made. It might also be helpful for the government and organizations to help mothers acquire good feeding practice knowledge, beliefs, prevent abuse and domestic violence, and increase independence from their husbands.

Despite the high levels of child malnutrition and the low status of women in Bihar, indicators of women's empowerment are not important determinants of child malnutrition in this context. For further study, more detailed information is needed to measure women's empowerment and to explore the pathways between women's empowerment and child nutritional status.

Appendix A

Baseline characteristics of children in the original dataset but excluded from this study. N=400

Characteristics	n	Mean (SE) / Percentage
Children's age in months n=236		29.1 (0.93)
0-11	56	22.0%
12-23	41	17.2%
24-59	139	60.8%
Children's sex		
Female	197	49.0%
Male	203	51.0%
Number of children under 5 living together**		1.6 (0.08)
0	76	17.4%
1	122	31.7%
2	122	29.9%
3	64	15.8%
4+	16	5.1%
Mother's age		26.5 (0.42)
<=25	205	52.1%
26-30	95	23.1%
31-35	61	14.6%
36+	39	10.3%
Mother's education*		
No education	283	76.7%
Primary	34	8.0%
Secondary and higher	83	15.4%
Maternal age at marriage		16.2 (0.17)
<=16	240	61.7%
17+	160	38.3%
Mother's Religion n=399		
Hindu	323	79.9%
Muslim	75	20.0%
Jain	1	0.1%
Mother's Caste* n=398		
Scheduled	90	25.7%
Not scheduled	308	74.3%
Household residence		

Urban	126	12.0%
Rural	274	88.0%
Household wealth level**		2.1 (0.08)
Poorest	142	39.7%
Poorer	114	33.0%
Middle	52	11.5%
Wealthier	56	11.2%
Wealthiest	36	4.6%

*Compared to the included samples, $p<0.05$ significantly different for Rao-Scott chi-square test;
** Compared to the included samples, $p<0.01$ significantly different for Rao-Scott chi-square test;

Most of baseline characteristics of the excluded and included sample children are similar except that statistically significant difference exits in number of other children 5 years or under living together, mother's education level, mother's caste, and household wealth level. When looking the data in detail, it's found that compared with sample children included in the study, there are relatively less children five years or under living in the same household with the excluded sample children. However, there are larger proportions of children whose mothers have no education (76.7% vs. 68.8%), or are scheduled caste (25.7% vs. 19.7%) and there are more children from the poorest households (39.7% vs. 31.3%) in the excluded sample. There is no significant difference for other baseline characteristics.

Appendix B

Distribution of maternal empowerment indicators in Bihar, India NFHS-3, 2005-2006, n=1357

Maternal empowerment indicators	n (%)
*Who decides mothers' own cash income n=201**	
Respondent alone	57 (27.7)
Respondent and husband	119 (58.7)
Husband alone	14 (7.1)
Someone else	11 (6.6)
Final say on own health care	
Respondent alone	277 (21.1)
Respondent and husband	423 (31.2)
Husband alone	423 (29.4)
Someone else	197 (15.1)
other	37 (3.3)
Final say on making large household purchases	
Respondent alone	99 (8.3)
Respondent and husband	560 (40.3)
Husband alone	361 (26.4)
Someone else	278 (20.2)
other	59 (4.9)
Final say on making household purchases for daily use	
Respondent alone	385 (28.7)
Respondent and husband	366 (27.1)
Husband alone	248 (17.1)
Someone else	297 (22.1)
other	61 (5.0)
Final say on deciding what to do with money husband's earnings	
Respondent alone	145 (11.6)
Respondent and husband	701 (50.5)
Husband alone	276 (19.8)
Other	207 (15.7)
Husband has no earnings	28 (2.4)
Final say on visits to family or relatives	
Respondent alone	98 (7.6)
Respondent and husband	615 (43.8)
Husband alone	313 (23.4)
Someone else	282 (21.0)
Other	49 (4.2)

*only mothers who have cash income are included;

Association between indicators of mothers' empowerment with more than three levels and nutritional status of children under five in Bihar, India. NFHS-3, n=1920***

	Stunting		Wasting		Underweight	
	Crude OR 95% CI	Adjusted OR 95% CI	Crude OR 95% CI	Adjusted OR 95% CI	Crude OR 95% CI	Adjusted OR 95% CI
Who decides mothers' own cash income n=293						
Respondent alone	2.1 (0.6, 7.1)	2.2 (0.6, 7.9)	7.4* (1.0, 52.1)	7.2 (0.9, 57.9)	2.8 (0.7, 10.8)	3.5* (1.0, 11.8)
Respondent and husband	2.2 (0.7, 6.8)	2.2 (0.7, 7.0)	4.1 (0.5, 35.2)	4.4 (0.5, 40.0)	2.8 (0.7, 10.8)	3.3 (0.9, 12.0)
Husband alone	Reference	Reference	Reference	Reference	Reference	Reference
Someone else	2.7 (0.7, 10.9)	4.6* (1.0, 20.5)	12.0 (0.9, 156.9)	8.5 (0.6, 126.0)	5.1* (1.0, 24.9)	10.5** (2.1, 52.5)
Final say on own health care						
Respondent alone	1.2 (0.9, 1.6)	1.1 (0.8, 1.5)	1.0 (0.8, 1.4)	1.1 (0.8, 1.5)	1.0 (0.8, 1.4)	0.9 (0.7, 1.3)
Respondent and husband	1.2 (0.9, 1.5)	1.1 (0.8, 1.4)	1.0 (0.8, 1.4)	1.1 (0.8, 1.4)	1.0 (0.8, 1.3)	0.9 (0.7, 1.2)
Husband alone	Reference	Reference	Reference	Reference	Reference	Reference
Someone else	0.8 (0.6, 1.1)	1.1 (0.7, 1.6)	1.0 (0.7, 1.5)	0.9 (0.6, 1.4)	0.9 (0.6, 1.2)	1.1 (0.8, 1.6)
other	0.6 (0.3, 1.1)	0.7 (0.4, 1.2)	2.4* (1.1. 5.4)	2.3 (0.9, 5.9)	1.4 (0.7, 2.8)	1.6 (0.8, 3.5)
Final say on making large household purchases						
Respondent alone	1.0 (0.7, 1.6)	0.9 (0.6, 1.5)	1.1 (0.6, 1.8)	1.2 (0.7, 2.0)	1.2 (0.7, 1.9)	1.1 (0.7, 1.9)
Respondent and husband	0.9 (0.7, 1.1)	0.8 (0.6, 1.1)	1.0 (0.8, 1.3)	1.1 (0.8, 1.4)	0.9 (0.7, 1.2)	0.9 (0.7, 1.2)
Husband alone	Reference	Reference	Reference	Reference	Reference	Reference
Someone else	0.6** (0.4, 0.8)	0.9 (0.6, 1.2)	0.9 (0.6, 1.3)	0.9 (0.6, 1.3)	0.6** (0.5, 0.9)	0.9 (0.7, 1.3)
other	0.5** (0.3, 0.8)	0.7 (0.4, 1.1)	2.1* (1.0, 4.1)	2.0 (0.9, 4.5)	1.2 (0.7, 2.0)	1.6 (0.8, 2.9)
Final say on making household purchases for daily use						
Respondent alone	1.2 (0.9, 1.6)	1.2 (0.8, 1.6)	1.0 (0.7, 1.5)	1.0 (0.7, 1.5)	1.2 (0.9, 1.6)	1.1 (0.8, 1.6)
Respondent and husband	1.0 (0.7, 1.4)	1.0 (0.7, 1.5)	1.2 (0.8, 1.6)	1.2 (0.8, 1.7)	1.3 (0.9, 1.8)	1.3 (0.9, 1.8)
Husband alone	Reference	Reference	Reference	Reference	Reference	Reference
Someone else	0.6** (0.5, 0.8)	1.0 (0.7, 1.3)	0.9 (0.6, 1.3)	0.8 (0.5, 1.2)	0.8 (0.6, 1.1)	1.1 (0.8, 1.6)
other	0.6* (0.3, 1.0)	0.8 (0.5, 1.3)	1.9 (0.9, 3.8)	1.7 (0.8, 3.8)	1.4 (0.8, 2.6)	2.0* (1.0, 3.8)
Final say on deciding what to do with money husband's earnings						
Respondent alone	1.5 (1.0, 2.3)	1.5 (0.9, 2.4)	1.4 (0.9, 2.2)	1.5 (0.9, 2.3)	1.5 (1.0, 2.3)	1.4 (0.9, 2.2)
Respondent and husband	1.1 (0.9, 1.5)	1.1 (0.8, 1.4)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)	1.1 (0.8, 1.5)
Husband alone	Reference	Reference	Reference	Reference	Reference	Reference

Other	0.7** (0.5, 0.9)	1.0 (0.7, 1.3)	1.2 (0.8, 2.0)	1.3 (0.8, 2.0)	0.8 (0.6, 1.2)	1.2 (0.8, 1.7)
Husband has no earnings	0.8 (0.3, 1.7)	1.2 (0.5, 2.8)	1.6 (0.7, 3.3)	1.6 (0.7, 3.6)	1.0 (0.5, 2.1)	1.5 (0.7, 3.3)
Final say on visits to family or relatives						
Respondent alone	1.0 (0.6, 1.6)	0.9 (0.5, 1.5)	1.0 (0.6, 1.7)	1.0 (0.6, 1.7)	1.0 (0.6, 1.6)	0.9 (0.5, 1.5)
Respondent and husband	0.8 (0.6, 1.0)	0.8 (0.6, 1.0)	1.0 (0.8, 1.4)	1.1 (0.8, 1.4)	0.9 (0.7, 1.1)	0.9 (0.6, 1.1)
Husband alone	Reference	Reference	Reference	Reference	Reference	Reference
Someone else	0.5** (0.4, 0.7)	0.7* (0.5, 1.0)	0.9 (0.6, 1.2)	0.8 (0.5, 1.1)	0.6** (0.4, 0.8)	0.8 (0.6, 1.1)
Other	0.5* (0.2, 0.9)	0.6 (0.3, 1.1)	2.1 (1.0, 4.7)	2.0 (0.8, 5.0)	1.3 (0.7, 2.6)	1.7 (0.8, 3.4)

*p<0.05 significant;

**p<0.01 significant;

*** Control variables: child age in month, number of other children five years or under living in the same household, mother's age, and maternal age at marriage as continuous variables; and child sex, mother's education level, mother's religion, mother's caste, household region, and household wealth level as categorical variables.

Appendix C: "someone else" ("other" for final say in husband's earnings use) sees to have a different impact on child nutritional status compared to other levels, so dummy variables of "someone else" ("other") are created to examine whether the difference really exists.

Association between indicators of mothers empowerment with each answer as a level and nutritional status of children under five in Bihar, India, NFHS-3 survey data, 2005-2006, n=1920***

	Stunting		**Wasting**		**Underweight**	
	Crude OR 95% CI	Adjusted OR 95% CI	Crude OR 95% CI	Adjusted OR 95% CI	Crude OR 95% CI	Adjusted OR 95% CI
Who decides mothers' own cash income n=293						
Respondent or husband	Reference	Reference	Reference	Reference	Reference	Reference
Someone else	1.3 (0.4, 4.0)	2.1 (0.7, 6.5)	2.6 (0.7, 9.4)	1.7 (0.4, 6.7)	2.0 (0.6, 6.4)	3.2 (0.9, 11.8)
Final say on own health care						
Respondent or husband	Reference	Reference	Reference	Reference	Reference	Reference
Someone else	0.7* (0.5, 1.0)	1.0 (0.7, 1.4)	1.0 (0.7, 1.3)	0.9 (0.7, 1.3)	0.9 (0.6, 1.2)	1.2 (0.8, 1.6)
Final say on making large household purchases						
Respondent or husband	Reference	Reference	Reference	Reference	Reference	Reference
Someone else	0.6** (0.5, 0.8)	0.9 (0.7, 1.2)	0.9 (0.7, 1.3)	0.9 (0.6, 1.2)	0.7 (0.5, 0.9)	1.0 (0.7, 1.3)
Final say on making household purchases for daily use						
Respondent or husband	Reference	Reference	Reference	Reference	Reference	Reference
Someone else	0.6** (0.5, 0.7)	0.9 (0.7, 1.2)	0.8 (0.6, 1.1)	0.7* (0.5, 1.0)	0.7** (0.5, 0.8)	1.0 (0.7, 1.3)
Final say on deciding what to do with money husband's earnings						
Respondent or husband	Reference	Reference	Reference	Reference	Reference	Reference
Other	0.6** (0.5, 0.7)	0.9 (0.7, 1.1)	1.1 (0.8, 1.6)	1.1 (0.8, 1.6)	0.7* (0.6, 1.0)	1.1 (0.8, 1.5)
Final say on visits to family or relatives						
Respondent or husband	Reference	Reference	Reference	Reference	Reference	Reference
Someone else	0.6** (0.4, 0.7)	0.8 (0.6, 1.1)	0.9 (0.7, 1.2)	0.8 (0.6, 1.1)	0.6** (0.5, 0.8)	0.9 (0.7, 1.2)

*p<0.05 significant;

**p<0.01 significant;

***Control variables: child age in months, number of other children five years or under living in the same household, mother's age, and maternal age at marriage as continuous variables; and child sex, mother's education level, mother's religion, mother's caste, household region, and household wealth level as categorical variables.

Appendix D

Association between indicators of mothers' tolerance of abuse & attitude towards domestic violence and nutritional status of children under five in Bihar, India (NFHS-3, n=1920)

	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Whether the mother think it's justified to be beaten by her husband if						
Go out without telling						
- No	0.7* (0.6, 1.0)	0.9 (0.7, 1.1)	1.0 (0.8, 1.2)	1.0 (0.8, 1.3)	0.8 (0.6, 1.1)	0.9 (0.7, 1.2)
- Don't know	0.0** (0.0, 0.0)	0.0** (0.0, 0.0)	2.6 (0.2, 43.7)	1.5 (0.1, 16.9)	0.7 (0.0, 11.1)	0.8 (0.0, 24.6)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Neglect the house or children						
- No	0.8 (0.6, 1.0)	0.9 (0.6, 1.2)	1.0 (0.8, 1.3)	1.1 (0.8, 1.4)	0.8 (0.6, 1.1)	0.9 (0.6, 1.2)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Argue with him						
- No	0.9 (0.7, 1.1)	1.0 (0.8, 1.2)	1.0 (0.8, 1.2)	1.1 (0.8, 1.3)	0.9 (0.7, 1.1)	0.9 (0.8, 1.2)
- Don't know	0.4 (0.0, 4.2)	0.5 (0.1, 4.9)	5.2 (0.4, 61.5)	5.1 (0.4, 60.1)	1.4 (0.1, 15.1)	2.0 (0.1, 29.8)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Refuse to have sex with him						
- No	0.8 (0.6, 1.1)	0.9 (0.7, 1.3)	1.0 (0.7, 1.5)	1.2 (0.8, 1.7)	0.9 (0.6, 1.2)	1.0 (0.7, 1.4)
- Don't know	0.4* (0.2, 1.0)	0.5 (0.2, 1.3)	4.2* (1.1, 16.2)	4.2* (1.1, 15.7)	0.8 (0.3, 1.8)	0.9 (0.4, 2.0)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Doesn't cook food properly						
- No	0.7* (0.5, 1.0)	0.8 (0.6, 1.1)	1.3 (0.9, 1.7)	1.4* (1.0, 1.9)	0.9 (0.7, 1.2)	1.1 (0.8, 1.5)
- Don't know	2.4 (0.6, 10.3)	1.6 (0.6, 4.7)	2.2** (1.3, 3.6)	2.0** (1.3, 3.0)	1.1 (0.2, 7.1)	0.7 (0.1, 3.9)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Wife is unfaithful						
- No	1.0 (0.8, 1.3)	1.1 (0.9, 1.4)	1.1 (0.9, 1.3)	1.2 (1.0, 1.4)	1.0 (0.8, 1.2)	1.1 (0.9, 1.4)
- Don't know	1.6 (0.5, 5.1)	1.3 (0.5, 3.5)	2.0 (0.9, 4.5)	1.9 (0.7, 5.1)	2.4 (0.6, 9.0)	2.0 (0.5, 8.3)
- Yes	Reference	Reference	Reference	Reference	Reference	Reference
Wife is disrespect for in-laws						

-	No	0.8 (0.7, 1.1)	0.9 (0.7, 1.2)	1.0 (0.8, 1.2)	1.0 (0.8, 1.3)	0.8 (0.6, 1.0)	0.9 (0.7, 1.2)
-	Don’t know	2.1 (0.5, 9.3)	2.0 (0.4, 9.9)	2.0 (0.6, 7.2)	2.3 (0.6, 8.0)	1.1 (0.3, 4.4)	1.0 (0.2, 4.8)
-	Yes	Reference	Reference	Reference	Reference	Reference	Reference

*p<0.05 significant;

**p<0.01 significant;

*** Control variables: child age in months, number of other children five years or under living in the same household, mother’s age, and maternal age at marriage as continuous variables; and child sex, mother’s education level, mother’s religion, mother’s caste, household region, and household wealth level as categorical variables.

Appendix E

	Stunting		Wasting		Underweight	
	Male	Female	Male	Female	Male	Female
Decision-making autonomy						
Mother's employment and main say in earning use						
Earns cash, has main say alone in earnings use	55.2	69.1	32.7	27.3	57.8	69.1
Earns cash and has joint say in earnings use	63.0	61.8	22.0	17.3	61.1	62.6
Earn cash, no main say in earning use	58.5	45.3	12.6	28.8	52.2	52.5
Does not earn cash	63.2	66.6	26.8	27.7	61.7	68.1
Not been employed	50.3	54.2	30.2	26.4	51.2	54.5
Mother's say in own health care						
Mainly alone	57.9	59.2	28.8	24.9	52.8	61.3
Jointly	57.8	60.3	28.2	25.8	56.1	57.1
No main say	50.5	55.8	27.3	25.1	53.2	57.2
Mother's say in making large household purchase						
Mainly alone	60.8	61.7	24.8	31.8	59.7	66.4
Jointly	56.4	58.0	28.6	24.3	55.1	57.7
No main say	51.7	58.3	27.0	25.1	51.2	57.6
Mother's say in making purchase for daily needs						
Mainly alone	61.2	62.3	26.2	26.9	54.4	63.4
Jointly	56.9	58.9	31.7	26.4	61.4	58.9
No main say	48.0	54.7	25.8	23.9	47.9	53.8
Mother has a say in husband's earnings						
Mainly alone	65.5	63.5	31.7	31.0	59.5	68.9
Jointly	56.0	59.4	26.7	25.9	55.6	58.6
No main say	52.6	56.5	28.7	21.4	51.3	57.1
Other	43.9	46.3	31.4	26.2	50.4	49.4
Freedom of Mobility						
Mother's say in making visits to own family or relatives						
Mainly alone	66.7	56.9	25.1	28.3	55.6	63.8
Jointly	56.2	58.3	28.7	25.8	57.1	57.0
No main say	50.7	58.4	26.9	24.3	50.0*	58.0
Mother's say in going to market						
Mainly alone	54.4	56.2	32.7*	26.8	55.7	60.2
Jointly	54.2	60.5	24.7	27.4	52.9	60.0
No main say	54.2	50.4	30.2	17.7	55.9	47.7
Mother's say in going to health facility						
Mainly alone	53.7	59.3	30.6	25.3	54.9	59.1
Jointly	53.6	57.0	26.2	25.4	53.3	58.0
No main say	70.3*	47.5	45.0	35.1	68.0**	50.2
Mother's say in going outside village						

Mainly alone	54.5	59.5	30.4	25.7	53.9	60.6
Jointly	53.1	57.0	26.7	27.7	55.0	57.7
No main say	57.4	55.1	31.0	19.5	53.6	55.2
Attitude towards domestic violence						
Wife beating justified if						
go out without telling						
No	51.5	57.0	28.7	25.2	53.4	56.7
Yes	63.3	58.7	28.2	27.5	57.6	62.5
neglect the house or the children						
No	53.0	56.0	28.7	25.8	54.4	55.4
Yes	58.8	62.5	28.2	25.5	54.8*	67.7
argue with him						
No	53.4	56.6	28.9	24.7	53.3	56.6
Yes	56.4	58.8	27.8	27.4	56.7	60.8
refuse to have sex with him						
No	53.5	57.4	28.8	25.3	53.5	58.2
Yes	59.5	59.9	25.3	27.6	59.3	60.1
doesn't cook food properly						
No	52.4	56.4	29.8	25.9	54.0	57.8
Yes	62.5	61.8	22.9	24.1	56.6	59.6
wife is unfaithful						
No	53.8	58.0	29.7*	24.7	54.4	57.5
Yes	55.7	55.0	25.6	27.0	54.2	58.5
wife is disrespect for in-laws						
No	50.8*	58.2	29.0	24.3	51.9	57.1
Yes	61.5	55.1	27.7	27.7	59.5	60.3
Mother was employed during past year						
Yes	61.8	64.1	25.5	24.5	60.4	65.6
No	50.3	54.2	30.2	26.4	51.2	54.5

*p<0.05 significant;
**p<0.01 significant.

Appendix F

Linear regression results of full model, crude model, and base model, which don't provide additional insights towards relationship between women's empowerment and nutritional status of children under five rather than logistic regressions.

Estimated coefficient and adjusted R-square of base model, full adjusted model and with each indicator of women's empowerment added to the base model, NFHS-3 survey data of Bihar, India, 2005-2006, n=1920

Indicator added	**Height-for-age Z-score**		**Weight-for-height Z-score**		**Weight-for-age Z-score**	
	Estimated coefficient	Adjusted R-square	Estimated coefficient	Adjusted R -square	Estimated coefficient	Adjusted R-square
Base model including all controlled factors*		0.1303		0.02799		0.08130
Make decisions about						
how the money the woman earns will be used	0.02	0.1300	-0.05	0.02933	-0.01	0.08094
how the husband's earnings will be used	0.05	0.1307	0.03	0.02812	0.05	0.08224
health care for the woman herself	-0.03	0.1295	-0.01	0.02978	-0.02	0.08656
making major household purchase	-0.00	0.1284	0.05	0.03148	0.03	0.08781
making purchases for daily needs	0.04	0.1290	0.04	0.03168	0.04	0.08743
Have freedom to						
visits woman's family or relatives	0.01	0.1278	0.06	0.03203	0.04	0.08639
go to market	0.02	0.1299	0.07	0.02912	0.06	0.08211
go to health facility	-0.01	0.1299	0.01	0.02750	0.00	0.08082
go to places outside the village	0.01	0.1299	0.04	0.02794	0.03	0.08116

Think it's unjustified for a husband to beat his wife						
if she goes out without telling him	-0.05	0.1300	0.06	0.02780	0.03	0.08105
if she neglects the house or the children	-0.12	0.1308	-0.03	0.02756	-0.07	0.08139
if she argues with him	0.01	0.1302	-0.02	0.02737	-0.01	0.08109
if she refuses to have sex with him	0.04	0.1301	0.01	0.02597	0.03	0.08154
if she doesn't cook properly	-0.06	0.1289	0.14	0.03429	0.08	0.08069
if he suspects her of being unfaithful	0.13	0.1296	0.04	0.02647	0.11	0.08064
if she shows disrespect for in-laws	0.03	0.1306	-0.02	0.02730	0.01	0.08142
Maternal employment	0.07	0.1302	-0.08	0.02836	0.01	0.08082
Husband-wife age difference	-0.02*	0.1319	-0.01	0.02868	-0.02	0.08434
Husband-wife education year difference	0.01	0.1304	0.01	0.02847	0.01	0.08251
Full model		0.1285		0.03381		0.09540

*variables in base model: child age in months, number of other children five years or under living in the same household, mother's age, and maternal age at marriage as continuous variables; and child sex, mother's education level, mother's religion, mother's caste, household region, and household wealth level as categorical variables.

(1) For the full model with height-for-age Z-score: compared to the base model, the R-square of the full model increases a little bit (from 0.1349 to 0.1426), however, the adjusted R-square becomes lower (0.1303 to 0.1285).

The least significant indicator	p-value	Adjusted R-square after dropping it
Allowed to go to market	0.9164	0.1290
If beaten justified if go out without telling him	0.8608	0.1294
Decide visiting own family or relatives	0.8635	0.1300
If beaten justified if argue with him	0.7937	0.1305
Make decision about how to spend own cash income	0.7091	0.1309
If beaten justified if refuse to have sex with him	0.7031	0.1318
Make decisions about large household purchase	0.6198	0.1314

(2) For the full model with weight-for-height Z-score: adjusted R-square of full model increased to 0.03381.

The least significant indicator	p-value	Adjusted R-square after dropping it
Make decisions about large household purchase	0.7544	0.03388
If beaten justified if refusing to have sex with him	0.7212	0.03545
Maternal employment	0.6246	0.03580
If beaten justified if suspected unfaithful	0.5882	0.03586
Allowed go to places out of village	0.5892	0.03622
If beaten justified if disrespect for in-laws	0.4855	0.03745
Decide visiting own family or relatives	0.4269	0.03831
Wife-husband age difference’	0.3379	0.03819

(3) For the full model with weight-for-age Z-score: The adjusted R-square of full model is 0.09540; the least significant indicator is ‘making decisions on large household purchase’ with a p-value equal to 0.9077. After dropping this indicator, the adjusted R-square is 0.09440, which is smaller than the full model.

Appendix G: Polychoric PCA and factor analysis[6];

Examples of Pearson, Spearman, and Polychoric correlation

Variables	Pearson Correlation	Spearman Correlation	Polychoric Correlation
healthcare * smoney	0.1809	0.1702	0.2463
lhpurchase * healthcare	0.3770	0.3895	0.5122
hpurchase * healthcare	0.5003	0.4955	0.6360
fvisit * healthcare	0.4181	0.4112	0.5586
hpurchase * lhpurchase	0.4594	0.4581	0.6125

Eigenvalue and variance explained by each factor:

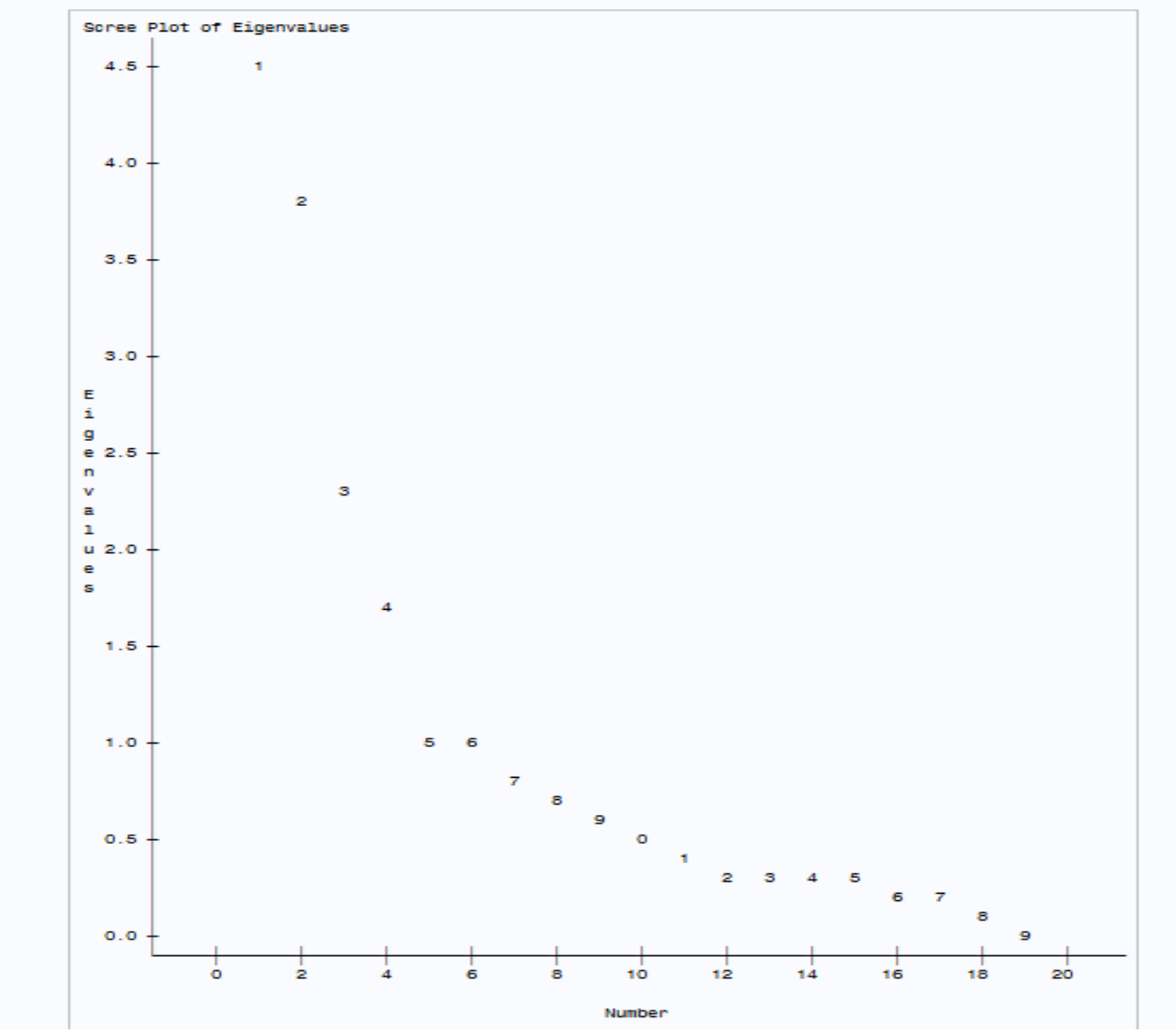
	Eigenvalue	Proportion	Cumulative
1	4.53735890	0.2388	0.2388
2	3.84353110	0.2023	0.4411
3	2.27627585	0.1198	0.5609
4	1.70903528	0.0899	0.6509
5	1.00491877	0.0529	0.7037
6	0.97236927	0.0512	0.7549
7	0.75342629	0.0397	0.7946
8	0.70496080	0.0371	0.8317
9	0.60172304	0.0317	0.8633
10	0.50119372	0.0264	0.8897
11	0.36581024	0.0193	0.9090
12	0.34599529	0.0182	0.9272
13	0.33136231	0.0174	0.9446
14	0.30844564	0.0162	0.9609

[6] Variables names used in tables below. If a husband justified in hitting or beating his wife (1) if she goes out without telling him (goutbeat); (2) if she neglects the house or the children (neglectbeat); (3) if she argues with him (arguebeat); (4) if she refuses to have sex with him (rsexbeat); (5) if she doesn't cook properly (burnbeat); (6) is he suspects her of being unfaithful (unfaithbeat); (7) if she shows disrespect for in-laws (disrpbeat). Who usually decides (1) how the cash income the woman earns herself will be used (smoney); (2) how the husband's earnings will be used (hmoney); (3) health care for the woman (healthcare); (4) major household purchase (lhpurchase); (5) purchases for daily household needs (hpurchase). Freedom to (1) visits woman's family or relatives (fvisit); (2) go to market (gmarket); (3) go to health facility (gfacility); (4) go to places outside the village (goutvil). Maternal employment (employment); Wife-husband age difference (age_diff) & education year difference (edu_diff).

	Eigenvalue	Proportion	Cumulative
15	0.26288476	0.0138	0.9747
16	0.22177757	0.0117	0.9864
17	0.15569902	0.0082	0.9946
18	0.11153237	0.0059	1.0004
19	-.00830023	-0.0004	1.0000

*First five are retained;

Scree Plot



Rotated Factor Pattern

	Factor1	Factor2	Factor3	Factor4	Factor5
burnbeat	0.85207	0.02782	-0.04039	-0.09290	0.04146
neglectbeat	0.81694	0.03145	-0.06258	-0.02247	0.03847
goutbeat	0.79659	0.00580	0.05714	0.02597	-0.02370
arguebeat	0.79357	0.07927	0.11849	0.00270	-0.03713
unfaithbeat	0.76794	-0.04521	0.21945	-0.03997	-0.05779
rsexbeat	0.73796	-0.02300	-0.14484	0.04989	0.13494
disrpbeat	0.70695	0.10072	0.07052	-0.09776	-0.02059
fvisit	0.05314	0.84313	0.01087	-0.00701	-0.04006
lhpurchase	0.07953	0.82600	0.07400	-0.00926	0.00508
hpurchase	0.02803	0.82345	0.07251	0.15440	0.01047
healthcare	0.05874	0.76887	0.15685	0.17807	-0.11708
hmoney	-0.05264	0.73461	0.07529	0.00088	0.05060
gfacility	0.10430	0.10292	0.92814	0.07850	0.00927
goutvil	-0.00630	0.04966	0.90861	0.01623	-0.04743
gmarket	0.05999	0.20419	0.86948	0.10111	0.01191
smoney	-0.12331	0.11535	0.15717	0.94905	0.05606
employment	-0.13112	0.08169	0.15973	0.94895	0.05994
edu_diff	0.04321	0.03236	-0.04493	0.39250	0.07113
age_diff	0.05401	-0.04929	-0.02101	-0.03671	0.98224

*variables with loading values highlighted for a specific factor are grouped into one dimension;
**variables in bold are selected to represent their dimensions.

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