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Abstract

Globally, reduction of undernutrition has remained a priority among public health professionals and policy makers. Although undernutrition affects all age-groups, children belonging to under-five age are at the highest risk.Although the proportion of stunted, underweight and wasted children declined from 61 percent, 63 percent and 22 percent to 48 percent, 44 percent and 21 percent respectively between 1992-93 and 2015-16 according to the National Family Health Surveys (NFHS), these percentages are still the highest among all the states in India. Numerically, 9.2 million children in Bihar are stunted. Moreover, a substantial regional variation exists with respect to child undernutrition. The proportion of stunted children varies from 37 percent in Gopalganj district to 57 percent in Sitamarhi district. Notably, Bihar alone contributes around 15 percent of undernourished children in India. 36 out of 38 districts in Bihar feature among 201 districts in India, where prevalence of stunting is the highest. More importantly, out of 100 districts, where prevalence of stunting is the highest, one-quarter belonging to Bihar. Against this backdrop, using fourth round of NFHS data, the present study aims to assess effects of various endowments as well as returns to those endowments on regional disparities of childhood stunting by employing recentred function quantile regression modelling and counterfactual decomposition technique.The purpose of the study is to highlight important region-specific dimensions for reduction of child undernutrition in a resource-constrained setting. The results show that the performance of Saran division with respect to child's height-for-age z-score (HAZ) outcomes appears to be significantly better with its comparators. When compared with HAZ scores of Saran division with other divisions, we broadly found that covariate effects dominate over coefficient effects in Bhagalpur, Munger and Koshi divisions, while coefficient effects have substantial influence in contributing child HAZ disparity in all other divisions along with covariate effects. We argue that not only the improvements of the endowments related to child, mother and households but also effective access to the programmes are essential prerequisites to reduce intra-state disparity in child nutritional outcomes.

Understanding intra-state disparities in childhood stunting in Bihar, India

Introduction

Globally, reduction of under nutrition has remained a priority among public health professionals and policy makers. Although under nutrition affects all age-groups, children belonging to under-five age are at the highest risk. According to the World Health Organization (WHO), 156 million under-five children are stunted, 93 million are underweight, and 50 million are wasted globally (WHO, 2015). Approximately half of infant deaths is due to malnutrition and malnutrition is found to be the single largest factor contributing to global burden of diseases (Lopez et al. 2006; Kotloff et al. 2013). Although efforts on reduction of child undern utrition began with the Copenhagen Consensus, it gained momentum through the Millennium Development Goals (MDGs) for 2015 and subsequently furthered to achieve World Health Assembly targets for 2025, and the proposed Sustainable Development Goals (SDGs) to 2030. In recognition of the high social and economic costs of stunting, the WHO nutrition goals for 2025, as adopted by the World Health Assembly, is to reduce number of stunted under-five children by 40 percent (WHO, 2014). It may also to be noted that Goal 1 of MDGs intended to eradicate hunger and poverty, and reduce the number of underweight children by half within 2015 from 1990 level, while Goal 2 of SDGs aims to end hunger and all forms of malnutrition by 2030. Despite sustained and intensive efforts globally, nationally and regionally, prevalence of malnutrition has remained high in the developing countries, particularly in the countries belonging to South Asia.

A detailed multi sectoral conceptual framework to understand the factors affecting child under nutrition was developed by UNICEF (1990). According to the framework, basic causes of malnutrition in a society is related to the historical background of the society, political and ideological superstructure and, economic structure which together affect functioning of formal and non-formal institutions and other potential resources. Underlying causes are unhealthy environment, inadequate or improper education, household food security, lack of care for children and women and scarcity of health services. Immediate causes are inadequate dietary intake and infectious diseases which

severely affects health status, child growth and development, and results in malnutrition or even death. In other words, basic causes are the 'exogenous' determinants, which influence child nutrition through a set of proximate determinants - which can be viewed as 'endogenous' factors (Srinivasan et al. 2013).

Studies found that under nutrition during childhood, particularly stunting, is strongly associated with various short and long-term consequences including increased morbidity and mortality (Black et al. 2013; Prendergast and Humphrey 2014: Dewana et al. 2017), delayed growth and cognitive development (Horton and Hoddinott 2014; Grantham-McGregor et al. 2007) and hence affects educational success in the long run, which are important for future labour productivity and hence economic growth (Horton and Hoddinott 2014; Dewey and Begum 2011). It may be worth noting that a rapid reduction of stunting in India is imperative to lessen global burden of childhood stunting because India is the home for nearly one-third of such children (De Onis et al. 2011; Global Nutrition Report 2018). To note, though the rates of stunting and underweight have declined from 52 percent to 38 percent, 53.4 percentto 36 percent respectively, the proportion of rate of wasting has increased from 17.5 percentto 21 percent between 1992-93 to 2015-16in India (IIPS 1995; IIPS and ICF 2017).

Unacceptably high stunting rate in India, which is incommensurate with economic growth has been a matter of considerable debate and discussion among researchers and policy makers (Ramalingaswami et al. 1997; Deaton and Dreze 2009; Walton 2009; Panagariya 2013) and referred as "Great Indian Nutrition Debate" (Desai and Thorat 2013). Deaton and Dreze (2009) have pointed out that decline in average per capita calorie intake has occurred across the distribution of real per capita expenditure, in spite of increases in real income and no long-term increase in the relative price of food. Panagariya (2013) has tried to establish that prevailing narratives of child under nutrition is false and is an 'artefact of a faulty methodology'; however, such a claim was dismissed by various scholars (Gilllespieet al. 2013; Gupta el al. 2013; Lodha et al. 2013; Jaychandran and Pande 2013). From the debate, two important points emerged. First, neither incorrect methodology of estimation nor genetic predisposition are primary reason for high levels of child under nutrition in India. Secondly, apart from economic growth at the aggregate level, there are various other socio-demographic, economic and cultural factors operating at individual, household and societal level that play significant role in determining child under nutrition in India.

A number of studies conducted in developing countries including India have found that higher consumption expenditure in household lowers the risk of child malnutrition (Torlesse et al. 2003; Sari et al. 2009; Humphries et al. 2017). Other studies emphasized economic gradients such as lack of resources and non-availability of food due to poverty and inequity enhance the risk of malnutrition among children and contributing to the vicious cycle of poverty and malnutrition (Subramanian and Kawachi 2004; Subramanyam et al. 2011; Gwatkin et al. 2007; Kumar et al. 2014; Harttgenet al. 2013). Spears (2013) and Rah et al. (2015) highlighted the strong and positive association between household sanitation and linear growth among children in India and, other countries and regions. Studies have also found that low body-mass index (BMI) among mothers could lead to intrauterine growth retardation of foetus and resulted into low birth-weight babies, who are, in turn, at high risk of malnutrition (Black et al. 2013; Rachmi et al., 2016; Geo-Horta et al., 2016). Vollmer et al. (2016) found strong and positive association between parental education and child growth in low- and middle-income countries. Imai et al. (2014) argued that relative bargaining power of women in the household has statistically positive and significant effect on child's anthropometric outcomes.

Increasing recognition of the multiple pathways in causing child under nutrition and centrality of food intake, other macro-level determinants such as agricultural production, natural calamity, effects of intervention from governmental and non-governmental agencies etc. have gained importance in the literature. Menon et al. (2008) found that State Hunger Index (comprised of calorie inadequacy, child underweight and child mortality) for Indian states has weak relationship with state per-capita income and economic growth. Relationship between nutritional outcomes and, economic and agricultural growth was found to be strong and positive between 1992-2005 in some of the Indian states but not that strong in others (Heady et al. 2012). While examining the association among agricultural production, diet diversity and child anthropometric outcomes in rural Indian households, Bhagowalia et al. (2012) observed that although ownership of livestock and irrigation have positive significant effect on child nutrition, many variables defining agricultural-nutrition pathways in India were found to be weak or unclear. Vepa et al. (2014) argued that Indian agricultural growth through higher food grain production and land productivity can reduce child under nutrition in rural India when it penetrates to grassroot level in the form of labour productivity and higher wages. Kadiyala et al. (2014) argued that agriculture–nutrition research will need to be broadened through more explicit experimental designs, specific household surveys and nutrition-

sensitive macroeconomic simulation models that can rigorously gauge the nutritional impacts of large-scale policies and programs.

Jain (2015) and Kandpal (2011) examined the effect of Integrated Child Development Services (ICDS) on child nutritional status and found positive treatment effect of ICDS on nutritional status *per se*. Singh and Gupta (2016) found that there are programme gaps in coverage of supplementary nutrition in children in rural ICDS areas, its regular supply to the beneficiaries, in pre-school activities coverage, recording of immunization, and regular health check-up of beneficiaries and referral of sick children. Kumar et al. (2016) found that children exposed to a drought *in utero* or at birth have worse anthropometric outcome, and a higher probability of dying during infancy. They argued that because droughts put rural households under financial stress, reduced income from agricultural production is responsible for the detrimental health effects of droughts. Some small-scale studies conducted in rural settings in eastern India found that though exposure to flood has significant negative influence on child wasting, it did not have any effect on stunting and moderate effect on underweight (Rodriguez-Llanes et al. 2016).

In the recent past, using fourth round of National Family and Health Survey (NFHS) data, Menon et al. (2018) have tried to distinguish determinants of stunting between low and high stunting prevalence districts by employing ordinary least square (OLS) based regression-decomposition method. They observed that women's BMI, education, child's adequate diet, household asset, sanitation, age at marriage, antenatal care and household size together explains 71 percent of the observed differences in stunting prevalence across Indian districts. Using same data set and by employing spatial econometric model, Khan and Mohanty (2018) concluded that mother's BMI and household's wealth are strong and significant predictors of all the three anthropometric outcomes, while women's educational attainment and breast feeding practices have significant association with stunting and underweight.

Literature reviewed above has tried to identify some of the key observable characteristics that help in explaining variation in child anthropometric outcomes in developing countries including India. Although factors responsible for cross-state heterogeneity have been recognized, the reasons for such heterogeneity have not been studied deeply. Moreover, most of these studies have tried to find out the covariates affecting child anthropometric outcomes at mean (average) level by using OLS. Some of them also have used categorical dependent models such as logit or probit models to

explain anthropometric outcomes like stunting. It is worth mentioning that such binary or multinomial models not only constraints the effect of explanatory variables to be same across the distribution of the outcome variable but also sacrifices statistical information in grouping continuously distributed dependent variable like height-for-age Z-score (HAZ) into small number of categories. Few researchers (Borooah, 2005; Imai et al. 2014; Kandpal and McNamara 2009) have modelled the entire distribution of an anthropometric outcome such as HAZ by employing quantile regression technique developed by Koenker and Bassett (1978). These studies have observed differential effects of explanatory variables on different parts of the distribution of the outcome variable. To note, quantile regression employed in the aforesaid studies could only able to estimate 'conditional effect' i.e. changes in predictor variables for sub-groups with specific values of covariates (conditional effects). However, assessing the effect of change in a covariate in a population of individuals with different characteristics (unconditional effect) is more meaningful to arrive at a conclusion and thus employed in the present study.

Meanwhile, a separate literature has developed in documenting disparities regarding different dimensions of endowments across space, which might influence on strength of association between endowments and nutritional outcome. Aspects like strength of institutions in implementing public policies, reach of public services, quality of governance, bargaining power of communities, and macro-level political economy etc. have been highlighted in the literature. In Indian context, a sharp disparity of institutional performance (measured in terms of quality of public services such as health, education and public distribution system)between northern and north-central states, and southern states was observed. It was also argued that such contrasting institutional performance even related to Human Development and Gender Development indices. According to Besley and Burgess (2002), equivalent growth in income could result in disproportionate impacts in reduction of poverty in states positioned at two ends of income poverty. They related these differences to the issues pertain to voice and accountability because it was found that the states with higher circulation of newspaper and political competition spend more on relief fund for natural calamity and provide more food grains through public distribution system during natural disaster. Influence of inter-state political and institutional factors on child under nutrition was investigated by Harriss and Kohli (2009). They differentiated between the politics of “clientelism” and “programmatic” politics and argued that such political spectrum could impinge on worse and better child anthropometric outcomes

respectively. Heady et al. (2012) and Menon et al. (2008) have also noted that strength of association between observed covariates and nutritional outcomes might also be different across states.

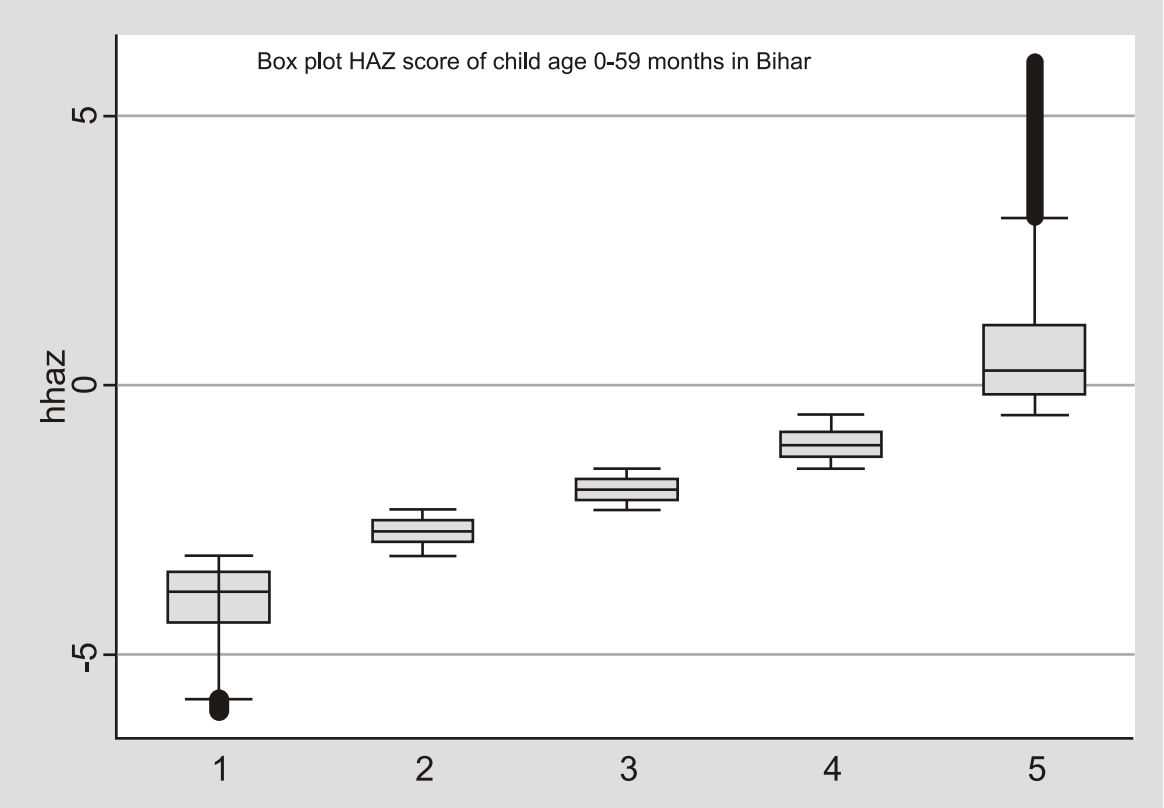
Another set of methodology has been developed to disentangle the effects of *covariate* and *coefficient* in the estimated quantile regression equation. In the present context, differences in the nutrition outcomes across space (for example, counties/states/regions) or time explained by differences in observed covariates may be termed as *covariate effects*, while differences explained by differing strength of relationship between covariates and outcomes, may be termed as *coefficient effect*. In other words, relationship between specific *endowments* and outcome variable can be looked as *covariate effect*, while *returns to specific endowments* can be seen as *coefficient effect*. In order to understand drivers of differences in nutrition outcome relative contribution of covariate and coefficient effects are important not only because population in developing countries are often spatially, socio-economically, and culturally heterogenous but also implementation of various programmes related to public services (for example, nutritional services) varies across space. Using third round of NFHS data, Cavatorta et al. (2015) have performed both OLS as well as *conditional* quantile regression-based counterfactual decomposition (conditional QR-CD, in short) to understand the drivers of large disparities in HAZ in five states of India, namely, Bihar, Uttar Pradesh, Madhya Pradesh, Gujarat and Odisha compared with benchmark state of Tamil Nadu. They surprisingly found that only a modest proportion of HAZ differences are attributable to the differences in endowment, while a substantial part of the differences is accountable to the superior track record of food and nutrition policy of Tamil Nadu and implementation thereof. On the contrary, study conducted by using *unconditional* QR-CD to understand rural-urban disparities in child nutrition in Bangladesh and Nepal found that differences in the levels of some of the socio-economic characteristics, namely, maternal education, spouse's education and wealth index accounted for a major share of rural-urban disparities in the lowest quantiles of child anthropometric outcomes (Srinivasan et al. 2013). Consequently, they observed that the differences in the strength of association attributed for less than a quarter of rural-urban gap at the lower end of the distribution of HAZ scores (ibid).

To sum up, one set of literature have focussed to identify effect of different covariates (or endowments) which could affect differential outcomes in child anthropometry, while another set of literature primarily concentrated in bringing out how

the differences in larger politico-economic landscape can impact on child nutritional outcomes and argued that there are many reasons to believe that not only the endowment but also returns to the endowment can affect child nutritional status equally. For example, even if children in two different regions/states are endowed with equal maternal education and access to health services, quality of those services may differ substantially between comparable units. A small literature has also demonstrated that a substantial proportion of cross-state HAZ gap in India is attributable to the returns to endowment rather than endowment *per se*.

In the present study, we would like to explore factors contributing in intra-state disparities of observed HAZ gap in the state of Bihar – the state comprised of the highest proportion of stunted children in India. We use the fourth round of NFHS data to assess covariate and coefficient effects to explain HAZ differentials between benchmark and comparison regions with in Bihar. We apply *unconditional* QR-CD methods (*Recentred Influenced Function Regression*, to be precise) and allow the covariate and coefficient effects, in the aggregate as well as with respect to individual variables, to differ along the entire HAZ distribution. Figure 1 suffices why quantile regression approach seems essential.

Figure 1



Our primary research question is that, are contribution of covariate versus coefficient effects to cross-region comparisons different at the lower tail of the HAZ distribution, where severe stunting is prevalent, compared to the middle and upper segments of the HAZ distribution? Such distribution-wise understanding can be valuable in a policy atmosphere where targeting most vulnerable is important (Srinivasan et al. 2013; Cavatorta et al. 2015). Our principal hypothesis is that most of the regional disparity in HAZ distribution arises from covariate, rather than coefficient effects within a backward state where implementation of public policies and programmes, functioning of the public institutions, quality of governance should not vary much across regions. We are also interested to explore whether coefficient effects become important as we proceed from the lower to upper spectrum of HAZ distribution or vice-versa.

Study Settings

Bihar is located in the eastern part of India. It has an area of 94,163 sq. km. and a population of 103.8 million (Government of India, 2011). Bihar is entirely land-locked state and is bounded by Uttar Pradesh in the west, Jharkhand in the south, West Bengal in the east and Nepal in the north. Bihar lies in the sub-tropical region of temperate zone and characterized by a hot summer and cold winter. River Ganges divides Bihar into two unequal halves and flows through the middle from west to east. The state of Bihar is divided into nine administrative divisions, 38 districts, 101 sub-divisions, 534 community development blocks, 8,406 panchayats and 45,103 revenue villages. It also has 199 towns including 139 statutory towns.

Decadal population growth rate during 2001-11 was 25.4 percent compared to 17.7 percent nationally; in fact, Bihar had the highest population growth in India. Highest decadal growth was observed in Madhepura district (30.7 percent), while it was the lowest in Gopalganj district (18.8 percent). Bihar also has the highest population density in the country (1102 persons per sq. km. against 328 persons per sq. km. nationally). Population density was found to be the highest in Sheohar (1882 persons per sq. km.) and the lowest in Kaimur (488 persons per sq. km.). However, Bihar is the second least urbanized state in India; more than 88 percent population live in rural areas. Proportion of urban population also varies across space – 21.4 percentage people live in urban areas in Patna district, while it is only 0.24 percentage in Sheohar district. Overall sex ratio in Bihar was 918 females per 1000 males with the highest in Gopalganj (1015 females per 1000 males) and the lowest in Munger as well as in Bhagalpur (879 females per 1000 males). Literacy rate in Bihar was

found to be 61.8 percent with the highest in Rohtas (75.6 percent) and the lowest in Purnia (52.5 percent). Although the state has recorded impressive progress in economic front in the recent past (at 10.3 percent, Bihar Economic Survey 2017-18), nearly70percent (Planning Commission's report 2014) population live still below poverty line. Currently, Bihar has the highest total fertility rate (TFR) (3.3 children per woman) in India, varies from Araria (4.4) to Patna (2.7) (Annual Health Survey 2011-12). Infant mortality rate (IMR) (52 per 1,000 live-births) in Bihar is one of the highest in India and ranges from Patna (37 per 1000 live-births) to Madhepura (68 per 1,000 live-births)(AHS, 2011-12).

Undernourishment among under-five children has continued to persist in Bihar from past several decades. Malnutrition (maternal and child malnutrition together) continued to be the largest risk factor driving the most death and disability since 1990 (ICMR, PHFI and IHME 2017). Although the proportion of stunted, underweight and wasted children declined from 61 percent, 63 percent and 22 percent to 48 percent, 44 percent and 21 percent respectively between 1992-93 and 2015-16 (IIPS 1995; IIPS and ICF 2017), these percentages are still the highest among all the states in India. Moreover, a substantial regional variation exists with respect to child under nutrition. The proportion of stunted children varies from 37 percent in Gopalganj district to 57 percent in Sitamarhi district, while such differences ranges from 31 percent in Gopalganj district to 54 percent in Arwal district as far as proportion of underweight children is concerned. It may also be noted that Arwal district has the highest proportion of wasted children (30percent), while Sheohar district comprised of the lowest proportion of wasted children (15 percent).Numerically, 9.2, 8.4, 4.0 million children in Bihar are stunted, underweight and wasted respectively with substantial regional variations. Notably, Bihar alone contributes around 15percent of undernourished children in India.36 out of 38 districts in Bihar feature among 201 districts in India, where prevalence of stunting is the highest. More importantly, out of 100 districts, where prevalence of stunting is the highest, one-quarter belonging to Bihar.

Materials and Methods

Data and variables

Data for this study are obtained from the fourth round of NFHS (National Family Health Survey), which was carried out between 2015 and 2016, and conducted by International Institute for Population Sciences (IIPS), Mumbai and ICF. NFHS is an Indian variant of Demographic and Health Surveys (DHS) which collects and disseminates information on

fertility, mortality, family planning, and important aspects of reproductive health, nutrition and healthcare based on a nationally representative household surveys for 90 countries. It is worth mentioning that the data set is available in the public domain subject to a prescribed registration and approval process. Requisite permission in accessing and usage of data set was obtained from the MEASURE-DHS archive. The survey collected information from 601,509 households and interviewed 527,889 ever-married women (in the age group 15-49) in all the states and union territories in India. In addition, the survey collected information on indicators pertaining to maternal and child health care of 259,627 children born during the five years preceding the survey. In Bihar, a total of 45,812 women were interviewed and data on 25,437 children residing in 36,772 households were collected. Besides, NFHS also collected information on various socio-demographic and economic indicators of mother, child and households. This is for the first time, NFHS has collected information on the aforesaid indicators at the district-level and thus enabled us to understand intra-state regional variations of different indicators. In addition to NFHS, data from various state government departments as reported in Economic Survey of Bihar were also used to substantiate our findings.

Height-for-age Z scores (HAZ) has been used as an indicator of child nutrition. Stunting has been defined as HAZ below minus two standard deviation of the WHO International Reference Standard (WHO 2010). Stunting is considered as a standard indicator of child undernutrition and health status as it reflects chronic under nutrition caused by long-term deprivation. Out of 25,437 under-five children (0-59 months of age) complete information on HAZ score was available for 22,275 children. HAZ has been used as outcome variable in all our regression models. Although we started with reduced form of conceptual framework of UNICEF as mentioned earlier and previous literature, we needed to further refine our covariate set since decomposition of observed HAZ differences into covariate and coefficient effects require well-specified regressions models which should include key relevant covariates (Cavatorta et al. 2015). Our final regression models include following covariates representing child, maternal, household and spatial characteristics.

We included current age of the child (in months), square of the age, sex of the child (male/female), size of the child at birth (more than average, average, small) as a proxy for birth weight, early initiation of breast feeding, and number of siblings as child characteristics. Maternal characteristics comprises age of the mother at first birth, maternal education, anaemia (no, mild/moderate and severe), degree of media exposure, dietary

diversity index (additive index created from consumption of milk, pulses/beans, green leafy vegetables, fruits, egg, fish, and chicken almost regularly or irregularly). In addition, institutional delivery and receipt of benefit from ICDS services during 12 months preceding the survey have also been considered as a proxy of contact with health personnel by mother.

Household wealth quintile (bottom, middle, rich),family structure (nuclear, non-nuclear), socio-religious category (Hindu SC/ST, Hindu OBC, Hindu others, Muslims/others), household environment index and index of household's ownership of irrigated agricultural land and livestock were incorporated as household level variables. Index of household environment was created by employing principal component analysis (PCA) from eight binary variables, viz., availability of potable drinking water, safe sanitation facility, cleaner cooking fuel, separate room as kitchen, habit of handwash with soap among household members, and finished main material of floor, wall and roof in the physical structure of household. Factor scores was normalized and used in specified regression models. Similarly, normalized factor scores were also generated to produce index of household's ownership of irrigated agricultural land and livestock using seven binary variables, namely, possession of irrigated agricultural land, cows, camels, horses, goats, sheep, and chicken. It may be mentioned here that instead of household consumption expenditure and income, household wealth index as calculated by DHS is based on possession of household durable assets and hand holding. For construction of index, the variables were first broken into sets of dichotomous variables and indicator weights are assigned using PCA as suggested by Filmer and Pritchett (2001) and then divided into quintiles. In addition to the variables representing child, maternal and household characteristics, place of residence (rural/urban) was also included in the regression models.

We would also like to mention that we have also included normalized factor scores of per capita productions of agricultural and allied products, namely, fish, milk, rice, wheat, maize, pulse, guava, banana, potato, onion, cauliflower, brinjal and mango as an indicator of macro-level agricultural production, proportion of villages located within 25 Km of town as a proxy for remoteness (town25 as given in Table 1), and proportion of villages affected by flood during the span of 15 years preceding the survey representing frequency of flood as a proxy for vulnerability to natural disaster in the regression models as district-fixed effects initially; however, dropped later because of endogeneity problem.

Methods

In order to assess regional differentials in HAZ scores, first, distributions of HAZ scores are estimated separately for all the regions using kernel density smoothing techniques. From the kernel density smoothing estimates of HAZ scores, regional differential is computed at each quintile and provided raw difference in HAZ score across the distribution.

As mentioned above, main objective of the present study is to decompose the regional differences in child anthropometric outcomes into the covariate effect (i.e. differences in HAZ scores due to differential level of characteristics in differing regions), and the coefficient effect (i.e. differences in HAZ scores due to the differential returns to those characteristics across the entire distribution of HAZ scores in differing regions). To note, OLS or logit/probit type regression approaches are not only appropriate in this case as mentioned above, but also decompositions based upon OLS results would apply only to the mean regional differences in HAZ scores, but not to the other distributional characteristics such as quintile. Additionally, Koenker and Hallock (2001) cautioned against simply segmentation of the outcome variable, for example HAZ scores into deciles, and run OLS on those segments separately as it introduces sample selectivity bias. Koenker and Bassett (1978) developed quantile regression method, which can estimate only conditional quantile effects of changes in explanatory variable and thus not very suitable for the present study because such method does not capture the effect of a change in a predictor variable in a population of individuals with different characteristics rather than influence among group of individuals with specific values of covariates. In this study, to decompose the regional HAZ score differential along the entire distribution, we have applied Blinder-Oaxaca decomposition method for unconditional quantile regression models suggested by Firpo et al. (2009) and Fortin et al. (2011).

Firpo et al. (2009) have proposed a regression method to estimate the impact of changing the distribution of explanatory variables on the marginal (unconditional) quantiles of outcome variable. The method consists of employing a regression of a transformation – the recentered influence function (RIF) – of the dependent variable (Y) on the explanatory variables (X). This approach allows estimating the contribution of each explanatory variable for the components of the HAZ decomposition and thus extends the Blinder and Oaxaca decomposition to other distributional statistics than the mean (Fortin et al., 2011).

To estimate the unconditional quantile regression, first we have derived the RIF of the response variable (HAZ score, in our case). The RIF for the q_{th} quantile is given by the following expression:

To estimate the unconditional quantile regression, first we have derived the RIF of the response variable (HAZ score, in our case). The RIF for the q_{th} quantile is given by the following expression:

$$RIF(Y, q_\tau) = q_\tau + \frac{\tau - I(Y \leq q\tau)}{fy(q\tau)} \qquad (1)$$

Where $f_Y(q_\tau)$ is the marginal density function of Y at the point q_τ estimated by kernel methods; q_τ is the sample quantile; $I(Y \leqslant q_\tau)$ is an indicator function indicating whether the value of the outcome variable is below q_τ. RIF provides a linear approximation to a non-linear functional (ν(Y)) (such as median) of the Y distribution and thus allow computing partial effects for single covariates (Firpo et al. 2009). Firpo et al. (2009)have also shown that by estimating OLS of the new dependent transformed variable on the covariates (X), the RIF quantile regression may be implemented. In our case, considering two regions (A and B), RIF regressions for HAZ score in both regions are estimated as:

$$E[RIF(Y_{i \in g}; q_\tau) \mid X_{i \in g}] = X_{i,g}\beta_{\tau,g} g = A, B \qquad (2)$$

Coefficients $\beta_{\tau,\ g}$represents the approximate marginal effects of the predictor variables on the HAZ quantile q_τ for children age 0-59 months in region g = A, B.

To decompose the observed differences of HAZ scores between two regions A and B (say Saran and Bhagalpur in this case), into covariate (differing endowments of observed determinants of HAZ) and coefficient (differing strength of relationships between observed determinants and HAZ) effects, it is also necessary to estimate the counterfactual HAZ distribution. We have obtained the counterfactual HAZ distribution (say C distribution) by combining the covariates of region A with the distribution of characteristics of region B. This is the distribution of HAZ scores in B region that would have prevailed if the households in the B region had the same returns to their characteristics as households in the A region.

If q_{τ_A} and q_{τ_B} are given quantiles of the HAZ score distribution in A and B regions respectively, and q_{τ_C} is the same quantile of the counterfactual C distribution, then the overall difference between B and A HAZ scores at any given quantile can be decomposed as:

$$q_{\tau\_B} - q_{\tau\_A} = [q_{\tau\_B} - q_{\tau\_C})] + [q_{\tau\_C} - q_{\tau\_A}] \qquad (3)$$

where $[q_{\tau\_C} - q_{\tau\_A}]$ represents the covariate effect and $[q_{\tau\_B} - q_{\tau\_C})]$ represents the coefficient effect.

The covariate and coefficient effects are each decomposed into the contribution of individual covariates using the RIF regression as mentioned in equation (2) to obtain unconditional quantile effects of covariates on HAZ scores.

Using the RIF unconditional quantile estimates the following decomposition of HAZ score can be obtained for any given quantile:

$$\widehat{q_{\tau\_B}} - \widehat{q_{\tau\_A}} = \left[\overline{X_B}\left(\widehat{\beta_C} - \widehat{\beta_B}\right) + \widehat{R^{Coeff}}\right] + \left[\left(\overline{X_A}\widehat{\beta_A} - \overline{X_B}\widehat{\beta_C}\right) + \widehat{R^{Cov}}\right] \qquad (4)$$

Where $\widehat{q_{\tau\_B}} - \widehat{q_{\tau\_A}}$ represents the raw difference in B and A HAZ scores at the τth quantile and X represents the covariate averages. Note that $\widehat{\beta_C}$ is estimated from a RIF regression of the counterfactual HAZ score distribution. $\left(\widehat{\beta_C} - \widehat{\beta_B}\right)$ is, therefore, the difference in the effects of covariates between regions and $\overline{X_B}\left(\widehat{\beta_C} - \widehat{\beta_B}\right)$ represents the coefficient effect. $\left(\overline{X_A}\widehat{\beta_A} - \overline{X_B}\widehat{\beta_C}\right)$ represents the differences between B and A HAZ scores attributable to the differences in characteristics of endowments and hence represents the covariate effect. $\widehat{R^{Cov}}$ and $\widehat{R^{Coeff}}$ are errors related to the estimation of coefficient and covariate effects.

It is worth pointing out here that although we have tried our level best to minimize endogeneity problem while making choice regarding predictor variables, and it is consistent with previous literature (Srinivasan et al. 2013; Cavatorta et al. 2015), still endogeneity could persist among different predictor variables and leading to difficulties in parameter interpretation. However, it is important to note that objective of the counterfactual decomposition is not identifying causality, but rather explaining variations in HAZ scores and judge the relative importance of covariate and coefficient effects (Srinivasan et al. 2013; O'Donnell et al. 2009). Thus, one should be cautious while interpreting coefficients of the variables that are potentially endogenous, though validity of decomposition is not questioned.

Results

Descriptive statistics

Table 1 presents descriptive statistics of observed HAZ scores and other background characteristics in nine administrative regions of Bihar. At the mean level, under-five

children of Saran division are the least likely to be stunted compared to other regions, while children of Tirhut division are most likely to be stunted. More specifically, differences in mean HAZ scores between Saran and Tirhut stands at 0.37. One may also note that mean HAZ scores among under-five children of Saran and those at the national-level is also very minimal (0.05) (not shown in the table), though differ significantly with the state-level HAZ scores (0.29). Among children belonging to the bottom ten percentile, the highest difference in HAZ scores was observed between Saran and Purnia (0.38); however, at the top ten percentile the highest gap is found between Saran and Tirhut (0.34).

TABLE 1 SAMPLE MEAN

Characteristics	Saran	Patna	Magadh	Bhagalpur	Munger	Tirhut	Darbhanga	Koshi	Purnia	Total (Bihar)
Child Characteristic										
Age of Child (Mean)	29.46	30.49**	30.46*	29.58	29.94	29.37	29.22	30.27	29.51	29.90***
Age2	1159.6	1217.7*	1213.3	1156.1	1183.1	1150.1	1139	1201.9	1160.7	1180.9***
Female	0.49	0.48	0.47	0.46	0.49	0.48	0.51	0.48	0.48	0.48
Birth Size										
Average	0.59	0.78***	0.76***	0.74***	0.73***	0.64***	0.68***	0.75***	0.68***	0.71***
Above than average	0.27	0.11***	0.13***	0.15***	0.13***	0.21**	0.19**	0.14***	0.19***	0.16***
Small	0.14	0.11	0.11	0.11	0.14	0.15	0.14	0.12	0.14	0.13
Early Breastfeeding (Yes %)	0.36	0.37***	0.40	0.33	0.36	0.37	0.34	0.35	0.37	0.37
No. of Sibling (Mean)	1.68	1.76**	1.73	1.84***	1.90***	1.89***	1.87***	1.98***	2.05***	1.86***
Institutional Delivery (yes %)	0.73	0.82***	0.70	0.71	0.71	0.56***	0.58***	0.61***	0.52***	0.67***
Type of family (joint) (%)	0.73	0.65***	0.66***	0.55***	0.60***	0.57***	0.58***	0.53***	0.45***	0.59***
Age of mother at first birth (mean)	20.7	20.6	20.1***	20.5	19.9***	20.2***	20.3***	20.3***	20.5*	20.3***
Maternal height (cm) (Mean)	150.1	149.8*	149.2***	148.5***	149.2***	150.0	149.9	149.6**	149.8	149.6***
Maternal education (%)	4.76	5.02	4.21***	3.64***	3.55***	3.12***	3.02***	2.43***	2.48***	3.64***
Mother's anaemia										
Mild/moderate	0.43	0.48**	0.50***	0.52***	0.50***	0.44	0.47	0.47	0.50***	0.48**
Severe	0.18	0.15	0.14	0.16	0.16	0.17	0.20	0.18	0.20	0.17
Maternal dietary index (mean)	14.5	13.7***	13.04***	14.25**	14.22***	14.21**	13.58***	13.24***	14.56	13.90***
Place of residence										
Rural	0.94	0.81***	0.92**	0.90***	0.86***	0.93	0.94	0.94	0.94*	0.90***
Urban	0.06	0.19***	0.08	0.10	0.14*	0.07	0.06	0.06	0.08	0.10
Religion and caste composition										
Hindu/Sc/St	0.25	0.26	0.31**	0.22	0.22	0.23	0.26	0.24	0.17**	0.24
Hindu/OBC	0.52	0.55	0.52	0.59**	0.57*	0.53	0.47*	0.53	0.29***	0.51
Hindu/Others	0.10	0.11	0.09	0.04	0.10	0.08	0.09	0.05	0.03*	0.08
Muslims/ST/OBC/Others	0.13	0.09	0.08*	0.15	0.11	0.17	0.17	0.19	0.50***	0.17
Media Exposure (mean)	1.91	1.73***	1.11***	1.34***	1.37***	1.50***	1.08***	0.88***	1.02***	1.35***
SLI										
Low	0.21	0.18	0.0.31***	0.35***	0.29***	0.39***	0.44***	0.49***	0.44***	0.33
Medium	0.36	0.29***	0.32	0.33	0.35	0.34	0.31*	0.35	0.36	0.33
High	0.43	0.53***	0.36***	0.33***	0.36***	0.26***	0.24***	0.17***	0.20***	0.33
Benefited from ICDS services	0.39	0.58***	0.58***	0.57***	0.61***	0.46**	0.41	0.59***	0.59***	0.54***
Households Environment index (mean)	0.08	0.61***	0.10	-0.05**	0.15	-0.19	-0.36***	-0.44***	-0.43	-0.30
Agricultural land & Livestock index (Mean)	0.42	-0.08***	0.24***	0.15***	-0.10***	-0.06***	-0.15***	-0.02***	-0.12***	0.10***
Town 25 (mean)	25.2***	22.7***	26.1**	40.1***	24.6	24.4**	28.3***	41.7***	40.6***	28.9***
Agricultural allied product index (Mean)	0.11	0.18**	-1.36***	-0.31***	-0.82	1.41***	1.77***	0.04***	-0.59***	1.32***
Frequency of floods (mean)	14.01	10.6***	1.21***	11.53***	11.80***	19.17***	10.31***	4.62***	4.51***	9.94***
Total	1434	3753	2785	1164	3677	3318	1678	2058	2408	22275

***p<0.001; **p<0.01; *p<0.05

Mean age of the children does not vary much according to region; mean age of the children is between 29 and 30 months. Proportion of girls are disproportionately lesser than boys except in Koshi division. 27 percent of the children in the Saran division are born with greater than average size, while such percentage was only 11 in Patna division. However, 78 percent of children of Patna division born with normal size compared to 59 percent in Saran division. Early initiation of breast feeding does not vary substantially across regions and lies between 36 percent in saran division to 40 percent in Magadh division. Sibling size of children, which is defined as total number of living younger and older siblings, has found to be significantly higher in almost all the regions compared to Saran division; with highest in Purnia division (2.05 in Purnia compared to 1.68 in Saran).

Mother's age at first birth is observed to the lowest in Munger division (19.9 years) and the highest in Saran division (20.7 years) with state average 20.3 years. Mother's height is found to be the lowest in Bhagalpur division (148.5 cm) and the highest in Saran division (150.1 cm) closely followed by Tirhut. Mothers from Patna division have the highest completed years of schooling (5.02 years), while mothers from Koshi division has the lowest educational attainment (2.43 years). Mild/moderate anaemia among women has been found to be the highest in Bhagalpur division (52 percent), while severe anaemia does not vary significantly across regions. Mothers belong to Purnia division have more dietary diversity compared to other regions. Degree of mass media exposure is found to be the highest among the women in Saran division, while it is the lowest in Koshi division. Proportion of institutional delivery also varies widely across regions – although 82 percent of women in Patna division delivered in institution, it is only 52 percent in Purnia division. 61 percent children have received any benefit from ICSD services during one year preceding the survey in Munger division, which is found to the highest among all the regions. However, reach of ICSD is observed to be poor in Saran division, where only 39 percent children benefitted from ICDS.

Nuclear structure of family is not widely prevalent in most of the regions in Bihar except Purnia, where 45 percent households are non-nuclear. As far as religion and caste composition is concerned, SC/ST Hindu is found the highest in Magadh division, while proportion of OBC Hindu is the highest in Bhagalpur division. Muslims are mainly concentrated in Purnia division. Proportion of the poor households is observed to the highest in Koshi division (49 percent), whereas majority of households in Patna division belong to the affluent sections (53 percent). Household environment index as constructed

by a number of indicators is found to be the best among the households of Patna division and worst in Koshi division. Proportion of urban residents is found to be the highest in Patna division followed by Munger division and considerably low in other regions.

Results of Recentered influence function (RIF) quantile regression

The estimates obtained from the unconditional RIF quantile regression for Bihar and nine divisions separately are shown in Tables 2 to 7 respectively. Although all the variables considered in the RIF quantile regression found to have significant influence on childhood stunting, such associations vary across regions.

Increase in child's age significantly tend to lower HAZ score, reflecting growth faltering among young children at aggregate level and also in all the regions. It is important to note that the negative effect of age increases substantially as we move from the lower tail to the upper tail, at least up to 75th quantile, in almost all the regions – indicating children who have had better nutritional status stand to lose more on account of growth faltering as they grow older. Such a pattern underscores the importance of flexibly modelling effects across the distribution. There is no apparent gender disparity against female in childhood stunting in Bihar at the aggregate level and also in all other divisions. Significant negative effect of smaller birth size (proxy for low birth weight) on growth faltering somewhat reduces as we move from lower tail to upper tail of the distribution at the aggregate level. Notably, in Patna, Bhagalpur and Munger divisions, children with smaller size at birth are significantly less likely to recover from growth faltering even in the higher quantiles. Early initiation of breast feeding is found to be positively and significantly associated with HAZ scores among bottom quantile of children only in Purnia. Greater sibling size significantly tends to reduce HAZ scores for the indexed children belong to the bottom quantile at the aggregate level and in Munger division. Greater number of siblings also significantly tend to reduce HAZ scores among children of 25th percentile in Saran and Patna. Our analysis also revealed that, at the aggregate level, children of higher HAZ scores are significantly less likely to be benefitted from ICDS Similar pattern has been observed in Purnia, Patna and Tirhut divisions.

As we move from lower tails to the upper tails of HAZ distribution, mother's higher age at first birth is found to have positive and significant influence on HAZ scores in Bihar, particularly in Patna and Munger. Even after controlling other confounding variables, mother's height has net positive and significant influence on a child's HAZ scores across

quantiles and regions in Bihar. Positive and significant effect of higher maternal BMI on child's HAZ scores observed at the aggregate level for every quantile except the bottom quantile and its effect is found to be somewhat higher compared to maternal height, though varies somewhat regionally. Maternal BMI has found to have net positive and significant influence on child's HAZ scores in all the quantiles in Purnia, and in some quantiles in Bhagalpur, Darbhanga and Munger divisions; however, negatively at the bottom quantile in Koshi division. At the aggregate level, we found that as we move from the lower tails to the upper tails of HAZ distribution, significant positive influence of mother's completed years of schooling weakens. Such observation holds for most of the regions. Our analysis suggests that mother's anemia, particularly, severe anemia negatively and significantly affect HAZ scores of their children belong to the lower quantiles at the aggregate level and also in Magadh and Purnia. However, in Munger division, severe anemia among mothers tend to affect significantly on their children's HAZ scores across quantiles except bottom 10 percentile. Mother's dietary diversity is found to have net positive and significant influence on child HAZ scores at the median at the aggregate level, though its effect varies across regions and quantiles. Exposure to mass media of mothers significantly enhance HAZ scores among children placed at the upper tail of HAZ distribution at the aggregate level and in Bhagalpur and in Tirhut regions. Our analysis suggests positive and significant net effect of institutional delivery on child's HAZ scores for the children belong to 25th – 50th percentiles at the aggregate level and in Purnia division respectively.

Table 2: Unconditional Re-centred Influence Function (RIF) quantile regression results for Bihar (2015-16)

	10	25	50	75	90
Child Characteristic					
Age of Child	-0.056***	-0.085***	-0.107***	-0.134***	-0.114***
Age^2	0.001***	0.001***	0.001***	0.002***	0.001***
Female	0.214***	0.152***	0.063*	-0.005	0.139**
Birth Size					
Average					
Above than average	0.017	-0.020	0.006	0.051	0.025
Small	-0.343***	-0.297***	-0.289***	-0.196***	-0.094
Early Breastfeeding (Yes)	-0.028	-0.062	-0.016	-0.034	0.054
No. of Sibling	-0.047**	-0.020	-0.006	-0.010	0.012
Benefited from ICDS services	-0.003	-0.076*	-0.125***	-0.214***	-0.192***
Mother's Characteristics					
Institutional Delivery (yes)	0.076	0.082*	0.040	-0.013	-0.055
Age of mother at first birth	0.000	-0.001	0.004	0.021***	0.026***
Maternal height (cm)	0.004***	0.005***	0.004***	0.005***	0.004***
Mother's BMI	0.006	0.009*	0.012**	0.016**	0.027***
Maternal education	0.018***	0.029***	0.026***	0.007	0.013
Mother's anaemia					
Mild/moderate	-0.089*	-0.047	-0.116***	-0.085	-0.104
Severe	-0.224***	-0.087	-0.088*	-0.078	-0.085
Maternal dietary index	0.012	0.003	0.011*	0.005	0.01
Media Exposure index	-0.010	-0.002	0.014	0.042**	0.009
Household's Characteristics					
Type of family (Joint)	-0.047	0.017	-0.018	-0.041	-0.037
Religion and caste composition					
Hindu/Sc/St					
Hindu/OBC	0.212***	0.108**	0.093*	0.088	0.088
Hindu/Others	0.168*	0.157**	0.359***	0.689***	0.576***
Muslim/Others	0.020	-0.091	-0.040	-0.067	-0.128
Assets Index	0.005	-0.005	0.001	0.012	0.017
Households Environment index	0.114***	0.128***	0.103***	0.107***	0.038
Agricultural land &livestock index	0.031*	0.011	0.020	0.010	-0.001
Spatial					
Rural					
Urban	0.039	0.130*	0.108	0.131	0.107
Region					
Patna					
Magadh	-0.014	-0.101	-0.092	-0.056	0.069
Bhagalpur	0.156	0.063	0.040	0.264**	0.237
Munger	0.144*	0.148**	0.150***	0.165**	0.113
Saran	0.279***	0.185**	0.262***	0.347***	0.296*
Tirhut	0.080	0.077	0.022	-0.039	-0.073
Darbhanga	0.173*	0.135	0.067	0.139	0.093
Koshi	0.187**	0.184**	0.163**	0.277***	0.422***
Purnia	0.141	0.129	0.134*	0.074	0.009
Constant	-9.227***	-8.964***	-7.714***	-7.442***	-4.795***
R squared	0.0470	0.0913	0.1398	0.1268	0.0586
Adjusted R squared	0.0467	0.0910	0.1396	0.1266	0.0584

*****p<0.001; **p<0.01; *p<0.05**

Table 3: Unconditional Re-centred Influence Function (RIF) quantile regression results for Saran and Patna Division in Bihar (2015-16)

	Saran					Patna				
	10	25	50	75	90	10	25	50	75	90
Child Characteristic										
Age of Child	-0.055***	-0.076***	-0.111***	-0.122***	-0.108**	-0.064***	-0.077***	-0.101***	-0.135***	-0.115***
Age^2	0.001**	0.001***	0.002***	0.002**	0.001*	0.001***	0.001***	0.001***	0.002***	0.001***
Female	0.382**	0.413***	0.257*	0.097	0.224	0.083	0.085	0.068	0.010	0.132
Birth Size										
Average										
Above than average	-0.125	-0.065	0.101	0.026	0.044	0.436***	0.292**	0.239**	0.194	0.097
Small	-0.595**	-0.418*	-0.403**	-0.334	-0.38	-0.366*	-0.143	-0.124	-0.257	-0.456**
Early Breastfeeding (Yes)	-0.095	-0.215	0.083	0.192	-0.051	-0.130	-0.004	-0.076	0.057	0.171
No. of Sibling	-0.037	-0.114*	0.048	0.074	0.045	-0.065	-0.086**	-0.019	-0.06	-0.037
Benefited from ICDS services	0.010	0.042	-0.028	0.102	-0.099	-0.053	-0.072	-0.183**	-0.297**	-0.114
Mother's Characteristics										
Institutional Delivery (yes)	0.116	0.056	0.093	-0.026	0.190	0.181	0.009	-0.038	-0.08	-0.183
Age of mother at first birth	0.029	0.028	0.036*	0.031	0.064	-0.028	-0.008	-0.011	0.018	0.002
Maternal height (cm)	0.004***	0.005***	0.004***	0.003**	0.001	0.004***	0.004***	0.004***	0.006***	0.002
Mother's BMI	-0.006	-0.008	-0.009	-0.002	0.012	0.012	0.004	0.002	0.011	0.023
Maternal education	0.044**	0.064***	0.054***	0.034	0.045	0.014	0.024**	0.013	-0.008	0.015
Mother's anaemia										
Mild/moderate	-0.209	-0.158	-0.113	-0.160	0.042	-0.222*	-0.043	-0.063	-0.249**	-0.144
Severe	-0.385	-0.032	-0.064	-0.005	0.154	-0.281	-0.038	-0.158	-0.230	-0.095
Maternal dietary index	-0.025	0.001	-0.018	-0.044*	-0.048	0.019	0.012	0.010	0.020	0.084**
Media Exposure index	-0.034	-0.019	-0.006	0.024	0.006	-0.004	0.002	0.039	-0.020	-0.087
Household's Characteristics										
Type of family (Joint)	0.178	0.086	0.222	-0.071	0.100	-0.180	0.119	0.005	0.065	-0.003
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	-0.260	-0.209	0.017	0.354	0.504*	0.233	0.101	0.088	0.017	-0.073
Hindu/Others	-0.576*	-0.493*	0.337	0.781*	0.956	0.323*	0.357**	0.426***	0.571**	0.379
Muslim/Others	-0.394	-0.366	0.067	0.435	0.66	-0.145	0.098	-0.124	-0.258	-0.404
Assets Index	-0.044	-0.03	-0.044	-0.038	-0.036	-0.001	-0.014	0.016	0.035	0.04
Households Environment index	0.065	0.105*	0.125**	0.122	0.079	0.129**	0.09**	0.062	0.112*	-0.009
Agricultural land & livestock index	0.027	0.024	-0.017	0.020	-0.101	0.061	0.025	0.011	-0.046	-0.016
Spatial										
Rural										
Urban	0.269	0.562*	0.084	0.152	-0.503	0.119	0.230*	0.255**	0.428**	0.366
Constant	-9.268***	-9.383***	-6.319***	-4.309*	-1.537	-9.508***	-8.431***	-7.175***	-7.820***	-2.061
R squared	0.0757	0.1167	0.1737	0.1342	0.0618	0.0626	0.1118	0.1507	0.1395	0.0682
Adjusted R squared	0.0735	0.1146	0.1718	0.1321	0.0595	0.0615	0.1107	0.1497	0.1384	0.067

***p < 0.001; **p < 0.01; *p < 0.05

Table 4: Unconditional Re-centred Influence Function (RIF) quantile regression results for Magadh and Bhagalpur Division in Bihar (2015-16)

	Magadh					Bhagalpur				
	10	25	50	75	90	10	25	50	75	90
Child Characteristic										
Age of Child	-0.048***	-0.087***	-0.096***	-0.098***	-0.135***	-0.064**	-0.069***	-0.101***	-0.181***	-0.194**
Age^2	0.001***	0.001***	0.001***	0.001***	0.002***	0.001**	0.001***	0.001***	0.002***	0.003**
Female	0.261**	0.332***	0.061	0.015	0.266	0.493**	0.197	0.209	0.152	0.676
Birth Size										
Average										
Above than average	0.170	0.004	-0.202	0.029	0.114	-0.325	-0.151	0.085	0.401	0.364
Small	-0.316	-0.314	-0.358**	-0.127	-0.066	0.043	-0.031	-0.691***	-0.697*	-0.88
Early Breastfeeding (Yes)	0.083	-0.086	0.157	0.058	0.143	-0.059	-0.042	0.182	-0.062	0.126
No. of Sibling	-0.029	0.014	-0.006	-0.022	-0.056	-0.023	-0.022	-0.042	0.122	0.281*
Benefited from ICDS services	0.026	0.002	0.062	0.052	0.047	-0.277	-0.265	-0.212	-0.361	-0.804
Mother's Characteristics										
Institutional Delivery (yes)	0.087	0.102	-0.007	-0.083	-0.281	0.214	0.209	-0.100	-0.325	-0.497
Age of mother at first birth	-0.009	0.012	0.021	0.020	0.020	-0.001	0.023	0.017	0.105**	0.116*
Maternal height (cm)	0.002	0.004***	0.006***	0.005***	0.007***	0.003	0.003**	0.005***	0.009***	0.008
Mother's BMI	-0.007	-0.018	0.005	0.017	0.044	0.041	0.047**	0.057**	0.089	0.108
Maternal education	0.000	0.031*	0.026**	0.032*	0.005	-0.029	0.004	0.002	-0.036	0.025
Mother's anaemia										
Mild/moderate	-0.009	-0.036	-0.136	0.011	-0.179	-0.334	-0.202	-0.274	-0.634*	-1.777**
Severe	-0.484*	-0.321*	-0.005	0.119	0.159	-0.035	-0.121	-0.182	-0.437	-1.208*
Maternal dietary index	0.011	0.024	0.02	0.018	0.029	0.005	0.012	0.039*	0.055	0.067
Media Exposure index	-0.022	-0.003	-0.009	0.020	0.166	-0.024	-0.059	-0.011	0.139	0.262*
Household's Characteristics										
Type of family (Joint)	0.091	0.169	0.113	0.107	0.062	0.229	0.080	-0.043	-0.094	0.309
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	0.339*	0.387**	0.203	0.032	-0.308	0.055	-0.058	0.044	0.253	1.038*
Hindu/Others	0.287	0.546**	0.618***	1.058***	0.932*	-0.324	-0.531	0.179	1.100	0.653
Muslim/Others	0.396	0.106	-0.002	-0.09	-0.115	-0.455	-0.349	-0.539*	-1.467***	-1.422*
Assets Index	-0.005	-0.008	0.013	0.021	-0.006	-0.001	0.012	0.003	0.032	0.005
Households Environment index	0.143**	0.186***	0.245***	0.181**	0.137	0.242*	0.181***	0.116*	0.171	-0.177
Agricultural land & livestock index	0.023	-0.055	-0.005	-0.038	0.029	0.046	0.060	0.059	-0.135	-0.294*
Spatial										
Rural										
Urban	-0.346	-0.358	-0.317*	-0.132	0.545	-0.241	-0.098	-0.475	-0.672	-1.208
Constant	-6.591***	-9.362***	-10.298***	-8.032***	-9.184**	-8.796**	-8.558***	-10.005***	-15.381***	-13.313*
R squared	0.078	0.130	0.201	0.170	0.083	0.052	0.104	0.152	0.180	0.108
Adjusted R squared	0.077	0.129	0.200	0.168	0.081	0.049	0.101	0.149	0.177	0.105

***p < 0.001; **p < 0.01; *p < 0.05

Table 5: Unconditional Re-centred Influence Function (RIF) quantile regression results for Darbhanga and Koshi Division in Bihar (2015-16)

	Darbhanga					Koshi				
	10	25	50	75	90	10	25	50	75	90
Child Characteristic										
Age of Child	-0.069***	-0.124***	-0.121***	-0.129***	-0.123***	-0.04*	-0.075***	-0.104***	-0.169***	-0.207***
Age^2	0.001**	0.002***	0.002***	0.002***	0.001*	0.001***	0.001***	0.002***	0.002***	0.002***
Female	0.201	0.127	0.053	-0.078	-0.152	0.626***	0.189*	0.141	0.233	0.702**
Birth Size										
Average										
Above than average	-0.176	-0.277	-0.084	0.051	0.216	0.350	0.238	0.387**	0.180	1.020*
Small	-0.845**	-0.410*	-0.467**	-0.373*	-0.011	-0.337	-0.225	-0.006	-0.327	-0.350
Early Breastfeeding (Yes)	-0.433*	-0.220	-0.033	-0.064	0.010	-0.246	-0.102	-0.213*	-0.399**	-0.393
No. of Sibling	-0.023	0.040	-0.005	-0.048	-0.027	-0.019	-0.030	-0.009	-0.036	0.008
Benefited from ICDS services	0.231	0.260	0.169	-0.033	0.019	0.070	-0.043	0.061	0.057	-0.319
Mother's Characteristics										
Institutional Delivery (yes)	0.105	0.102	0.023	-0.058	0.031	0.101	-0.023	-0.090	-0.096	-0.196
Age of mother at first birth	-0.006	-0.044*	-0.005	0.021	0.090*	-0.016	-0.002	-0.010	-0.019	-0.014
Maternal height (cm)	0.005***	0.006***	0.006***	0.005***	0.009**	0.004**	0.005***	0.005***	0.007***	0.007*
Mother's BMI	0.052*	0.058**	0.057***	0.043	0.026	-0.066*	-0.015	0.012	0.017	-0.018
Maternal education	0.011	0.037*	0.016	0.002	0.003	0.002	0.020	0.015	0.034	0.096*
Mother's anaemia										
Mild/moderate	-0.043	-0.054	-0.089	0.04	0.297	-0.236	0.018	-0.132	0.118	-0.655*
Severe	-0.246	-0.074	0.044	0.157	0.484	-0.015	0.016	-0.031	0.152	-0.487
Maternal dietary index	0.000	-0.028	-0.027	-0.039*	-0.018	-0.029	-0.016	-0.01	-0.017	-0.007
Media Exposure index	-0.035	-0.075	-0.05	-0.003	-0.036	-0.012	0.041	0.046	0.024	0.011
Household's Characteristics										
Type of family (Joint)	-0.127	0.054	0.014	-0.006	-0.292	0.270	-0.086	0.088	-0.069	-0.214
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	0.193	0.015	0.310**	0.262	0.499	0.237	-0.011	-0.026	-0.267	-0.709*
Hindu/Others	0.269	0.113	0.647**	0.866***	0.828	0.409	-0.211	-0.004	-0.225	-0.376
Muslim/Others	-0.434	-0.681**	-0.182	-0.289	-0.595	0.523	0.002	-0.019	-0.087	0.125
Assets Index	-0.01	0.023	0.028	0.060	0.055	0.031	-0.006	-0.008	-0.033	0.024
Households Environment index	0.113	0.202***	0.13**	0.153**	0.125	0.121	0.111**	0.125**	0.148	0.062
Agricultural land & livestock index	-0.047	-0.109*	-0.036	0.000	-0.012	0.220***	0.064	0.066	0.057	0.064
Spatial										
Rural										
Urban	-0.092	-0.376	-0.201	-0.094	-0.311	0.718**	0.350	0.192	-0.090	-1.414**
Constant	-11.342***	-10.119***	-9.551***	-7.718***	-12.919**	-6.91***	-8.895***	-8.18***	-8.858***	-5.039
R squared	0.094	0.153	0.203	0.162	0.086	0.055	0.107	0.136	0.138	0.084
Adjusted R squared	0.093	0.152	0.202	0.161	0.084	0.053	0.105	0.133	0.136	0.081

***p < 0.001; **p < 0.01; *p < 0.05

Table 6: Unconditional Re-centred Influence Function (RIF) quantile regression results for Munger and Tirhut Division in Bihar (2015-16)

	Munger					Tirhat				
	10	**25**	**50**	**75**	**90**	**10**	**25**	**50**	**75**	**90**
Child Characteristic										
Age of Child	-0.068***	-0.077***	-0.102***	-0.148***	-0.144***	-0.038**	-0.071***	-0.095***	-0.112***	-0.092***
Age^2	0.001***	0.001***	0.001***	0.002***	0.002***	0.000***	0.001***	0.001***	0.001***	0.001***
Female	0.047	0.014	-0.099	0.001	0.225	0.096	0.073	0.003	0.002	0.022
Birth Size										
Average										
Above than average	0.005	0.096	0.162	0.338*	0.099	-0.146	-0.159	-0.100	-0.130	0.053
Small	-0.219	-0.257*	-0.170	-0.309*	-0.166	-0.141	-0.448***	-0.323**	0.058	0.111
Early Breastfeeding (Yes)	-0.083	-0.075	0.050	-0.204*	-0.028	0.108	-0.097	-0.047	-0.079	0.083
No. of Sibling	-0.078*	-0.026	0.006	-0.014	0.017	-0.062	0.004	0.009	-0.001	-0.003
Benefited from ICDS services	-0.015	-0.100	-0.142	-0.050	-0.144	-0.061	-0.144	-0.297***	-0.317**	-0.391**
Mother's Characteristics										
Institutional Delivery (yes)	-0.128	-0.095	-0.089	-0.135	-0.056	0.029	0.074	0.098	0.083	0.111
Age of mother at first birth	0.036	0.016	0.010	0.044**	0.026	-0.008	0.010	0.013	0.02	0.017
Maternal height (cm)	0.007***	0.005***	0.007***	0.007***	0.006***	0.004***	0.003***	0.003***	0.004***	0.003**
Mother's BMI	0.032**	0.013	0.031*	0.024	0.056**	-0.001	0.004	0.003	0.004	0.014
Maternal education	0.022	0.03**	0.054***	0.028*	0.038	0.030*	0.023	0.023*	-0.006	-0.022
Mother's anaemia										
Mild/moderate	0.119	-0.113	-0.155*	-0.130	-0.180	-0.173	0.034	-0.114	0.122	0.017
Severe	-0.106	-0.386***	-0.287**	-0.527***	-0.591**	0.047	0.144	-0.086	0.095	-0.094
Maternal dietary index	0.006	-0.001	-0.022	-0.008	-0.014	-0.003	0.002	0.042***	0.03*	0.012
Media Exposure index	0.031	0.008	-0.016	-0.037	-0.029	-0.010	0.035	0.063**	0.104***	0.035
Household's Characteristics										
Type of family (Joint)	-0.061	-0.172*	-0.199*	-0.345**	-0.204	0.065	-0.009	-0.045	-0.077	0.205
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	0.341*	0.012	-0.050	0.184	-0.066	0.218	0.194	0.055	0.090	-0.103
Hindu/Others	0.364	0.002	0.284	0.543**	0.093	0.193	0.375*	0.176	0.604**	0.388
Muslim/Others	0.373	0.077	0.007	0.138	-0.128	0.073	-0.026	-0.030	-0.011	-0.317
Assets Index	0.016	0.012	0.003	0.033	-0.015	0.031	-0.003	-0.014	0.019	0.035
Households Environment index	0.007	0.110***	0.148***	0.073	0.047	0.130**	0.088**	0.030	0.001	0.009
Agricultural land & livestock index	-0.022	0.012	0.002	0.049	-0.044	-0.01	0.014	0.013	0.028	0.012
Spatial										
Rural										
Urban	-0.200	-0.107	-0.316**	-0.120	-0.266	0.216	0.377*	0.218	0.182	0.373
Constant	-14.873***	-9.976***	-10.477***	-10.46***	-7.349***	-8.399***	-7.446***	-6.272***	-6.835***	-3.474*
R squared	0.051	0.102	0.161	0.139	0.091	0.047	0.082	0.133	0.118	0.067
Adjusted R squared	0.049	0.100	0.160	0.137	0.089	0.046	0.082	0.132	0.117	0.066

***p < 0.001; **p < 0.01; *p < 0.05

Table 7: Unconditional Re-centred Influence Function (RIF) quantile regression results for Purnia Division in Bihar (2015-16)

	Purnia				
	10	25	50	75	90
Child Characteristic					
Age of Child	-0.087***	-0.095***	-0.105***	-0.133***	-0.125***
Age^2	0.001***	0.001***	0.001***	0.002***	0.002***
Female	0.352**	0.191*	0.025	0.001	0.013
Birth Size					
Average					
Above than average	0.039	-0.039	-0.010	-0.026	-0.294
Small	-0.425*	-0.091	-0.181	-0.034	0.117
Early Breastfeeding (Yes)	0.363**	0.078	-0.036	0.047	0.234
No. of Sibling	-0.020	-0.035	0.008	0.004	0.041
Benefited from ICDS services	-0.021	-0.243**	-0.306***	-0.317**	-0.295
Mother's Characteristics					
Institutional Delivery (yes)	0.122	0.176	0.182*	0.109	-0.189
Age of mother at first birth	0.013	-0.019	-0.006	-0.009	0.011
Maternal height (cm)	0.005***	0.004***	0.004***	0.005***	0.003**
Mother's BMI	0.042**	0.025*	0.025*	0.052***	0.096***
Maternal education	0.014	0.034*	0.019	0.001	0.004
Mother's anaemia					
Mild/moderate	-0.067	-0.170	-0.223**	-0.067	0.026
Severe	-0.491*	-0.326**	-0.120	-0.078	0.153
Maternal dietary index	0.054**	0.021	0.020	0.016	-0.026
Media Exposure index	-0.065	-0.035	-0.017	-0.014	0.043
Household's Characteristics					
Type of family (Joint)	-0.447***	-0.233*	-0.056	-0.006	-0.021
Religion and caste composition					
Hindu/Sc/St					
Hindu/OBC	0.247	0.170	-0.001	0.139	0.109
Hindu/Others	0.538	-0.184	-0.167	0.368	0.948
Muslim/Others	-0.032	0.052	0.005	0.065	0.210
Assets Index	0.007	-0.036	0.004	0.049	0.040
Households Environment index	0.180**	0.082	0.065	-0.004	0.050
Agricultural land & livestock index	0.070	0.040	0.017	0.055	-0.016
Spatial					
Rural					
Urban	-0.144	0.093	0.307	0.331	0.156
Constant	-11.525***	-7.408***	-7.245***	-7.001***	-4.501**
R squared	0.0535	0.0811	0.1210	0.1125	0.0707
Adjusted R squared	0.052	0.0797	0.1196	0.1111	0.0692

***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

It is revealed from our analysis that the households having non-nuclear family structure are significantly more likely to have children with lower HAZ scores in lower quantiles in Purnia and even in the upper quantiles in Munger; however, it does have any significant effect on child HAZ scores at the aggregate level. As far as socio-religious composition of the household is concerned, we found that Hindu OBC and upper caste children are more likely to have higher HAZ scores compared to Hindu SC/ST children across quantiles at the aggregate level. However, at the regional level, children belong to Muslims/others communities are significantly less likely to have higher HAZ scores compared to Hindu SC/ST even at the upper quantiles. It is surprising to observe that children belong lower quantiles to the upper caste Hindu are significantly less likely to have higher HAZ scores compared to Hindu SC/ST. It is worth mentioning that although possession of household assets did not have any significant influence on child's HAZ outcomes at the aggregate level as well as across regions, better household environment has positive and significant influence on child HAZ outcomes at the aggregate level and in every region, particularly at the lower tails of the distribution. Positive and significant effect of possession of agricultural land and livestock has been observed at the lower end of the HAZ distribution, however, it weakens as we move from lower tails to upper tails of HAZ distribution in almost all the regions.

Urban residence positively and significantly associated with a child's higher HAZ scores even after controlling other potentially confounding factors at the aggregate level, particularly at the lower quantiles.

Thus, we have observed that various factors are influencing child's HAZ scores in varying degree at different quantiles and regional variations of such influence are also pronounced.

Counterfactual decompositions

Figure 2 shows the empirical HAZ distributions for Saran division (solid lines) and each comparator division (short-dashed lines). One can note that in each case, HAZ distribution of Saran division lies everywhere to the right of the distribution of the division it is being compared with, which indicates the generally more favourable distribution of HAZ in Saran division. Notably, the gap between distributions tends to be consistent across quantiles except the highest quantile for most of the regions, indicating that the HAZ distribution is relatively more unfavourable in the other divisions compared to Saran division except at the highest quantile. The gap somewhat widens towards the median and

remained quite large in most of the divisions implying significant disparities in HAZ scores persist even at the median level. The figures also depict graphical presentation of counterfactual distribution (long-dashed lines) along the entire HAZ distribution. The counterfactual distributions represent the HAZ distributions of each division under the scenario that all covariates were distributed as in Saran (benchmark division), but their associations (coefficients) with HAZ remained those pertaining to the division under consideration (comparison divisions).

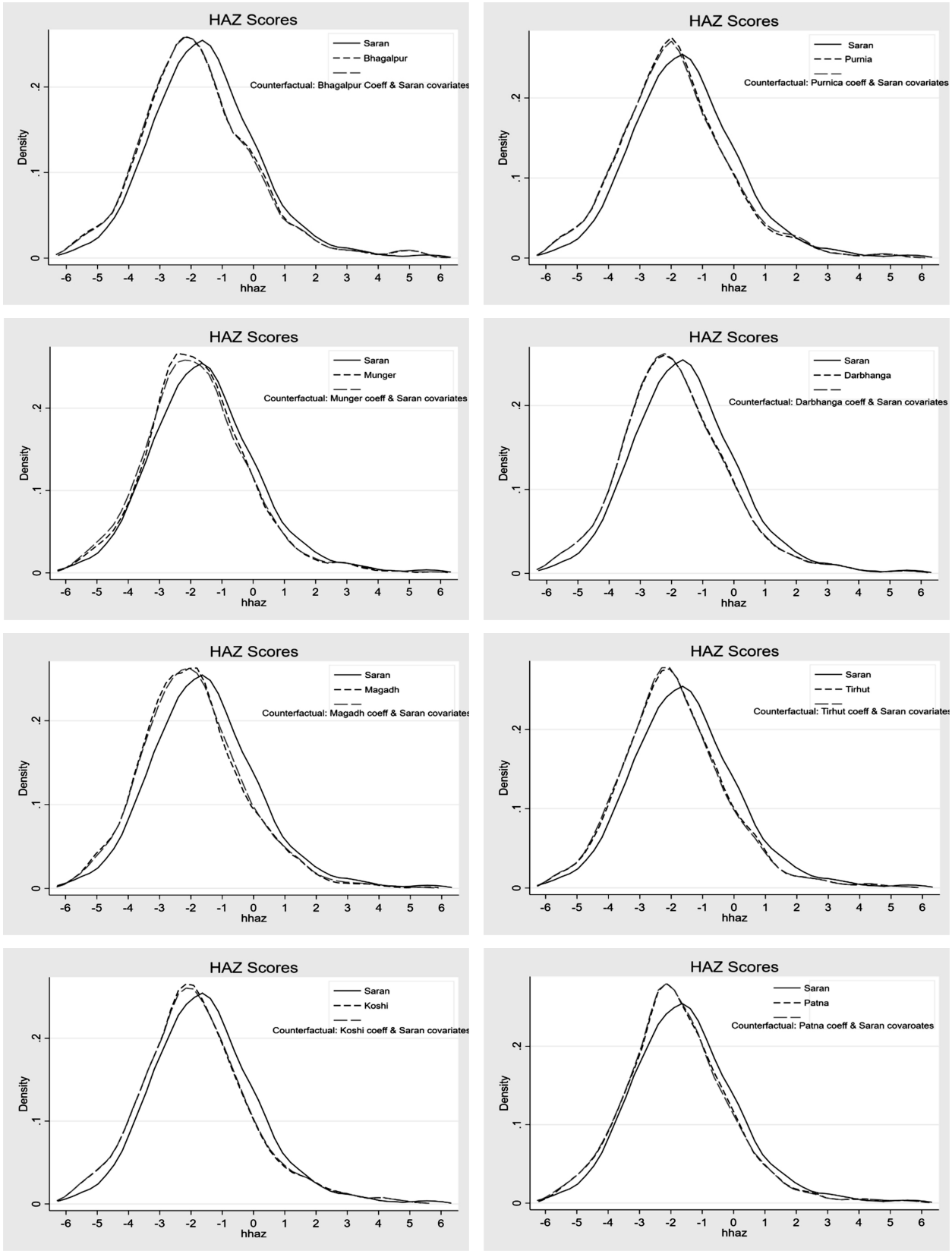


Figure 2: Distribution of regional HAZ scores in Bihar

The differences in HAZ scores across quantiles and divisions, the decomposition of these differences into aggregate covariate and coefficient effects and the contribution of broad characteristics to these effects are presented in Tables 8-15. Appendix Tables A1-A8 depict the contribution of individual characteristics in disentangling covariate and coefficient effects in detail. From Figure 2, one can also note that curves for HAZ scores of comparison regions and their counterfactual distribution nearly coincide each other at the upper quantiles for most of the regions, suggesting that covariate differences explain the bulk of the regional gap in the distribution of HAZ scores. However, such observation does not hold for lower tails and at the median of the HAZ distribution.

Tables 8-15 revealed considerable variations in counterfactual HAZ distributions and, covariate and coefficient effects across divisions while comparing with benchmark division of Saran. One needs to keep in mind that the negative sign of the observed raw gap in HAZ scores between Saran and other divisions reflects the fact that raw HAZ scores of other divisions are lower than the Saran division in all quantiles, except at the highest quantile of Koshi division. Additionally, it must also be kept in mind that the direction of effect of contribution of characteristics in the lower panels of the Tables 8-15 – negative figures imply a contribution to *increase* in the regional disparity in HAZ scores, while positive figures show a contribution to *diminish* it. A careful look to these tables reveals some pattern of covariate effects and coefficient effects across regions and quantiles. Values of total differentials, covariate effects and coefficient effects mentioned in the Tables 8-15 has also provided in Appendix Figures A1 – A8. In these figures, the line (covariate effects or coefficient effects) nearer to the total differentials contributes the most in the prevailing disparity in HAZ scores.

If we compare covariate, coefficient effects, and overall HAZ scores of Saran with other regions, broadly two types of patterns emerge. First, Bhagalpur, Munger and Koshi divisions with those of Saran division, we found that covariate effects significantly contribute in increasing HAZ disparity compared with coefficient effects, except at the lowest quantile of Koshi division (Table 8, 10, 13 and Appendix Figures A3, A4, A7). Covariate effects accounted for 51– 146 percent of overall differences in HAZ scores at different quantiles in Bhagalpur and are more pronounced in the higher quantile (Table 8), while such effects accounted for 52 – 89 percent of overall differences in HAZ scores at varying quantiles in Munger division and are more marked at the lower quantiles (Table 10). On the contrary, in Koshi division, coefficient effects account for 81 percent of overall

differences at the lowest quantile (Table 13). However, as we move from the lower to higher quantile, covariate effects dominate over coefficient effects. Compared to Saran division, differences in the maternal endowments contributed 78 – 96 percent in Bhagalpur division, while such proportions are 71 – 92 in Munger division and 78 – 109 percent in Koshi division. Appendix Tables A8, A5 and A7 suggest that much of these variations are attributable to maternal BMI and maternal height. Disparities of child characteristics followed by household endowments also contribute in some variations. These tables also show that although positive and significant coefficient effects of maternal characteristics (returns to maternal endowments) have tried to reduce such disparities to a significant extent, it seems that returns to child endowments accentuate such disparities across quantiles as evident by significant negative coefficient effects. Returns to household endowments also contributes in reducing HAZ gap at higher quantiles in Munger and Koshi division.

Table 8: Oaxaca Blinder decomposition of HAZ scores of Saran and Bhagalpur Division of Bihar

	10	25	50	75	90
Saran HAZ score	-3.481***	-2.571***	-1.427***	-0.284***	0.839***
Patna HAZ score	-3.755***	-2.844***	-1.879***	-0.593***	0.510***
Observed Raw gap in HAZ scores	**-0.274****	**-0.273*****	**-0.452*****	**-0.309****	**-0.329****
Covariate effect	-0.138*	-0.244**	-0.324***	-0.452***	-0.419***
(% contribution)	50.5	89.3	71.7	146.4	127.3
Coefficient Effect	-0.135	-0.029	-0.128	0.143	0.090
(%contribution)	49.5	10.7	28.3	-46.4	-27.3

	Covariate effect					**Coefficient effect**				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.138**	-0.244**	-0.324***	-0.452***	-0.419***	-0.135	-0.029	-0.128	0.143	0.090
Child Characteristics	-0.074***	-0.611***	-0.986***	-1.460***	-0.619***	-0.621***	-0.709***	-1.334***	-1.588***	-1.519***
(%)	2.2	10.6	12.8	13.0	7.4	12.3	16.9	43.1	79.4	167.9
Mother Characteristics	-3.266***	-5.524***	-6.471***	-8.785***	-7.402***	5.864***	6.619***	6.146***	5.055**	4.571***
(%)	95.6	96.0	83.8	78.1	88.4	-115.7	-158.0	-198.7	-253.0	-505.4
Household Characteristics	-0.051*	0.369***	-0.190***	-0.904***	-0.211***	-0.261***	-0.064***	0.209***	0.158***	0.435***
(%)	1.5	-6.4	2.5	8.0	2.5	5.1	1.5	-6.8	-7.9	-48.1
Spatial Characteristics	-0.024***	0.010***	-0.071***	-0.101***	-0.139***	0.027***	0.027***	0.030***	0.020***	-0.010***
(%)	0.7	-0.2	0.9	0.9	1.7	-0.5	-0.6	-1.0	-1.0	1.1
Constant						-10.078***	-10.060***	-8.144***	-5.644***	-4.382***
Total	-3.415***	-5.756***	-7.719***	-11.250***	-8.371***	-5.068***	-4.188***	-3.093***	-1.998***	-0.905***
Residuals	3.277	5.512	7.395	10.798	7.952	4.933	4.159	2.965	2.142	0.995

*****p < 0.001; **p < 0.01; *p < 0.05**

Table 9: Oaxaca Blinder decomposition of HAZ scores of Saran and Purnia division of Bihar

	10	25	50	75	90
Saran HAZ score	-3.481***	-2.571***	-1.427***	-0.284***	0.839***
Purnia HAZ score	-3.883***	-2.923***	-1.875***	-0.789***	0.308***
Observed Raw gap in HAZ scores	**-0.402*****	**-0.351*****	**-0.448*****	**-0.505*****	**-0.532*****
Covariate effect	-0.174**	-0.149**	-0.200***	-0.313***	-0.285**
(% contribution)	43.3	42.5	44.7	62.0	53.5
Coefficient Effect	-0.228*	-0.202**	-0.248**	-0.192	-0.247
(%contribution)	56.7	57.5	55.3	38.0	46.5

	Covariate effect					**Coefficient effect**				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.174**	-0.149**	-0.200***	-0.313***	-0.285***	-0.228*	-0.202**	-0.248**	-0.192	-0.247
Child Characteristics	-0.355***	-0.565***	-0.871***	-1.324***	-1.012***	-0.616***	-0.704***	-1.329***	-1.583***	-1.514***
(%)	8.6	19.3	18.5	16.0	8.3	12.2	16.8	43.0	79.2	167.4
Mother Characteristics	-3.533***	-2.659***	-3.959***	-6.384***	-10.069***	5.844***	6.598***	6.126***	5.035***	4.551***
(%)	85.5	91.1	84.1	77.4	82.4	-115.4	-157.6	-198.2	-252.0	-503.2
Household Characteristics	-0.233***	0.301***	0.106***	-0.580***	-1.156***	-0.272***	-0.075***	0.198***	0.147***	0.424***
(%)	5.6	-10.3	-2.3	7.0	9.5	5.4	1.8	-6.4	-7.4	-46.9
Spatial Characteristics	-0.012***	0.004***	0.017***	0.035***	0.021***	0.027***	0.027***	0.030***	0.020***	-0.010***
(%)	0.3	-0.1	-0.4	-0.4	-0.2	-0.5	-0.6	-1.0	-1.0	1.2
Constant						-10.049***	-10.031***	-8.116***	-5.617***	-4.356***
Total	-4.134***	-2.918***	-4.706***	-8.253***	-12.216***	-5.066***	-4.186***	-3.091***	-1.998***	-0.905
Residuals	3.959	2.769	4.506	7.940	11.931	4.838	3.984	2.844	1.806	0.658

*****p < 0.001; **p < 0.01; *p < 0.05**

Table 10: Oaxaca Blinder decomposition of HAZ scores of Saran and Munger division of Bihar

	10	25	50	75	90
Saran HAZ score	-3.481***	-2.571***	-1.427***	-0.284***	0.839***
Munger HAZ score	-3.697***	-2.756***	-1.745***	-0.642**	0.458***
Observed Raw gap in HAZ scores	**-0.217**	**-0.184**	**-0.318*** **	**-0.358** **	**-0.381***
Covariate effect	-0.193***	-0.137***	-0.188***	-0.187***	-0.236***
(% contribution)	89.0	74.5	59.0	52.1	62.0
Coefficient Effect	-0.024	-0.047	-0.131	-0.171	-0.145
(%contribution)	11.0	25.5	41.0	47.9	38.0

	Covariate effect					**Coefficient effect**				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.193***	-0.137***	-0.188***	-0.187***	-0.236***	-0.024	-0.047	-0.131	-0.171	-0.145
Child Characteristics	-0.238*	-0.283**	-0.432**	-0.478**	-0.675**	0.241	0.079	0.087	-1.553***	-1.484***
(%)	7.7	17.1	17.8	21.3	20.3	35.1	62.2	20.0	80.7	167.8
Mother Characteristics	-2.843*	-1.396*	-1.903*	-1.584*	-2.585*	-6.879	2.222	-1.633	4.628***	4.144***
(%)	91.9	84.3	78.7	70.6	77.7	-1003.5	1741.3	-376.5	-240.5	-468.8
Household Characteristics	0.005	0.026	-0.057**	-0.167***	-0.060	0.406	-0.247	-0.099	0.152*	0.430***
(%)	-0.2	-1.6	2.4	7.5	1.8	59.2	-193.3	-22.9	-7.9	-48.6
Spatial Characteristics	-0.019**	-0.003	-0.026***	-0.016**	-0.005	0.029	0.018	-0.052	0.020**	-0.010
(%)	0.6	0.2	1.1	0.7	0.2	4.2	13.9	-11.9	-1.0	1.2
Constant						6.890	-1.945	2.130	-5.172***	-3.964***
Total	-3.095*	-1.656*	-2.419 **	-2.244 *	-3.325*	0.686**	0.128	0.434**	-1.924***	-0.884***
Residuals	2.903	1.519	2.231	2.058	3.089	-0.709	-0.175	-0.564	1.753	0.739

***p < 0.001; **p < 0.01; *p < 0.05

Table 11: Oaxaca Blinder decomposition of HAZ scores of Saran and Tirhut division of Bihar

	10	25	50	75	90
Saran HAZ score	-3.481***	-2.571***	-1.427***	-0.284***	0.839***
Tirhut HAZ score	-3.823***	-2.874***	-1.870***	-0.770***	0.398***
Observed Raw gap in HAZ scores	**-0.342*** **	**-0.303*** **	**-0.443*** **	**-0.486*** **	**-0.441*** **
Covariate effect	-0.126**	-0.121***	-0.118***	-0.123**	0.242**
(% contribution)	36.9	39.8	26.6	25.2	-54.9
Coefficient Effect	-0.216**	-0.182**	-0.325***	-0.364***	-0.683
(%contribution)	63.1	60.2	73.4	74.8	154.9

	Covariate effect					**Coefficient effect**				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.126**	-0.121***	-0.118***	-0.123**	0.184**	-0.216**	-0.182**	-0.325**	-0.364***	-0.257
Child Characteristics	0.001	-0.013	-0.054	-0.039	-0.120	-0.262*	0.330	-0.462**	0.565***	-0.396
(%)	-0.7	6.1	23.8	16.8	35.5	745.9	-2515.6	5233.9	1736.1	34120.0
Mother Characteristics	-0.072	-0.103**	-0.103**	-0.121**	-0.018	2.218**	-0.543	3.560**	3.629	9.265
(%)	32.5	48.8	45.6	51.8	5.2	-6322.0	4132.4	-40373.5	-11157.8	-7989.2
Household Characteristics	-0.159***	-0.108**	-0.079*	-0.080	-0.215	-0.214	0.004	0.114	-0.052	0.037
(%)	71.4	51.2	34.7	34.2	63.4	609.4	-27.7	-1298.3	-159.1	-3204.6
Spatial Characteristics	0.007	0.013	0.009	0.006	0.014	0.021	0.009	0.016	-0.001	-0.043
(%)	-3.2	-6.1	-4.1	-2.7	-4.1	-60.9	-71.2	-186.1	3.1	-3696.5
Constant						-1.799	0.186	-3.238**	-3.148	-8.950
Total	-0.222***	-0.210***	-0.227***	-0.233***	-0.339	-0.035	-0.013	-0.009	-0.033	-0.001
Residuals	0.096	0.090	0.109	0.110	-0.089	-0.181	-0.169	-0.316	-0.331	-0.624

***p < 0.001; **p < 0.01; *p < 0.05

Table 12: Oaxaca Blinder decomposition of HAZ scores of Saran and Magadh districts of Bihar

	10	25	50	75	90
Saran HAZ score	-3.481***	-2.571***	-1.427***	-0.284***	0.839***
Patna HAZ score	-3.835***	-2.989***	-2.007***	-0.922**	0.302***
Observed Raw gap in HAZ scores	**-0.354*** **	**-0.418*** **	**-0.580*** **	**-0.638*** **	**-0.537*** **
Covariate effect	-0.111**	-0.150***	-0.178**	-0.277***	-0.372***
(% contribution)	31.2	35.8	30.7	43.4	69.2
Coefficient Effect	-0.244*	-0.268***	-0.402***	-0.361**	-0.165
(%contribution)	68.8	64.2	69.3	56.6	30.8

	Covariate effect					**Coefficient effect**				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.111**	-0.150***	-0.178**	-0.277***	-0.372**	-0.244*	-0.268***	-0.402***	-0.361**	-0.165
Child Characteristics	-0.302***	-0.429***	-0.422***	-0.892***	-0.843***	-0.166	2.617	-1.329***	-1.583***	-1.514***
(%)	69.4	43.0	17.2	20.0	17.1	17.8	122.3	43.6	79.9	167.5
Mother Characteristics	-0.049	-0.446**	-1.866***	-2.960***	-3.478***	4.805**	-18.203**	6.022***	4.932***	4.448***
(%)	11.3	44.7	76.1	66.3	70.5	-515.9	-850.4	-197.4	-248.8	-492.0
Household's characteristics	-0.068**	-0.102	-0.143	-0.601**	-0.625**	-0.116	-2.067	0.203***	0.152***	0.429***
(%)	15.6	10.2	5.8	13.5	12.7	12.4	-96.6	-6.7	-7.6	-47.5
Spatial Characteristics	-0.016***	-0.020***	-0.021***	-0.014***	0.013**	0.033	0.067	0.030***	0.020***	-0.010*
(%)	3.8	2.0	0.9	0.3	-0.3	-3.6	3.1	-1.0	-1.0	1.1
Constant						-5.488***	19.726*	-7.977***	-5.502***	-4.256***
Total	-0.436**	-0.996***	-2.452***	-4.467***	-4.934	-0.931***	2.141***	-3.050***	-1.982***	-0.904***
Residuals	0.326	0.847	2.274	4.190	4.562	0.688	-2.409	2.648	1.621	0.739

*****p < 0.001; **p < 0.01; *p < 0.05**

Table 13: Oaxaca Blinder decomposition of HAZ scores of Saran and Koshi division of Bihar

	10	25	50	75	90
Saran HAZ score	-3.481***	-2.571***	-1.427***	-0.284***	0.839***
Patna HAZ score	-3.804***	-2.803***	-1.821***	-0.622**	0.895***
Observed Raw gap in HAZ scores	**-0.324*** **	**-0.232** **	**-0.394*** **	**-0.338** **	**0.056**
Covariate effect	-0.063	0.238***	-0.260***	-0.248***	-0.466***
(% contribution)	19.4	102.8	66.1	73.2	-829.3
Coefficient Effect	-0.261**	0.006	-0.134	-0.091	0.522
(%contribution)	80.6	-2.8	33.9	26.8	929.3

	Covariate effect					**Coefficient effect**				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.063	-0.238***	-0.260***	-0.248***	-0.466***	-0.261**	0.006	-0.134	-0.091	0.522
Child Characteristics	-0.114	-0.575***	-0.703***	-1.206***	-1.669**	-0.375	-0.697***	-1.321***	-1.575***	-1.506***
(%)	-3.8	44.2	20.6	21.9	25.1	29.9	16.8	43.0	79.1	166.5
Mother Characteristics	3.237**	-1.010***	-2.718***	-4.715***	-6.031***	5.550***	6.512***	6.040***	4.949***	4.465***
(%)	109.2	77.7	79.5	85.5	90.6	-443.1	-156.6	-196.4	-248.4	-493.4
Household Characteristics	-0.174***	0.268***	-0.008	0.405***	1.063***	-0.217	-0.059***	0.215***	0.164***	0.441***
(%)	-5.9	-20.6	0.2	-7.3	-16.0	17.3	1.4	-7.0	-8.2	-48.7
Spatial Characteristics	0.015**	0.017**	0.010**	0.003**	-0.021**	0.042	0.027***	0.030***	0.020***	-0.010***
(%)	-0.5	1.6	0.3	0.1	-0.3	4.3	0.7	1.0	1.1	-0.7
Constant						-6.253***	-9.943***	-8.039***	-5.549***	-4.295***
Total	2.964***	-1.300***	-3.418***	-5.512***	-6.659***	-1.252***	-4.159***	-3.075***	-1.992***	-0.905***
Residuals	-3.027	1.062	3.158	5.265	6.193	0.992	4.165	2.941	1.901	1.427

*****p < 0.001; **p < 0.01; *p < 0.05**

Table 14: Oaxaca Blinder decomposition of HAZ scores of Saran and Darbhanga division of Bihar

	10	25	50	75	90
Saran HAZ score	-3.481***	-2.571***	-1.427***	-0.284***	0.839***
Patna HAZ score	-3.710***	-2.861***	-1.823***	-0.603***	0.542***
Observed Raw gap in HAZ scores	**-0.229****	**-0.289*****	**-0.396*****	**-0.319****	**-0.297**
Covariate effect	-0.088	-0.089	-0.117	-0.222**	-0.039
(% contribution)	38.2	30.7	29.7	69.5	13.1
Coefficient Effect	-0.142	-0.201**	-0.278**	-0.097	-0.259
(%contribution)	61.8	69.3	70.3	30.5	86.9

	Covariate effect					**Coefficient effect**				
	10	25	50	75	90	10	25	50	75	
90Aggregate effect	-0.088	-0.089	-0.117	-0.222**	-0.039	-0.142	-0.201**	-0.278**	-0.097	-0.259
Child Characteristics	0.065	0.009	0.022	-0.004	-0.021	0.146	0.457	-0.294	-0.170	0.227
(%)	-24.3	-3.5	-6.6	0.7	11.8	-357.6	-1739.4	841.0	787.8	171.6
Mother Characteristics	-0.166	-0.056	-0.156	-0.491***	-0.153	1.550	1.907	2.577	3.334	6.805
(%)	62.4	22.3	46.7	81.0	85.9	-3800.4	-7265.7	-7371.7	-15484.2	5145.9
Household Characteristics	-0.173*	-0.216***	-0.216***	-0.124	-0.028	-0.094	0.144	0.281	0.112	-0.232
(%)	65.0	86.3	64.6	20.5	15.9	231.1	-548.2	-802.5	-518.1	-175.2
Spatial Characteristics	0.008	0.013	0.016	0.013	0.024	0.035	0.026	0.020	-0.015	0.058
(%)	-3.1	-5.1	-4.7	-2.2	-13.5	-85.9	-100.7	-58.2	69.3	43.7
Constant						-1.678	-2.560	-2.619	-3.282	-6.726
Total	-0.267**	-0.250**	-0.334**	-0.606***	-0.178	-0.041	-0.026	-0.035	-0.022	0.132
Residuals	0.179	0.161	0.217	0.384	0.139	-0.101	-0.174	-0.243	-0.076	-0.391

***p < 0.001; **p < 0.01; *p < 0.05**

Table 15: Oaxaca Blinder decomposition of HAZ scores of Saran and Patna districts of Bihar

	10	25	50	75	90
Saran HAZ score	-3.481***	-2.571***	-1.427***	-0.284***	0.839***
Patna HAZ score	-3.714***	-2.716***	-1.766***	-0.643**	0.425***
Observed Raw gap in HAZ scores	**-0.233****	**-0.145**	**-0.339*****	**-0.359*****	**-0.414****
Covariate effect	0.005	-0.019	-0.017	-0.007	-0.102
(% contribution)	-2.2	12.8	5.0	2.0	24.5
Coefficient Effect	-0.238*	-0.126	-0.322***	-0.352***	-0.312*
(%contribution)	102.2	87.2	95.0	98.0	75.5

	Covariate effect					**Coefficient effect**				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	0.005	-0.019	-0.017	-0.007	-0.102	-0.238*	-0.126	-0.322***	-0.352***	-0.312*
Child Characteristics	-0.330***	-0.324***	-0.440***	-0.500***	-0.505***	-0.436	0.477	-0.717	-0.765	-1.516***
(%)	124.3	116.7	128.6	131.5	86.7	-59.2	171.4	-1,763.2	867.9	767.8
Mother Characteristics	-0.144	-0.084	-0.096	-0.178	-0.300**	4.344	0.247	-1.779	-3.489	2.142
(%)	54.4	30.1	28.1	46.7	51.5	589.4	88.6	-4,376.9	3,959.1	-1,085.0
Household's characteristics	0.173***	0.075*	0.102**	0.229***	0.132**	-0.285	0.139	-0.176	-0.642	0.095
(%)	-65.2	-27.2	-29.8	-60.3	-22.6	-38.6	49.8	-433.2	728.5	-48.0
Spatial Characteristics	0.036**	0.055***	0.092***	0.068***	0.091**	-0.039	-0.038	0.037	0.022	-0.009
(%)	-13.5	-19.7	-27.0	-18.0	-15.6	-5.4	-13.8	91.5	-24.5	4.4
Constant						-3.563	-0.546	2.676	4.786	-0.910
Total	-0.266*	-0.277**	-0.342***	-0.381**	-0.582***	0.737	0.279	0.041	-0.088	-0.197
Residuals	0.271	0.259	0.325	0.373	0.481	-0.975	-0.405	-0.363	-0.264	-0.115

***p < 0.001; **p < 0.01; *p < 0.05**

Secondly, if we compare raw HAZ scores, covariate and coefficient effects of Saran with those of Purnia, Tirhut, Magadh, and Darbhanga we found that significant coefficient effects, particularly, at the lower tails and the median, contribute in disparity of HAZ scores among regions in addition to covariate effects (Tables 9, 11, 12, 14; Appendix Figures A8, A5, A2, A6). Covariate effects accounted for 43 – 62 percent of overall differences in various quantiles, while coefficient effects contribute as much as 38 – 58 percent in Purnia region (Table 9). As observed earlier, maternal BMI and maternal height have explained much of the differences among covariates (Appendix Table A3). Returns to child characteristics as well as household characteristics contribute substantially at the upper tails of the HAZ distribution. In Tirhut division, despite statistically significant contribution of covariate effects, contribution of coefficient effects dominates over covariate effects across quantiles (except in the highest quantile) as noticed from Table 11. In coefficient effects, returns to child endowments overwhelmingly contribute in enhancing the HAZ differentials. Covariates pertaining to household characteristics, particularly, possession of household assets and better household environment; and maternal endowments such as maternal education and media exposure contribute substantially contribute in disparity of child's HAZ scores (Appendix Table A6).When Saran's HAZ scores compared with those of Magadh, coefficient effects dominate over covariate effects and contribute 31 – 69 percent of overall differences from higher tails to lower tails (Table 12). Table 12 also suggests that significant effect of child level attributes gradually weakens as we move from lower to upper quantiles, while effect of mother characteristics gains importance. As observed in case of Tirhut division, in coefficient effects, child level characteristics explain much of the variation in enhancing HAZ disparities. Among covariates, child age and birth size are found to have considerable influence at the lower tail; however, mother's BMI and height have substantial contribution at the upper tail. Membership of socio-religious category was also found to have important bearing as Appendix Table A6 revealed. One can note that, in Darbhanga, contribution of coefficient effects observed to be higher at the lower end of the distribution, while contribution of covariate effects has been found to be higher at 75 percent quantile in overall HAZ differences. In Darbhanga, household characteristics, particularly, household assets and household environment index; and maternal characteristics, namely, maternal BMI, media exposure and diet contribute significantly in different quantiles to the observed HAZ gap (Table 14, Appendix Table A4). When comparing overall HAZ scores and, covariate and coefficient effects between Saran and Patna, we

observed that coefficient effects alone explained almost overall HAZ differences between these two regions (Table 15). Although coefficient effects are significant for overall HAZ differences between Saran and Patna, child characteristics, particularly, child's age at the highest quantile contributes substantially in observed HAZ gap (Appendix Table A1). Apart from returns to child endowments at the higher quantiles, returns to unobserved characteristics seem to contribute in coefficient effects. Without loss of generality, it may be mentioned that the positive significant coefficient effects of return to maternal endowments offset by negative significant returns to child endowments in these regions apart from other unobserved effects.

Discussion

Regional variations of under nutrition among under-five children in a vast country like India have been well-documented by a number of studies conducted in the recent past (Menon et al. 2018; Khan and Mohanty, 2018; Covatorta et al. 2015; Mohsena et al., 2015; Pathak 2009). Significant variations across states with respect to culture, attitudes, and dietary habits of population have been well-known. In addition, functioning of institutions, levels of social, economic and human capital and political makeup also vary across states and regions in India. Unlike earlier studies, the present study has attempted to understand the drivers of the significant intra-state heterogeneity observed in the height-for-age (HAZ) of children in the state of Bihar – literature on which is seldom available. To note, Bihar has a large population size more than the countries like Ethiopia or Philippines and currently having the highest childhood stunting rate in India. Other key indicators of development, though improved gradually in the state over past two decades or so, the state is still lagging behind the national average and also compared toa number of other Indian states. Earlier studies carried out in Bihar have noted that although public investment has increased and assisted in the development of the rural physical and social infrastructure, disparities across districts and sub-district level still persist (Tsujita et al. 2010). They have also observed that the extent of implementation of various development initiatives differs across districts even at the village level. Since sectors key to nutrition, such as health and agriculture, are state subjects, our study on intra-state disparity of child HAZ outcomes would be an important contribution to understand lacunas in policy making and programme implementation at the micro-level nutrition-centric subjects.

We have used distribution-wide RIF regression and counterfactual decomposition method to understand drivers of childhood nutritional disparity across regions of Bihar.

We preferred this method because, first, it is less restrictive than mean regression, and second it allow us to disentangle covariate and coefficient effects for each quantile, which could be extremely valuable for the policy makers and programme implementers. Our results indicate that although relatively modest proportions of the observed HAZ differences can be explained by varying covariate effects across regions, cross-region disparities in HAZ scores are explained in large proportion by differences in returns to various endowments in many regions– as captured in coefficient effect. Thus, our hypothesis is partially accepted. As noted earlier, our empirical analyses involved a wide set of covariates drawn from the previous literature first, and the selection of final set was based on model fit. Thus, the plausibility of insufficient coverage of covariates in influencing our results could be low, given the informational constraints inherent in NFHS data. However, some of the weaknesses of the study are also acknowledged. First, cross-sectional data are not appropriate for identifying causal effects and thus the results are indicative at best and not conclusive. Secondly, our model specifications are limited by the nature of the NFHS data, group-wise decomposition methods impose the requirement of identical sets of covariates across groups (Covatorta et al. 2015), and interpretations of coefficient effects are speculative to some extent. Nonetheless, the present study helps in highlighting important region-specific dimensions for reduction of child undernutrition in a resource-constrained setting.

Clearly, performance of Saran division with respect to child HAZ outcomes appears to be significant with its comparators. When compared with HAZ scores of Saran division with other divisions, we broadly found that covariate effects dominate over coefficient effects in Bhagalpur, Munger and Koshi divisions, while coefficient effects have substantial influence in contributing child HAZ disparity in all other divisions along with covariate effects (except in Patna division, where almost total variation is explained by coefficient effect).As argued by Covatorta et al. (2015) coefficient effects in such comparison amass several potential effects together and do not provide specific information regarding factors or actions; however, health and nutritional related policies and programmes would likely to play an important role in this context. While comparing superior child nutritional outcomes of Tamil Nadu to the states with worse performer, they argued that effective implementation of ICSD, Public Distribution System, Noon Meal Scheme in the school played an important role in child anthropometric outcomes. In an earlier study, to understand dramatic improvement in child nutritional status in Vietnam during 1990, O'Donnell et al. (2009) found that covariate and coefficient effects are

equally important, and noted remarkable consistency of the strong coefficient effects with health, food and nutrition policies introduced in that period. Arguably, elements of such programmes have potential to influence both the slope coefficients as well as the intercept independently. For example, growth monitoring can arrest growth faltering reflected in the strength of relationship between child age and HAZ scores as well as can improve height independently of specific variables (Covatorta et al. 2015).

Relatively better performance of Saran division in terms of HAZ scores requires some explanation. Ghosh (2007) found that Saran division is one of the 'performing areas', where livelihood potential is rather low, yet the poverty levels are also low. In this region, limitations of the natural endowment have been overcome with certain development efforts. Considering a number of variables related to agriculture, services, education and health, Kumari (2014) found that although Saran division is not the best performer in terms agriculture, it is far ahead in services sector activities, educational performance and health services compared to other divisions. Anecdotal evidences also suggest that this region has a long tradition of large-scale migration to gulf, particularly among minorities, and thus receive remittances. This not only contributes in socio-economic development in this division but also helps in changing world view – resulted in changing fertility norms, creating demand for better education and healthcare, and ensure higher participation in services sector activities.

According to our study, in Bhagalpur, Munger and Koshi divisions, it would be wise for the state to focus substantially to improve endowments. Ghosh (2007) has argued that in Bhagalpur and Koshi livelihood-related interventions are most required because of high poverty and low livelihood potential. Social capital, which could serve as development input, is also found to be low in these regions (Ghosh 2007). For example, although implementation of various policies related to maternal and child health, food security and employment generation seems to be better in Koshi division as indicated by indicators such as proportion of child vaccination, benefit received from *Janani Suraksha Yojona* (JSY), person-days generated under Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), lifting of rice and wheat under National Food Security Act, this region is poor in terms of per capita GSDP, remoteness and, agricultural productivity (Economic Survey, Government of Bihar (GoB), 2018). Moreover, this region has the highest proneness to natural disaster (GoB, 2016), particularly recurrent incidence of flood and remained almost inaccessible during and following rainy season. Thus,

strategies regarding developing social capital, creating options for livelihood, and disaster mitigation should be the utmost priority areas for the reduction of childhood under nutrition in these regions. Although Munger division found to be an average performer in terms of poverty reduction, livelihood generation and social capital formation, there could be other unobservable characteristics which hinder in better nutritional outcomes for children and thus requires further investigation.

In other regions, namely, Magadh, Tirhut, Darbhanga and Purnia, we found covariate and coefficient effects – both are equally important. In other words, the state needs to focus in developing basic endowments on one hand and must try to implement policies and programmes related to health, nutrition, agriculture and livelihood generation more effectively on the other. Although Magadh, Tirhut and Darbhanga are the 'performing areas' (Ghosh 2007), holistic socio-economic development has not been taken place in these regions and such uneven development has not been translated into reduction in child under nutrition. For example, Kumari (2014) noted that Tirhut region, though one of the best performers in agriculture and services sectors, one of the poor achievers in educational and health services. Similarly, in spite of having well-developed agriculture, Magadh division performed badly in services sector. Further, a good proportion of districts of Tirhut and Darbhanga divisions are prone to natural disaster, which could also affect child nutritional outcomes. Ghosh (2007) and Kumari (2014) both have noted that social capital base, and livelihood potential both are low and performance related to services, education and health sector are also poor. In a study conducted by Singh et al. (2017) have demonstrated that under funding and under utilisation of funds co-exist in Purnia and underfunding of NHM programmes led to vicious cycle of under staffing and inadequate health infrastructure, resulted in under utilisation of limited resources. This in turn has adversely affected the fund allocations for the scheme.

To note, the state has prioritised public provisioning of nutrition sensitive programmes in the recent past aiming reduction in child undernutrition, though separate policy document in nutrition is yet to come up. We recommend inter-regional variations of factors affecting child undernutrition and level of implementation should be focussed in forthcoming nutritional policy of the state. The state has already prepared its agricultural road map (GoB 2017) and road map for risk reduction from natural disasters (GoB, 2016). There should be enough scope to corroborate these policies in the nutrition policy.

It may be mentioned that currently 18 centrally sponsored schemes and 30 state-

specific specific schemes are being implemented by 16 departments. One such state-specific nutritional intervention has been implemented through JEEViKA[4] platform in 101 blocks of 11 districts located in various divisions except Purnia and Bhagalpur through the technical support from non-governmental agencies. Initial evaluation suggests collectivization of healthy practices around reproductive, maternal, neonatal and child health in rural Bihar has increased significantly through this intervention (Saggurti et al. 2018). It is hoped that nutrition sensitive programmes would result in reduction of child undernutrition in the long run. We suggest such intervention should be scaled-up further, if proven successful. To ensure better dividends from these schemes, there is a need for developing a comprehensive framework for appropriate budgeting and expenditure for these schemes and brining convergence, greater coordination among the administrative departments (Acharya et al. 2017). In line with Gillespie et al. (2013),we conclude that apart from scaling up proven nutrition sensitive interventions, focussing on policy processes and outcomes, and their political underpinnings will be critical to reduce child undernutrition in Bihar.

[4]JEEViKA is an initiative of the Government of Bihar for poverty alleviation, which aims at social and economic empowerment for the rural poor by improving their livelihoods by developing institutions of women like self-help groups (SHGs) and their federations. It will eventually enable rural households in accessing and negotiating better public provisioning of credit, assets and services.

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Appendix

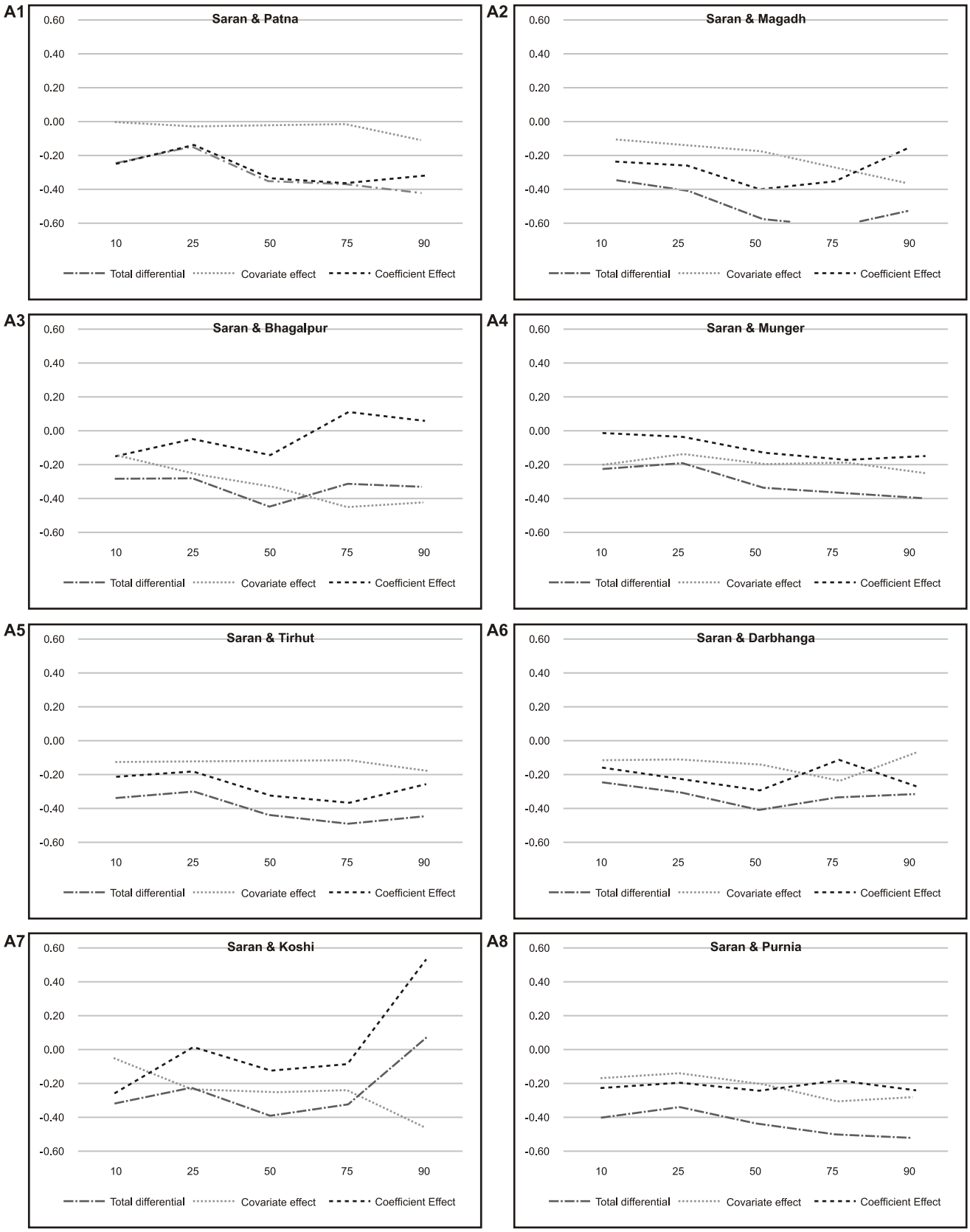

Figure A: Decomposition of differences in the distribution of HAZ score

Table A1: Detailed Oaxaca Blinder decomposition of HAZ scores of Saran and Patna division of Bihar

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	0.005	-0.019	-0.017	-0.007	-0.102*	-0.238*	-0.126	-0.322***	-0.352***	-0.312*
Child Characteristic										
Age of Child	-0.308***	-0.383***	-0.526***	-0.620***	-0.634***	-0.819	1.107	0.010	-0.931	-2.743***
%	115.9	137.9	153.7	162.8	108.9	-111.1	397.3	25.8	1056.7	1389.0
Age2	0.164**	0.211**	0.268**	0.285**	0.268**	0.504	-0.896	-0.308	0.547	1.270***
%	-61.8	-76.3	-78.3	-75.0	-46.0	68.4	-321.8	-758.1	-620.8	-643.1
Female	0.001	0.000	0.000	-0.001	0.001	-0.205	-0.239	0.009	0.174	0.185
%	-0.3	0.0	-0.1	0.2	-0.2	-27.8	-85.8	22.8	-197.2	-93.6
Birth Size										
Average										
Above than average	-0.181***	-0.109***	-0.098***	-0.059*	-0.079	-0.059	-0.049	-0.064	-0.122	-0.166
%	68.2	39.3	28.6	15.5	13.6	-7.9	-17.7	-156.5	137.9	84.1
Small	0.007	0.002	0.002	0.002	0.007	0.244	0.126	0.022	0.071	-0.042
%	-2.5	-0.7	-0.6	-0.5	-1.1	33.1	45.3	53.2	-80.4	21.4
Early Breastfeeding (Yes)	-0.003	-0.001	-0.002	0.001	0.011	0.060	-0.065	-0.239*	-0.407	-0.136
%	1.2	0.3	0.6	-0.2	-1.9	8.1	-23.5	-588.9	462.3	68.8
No. of Sibling	-0.008	-0.013	-0.009	-0.003	-0.002	-0.216	0.309	-0.144	-0.070	0.134
%	3.1	4.6	2.5	0.8	0.4	-29.3	110.8	-353.5	78.9	-67.7
Benefited from ICDS services	-0.001	-0.032**	-0.076***	-0.106***	-0.076***	0.054	0.186	-0.003	-0.027	-0.018
%	0.5	11.6	22.2	27.8	13.1	7.4	66.8	-8.0	30.5	8.9
Mother's Characteristics										
Institutional Delivery (yes)	0.049**	0.025	0.000	0.019	-0.042	-0.153	0.136	-0.079	-0.017	0.200
%	-18.4	-9.1	0.1	-5.1	7.2	-20.7	48.7	-195.0	19.1	-101.1
Age of mother at first birth	0.009	0.004	0.006	-0.007	-0.008	-1.843	-1.416	-0.978	0.941	1.462**
%	-3.3	-1.5	-1.7	1.8	1.3	-250.1	-508.1	-2405.1	-1067.4	-740.3
Maternal height (cm)	-0.077	-0.079	-0.089	-0.093	-0.065	6.416	1.547	-1.423	-5.846	1.344
%	28.8	28.5	26.1	24.5	11.1	870.6	555.2	-3501.0	6633.1	-680.9
Mother's BMI	-0.035	-0.015	0.012	-0.054	-0.087	-0.646	0.082	0.181	0.028	-0.203
%	13.2	5.6	-3.6	14.1	14.9	-87.7	29.6	446.1	-31.5	102.9
Maternal education	0.003	0.004	0.002	-0.002	0.004	-0.389	-0.423	0.033	-0.306	0.081
%	-1.0	-1.5	-0.6	0.5	-0.8	-52.7	-151.9	81.1	346.9	-40.8
Mother's anaemia										
Mild/moderate	-0.037**	-0.004	-0.005	-0.034**	-0.026*	0.160	0.008	0.121	-0.125	-0.158
%	13.8	1.4	1.6	8.9	4.5	21.7	2.8	298.6	141.8	79.9
Severe	-0.005	-0.002	-0.003	-0.005	-0.003	-0.063	-0.035	-0.016	-0.107	-0.056
%	2.0	0.6	1.0	1.2	0.5	-8.5	-12.6	-38.9	121.3	28.2
Maternal dietary index	-0.050**	-0.024	-0.005	-0.039*	-0.192***	0.893	0.561	0.304	1.739*	-0.570
%	18.8	8.7	1.5	10.2	33.0	121.2	201.3	747.8	-1973.7	288.9
Media Exposure index	-0.001	0.007	-0.013	0.036	0.118***	-0.031	-0.213	0.077	0.203	0.043
%	0.3	-2.6	3.8	-9.3	-20.3	-4.3	-76.4	189.6	-230.5	-22.0

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Household's Characteristics										
Type of family (Joint)	0.021**	-0.022**	0.000	-0.001	0.012	-0.447	-0.175	-0.623	-0.483	-0.245
%	-7.8	8.1	0.1	0.3	-2.0	-60.7	-62.7	-1532.4	548.2	124.2
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	0.013	0.010	0.009	-0.002	-0.006	0.018	0.209	0.303	-0.023	0.300**
%	-4.7	-3.6	-2.7	0.6	1.0	2.5	75.1	746.3	26.6	-152.1
Hindu/Others	0.010	0.009	0.014	0.013	0.013	0.077	0.050	0.026	-0.063	0.046
%	-3.8	-3.2	-4.1	-3.4	-2.3	10.5	17.8	62.9	70.9	-23.4
Muslim/Others	0.018	-0.014	0.016	0.019	0.055*	0.089	0.047	0.097	-0.084	0.013
%	-6.9	5.2	-4.6	-4.9	-9.4	12.0	17.0	238.6	95.4	-6.6
Assets Index	-0.042**	-0.018	0.047***	0.055***	0.061**	-0.129	0.000	-0.009	0.003	0.007
%	15.8	6.6	-13.9	-14.5	-10.4	-17.6	0.0	-21.1	-2.9	-3.3
Households Environment index	0.215***	0.146***	0.030	0.120***	-0.029	0.035	0.012	0.004	0.009	0.017
%	-81.0	-52.8	-8.8	-31.5	5.0	4.8	4.2	10.2	-10.1	-8.5
Agricultural land and Livestock index	-0.061***	-0.035**	-0.014	0.027*	0.026	0.072	-0.004	0.025	0.000	-0.043
%	23.1	12.6	4.1	-7.0	-4.5	9.8	-1.5	62.3	0.2	21.7
Spatial										
Rural										
Urban	0.036**	0.055***	0.092***	0.068***	0.091***	-0.039	-0.038	0.037	0.022	-0.009
%	-13.5	-19.7	-27.0	-18.0	-15.6	-5.4	-13.8	91.5	-24.5	4.4
Constant						-3.563	-0.546	2.676	**4.786**	-0.910
Residuals	0.271	0.259	0.325	0.373	0.481	-0.975	-0.405	-0.363	-0.264	-0.115
Total	-0.266*	-0.277	-0.342	-0.381**	-0.582***	0.737	0.279	0.041	-0.088*	-0.197

***p < 0.001; **p < 0.01; *p < 0.05

Table A2 : Detailed Oaxaca Blinder decomposition of HAZ scores of Saran and Magadh division of Bihar

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.111**	-0.150***	-0.178**	-0.277***	-0.372***	-0.244*	-0.268***	-0.402***	-0.361**	-0.165
Child Characteristic										
Age of Child	-0.837***	-1.285***	-1.468***	-1.899***	-1.832***	-0.243	7.101**	-2.904***	-3.277***	-2.692***
%	191.9	129.0	59.9	42.5	37.1	26.1	331.7	95.2	165.3	297.8
Age2	0.599***	0.835***	0.908***	1.046***	0.912***	0.013	-4.167*	1.394***	1.518***	1.106***
%	-137.4	-83.8	-37.1	-23.4	-18.5	-1.4	-194.7	-45.7	-76.6	-122.3
Female	0.078*	0.079*	0.015	0.013	0.024	0.005	0.030	0.186***	0.056***	0.079***
%	-18.0	-8.0	-0.6	-0.3	-0.5	-0.5	1.4	-6.1	-2.8	-8.8
Birth Size										
Average										
Above than average	-0.122***	-0.022	0.070***	-0.079***	0.063**	-0.029	-0.048	0.009	-0.015	-0.059***
%	27.9	2.2	-2.9	1.8	-1.3	3.1	-2.3	-0.3	0.7	6.6
Small	-0.034***	-0.022***	-0.032***	-0.018***	-0.008	-0.024	0.203	-0.076***	-0.055***	-0.050***
%	7.9	2.2	1.3	0.4	0.2	2.6	9.5	2.5	2.8	5.5
Early Breastfeeding (Yes)	0.031***	-0.016***	0.051***	0.022***	0.003	-0.066	-0.340	0.046***	0.070***	-0.015
%	-7.1	1.6	-2.1	-0.5	-0.1	7.0	-15.9	-1.5	-3.5	1.7
No. of Sibling	-0.055***	0.000	0.003	-0.020**	-0.025**	0.110	-0.159	0.044***	0.048***	0.159***
%	12.7	0.0	-0.1	0.4	0.5	-11.8	-7.4	-1.4	-2.4	-17.6
Benefited from ICDS services	0.037***	0.002	0.032***	0.042***	0.020	0.068	-0.002	-0.028***	0.072***	-0.042**
%	-8.5	-0.2	-1.3	-0.9	-0.4	-7.3	-0.1	0.9	-3.6	4.6
Mother's Characteristics										
Institutional Delivery (yes)	-0.022***	-0.024***	-0.029***	0.023***	0.046***	0.193	0.265	0.042**	-0.122***	0.030
%	5.1	2.5	1.2	-0.5	-0.9	-20.7	12.4	-1.4	6.1	-3.3
Age of mother at first birth	0.016**	-0.034***	-0.072***	-0.084***	-0.047***	0.149	-4.945	0.725***	0.796***	1.388***
%	-3.7	3.4	2.9	1.9	1.0	-16.0	-231.0	-23.8	-40.2	-153.5
Maternal height (cm)	-0.667***	-1.306***	-1.958***	-1.711***	-2.032***	4.913**	-17.164**	5.483***	4.796***	3.202***
%	153.0	131.1	79.8	38.3	41.2	-527.4	-801.8	-179.7	-241.9	-354.3
Mother's BMI	0.673**	1.010***	0.160	-1.225***	-0.904**	-0.095	1.733***	-0.232***	-0.130***	0.291***
%	-154.4	-101.4	-6.5	27.4	18.3	10.1	81.0	7.6	6.5	-32.1
Maternal education	0.030***	-0.084***	-0.060***	-0.086***	0.033*	-0.022	-0.294	0.349***	0.130***	0.253***
%	-6.8	8.4	2.4	1.9	-0.7	2.4	-13.7	-11.4	-6.6	-28.0
Mother's anaemia										
Mild/moderate	-0.002	0.009	0.036	-0.003	0.020	-0.184**	-0.512	-0.070***	-0.126***	-0.075***
%	0.3	-0.9	-1.5	0.1	-0.4	19.8	-23.9	2.3	6.4	8.3
Severe	-0.064***	-0.037***	0.006**	0.038***	0.010*	-0.085*	-0.146	-0.013**	-0.018***	-0.034***
%	14.7	3.7	-0.3	-0.9	-0.2	9.2	-6.8	0.4	0.9	3.8
Maternal dietary index	-0.073***	-0.088***	-0.082***	-0.068***	-0.087***	0.084	2.634	-0.230***	-0.498***	-0.611***
%	16.7	8.8	3.3	1.5	1.8	-9.0	123.1	7.5	25.1	67.6
Media Exposure index	0.059***	0.108***	0.132***	0.156***	-0.515***	-0.147**	0.226	-0.032***	0.103***	0.004
%	-13.5	-10.9	-5.4	-3.5	10.4	15.8	10.6	1.0	-5.2	-0.4

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Household's Characteristics										
Type of family (Joint)	-0.010	-0.020	-0.016	-0.033	-0.034	-0.025	-1.854**	0.169***	-0.108***	-0.025
%	2.3	2.0	0.6	0.7	0.7	2.7	-86.6	-5.5	5.5	2.8
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	0.139***	0.121***	0.051***	0.061***	-0.106***	-0.080	-0.050	0.031*	0.129***	0.276***
%	-31.9	-12.1	-2.1	-1.4	2.2	8.6	-2.4	-1.0	-6.5	-30.5
Hindu/Others	-0.181**	-0.244**	-0.248**	-0.750**	-0.515**	-0.024	-0.216	0.011**	0.065***	0.086***
%	41.4	24.5	10.1	16.8	10.4	2.5	-10.1	-0.3	-3.3	-9.5
Muslim/Others	-0.031	-0.009	0.009	0.003	-0.005	-0.028	0.040	0.010*	0.042***	0.104***
%	7.1	0.9	-0.4	-0.1	0.1	3.1	1.9	-0.3	-2.1	-11.5
Assets Index	0.011	0.016	0.031	0.048	0.010	0.008	-0.092	-0.036***	-0.004	-0.009
%	-2.5	-1.6	-1.3	-1.1	-0.2	-0.8	-4.3	1.2	0.2	1.0
Households Environment index	0.016	0.021	0.029	0.030	0.021	0.006	-0.006	0.016	0.019	0.006
%	-36.8	-21.4	-12.0	-6.6	-4.2	-6.5	-2.8	-5.4	-9.4	-6.5
Agricultural land and Livestock index	-0.012	0.013	0.001	0.041	0.004	0.027	0.110	0.003	0.010**	-0.007
%	2.8	-1.3	0.0	-0.9	-0.1	-2.9	5.1	-0.1	-0.5	0.8
Spatial										
Rural										
Urban	-0.016***	-0.020***	-0.021***	-0.014***	0.013**	0.033	0.067	0.030***	0.020***	-0.010*
%	3.8	2.0	0.9	0.3	-0.3	-3.6	3.1	-1.0	-1.0	1.1
Constant						-5.488***	19.726*	-7.977***	-5.502***	-4.256***
Residuals	0.326	0.847	2.274	4.190	4.562	0.688	-2.409	2.648	1.621	0.739
Total	-0.436**	-0.996***	-2.452***	-4.467***	-4.934***	-0.931***	2.141***	-3.050***	-1.982***	-0.903***

***p < 0.001; **p < 0.01; *p < 0.05

Table A3 : Detailed Oaxaca Blinder decomposition of HAZ scores of Saran and Purnia division of Bihar

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.174**	**-0.149****	**-0.200*****	**-0.313*****	**-0.285****	**-0.228***	**-0.202***	**-0.248****	**-0.192**	**-0.247**
Child Characteristic										
Age of Child	-0.935***	-1.222***	-1.753***	-2.592***	-2.692***	-1.148***	-1.196***	-2.904***	-3.277***	-2.692***
%	22.6	41.9	37.2	31.4	22.0	22.7	28.6	93.9	164.0	297.6
Age2	0.574***	0.723***	1.015***	1.442***	1.423***	0.511***	0.536***	1.394***	1.518***	1.106***
%	-13.9	-24.8	-21.6	-17.5	-11.6	-10.1	-12.8	-45.1	-76.0	-122.3
Female	0.117***	0.077***	0.015***	0.027***	0.005***	0.130***	0.121***	0.186***	0.056***	0.079***
%	-2.8	-2.6	-0.3	-0.3	0.0	-2.6	-2.9	-6.0	-2.8	-8.8
Birth Size										
Average										
Above than average	-0.061***	-0.029***	0.041***	0.039***	0.275***	-0.024***	-0.010***	0.010***	-0.014***	-0.058***
%	1.5	1.0	-0.9	-0.5	-2.3	0.5	0.2	-0.3	0.7	6.4
Small	-0.035***	-0.003***	-0.027***	0.005***	0.012***	-0.060***	-0.039***	-0.077***	-0.056***	-0.051***
%	0.8	0.1	0.6	-0.1	-0.1	1.2	0.9	2.5	2.8	5.7
Early Breastfeeding (Yes)	0.074***	0.044***	-0.002***	0.010***	0.092***	-0.017***	-0.056***	0.047***	0.070***	-0.015***
%	-1.8	-1.5	0.0	-0.1	-0.8	0.3	1.3	-1.5	-3.5	1.7
No. of Sibling	-0.048***	-0.040***	0.033***	0.017***	0.115***	-0.028***	-0.084***	0.041***	0.045***	0.156***
%	1.2	1.4	-0.7	-0.2	-0.9	0.6	2.0	-1.3	-2.3	-17.3
Benefited from ICDS services	-0.041***	-0.115***	-0.194***	-0.272***	-0.243***	0.021***	0.024***	-0.026***	0.075***	-0.039***
%	1.0	3.9	4.1	3.3	2.0	-0.4	-0.6	0.8	-3.7	4.3
Mother's Characteristics										
Institutional Delivery (yes)	-0.049***	-0.039***	-0.046***	-0.041***	0.044***	0.086***	0.072***	0.055***	-0.109***	0.043***
%	1.2	1.3	1.0	0.5	-0.4	-1.7	-1.7	-1.8	5.5	-4.7
Age of mother at first birth	-0.036***	0.039***	0.016***	0.060***	-0.031***	0.371***	0.593***	0.705***	0.776***	1.367***
%	0.9	-1.4	-0.3	-0.7	0.2	-7.3	-14.2	-22.8	-38.8	-151.2
Maternal height (cm)	-1.402***	-1.364***	-2.160***	-2.659***	-1.593***	5.744***	5.773***	5.606***	4.919***	3.326***
%	33.9	46.7	45.9	32.2	13.0	-113.4	-137.9	-181.4	-246.2	-367.7
Mother's BMI	-2.043***	-1.147***	-1.662***	-3.808***	-8.281***	-0.106***	-0.026***	-0.221***	-0.119***	0.301***
%	49.4	39.3	35.3	46.1	67.8	2.1	0.6	7.2	5.9	-33.3
Maternal education	-0.098***	-0.196***	-0.183***	-0.053***	-0.100***	0.213***	0.229***	0.339***	0.121***	0.244***
%	2.4	6.7	3.9	0.6	0.8	-4.2	-5.5	-11.0	-6.1	-27.0
Mother's anaemia										
Mild/moderate	0.020***	0.052***	0.068***	0.054***	-0.017***	-0.135***	-0.077***	-0.067***	-0.124***	-0.072***
%	-0.5	-1.8	-1.5	-0.7	0.1	2.7	1.8	2.2	6.2	8.0
Severe	-0.046***	-0.046***	-0.017***	-0.034***	0.035***	-0.090***	-0.013***	-0.013***	-0.018***	-0.034***
%	1.1	1.6	0.4	0.4	-0.3	1.8	0.3	0.4	0.9	3.7
Maternal dietary index	-0.048***	-0.006***	-0.011***	-0.014***	0.022***	-0.192***	0.061***	-0.246***	-0.514***	-0.627***
%	1.2	0.2	0.2	0.2	-0.2	3.8	-1.5	7.9	25.7	69.4
Media Exposure index	0.168***	0.048***	0.037***	0.111***	-0.150***	-0.047***	-0.013***	-0.033***	0.103***	0.003
%	-4.1	-1.6	-0.8	-1.3	1.2	0.9	0.3	1.1	-5.1	-0.3

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Household's Characteristics										
Type of family (Joint)	0.154***	0.096***	0.030***	0.057***	0.056***	-0.034***	0.093***	0.156***	-0.121***	-0.039***
%	-3.7	-3.3	-0.6	-0.7	-0.5	0.7	-2.2	-5.0	6.1	4.3
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	0.048***	0.046***	0.026***	0.032***	0.076***	-0.153***	-0.089***	0.036***	0.134***	0.281***
%	-1.2	-1.6	-0.5	-0.4	-0.6	3.0	2.1	-1.2	-6.7	-31.1
Hindu/Others	-0.269***	0.219***	0.057***	-0.661***	-1.349***	-0.062***	-0.039***	0.014***	0.068***	0.089***
%	6.5	-7.5	-1.2	8.0	11.0	1.2	0.9	-0.4	-3.4	-9.8
Muslim/Others	-0.018***	0.026***	0.015***	0.023***	0.142***	-0.044***	-0.027***	0.008***	0.040***	0.101***
%	0.4	-0.9	-0.3	-0.3	-1.2	0.9	0.7	-0.2	-2.0	-11.2
Assets Index	0.002***	-0.001***	0.004***	0.022***	-0.010***	-0.012***	-0.035***	-0.033***	-0.001	-0.006***
%	-0.1	0.0	-0.1	-0.3	0.1	0.2	0.8	1.1	0.1	0.7
Households Environment index	-0.080***	-0.052***	-0.022***	-0.018***	-0.082***	0.005	0.013	0.016	0.018***	0.006
%	1.9	1.8	0.5	0.2	0.7	-0.1	-0.3	-0.5	-0.9	-0.6
Agricultural land and Livestock index	-0.069***	-0.032***	-0.004***	-0.035***	0.013***	0.027***	0.009***	0.002	0.009***	-0.008***
%	1.7	1.1	0.1	0.4	-0.1	-0.5	-0.2	-0.1	-0.5	0.9
Spatial										
Rural										
Urban	-0.012***	0.004***	0.017***	0.035***	0.021***	0.027***	0.027***	0.030***	0.020***	-0.010***
%	0.3	-0.1	-0.4	-0.4	-0.2	-0.5	-0.6	-1.0	-1.0	1.2
Constant						-10.049***	-10.031***	-8.116***	-5.617***	-4.356***
Residuals	3.959	2.769	4.506	7.940	11.931	4.838	3.984	2.844	1.806	0.658
Total	-4.134***	-2.918***	-4.706***	-8.253***	-12.216***	-5.066***	-4.186***	-3.091***	-1.998***	-0.905***

***p < 0.001; **p < 0.01; *p < 0.05

Table A4: Detailed Oaxaca Blinder decomposition of HAZ scores of Saran and Darbhanga division of Bihar

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.088	-0.089	-0.117	-0.222**	-0.039	-0.142	-0.201**	-0.278**	-0.097	-0.259
Child Characteristic										
Age of Child	0.139*	0.166**	0.279**	0.358**	0.322**	0.117	0.752	-0.462	-0.538	0.683
%	-52.1	-66.5	-83.6	-59.0	-180.4	-285.7	-2864.0	1322.9	2499.9	516.6
Age2	-0.128**	-0.183**	-0.299**	-0.346**	-0.261**	-0.141	-0.465	0.105	0.216	-0.182
%	47.9	73.3	89.4	57.0	146.2	346.8	1772.4	-300.9	-1001.7	-137.5
Female	0.009	0.003	0.003	-0.001	-0.003	0.027	0.040	0.070	0.074	0.015
%	-3.2	-1.1	-0.9	0.1	1.6	-65.6	-150.8	-199.3	-342.4	11.2
Birth Size										
Average										
Above than average	0.045	0.013	0.032	0.003	-0.042	-0.023	0.015	0.014	-0.018	-0.192
%	-16.9	-5.3	-9.6	-0.4	23.8	57.3	-57.6	-41.0	83.9	-144.9
Small	-0.015	-0.007	-0.006	-0.014	-0.007	-0.035	0.006	-0.027	-0.050	-0.189
%	5.8	2.9	1.9	2.4	4.2	86.5	-21.9	77.4	233.8	-143.0
Early Breastfeeding (Yes)	0.011	0.006	0.002	0.000	-0.001	0.052	-0.021	-0.016	0.033	0.057
%	-4.2	-2.4	-0.5	0.0	0.5	-128.2	80.4	44.9	-153.5	43.4
No. of Sibling	-0.013	-0.001	-0.003	-0.009	-0.037	0.131	0.023	0.028	0.061	-0.030
%	4.7	0.5	0.8	1.5	20.6	-321.5	-89.4	-79.5	-283.2	-22.9
Benefited from ICDS services	0.017	0.012	0.014	0.005	0.008	0.019	0.107	-0.006	0.054	0.064
%	-6.2	-4.9	-4.0	-0.9	-4.7	-47.1	-408.5	16.5	-249.0	48.6
Mother's Characteristics										
Institutional Delivery (yes)	-0.024	-0.033	-0.003	0.007	0.009	0.153	0.141	0.079	-0.132	-0.655**
%	9.0	13.4	0.9	-1.1	-5.1	-376.2	-536.2	-225.4	612.8	-495.4
Age of mother at first birth	0.000	0.031***	0.012	-0.012	-0.072*	-0.180	0.111	0.169	0.217	0.352
%	0.1	-12.3	-3.5	2.0	40.2	441.7	-424.2	-483.7	-1006.0	266.4
Maternal height (cm)	-0.014	-0.014	-0.017	-0.022	-0.031	1.802	1.330	2.158	3.340	8.551
%	5.3	5.4	5.2	3.6	17.3	-4417.9	-5067.9	-6174.9	-15514.0	6465.8
Mother's BMI	-0.189**	-0.159***	-0.266***	-0.382***	-0.166	-0.021	0.078	0.096	-0.133	-0.749
%	70.9	63.4	79.5	63.1	93.4	52.6	-298.6	-274.5	619.5	-566.1
Maternal education	-0.020	-0.024	-0.129**	-0.124	-0.016	-0.027	-0.214*	0.076	-0.024	0.023
%	7.7	9.5	38.5	20.5	9.0	66.7	815.6	-216.5	110.3	17.0
Mother's anaemia										
Mild/moderate	-0.004	-0.003	-0.002	0.001	0.006	-0.118*	-0.131	-0.058	-0.203**	-0.523**
%	1.4	1.1	0.6	-0.2	-3.4	290.3	498.0	166.3	941.4	-395.2
Severe	-0.028	-0.006	0.006	-0.007	0.019	-0.051	-0.045	-0.002	-0.047	-0.109
%	10.6	2.6	-1.8	1.2	-10.7	124.8	171.9	6.9	218.5	-82.1
Maternal dietary index	-0.060	0.051	0.075*	0.105*	0.125	0.013	0.696	0.095	0.257	0.261
%	22.3	-20.4	-22.4	-17.4	-70.4	-31.2	-2651.1	-272.7	-1193.6	197.1
Media Exposure index	0.173*	0.100**	0.168**	-0.057	-0.028	-0.020	-0.060	-0.036	0.059	-0.346*
%	-64.9	-40.2	-50.3	9.4	15.5	48.7	226.9	102.8	-273.1	-261.6

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Household's Characteristics										
Type of family (Joint)	0.051	-0.007	-0.010	-0.017	0.033	-0.008	0.018	0.158	-0.071	-0.133
%	-19.2	2.7	3.1	2.8	-18.6	18.8	-69.9	-451.1	332.1	-100.8
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	-0.018	-0.002	-0.017	-0.021	-0.054	-0.148	0.045	0.091	0.134	0.075
%	6.8	0.7	5.2	3.5	30.5	364.0	-171.0	-261.0	-620.2	56.7
Hindu/Others	0.012	0.002	0.009	0.027	0.035	0.022	0.024	-0.013	0.020	-0.120
%	-4.4	-0.7	-2.6	-4.4	-19.8	-53.2	-90.7	37.1	-93.7	-90.9
Muslim/Others	-0.019	-0.023	-0.016	-0.018	-0.022	-0.008	0.050	0.038	0.034	-0.091
%	7.1	9.0	4.8	2.9	12.5	18.5	-191.7	-110.1	-158.4	-69.0
Assets Index	-0.147	-0.156***	-0.086	0.041	0.114	0.014	0.008	-0.016	-0.001	0.052
%	55.1	62.3	25.7	-6.8	-64.2	-34.6	-30.1	47.0	4.5	39.3
Households Environment index	-0.096*	-0.096**	-0.140**	-0.171**	-0.239**	0.000	-0.006	0.001	0.004	0.002
%	35.9	38.3	41.9	28.3	133.9	-0.7	24.5	-2.5	-19.5	1.6
Agricultural land and Livestock index	0.043	0.065**	0.045	0.035	0.104	0.033	0.005	0.022	-0.008	-0.016
%	-16.2	-26.0	-13.4	-5.8	-58.4	-81.7	-19.2	-61.9	37.1	-12.2
Spatial										
Rural										
Urban	0.008	0.013	0.016	0.013	0.024	0.035	0.026	0.020	-0.015	0.058
%	-3.125	-5.125	-4.664	-2.159	-13.503	-85.855	-100.692	-58.244	69.266	43.658
Constant						-1.678	-2.560	-2.619	-3.282	-6.726
Residuals	0.179	0.161	0.217	0.384	0.139	-0.101	-0.174	-0.243	-0.076	-0.391
Total	-0.267**	-0.250***	-0.334**	-0.606***	-0.178	-0.041	-0.026	-0.035	-0.022	0.132

***p < 0.001; **p < 0.01; *p < 0.05

Table A5: Detailed Oaxaca Blinder decomposition of HAZ scores of Saran and Munger devision of Bihar

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.193***	-0.137***	-0.188***	-0.187***	-0.236***	-0.024	-0.047	-0.131	-0.171	-0.145
Child Characteristic										
Age of Child	-0.462	-0.449	-0.627	-0.760	-1.050	1.282	1.008	0.141	-3.260***	-2.675***
%	14.9	27.1	25.9	33.9	31.6	187.1	789.9	32.5	169.4	302.7
Age2	0.280	0.249	0.304	0.368	0.492	-0.990	-0.693	-0.004	1.516***	1.104***
%	-9.0	-15.0	-12.6	-16.4	-14.8	-144.4	-542.8	-0.9	-78.8	-124.9
Female	0.015	0.006	-0.021	0.003	0.038	-0.427	-0.171	0.175	0.059**	0.083**
%	-0.5	-0.4	0.9	-0.1	-1.1	-62.3	-134.1	40.3	-3.1	-9.4
Birth Size										
Average										
Above than average	-0.005	-0.019	-0.051**	-0.073***	-0.123***	-0.055	-0.011	-0.009	-0.016	-0.060**
%	0.1	1.1	2.1	3.3	3.7	-8.0	-8.7	-2.1	0.8	6.8
Small	-0.015	-0.015	-0.014*	-0.013*	-0.001	0.021	0.079	-0.090	-0.057***	-0.052***
%	0.5	0.9	0.6	0.6	0.0	3.1	62.2	-20.7	3.0	5.9
Early Breastfeeding (Yes)	-0.003	-0.004	-0.001	-0.002	0.005	0.060	-0.171	-0.058	0.078***	-0.007
%	0.1	0.2	0.0	0.1	-0.1	8.8	-134.1	-13.3	-4.0	0.8
No. of Sibling	-0.061**	-0.011	0.009	0.013	0.044**	0.311	-0.094	-0.009	0.050	0.161***
%	0.2	0.1	0.0	-0.1	-0.1	4.5	-7.3	-0.2	-0.3	-1.8
Benefited from ICDS services	0.013	-0.040***	-0.031**	-0.013	-0.080***	0.038	0.132	-0.060	0.077**	-0.036
%	-0.4	2.4	1.3	0.6	2.4	5.6	103.2	-13.8	-4.0	4.1
Mother's Characteristics										
Institutional Delivery (yes)	0.013	0.007	0.004	0.004	0.002	0.318	0.341	-0.067	-0.119**	0.033
%	-0.4	-0.4	-0.1	-0.2	-0.1	46.3	267.3	-15.5	6.2	-3.7
Age of mother at first birth	-0.077***	-0.046***	-0.005	-0.054***	-0.097***	-3.740**	-0.841	0.566	0.808***	1.399***
%	2.5	2.8	0.2	2.4	2.9	-545.6	-658.9	130.5	-42.0	-158.3
Maternal height (cm)	-1.403*	-0.908*	-1.038*	-1.078*	-1.275*	-2.993	3.255	-2.608	4.522***	2.928**
%	45.3	54.8	42.9	48.0	38.4	-436.7	2551.0	-601.4	-235.0	-331.3
Mother's BMI	-1.207*	-0.311	-0.772*	-0.481	-1.225*	0.047	-0.089	0.034	-0.152*	0.268*
%	39.0	18.8	31.9	21.5	36.8	6.9	-69.7	7.8	7.9	-30.3
Maternal education	-0.056**	-0.085***	-0.184***	-0.127***	-0.131***	-0.750*	-0.255	-0.063	0.121***	0.244***
%	1.8	5.1	7.6	5.7	3.9	-109.4	-199.5	-14.5	-6.3	-27.6
Mother's anaemia										
Mild/moderate	-0.013	0.007	0.011	0.011	0.032	-0.128	-0.154	-0.165	-0.131***	-0.079*
%	0.4	-0.4	-0.5	-0.5	-1.0	-18.7	-120.4	-37.9	6.8	9.0
Severe	-0.010	-0.022**	-0.020**	-0.030**	-0.055**	-0.088	-0.031	-0.110	-0.020	-0.035
%	0.3	1.3	0.8	1.4	1.7	-12.8	-24.6	-25.5	1.0	4.0
Maternal dietary index	-0.018*	-0.005	0.023***	0.028***	0.001	0.681	0.051	0.963	-0.504***	-0.618***
%	0.6	0.3	-1.0	-1.2	0.0	99.4	40.3	222.0	26.2	69.9
Media Exposure index	-0.072**	-0.033**	0.077***	0.144***	0.163***	-0.226	-0.056	-0.182	0.103***	0.003
%	2.3	2.0	-3.2	-6.4	-4.9	-33.0	-44.2	-42.0	-5.4	-0.4

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Household's Characteristics										
Type of family (Joint)	0.012	0.033***	0.054***	0.060***	0.069***	0.101	-0.335	0.106	-0.116**	-0.033
%	-0.4	-2.0	-2.3	-2.7	-2.1	14.8	-262.9	24.4	6.0	3.8
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	0.072*	0.019	-0.015	0.036*	0.013	-0.084	0.032	-0.082	0.137***	0.284***
%	-2.3	-1.2	0.6	-1.6	-0.4	-12.2	25.5	-18.9	-7.1	-32.1
Hindu/Others	-0.100	-0.007	-0.034	-0.134	-0.146	0.170	-0.005	-0.140*	0.064***	0.085***
%	3.2	0.5	1.4	6.0	4.4	24.8	-4.3	-32.4	-3.3	-9.6
Muslim/Others	0.004	0.000	0.000	0.000	-0.002	0.116	0.029	-0.007	0.041**	0.102***
%	-0.1	0.0	0.0	0.0	0.1	16.9	23.1	-1.7	-2.1	-11.5
Assets Index	-0.017	0.004	-0.046*	-0.072*	-0.085*	0.094	-0.010	0.032	-0.001	-0.006
%	0.5	-0.2	1.9	3.2	2.5	13.6	-8.0	7.3	0.0	0.7
Households Environment index	0.000	-0.007	-0.010	-0.003	0.000	-0.019	0.009	0.007	0.019	0.006
%	0.0	0.4	0.4	0.1	0.0	-2.8	6.8	1.6	-1.0	-0.7
Agricultural land and Livestock index	0.033*	-0.016	-0.007	-0.054***	0.092***	0.027	0.034	-0.014	0.009	-0.008
%	-1.1	0.9	0.3	2.4	-2.8	4.0	26.5	-3.2	-0.5	0.9
Spatial										
Rural										
Urban	-0.019**	-0.003	-0.026***	-0.016**	-0.005	0.029	0.018	-0.052	0.020**	-0.010
%	0.6	0.2	1.1	0.7	0.2	4.2	13.9	-11.9	-1.0	1.2
Constant						6.890	-1.945	2.130	-5.172***	-3.964***
Residuals	2.903	1.519	2.231	2.058	3.089	-0.709	-0.175	-0.564	1.753	0.739
Total	-3.095*	-1.656*	-2.419*	-2.244*	-3.325*	0.686**	0.128	0.434**	-1.924***	-0.884***

***p < 0.001; **p < 0.01; *p < 0.05

Table A6: Detailed Oaxaca Blinder decomposition of HAZ scores of Saran and Tirhut division of Bihar

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.126**	-0.121***	-0.118***	-0.123**	-0.184**	-0.216**	-0.182**	-0.325***	-0.364***	-0.257
Child Characteristic										
Age of Child	0.031	0.044	0.061	0.083	0.097	-0.153	0.640	-0.941**	-1.267***	-0.569
%	-13.9	-21.1	-26.7	-35.7	-28.7	435.6	-4870.8	10672.3	3895.9	49037.7
Age2	-0.043	-0.069	-0.090	-0.125	-0.138	-0.003	-0.424	0.389*	0.583**	0.180
%	19.4	32.8	39.6	53.5	40.7	7.5	3229.4	-4406.3	-1792.8	-15493.2
Female	-0.004	-0.003	0.000	0.000	0.005	-0.017	0.002	0.087	0.045	0.020
%	1.6	1.3	0.2	0.2	-1.5	49.3	-12.0	-985.3	-139.4	-1748.7
Birth Size										
Average										
Above than average	0.037	0.044*	0.026	0.037	-0.018	-0.025	0.047	0.024	0.000	-0.076
%	-16.6	-20.7	-11.3	-16.1	5.2	72.2	-355.2	-275.9	0.0	6523.9
Small	-0.004	-0.023**	-0.021**	-0.004	0.000	-0.033*	-0.004	-0.016	-0.051**	-0.133**
%	1.7	11.2	9.4	1.8	-0.1	93.8	33.2	179.3	156.6	11502.8
Early Breastfeeding (Yes)	0.002	-0.002	-0.002	-0.003	0.006	0.026	0.002	0.030	0.043	-0.001
%	-1.1	1.0	0.7	1.2	-1.7	-75.0	-11.7	-344.7	-133.1	60.1
No. of Sibling	-0.014	0.010	0.001	-0.001	-0.004	-0.032	0.014	-0.031	0.036	0.158
%	6.4	-4.9	-0.4	0.6	1.1	92.5	-103.8	349.1	-110.6	-13624.3
Benefited from ICDS services	-0.004	-0.014	-0.028**	-0.026**	-0.070***	-0.025	0.056	-0.004	0.046	0.025
%	1.9	6.6	12.3	11.3	20.5	70.0	-424.6	45.4	-140.6	-2138.3
Mother's Characteristics										
Institutional Delivery (yes)	-0.014	-0.023	-0.010	-0.021	-0.001	0.100	0.057	0.053	-0.111	-0.241
%	6.1	10.9	4.5	8.9	0.2	-284.5	-435.8	-601.4	339.9	20816.6
Age of mother at first birth	0.002	-0.003	-0.006	-0.009	-0.005	-0.261	-0.194	0.174	0.467	0.717
%	-0.8	1.6	2.8	3.7	1.6	743.0	1478.1	-1978.8	-1436.5	-61821.4
Maternal height (cm)	0.013	0.011	0.009	0.015	0.014	2.429**	-0.262	3.440**	4.060	10.541**
%	-6.0	-5.4	-3.9	-6.6	-4.3	-6922.6	1997.8	-3900.9	-1248.6	-9089.8
Mother's BMI	0.005	-0.003	-0.004	0.001	-0.012	0.061	-0.157	-0.243	-0.451**	-0.843
%	-2.0	1.2	1.6	-0.5	3.5	-173.2	1194.0	2756.4	1385.4	72687.9
Maternal education	-0.090*	-0.066	-0.032	0.003	0.072	-0.011	-0.164	0.112*	-0.004	0.075
%	40.7	31.6	14.2	-1.2	-21.3	30.7	1250.0	-1267.0	13.6	-6459.6
Mother's anaemia										
Mild/moderate	0.004	-0.001	0.001	-0.002	0.003	-0.093**	-0.039	0.011	-0.124**	-0.337***
%	-1.8	0.5	-0.5	0.9	-0.8	265.1	296.3	-129.9	380.5	29086.3
Severe	0.001	0.002	0.000	0.004	-0.002	-0.040	-0.017	-0.004	-0.048	-0.107**
%	-0.5	-1.1	0.0	-1.7	0.7	113.2	128.0	45.4	148.7	9262.8
Maternal dietary index	0.003	-0.002	-0.020*	-0.031**	-0.030	0.112	0.339	0.093	-0.191	-0.349
%	-1.4	0.8	8.8	13.4	8.7	-320.6	-2578.3	-1053.2	587.5	30103.1
Media Exposure index	0.004	-0.018	-0.041**	-0.081***	-0.057	-0.080	-0.105	-0.076	0.031	-0.190*
%	-1.7	8.6	18.0	34.9	16.8	227.0	802.2	864.0	-96.5	16354.9

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Household's Characteristics										
Type of family (Joint)	-0.045	-0.034	0.024	0.055*	-0.009	-0.081	0.018	0.106	-0.063	-0.089
%	20.1	16.3	-10.5	-23.4	2.7	231.3	-135.0	-1200.6	192.9	7640.6
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	0.001	0.001	0.000	0.000	-0.002	-0.129**	-0.068	0.011	0.036	0.107
%	-0.4	-0.5	-0.2	0.2	0.5	366.6	520.2	-121.7	-109.3	-9232.6
Hindu/Others	-0.003	-0.019	-0.006	-0.009	-0.016	-0.027	0.016	-0.015	0.029	-0.017
%	1.2	9.0	2.5	3.9	4.6	76.9	-118.0	168.6	-90.2	1454.2
Muslim/Others	0.000	-0.004*	-0.002	-0.010	-0.042	-0.002	0.032	0.021	0.032	-0.015
%	0.2	1.9	0.9	4.2	12.3	6.6	-245.9	-241.0	-97.1	1280.1
Assets Index	-0.086	-0.014	-0.061	-0.108*	-0.087	0.021	0.054	-0.010	0.013	0.050
%	38.9	6.6	26.9	46.2	25.7	-61.3	-411.8	114.6	-39.0	-4315.8
Households Environment index	-0.053*	-0.038	-0.011	0.031	-0.008	-0.001	-0.017	0.003	0.008	-0.002
%	23.9	17.8	4.7	-13.5	2.4	3.6	129.0	-35.3	-23.7	188.2
Agricultural land and Livestock index	0.028	0.000	-0.024	-0.039	-0.051	0.005	-0.031	-0.002	-0.002	0.003
%	-12.5	0.1	10.4	16.6	15.0	-14.3	233.8	17.2	7.2	-219.4
Spatial										
Rural										
Urban	0.007	0.013	0.009	0.006	0.014	0.021	0.009	0.016	-0.001	0.043
%	-3.2	-6.1	-4.1	-2.7	-4.1	-60.9	-71.2	-186.1	3.1	-3696.5
Constant						-1.799	0.186	-3.238*	-3.148	-8.950*
Residuals	0.096	0.090	0.109	0.110	0.155	-0.181	-0.169	-0.316	-0.331	-0.256
Total	-0.222***	-0.210***	-0.227***	-0.233***	-0.339**	-0.035	-0.013	-0.009	-0.033	-0.001

***p < 0.001; **p < 0.01; *p < 0.05

Table A7 : Detailed Oaxaca Blinder decomposition of HAZ scores of Saran and Koshi division of Bihar

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.063	-0.238***	-0.260***	-0.248***	-0.466***	-0.261*	0.006	-0.134	-0.091	0.522**
Child Characteristic										
Age of Child	-0.299	-0.809	-1.024	-1.768	-2.304	-0.486	-1.206***	-2.914***	-3.287***	-2.702***
%	-10.1	62.2	30.0	32.1	34.6	38.8	29.0	94.8	165.0	298.6
Age2	0.123	0.360	0.476	0.759	0.888	0.140	0.542***	1.401***	1.524***	1.112***
%	4.1	-27.7	-13.9	-13.8	-13.3	-11.2	-13.0	-45.5	-76.5	-122.9
Female	0.197***	0.112***	0.088***	0.128***	0.367***	0.028	0.122***	0.188***	0.057***	0.081***
%	6.7	-8.6	-2.6	-2.3	-5.5	-2.3	-2.9	-6.1	-2.9	-8.9
Birth Size										
Average										
Above than average	-0.128***	-0.193***	-0.213***	-0.226***	-0.259***	0.006	-0.009**	0.010***	-0.013***	-0.058***
%	-4.3	14.8	6.2	4.1	3.9	-0.5	0.2	-0.3	0.7	6.4
Small	-0.026***	-0.028***	0.002***	-0.016***	-0.041***	-0.019	-0.038***	-0.075***	-0.055***	-0.050***
%	-0.9	2.1	-0.1	0.3	0.6	1.5	0.9	2.5	2.7	5.5
Early Breastfeeding (Yes)	-0.005	-0.014	-0.023	-0.058	-0.064	-0.112*	-0.054***	0.049***	0.072***	-0.013***
%	-0.2	1.1	0.7	1.1	1.0	8.9	1.3	-1.6	-3.6	1.4
No. of Sibling	-0.025***	0.002	-0.040***	-0.041***	-0.095***	-0.001	-0.078***	0.047***	0.051***	0.162***
%	-0.8	-0.2	1.2	0.7	1.4	0.1	1.9	-1.5	-2.6	-17.9
Benefited from ICDS services	0.050***	-0.006***	0.033***	0.015***	-0.163***	0.069	0.025	-0.026***	0.075***	-0.039***
%	1.7	0.4	-1.0	-0.3	2.4	-5.5	-0.6	0.8	-3.8	4.3
Mother's Characteristics										
Institutional Delivery (yes)	-0.009	-0.011	0.031	0.045	0.095	0.170	0.062***	0.044***	-0.119***	0.032***
%	-0.3	0.9	-0.9	-0.8	-1.4	-13.6	-1.5	-1.4	6.0	-3.6
Age of mother at first birth	0.022*	0.013	0.020*	0.039*	0.053*	0.207	0.622***	0.734***	0.805***	1.397***
%	0.8	-1.0	-0.6	-0.7	-0.8	-16.5	-15.0	-23.9	-40.4	-154.4
Maternal height (cm)	-0.959***	-1.973***	-2.253***	-3.121***	-3.413***	5.631***	5.660***	5.494***	4.807***	3.214***
%	-32.4	151.7	65.9	56.6	51.3	-449.7	-136.1	-178.7	-241.3	-355.1
Mother's BMI	3.851***	1.047***	-0.427***	-1.284***	-2.741***	-0.120	-0.028***	-0.223***	-0.121***	0.299***
%	129.9	-80.5	12.5	23.3	41.2	9.6	0.7	7.3	6.1	-33.1
Maternal education	-0.052***	-0.108***	-0.114***	-0.304***	-0.718***	0.031	0.231***	0.341***	0.123***	0.246***
%	-1.8	8.3	3.3	5.5	10.8	-2.5	-5.6	-11.1	-6.2	-27.2
Mother's anaemia										
Mild/moderate	0.081***	0.003**	0.061***	0.013***	0.256***	-0.193**	-0.077***	-0.067***	-0.124***	-0.072***
%	2.7	-0.2	-1.8	-0.2	-3.8	15.4	1.9	2.2	6.2	8.0
Severe	0.008***	0.009***	-0.012***	-0.012***	-0.065***	-0.085**	-0.013***	-0.013***	-0.018***	-0.034***
%	0.3	-0.7	0.3	0.2	1.0	6.8	0.3	0.4	0.9	3.7
Maternal dietary index	0.094***	0.024***	0.033***	0.030***	0.076***	0.001	0.071***	-0.236***	-0.504***	-0.618***
%	3.2	-1.9	-1.0	-0.5	-1.1	-0.1	-1.7	7.7	25.3	68.3
Media Exposure index	0.200***	-0.015***	-0.057***	-0.119***	0.427***	-0.092	-0.015***	-0.035***	0.100***	0.001
%	6.8	1.1	1.7	2.2	-6.4	7.3	0.4	1.1	-5.0	-0.1

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Household's Characteristics										
Type of family (Joint)	-0.064***	-0.014***	-0.026***	0.102***	0.080***	-0.060	0.106***	0.168***	-0.109***	-0.026
%	-2.2	1.1	0.8	-1.8	-1.2	4.8	-2.6	-5.5	5.4	2.8
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	0.066**	0.020**	0.015**	-0.074**	-0.189**	-0.108	-0.086***	0.040***	0.137***	0.284***
%	2.2	-1.6	-0.4	1.3	2.8	8.6	2.1	-1.3	-6.9	-31.4
Hindu/Others	-0.078***	0.344***	0.135***	0.494***	1.307***	-0.055	-0.038***	0.015***	0.069***	0.090***
%	-2.6	-26.4	-4.0	-9.0	-19.6	4.4	0.9	-0.5	-3.5	-10.0
Muslim/Others	0.067***	0.027***	-0.004***	-0.023***	-0.015***	-0.034*	-0.028***	0.007*	0.040***	0.101***
%	2.3	-2.0	0.1	0.4	0.2	2.7	0.7	-0.2	-2.0	-11.2
Assets Index	-0.019	-0.018	-0.007	-0.005	-0.048	0.013	-0.035***	-0.033***	-0.001	-0.006**
%	-0.6	1.4	0.2	0.1	0.7	-1.1	0.9	1.1	0.1	0.7
Households Environment index	-0.047***	-0.060***	-0.084***	-0.033***	-0.064***	-0.001	0.013	0.016	0.019	0.006
%	-1.6	4.6	2.5	0.6	1.0	0.1	-0.3	-0.5	-0.9	-0.6
Agricultural land and Livestock index	-0.100**	-0.031**	-0.035**	-0.056**	-0.008*	0.028	0.008***	0.002	0.009***	-0.008**
%	-3.4	2.4	1.0	1.0	0.1	-2.3	-0.2	-0.1	-0.4	0.9
Spatial										
Rural										
Urban	0.015**	0.017**	0.010**	0.003**	-0.021**	0.042	0.027***	0.030***	0.020***	-0.010***
%	0.5	-1.3	-0.3	-0.1	0.3	-3.4	-0.7	-1.0	-1.0	1.1
Constant						-6.253***	-9.943***	-8.039***	-5.549***	-4.295***
Residuals	-3.027	1.062	3.158	5.265	6.193	0.992	4.165	2.941	1.901	1.427
Total	2.964***	-1.300***	-3.418***	-5.512	-6.659	-1.252***	-4.159***	-3.075***	-1.992***	-0.905***

***p < 0.001; **p < 0.01; *p < 0.05

Table A8: Detailed Oaxaca Blinder decomposition of HAZ scores of Saran and Bhagalpur division of Bihar

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Aggregate effect	-0.138*	-0.244***	-0.324***	-0.452***	-0.419***	-0.135	-0.029	-0.128	0.143	0.090
Child Characteristic										
Age of Child	-0.999***	-1.345***	-1.798***	-2.374***	-1.295***	-1.156***	-1.205***	-2.913***	-3.285***	-2.701***
%	29.2	23.4	23.3	21.1	15.5	22.8	28.8	94.2	164.4	298.6
Age2	0.747***	0.869***	1.052***	1.220***	0.615***	0.514***	0.539***	1.397***	1.521***	1.109***
%	-21.9	-15.1	-13.6	-10.8	-7.3	-10.1	-12.9	-45.2	-76.1	-122.6
Female	0.138***	0.102***	0.080***	0.051***	0.114***	0.131***	0.121***	0.187***	0.056***	0.080***
%	-4.032	-1.775	-1.036	-0.449	-1.360	-2.583	-2.896	-6.049	-2.819	-8.873
Birth Size										
Average										
Above than average	0.192***	-0.011***	-0.044***	-0.312***	0.003***	-0.025***	-0.010***	0.010***	-0.014***	-0.058***
%	-5.6	0.2	0.6	2.8	0.0	0.5	0.2	-0.3	0.7	6.4
Small	0.000	0.000	-0.078***	-0.087***	-0.057***	-0.059***	-0.038***	-0.076***	-0.055***	-0.050***
%	0.0	0.0	1.0	0.8	0.7	1.2	0.9	2.4	2.8	5.5
Early Breastfeeding (Yes)	-0.048***	0.002***	0.047***	0.030***	-0.010***	-0.018***	-0.057***	0.046***	0.070***	-0.015***
%	1.4	0.0	-0.6	-0.3	0.1	0.3	1.4	-1.5	-3.5	1.7
No. of Sibling	-0.045***	-0.007***	-0.079***	0.166***	0.272***	-0.028***	-0.083***	0.042***	0.046***	0.157***
%	1.3	0.1	1.0	-1.5	-3.2	0.5	2.0	-1.4	-2.3	-17.4
Benefited from ICDS services	-0.060***	-0.220***	-0.167***	-0.153***	-0.261***	0.019***	0.023***	-0.027***	0.073***	-0.041***
%	1.7	3.8	2.2	1.4	3.1	-0.4	-0.5	0.9	-3.6	4.5
Mother's Characteristics										
Institutional Delivery (yes)	-0.035***	-0.039***	0.030***	0.078***	0.037***	0.088***	0.074***	0.056***	-0.108***	0.044***
%	1.0	0.7	-0.4	-0.7	-0.4	-1.7	-1.8	-1.8	5.4	-4.9
Age of mother at first birth	-0.005***	-0.098***	-0.039***	-0.180***	-0.107***	0.369***	0.591***	0.704***	0.774***	1.366***
%	0.2	1.7	0.5	1.6	1.3	-7.3	-14.1	-22.7	-38.7	-151.0
Maternal height (cm)	-1.037***	-1.743***	-2.378***	-3.386***	-2.454***	5.762***	5.791***	5.624***	4.937***	3.344***
%	30.4	30.3	30.8	30.1	29.3	-113.7	-138.3	-181.9	-247.1	-369.7
Mother's BMI	-2.543***	-3.811***	-4.119***	-5.235***	-4.699***	-0.108***	-0.029***	-0.224***	-0.121***	0.299***
%	74.4	66.2	53.4	46.5	56.1	2.1	0.7	7.2	6.1	-33.0
Maternal education	0.114***	-0.085***	0.040***	0.121***	-0.048***	0.214***	0.230***	0.340***	0.122***	0.245***
%	-3.3	1.5	-0.5	-1.1	0.6	-4.2	-5.5	-11.0	-6.1	-27.1
Mother's anaemia										
Mild/moderate	0.088***	0.057***	0.101***	0.185***	0.356***	-0.132***	-0.075***	-0.065***	-0.121***	-0.070***
%	-2.6	-1.0	-1.3	-1.6	-4.2	2.6	1.8	2.1	6.1	7.7
Severe	0.021***	-0.020***	-0.034***	-0.067***	-0.130***	-0.089***	-0.012***	-0.012***	-0.017***	-0.033***
%	-0.6	0.3	0.4	0.6	1.6	1.8	0.3	0.4	0.9	3.6
Maternal dietary index	-0.001***	-0.018***	-0.037***	-0.014***	-0.056***	-0.190***	0.063***	-0.244***	-0.512***	-0.626***
%	0.0	0.3	0.5	0.1	0.7	3.8	-1.5	7.9	25.6	69.2
Media Exposure index	0.132***	0.234***	-0.035***	-0.286***	-0.301***	-0.049***	-0.014***	-0.034***	0.101***	0.001
%	-3.9	-4.1	0.5	2.5	3.6	1.0	0.3	1.1	-5.1	-0.2

	Covariate effect					Co-efficient effect				
	10	25	50	75	90	10	25	50	75	90
Household's Characteristics										
Type of family (Joint)	-0.031***	-0.067***	0.022***	-0.011***	-0.071***	-0.023***	0.104***	0.167***	-0.110***	-0.027***
%	0.9	1.2	-0.3	0.1	0.9	0.4	-2.5	-5.4	5.5	3.0
Religion and caste composition										
Hindu/Sc/St										
Hindu/OBC	0.017***	-0.029***	0.001***	0.133***	0.146***	-0.154***	-0.090***	0.036***	0.133***	0.280***
%	-0.5	0.5	0.0	-1.2	-1.7	3.0	2.1	-1.2	-6.7	-31.0
Hindu/Others	0.038***	0.559***	-0.068**	-0.950***	-0.276***	-0.062***	-0.040***	0.013***	0.067***	0.088***
%	-1.1	-9.7	0.9	8.4	3.3	1.2	0.9	-0.4	-3.4	-9.7
Muslim/Others	-0.041***	-0.055***	-0.073***	-0.154***	-0.116***	-0.043***	-0.026***	0.009***	0.041***	0.102***
%	1.2	1.0	0.9	1.4	1.4	0.8	0.6	-0.3	-2.1	-11.3
Assets Index	0.047***	0.031***	0.005***	-0.001***	-0.029***	-0.012***	-0.035***	-0.033***	-0.001	-0.006***
%	-1.4	-0.5	-0.1	0.0	0.3	0.2	0.8	1.1	0.1	0.7
Households Environment index	-0.020	-0.021	-0.021	-0.021	-0.005	0.005	0.013	0.016	0.019	0.006
%	0.6	0.4	0.3	0.2	0.1	-0.1	-0.3	-0.5	-0.9	-0.6
Agricultural land and Livestock index	-0.062***	-0.049***	-0.058***	0.100***	0.141***	0.028***	0.009***	0.002***	0.010***	-0.008***
%	1.8	0.8	0.7	-0.9	-1.7	-0.5	-0.2	-0.1	-0.5	0.8
Spatial										
Rural										
Urban	-0.024***	0.010***	-0.071***	-0.101***	-0.139***	0.027***	0.027***	0.030***	0.020***	-0.010***
%	0.7	-0.2	0.9	0.9	1.7	-0.5	-0.6	-1.0	-1.0	1.1
Constant						-10.078	-10.060***	-8.144***	-5.644***	-4.382***
Residuals	3.277	5.512	7.395	10.798	7.952	4.933	4.159	2.965	2.142	0.995
Total	-3.415***	-5.756***	-7.719***	-11.250***	-8.371***	-5.068***	-4.188***	-3.093***	-1.998***	-0.905***

***p < 0.001; **p < 0.01; *p < 0.05

The Centre for Health Policy (CHP) at the Asian Development Research Institute (ADRI) has been set up with support from the Bill & Melinda Gates Foundation to strengthen the health sector in Bihar with a multidimensional and multi-disciplinary approach. Its aim is to engage in rigorous analysis of the health system and inform policy makers to fine-tune interventions for even stronger outcomes.

- Research and Analytical Studies

  It constitutes the core of CHP's activities. The areas of research include health infrastructure and delivery with emphasis on equity, health outcomes such as IMR, MMR, TFR and its predictors, health financing, private-public partnerships, regulatory framework and its implementation, and other issues which might emerge.

- Informing Policymakers on Strengthening the Existing Health System

  CHP aims to be the trusted partner of the state Government in providing evidence-based inputs in making the health system stronger, resilient and equitable.

- Sustainable Health Solutions

  CHP recognizes the need for establishing a strong health system which will be self-sustaining. It means immunity to natural disasters/calamities, financial uncertainties and other unanticipated factors. These pillars may be interrelated; CHP will provide a framework of synergy among actors working on these pillars.

- Collaboration

  CHP engages in collaboration with an extensive network of academic and policy research institutions both in India and abroad in health and the broader social sciences.