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Child health in the Sundarbans: How far mutually reinforcing shocks act as contextual determinants?

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Summary

Childhood chronic undernutrition and common childhood illness is highly prevalent in the Sundarbans delta region of West Bengal, India. The present work tested the hypothesis- frequent climatic shock is likely to predispose chronic and transient health shocks through behavioural responses of households in the presence of inaccessibility, inadequacy and acceptability barriers which act in the economy as long wave shocks. The work is based on a household and facility survey primary data collected in 19 blocks of the Sundarbans. The results highlight that transient climatic shock make the child health worse through the pathway of chronic poverty, low resilience, physical and social barriers to health seeking as well as ineffective service delivery system. Further in depth research is required to understand multiple vulnerabilities, related coping of households and ways to improve the service delivery mechanism to have healthy children in the Sundarbans in the near future.

I. Background

Childhood chronic undernutrition and related morbidities like Diarrhoea, fever, Acute Respiratory Infections is a major public health problem in developing countries, especially in South Asia with major welfare consequences (Black et al. 2008). Undernutrition and associated morbidities among children under the age of five are responsible for 35 percent deaths and 11 percent of global disease burden (Black et al. 2008). The prevalence is higher in Indian subcontinent as per one recent UNICEF study (UNICEF 2010). However, the concentration of undernutrition and illness among poor children in India raises the concern for policy makers to stress on equity in nutritional status and health to sustain economic growth and development in the long run (Kanjilal et al. 2010). Keeping in mind the agenda, the present work is a case study to investigate the contextual determinants of chronic undernutrition and morbidity of children under the age of five in one vulnerable pocket of India – the Sundarbans delta region in West Bengal.

The Sundarbans delta region is a unique vulnerable region where households face multiple adversities which disrupt their livelihood, health and ultimately the well being individually as well as collectively. Multiple adversities are results of multiple natures of shocks. Such shocks can be categorised in two ways – i) shocks at different levels (covariate and idiosyncratic), and ii) shocks of different durations (Long wave, transient) (Gaiha and Imai 2003, Standing 2005).

Covariate shock impacts the whole neighbourhood and poor or vulnerable households are less able or may not be able to cope with large covariate shocks over an extended period of time (Gaiha and Imai 2003). Example of covariate shock in the context of the Sundarbans is frequent extreme climate events. Some household level shocks are idiosyncratic shocks which impact only that household's income and consumption flows (Calvo and Dercon 2005). Idiosyncratic shocks are less severe in the presence of well-functioning markets (e.g. labour market, healthcare market) (Gaiha and Imai 2003). Hence

shock-triggered coping strategies depend on the nature of shocks and have different welfare consequences (Mazumdar and Mazumdar forthcoming.). But in the Sundarbans, market failure is evident and coping with even small idiosyncratic shock like minor health shock is difficult.

The Sundarbans also faces different-duration shocks like long wave and transitory shocks. When shocks impact through a long period of time are known as long wave shocks or chronic shocks (Standing 2005). In relation to healthcare uptake it can be argued that poor health seeking in public facility, poor service delivery system of government, infrastructural limitations- all are badly affecting health of the inhabitants over a longer period of time. These factors are acting like long wave shocks to health and nutritional status for long period of time in a steady path in geographically, economically and socially vulnerable area like the Sundarbans (Kanjilal et al. 2010). Transitory or transient shocks are generally one time shocks of shorter duration (Gallin 1999). Examples of transitory shock are transient demand shock which affects labour market in the short run; another is extreme climatic event[1].

Shocks are interactive in nature; forming feedback loops with each other (undernutrition-morbidity vicious circle) ultimately feeds back to poverty and confounds the impact of economic growth and development through retarding child's potential productive capacity (Heller and Drake 1979, Victora et al. 2008, Poel *et* al. 2007, Navaneetham and Jose 2005, Porter 2007, Setboonsarng 2005, Zere and McIntyre 2003). The rationale behind choosing undernutrition and morbidity as chronic and transient health shock indicators in pockets of abject poverty and climatic shocks is very straightforward. Undernourished children are found more among poor population living in unfavourable environment in developing world (Joint Agency Paper 2008). In shock prone areas, poor

[1] Transient or long wave shock may be idiosyncratic or covariate in nature e.g. climatic shock is a covariate transient shock whereas acute ailment is a transient idiosyncratic shock. Chronic undernutrition is an example of idiosyncratic long wave whereas limited or non-existent health seeking to public provider, limited service availability in public hospitals, poor geographical inaccessibility are examples of covariate long wave shocks.

economic status, weak cultural background, less childcare, poor health seeking during morbid periods influence child's level of undernutrition and associated morbidities (Haddad and Smith 2002, Carter and Maluccio 2003). In spite of that, impact of reinforcing shocks on child's nutritional status and morbidity in India is less investigated.

The present work will seek the answers like possibility of existence of covariate-transient shock gradient of chronic undernutrition and common childhood ailments in the Sundarbans, and the causal pathway of its action. The hypothesis is, frequent covariate-transient shock i.e. climatic shock influence undernutrition and morbidity of children through socioeconomic status, diversified livelihood patterns, socio-cultural and demographic traits of the household, complementarily with long wave shocks and caregiver's child feeding practice.

II. Review of existing literature

There exists huge body of literature on chronic and transient shocks and their impacts on human well being. Climate change is one such chronic shock and gradual change in climatic conditions is articulated through different forms like Hurricanes, Storms, Floods, Heat-waves, and Droughts which are limited duration transient shocks (The Hindu 2009). Extreme climatic shocks make poor inhabitants more vulnerable to other idiosyncratic or covariate shocks like health shock as poor people have less ability to cope with the shocks (Tanner and Mitchell 2008). Earlier literatures related to health of the people living in similar areas throughout the world view vulnerability of poor population increases as climatic shock brings health shocks and likelihood of worse health status differs by inhabitant's adaptive capacity to chronic shocks i.e. coping capability to rebuild affected economic and social conditions (Morrow 1999, Cutter *et* al 2003). Threat of climatic shock as a result of climate change to livelihood and then on health through various pathways is very common in areas like Latin American sub continents as well as in some parts of South

Asia like Vietnam and Bangladesh (Tinh and Hang 2003, Enarson 2000, Omitsu and Yamano 2006, Tanner and Mitchell 2008).

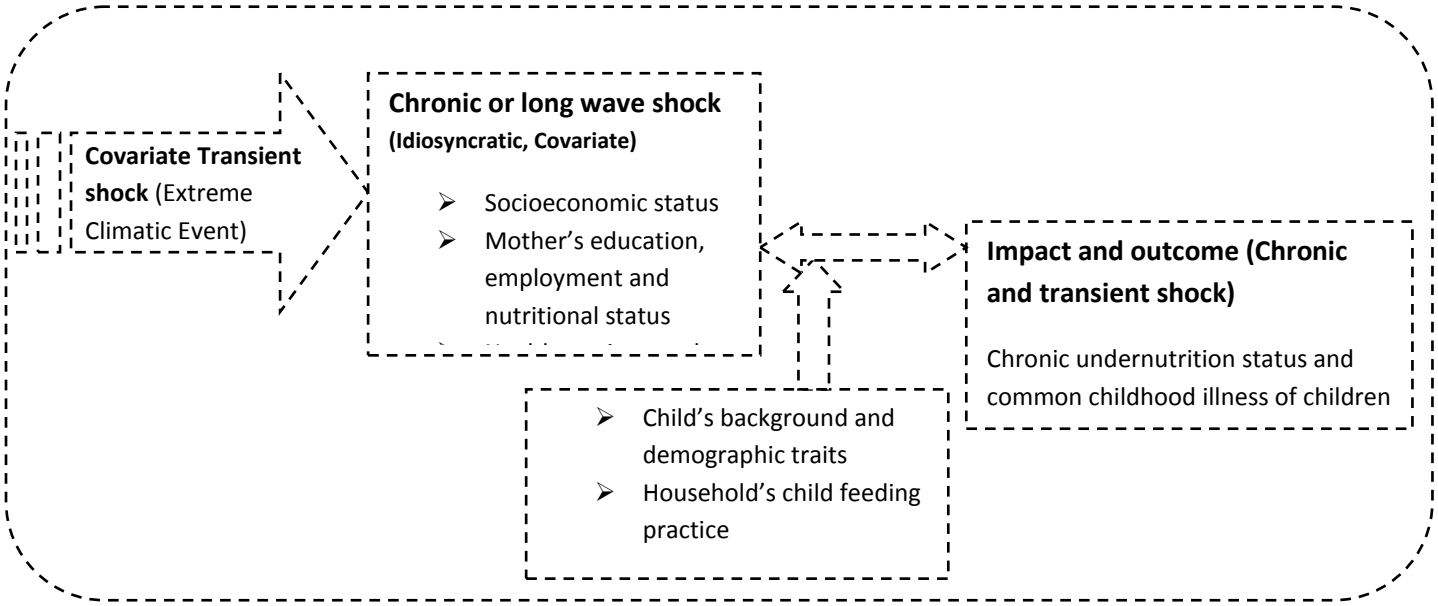
As found in one vulnerable area- Amazon region -protein energy undernutrition, intestinal parasitic infections, acute respiratory infection, iron deficiency are higher among poor and marginalised children whose families are victims of chronic climate shock (UNICEF 2009). Therefore, undernutrition and related morbidities are major consequence of climatic shock associated with climate change (The World Bank 2008, The Hindu 2009). When climate events destroy lands or houses; household resources are destroyed or crop production are hampered which make the affected population food insecure (Gregory *et* al. 2005). Food insecurity ultimately causes undernutrition through reduction in calorie intake. In addition to this, after covariate-transient climatic shock, disease outbreaks cause lots of suffering along with food shortage (Shea 2007). Against this background, it can be inferred that, in a region characterised by chronic poverty, traditional culture, poor health seeking behaviour, frequent climatic shocks aggravate health and nutritional deterioration of the children (DFID 2004, Waterston and Lenton 1995, The World Bank 2008). However, focus on vulnerability to undernourishment and morbidity in presence of mutually reinforcing shocks has got less attention in social science research (Polack 2010).

Currently different studies are focusing on impact of chronic climate shock through manifold covariate extreme climatic events on child health and recognised the need for integration of climate change issues in poverty reduction strategies (Polack 2010). Furthermore, another great concern of policy makers is South Asia and Sub Saharan Africa - the hub of most of the undernourished children[2] – which are showing great impact of chronic and transient climatic shocks on child's nutritional status and associated morbidities (The World Bank 2008). Since, among South Asian countries, India alone contains the largest proportion of undernourished children below the age of five and in different

[2] Presently, among the child population, 147 million children under the age of five are chronically undernourished and most of the undernourished lives in South Asia and Sub Saharan Africa (Svedberg 2006, The World Bank 2006, UNICEF 2009).

vulnerable pockets of India, frequent transient climatic shocks put inhabitants' into health risks, thus in depth research is required to investigate the health impact of reinforcing nature of multiple shocks in such vulnerable areas (O'Brien *et* al. 2004, UNICEF 2009). The present work will try to test the hypothesis- frequent climatic shock is likely to predispose chronic and transient health shocks through behavioural responses of households in the presence of inaccessibility, inadequacy and acceptability barriers which act in the economy as long wave shocks. The work will see whether shocks are reinforcing in nature and generate vicious circle of interlinked shocks in the Sundarbans.

Figure 1: Conceptual framework hypothesizing causal root of climatic shock towards child's health in the Sundarbans



III. Data and methods

The study area- The Sundarbans

The Sundarbans, a unique biosphere reserve of mangrove forests and one of the global heritage sites, are located in the extreme south of West Bengal state of India. The entire area is intersected by tidal rivers or estuaries from north and south and by innumerable narrow tidal creeks from east to west painting an assortment of beautiful but largely

formidable and inhospitable terrains. The area outside the reserve forest (54 islands), home of about 4 million people spread over 19 administrative blocks, is the human face of the Sundarbans which epitomises abject poverty, deprivation and acute struggle against geographical and environmental challenges. It is however important to note that the geographical challenges vary across blocks. People, who live in the remote Sundarbans – the blocks adjacent to the forest area or the Bay of Bengal – face much harder problems compared to those who live in the 'peripheries'(and closer to Kolkata).

Information of background characteristics, health seeking behaviour, anthropometry, common childhood illnesses like Diarrhoea and fever, child feeding practice are collected from household survey. Nineteen Block Medical Officer Health, Block Primary Health Nurse are interviewed at block level health facilities to understand the functioning of health service delivery system. The software package Stata/SE version 9.2 is used for analysis of data. For calculation of height-for-age scores the software package WHO-Anthro version 2.0.3 has been employed.

Sampling procedure

The study was carried out in 19 blocks from the two districts - North and South 24 Parganas- fall within the administrative boundary of the Sundarbans. This includes six blocks from North 24 Parganas, and the rest thirteen from South 24 Parganas. Survey followed a two-stage random sampling procedure to cover a 4 million population. From each of the19 blocks three primary sampling units (PSU) were selected through purposive sampling. In practice, villages have been considered as PSUs for the study. The selection of PSU's/villages was based on their distance from the block headquarter. Among three PSUs, each was selected from – very remote area of block, relatively less remote area and nearest (located within 5 km) to block head quarter. In this way, 57 PSUs/villages were sampled for carrying out the survey from 19 blocks.

In the second stage, a total of 20 households were selected from each of the selected PSUs/villages. A 10% over-sampling (i.e., additional 2 households in each PSU) of the households was considered in order to adjust for non-responses. The survey covered a total of 1141 households from 57 villages covering 6145 individuals. For demographic information of the child, the head of the household was considered as the primary respondent. In absence of the household head, interview was carried out with a senior household member who was generally aware about various family matters.

For collection of information on child health, only one mother from each household experiencing at least one live birth during last five-years was selected. In case a household had more than one eligible mother, selection of respondents followed similar method of National Family Health Survey (IIPS 2007). In total, information on maternal and child health was collected for 569 women and their youngest living child born in the last five years preceding the survey. Among them 507 children are used for analysis whose anthropometric and background information is available. Amongst 507 children, height and weight information of mothers are available for 492 children.

Response variable

The response variable is a categorical variable. It includes different combinations of children's nutritional status and history of common childhood illness. Child's long term nutritional status is measured in standard deviation scale following WHO 2006 reference population. It is known as height for age z score. When the z score is below -2 SD of the median z score of the reference population, indicates long term nutritional deprivation or stunting (WHO 2006). Common childhood illness comprises of occurrence of diarrhoeal and fever episodes among children under the age of five during the last fifteen days preceding the survey. Since number of children suffering from ARI is very low in the sample, only fever is taken for analysis. The response variable includes categories – undernourished and morbid, undernourished and not morbid, normal and morbid, normal and not morbid.

Predictor variables

Choice of independent variables is done in conformity with earlier studies. Here household's experience of any climatic shock, its interaction with different chronic shocks are the causal variables to see whether those variables influence the impact of perceived economic, educational, employment status and mother's observed health status on chronic undernutrition and morbidity. Along with it, whether impact reacts to controlling of socio-cultural, demographic and feeding practice related heterogeneity will also be investigated.

Socioeconomic and employment status: Household's self perceived economic status is one predictor in the study. Household's economic status is based on his perception about what is the expenditure status compared to income status, whether his family consumes two square meals everyday or not, what is his type of house, and ownership of house. Based on this information a factor score is generated. Three quintiles of the score are most poor, moderate poor and least poor. According to employment status, two categories are working and non-working mothers.

Mother's education and nutritional status: Mother's year of education in completed years is categorised in three groups, illiterate, literate up to primary level and educated more than primary level. Information on mother's height and weight are used to calculate her body mass index following the standard formula. According to standard norm, BMI less than 18.5kg/m^2 is taken as indicator of undernutrition. Range of BMI indicating normal nutritional status is 18.5 kg/m^2 and 24.99 kg/m^2 and BMI value from and above 25 kg/m^2 indicates overweight. Continuous BMI score is generated from height and weight of mothers. Then BMI score is categorised according to underweight, normal an overweight based on above mentioned classification.

Service uptake index: This index is created to capture difficulty to access health service. To construct this index, assumption behind it is, people prefer rural medical practitioners

(RMPs) than public provider due to easy availability of care, trustworthiness, cheaper option and at a time low perceived quality of care of government facility. Following assumption is, in a situation with availability of only two options – public provider and rural medical practitioner – inhabitants will choose RMPs over public providers. The index is created using factor analysis. Three elements are taken for creating the index – type of provider household usually go for treatment of common childhood illness, distance from that facility and mode of transport they use. These aspects are covered to understand not only the choice of provider but also the accessibility barrier households face to reach that provider. Three quintiles are generated from the first factor score – easy service uptake, moderate service uptake and difficult service uptake.

Service delivery space index- This index is created to understand the service delivery situation of 19 blocks in the Sundarbans. The indicators are (for each BPHCs): 1) physical infrastructure, 2) manpower availability, 3) bed occupancy rate and 4) utilisation rate of institutional care in birth. The service delivery score is created using factor analysis method and three quintiles are generated. The “wide space” blocks are evidently those where supply falls far short of demand.

Climatic shock as an exogenous shock variable: Information on frequent and large covariate-transient climatic shock is captured by interviewing whether a household’s asset like land or house damaged due to natural calamity during the last five years preceding the survey. The variable has three categories – whether household faced the climate shock only once in last five years, whether household faced the climate shock multiple times in last five years, whether household had not faced any climate shock during last five years.

Interaction variables: Whether climatic shock acts as complementary factor to chronic shocks are tested with taking three interaction variables – interaction of climatic shock with socioeconomic status, with service uptake index and with service delivery space index.

Child's background characteristics: The religion and caste of the household having eligible child for interview are used to capture the background characteristics. The religion and caste are clubbed into one variable where categories are other Hindu, scheduled caste Hindu (SC Hindu), scheduled tribe Hindu (ST Hindu) and Muslims & other minorities to avoid the collinearity between the two factors.

Child feeding practice: Child's feeding practice followed by the mother/caregiver is taken as indicator of awareness about childcare and feeding practice of the child. Two variables are taken – initiation of breastfeeding and exclusive breastfeeding. Initiation of breastfeeding has two categories – initiated breastfeeding during 1 hour of birth and initiated after 1 hour of birth. Exclusive breastfeeding also has two categories- children breastfed exclusively up to six months, and children breastfed exclusively more than six months.

Demographic characteristics: Child's demographic features captured through age in completed months, sex of the child and birth order. Child's age and birth order are continuous variables and sex of the child is a categorical one having two categories- male and female.

IV. Results

Sample characteristics

Table 1 represents sample characteristics of the mothers in 57 study villages of 19 blocks in the Sundarbans distributed in two districts –North 24 parganas and South 24 parganas. Northern part of the Sundarbans is situated in North 24 parganas, we can name it North Sundarbans and similarly, southern part is in South 24 parganas which we can name South Sundarbans. Near about 40 percent inhabitants are poorest of the poor, 60 percent of mothers have primary education and more than 75 percent of mothers are not engaged in any kind of employment. Three out of ten respondents reported difficulty in health seeking. About 31 percent respondents live in blocks with poor service delivery in government hospital. More than 47 percent of respondents belong to scheduled caste and scheduled

tribe Hindu families. More than half of the children whose information are collected are boys. Three out of five children are not put to breast within 1 hour of birth and almost 7 out of ten children are continued with exclusive breastfeeding more than six months of age.

Distribution of mothers differs by northern and southern part of the Sundarbans. Northern part is comparatively poor in terms of population composition (44 percent of respondents in northern Sundarbans and 36 percent in southern Sundarbans are poorest of the poor, percentage of illiterate is higher in northern Sundarbans, and 88 percent respondents belongs to marginalised section in northern Sundarbans compared to 77 percent in southern Sundarbans), condition of government hospital (46 percent respondents compared to 25 percent), and in terms of childcare indicated by one childcare indicator i.e. feeding practice (36 percent mothers initiated breastfeeding within 1 hour of birth in northern part but 43 percent did the same in southern region).

Prevalence of severe and moderate chronic undernutrition, diarrhoea and fever by background characteristics of the mothers

Table 2 presents the prevalence of chronic undernutrition and common childhood ailments in the Sundarbans during the study period. Almost 3 out of 5 children in the study area are moderately stunted among poorest of the poor and moderate poor, more than 60 percent moderately stunted children belong to illiterate, employed mothers; 57 percent children of underweight mothers, 60 percent children from marginalised section, 57 percent children living in blocks with poor government hospitals are moderately stunted. Stunting is marginally higher among children with poor feeding practice and surprisingly among boys.

Prevalence of diarrhoea is higher among children of poorest family (9.7 percent), illiterate mothers (10.5 percent), working mothers (8.5 percent), marginalised sections (7.9 percent among SC & ST Hindu and 8.2 percent among Muslims & others), children with improper feeding practice (7.9 percent among children who were exclusively breastfed for more than six months) and girl children (9.1 percent). Prevalence of fever is also high

among children belonging to poorest family (44 percent among most poor and 45 percent among moderate poor), illiterate mothers (44.8 percent), marginalised section (39 percent SC & ST Hindu and 46 percent among Muslims & others), and children with improper feeding practice (40.9 percent among children who were breastfed for more than six months).

Econometric analysis

The relative risk ratios (RRR) and p values of the multinomial logit regressions are presented in Table 3a, Table 3b, and Table 3c (only the significant variables are presented at 95 % significance level). The Table 3 shows the relative risk ratios between undernourished-morbid and undernourished-not morbid, normally nourished-morbid, normal-not morbid children under the age of five. Interpretation of the Tables is discussed below.

Undernourished and morbid vs. Undernourished and not morbid

Among undernourished children, relative risk of having morbid child is lower amongst more educated mothers (RRR=2.56, $p<0.05$) compared to illiterate mothers (Model 1). Controlling of exogenous climatic shock and its interaction with several chronic or permanent shocks increases the likelihood that educated mothers of undernourished children will have less morbid children (RRR=2.72, $p<0.05$) (Model 2). Controlling of socio-cultural, demographic and feeding practice related heterogeneity reduces the degree of influence of higher education (Model 3 and Model 4).

Normally nourished or overweight mothers of undernourished children are more likely to have morbid children compared to their underweight counterpart (RRR=0.62, $p<0.1$ for normal mothers; RRR=0.30, $p<0.1$ for overweight mothers) (Model 1).Controlling of multiple shocks and their interactions, household socio-cultural background, child's demographic traits and its feeding practice related heterogeneity reduces the degree of influence of both the predictors (Model 2, 3 & 4).

Undernourished children living in blocks with narrow scope of service delivery improvement are less likely to be not morbid (RRR=0.24, p<0.1) if climatic shock and its interaction with permanent shocks are controlled (Model 2). Controlling of background characteristics vanishes the significance of service delivery improvement possibility (Model 3). Controlling of childcare and feeding practice as well as his/her demographic characteristics shows that the nature of service delivery significantly fails to protect the inhabitants from health shock (Model 4).

Malnourished and morbid vs. Normal and morbid

Among morbid children, relative risk of presence of undernourishment is lower among children of more educated mothers (RRR=2.59, p<0.1) compared to illiterate mothers (Model 1). But controlling of transitory shock and its interaction with permanent shock causes the significance to disappear and reduces the degree of influence.

Relative risk of presence of undernutrition among morbid children is high among normally nourished mothers (RRR=-0.57, p<0.1) (Model 1). The degree of influence declines after controlling of shock impacts, child's background, demography and caring practice. Relative risk of having undernourished among morbid child is higher among moderate poor families faced frequent climatic shock compared to most poor families (RRR= 0.48, p<0.1) (Model 2). Degree of influence declines gradually as different sets of factors are controlled (Model 3, Model 4). Controlling of background related, demographic and childcare related heterogeneities shows the transitory shock works through the pathway of those influencing factors.

Among morbid set of children, SC and ST Hindu (RRR=0.31, p<0.01), Muslim and others (RRR=0.33, p<0.05) are more likely to have undernourished children compared to other Hindu households (Model 3). Degree of influence of religion and caste increases for SC and ST households after controlling for feeding and care practice and demographic traits (Model 4).

Malnourished and morbid vs. Normal and not morbid

Relative risk of both undernutrition and morbidity is lower among children of more educated mothers (RRR=2.67, $p<0.05$) than illiterate mothers compared to normal and not morbid (Model 1). The degree of influence increases when impact of transitory shock i.e. extreme climatic event and combined impact of permanent and transitory shocks are controlled (RRR=3.05, $p<0.05$) (Model 2). Controlling of background characteristics again shows that children of educated mothers are less vulnerable (RRR=2.56, $p<0.1$) but the degree of influence decreased (Model 3). The conclusion remains same if child feeding practice and demographic attributes are controlled in Model 4 but here the degree of influence increased (RRR=2.58, $p<0.1$).

Mothers educated up to primary level compared to illiterate mothers are less likely to have undernourished and morbid children than normal and not morbid children which become significant after controlling of transient and permanent shock and their combined impact (RRR=1.69, $p<0.1$) (Model 2). The significance vanishes as other factors are controlled in Model 3 and Model 4. It is because mother's education works through the pathway of those predictors.

Relative risk of undernutrition and morbidity among children are lower for them whose health service uptake is difficult but inclined towards public providers (RRR=6.05, $p<0.05$) which is significant after controlling of the impacts of multiple shocks and shock combinations (Model 2). Controlling of background and demographic characteristics and child feeding practice increases its influencing power. However, controlling of caste, religion, demographic and feeding practice related heterogeneities reveals the influencing power of health seeking behaviour.

Even blocks with good service delivery system, are more vulnerable to undernutrition-morbidity vicious circle when face transitory (climatic) shock, which weakens the chronically weak resource base of the inhabitants whose health seeking behaviour is at

sub optimal level (RRR=0.17, p<0.05) (Model 2). Degree of influence increases with controlling of socio-cultural predictors (Model 3). Controlling of demographic and care practice related predictors, reduces the degree of influence in Model 4.

Children from least poor families are less vulnerable to undernutrition-morbidity circle (RRR=2.09, p<0.1) even after controlling for impact of multiple shocks and their complementary effect (Model 2). Controlling of socio-cultural factors reduces the degree of influence (RRR=2.08, p<0.1) but again increases after controlling of demographic and care practice related heterogeneity (RRR=2.15, p<0.1) in Model 3 and Model 4 respectively. Blocks with narrow service delivery space are less vulnerable to undernutrition-morbidity vicious circle (RRR=1.90, p<0.1) (Model 2). Controlling the socio-cultural, demographic and child feeding related heterogeneity vanishes the significance of the factor (Model 3 and Model 4).

Scheduled caste Hindu, scheduled tribe Hindu (RRR=0.34, p<0.01) and Muslims & other (RRR=0.29, p<0.01) category children are more susceptible to undernutrition-morbidity vicious circle compared to other Hindu children (Model 3). Degree of influence of Muslims and others increases (RRR=0.31, p<0.01) when demographic traits and care practices are controlled (Model 4). Children of higher age group (RRR=1.01, p<0.1) are less vulnerable to undernutrition morbidity vicious circle (Model 4) as with age they develop their immunity against susceptibility.

V. Discussion

Based on the primary survey data collected in the Sundarbans delta region of West Bengal during November 2008 and December 2008 on self reported health status, ailments and health seeking behaviour as well as anthropometric information of the study population, the present work provides variations in chronic undernutrition, common childhood ailments and undernutrition-morbidity relationship among children under the age of five using multiple shock framework. The present findings will be interpreted in light of the multiple shocks, their

interactions and socioeconomic, demographic, socio-cultural context of the developing countries in general and India in particular.

Although, in developing world, especially in India, there has been an appreciable reduction in infant mortality rate, the prevalence of chronic undernutrition of children and related morbidities are not declining at par (IIPS 2007). A similar condition has been prevailing in West Bengal too and more so in the shock prone vulnerable region –the Sundarbans delta.

The major findings from the present study are as follows. Firstly, almost 3 out of 5 children among poorest section, marginalised group, illiterate, and underweight mothers as well as children living in blocks with poor service delivery condition of Government hospitals in the Sundarbans are stunted, secondly, prevalence of diarrhoea and fever are higher among children of poorest family, marginalised section, illiterate mothers and children under improper feeding practice in the study area. Thirdly, impact of frequent transient shock worsens the health and nutritional status of children living there. Fourthly, determinants-of-undernutrition as well as morbidity framework fails to hold in face of transient and chronic shocks which are interactive in nature; comes in large covariate and idiosyncratic forms in that delta region. Lastly, poorer section, marginalised sub-group of population with attributes like less social acceptability of healthcare, lack of awareness about childcare, living in inefficient supply side environment are more vulnerable to undernutrition-morbidity coexistence.

It is worthwhile to mention that the findings of the present study have to be interpreted in the light of some potential limitations inherent in the data. The present study was based on the information on symptoms of 'self-reported' health problems experienced by the children. However, it was neither clinically nor diagnostically measured. This may be a potential source of selection bias and leads to overestimation of reporting common childhood ailments since those who are knowledgeable enough about the signs and symptoms of child

health problems will tend to report more illnesses. Another limitation is that information on common childhood ailments, feeding practice are not collected for all the children whose height and weight are measured. In relation to analysis and interpretation, determinants of undernutrition among morbid children, suffering of undernourished and normal children were tested to capture the contextual determinants of undernutrition-morbidity feedback loop to some extent through a cross sectional study. Side by side, there we also see a unique positive side of the work since the analysis is successful to bring a flair picture of the presence of vicious circle in that vulnerable pocket and it is the goal of the paper; not that we tried to show the existence of vicious circle directly as we are not doing a cohort study.

Poor nutritional and health status of children and vicious circle of undernutrition and morbidity in underdeveloped areas is very common and also found in shock prone areas of developing world (Bartlett 2009). In Bartlett's work (2009) she mentioned that in Africa, stunted children are more vulnerable to recurrent illness episodes in regions facing extreme climate events. It is evident from our study that common childhood ailment is higher among chronically undernourished children. However, it is also found in previous research works that undernutrition acts as a catalyst for poverty as it make children less resilient to economic, social, natural shocks and increases the risk of health shocks (Heltberg 2006, Gopalan 1992, de Onis et al. 2000, Haddad 2002, Dasgupta 1993, Dasgupta 1997). Thus vulnerability to poverty deepening-undernutrition-ill health cycle is higher among families of chronically undernourished children of the shock prone area.

Among the set of undernourished children, whether they will be morbid or not depends upon their mother's educational achievement. Low prevalence of diarrhoea and fever among undernourished children of educated mothers supports the traditional hypothesis – mother's education negatively influences child's health status and it has a long run significance related to under nutrition-morbidity circle (Linnemayr et al. 2008, Benson 2005). Earlier literatures suggest that educated mothers take proper childcare, reduce possibility of childhood frequent illnesses and ultimately minimises the risk of aggravating

undernutrition. It is clear that multiple shocks – transitory and permanent – and their interactions also impacts health of the undernourished children of educated mother's less than illiterate mothers. It implies literacy gradient of undernutrition-morbidity circle is stronger and significant as educated mothers follow proper feeding practice, make no age or gender specific discrimination in intra-household food allocation, or not according to number of children. In the Sundarbans, mother's education influence through different background factors which is different from other previous studies. As found in rural Mexico, mother's education is not associated with child's health and nutrition when families face climatic shock (Skoufias et al. 2011). But in the Sundarbans, the scenario is a bit different. Here the care practice even after the hit of shock differs by mother's education.

When a family faces erosion of basic entitlement due to climatic shock in an already poor setting (termed as permanent shock i.e. chronic nature of shock having components like inaccessibility to and inadequacy of healthcare services), health shock comes more on undernourished children which is also visible in other parts of the developing world (SCN News 2010).

Furthermore, undernourished children of undernourished mothers are more susceptible to health shocks as they are fragile from prenatal period (Morales et al. 2004). Along with it, if they belong to underprivileged socio-cultural strata or follow improper feeding practice or have age or gender specific, number of living children specific discrimination inside the household there remains significant probability of health shock on undernourished children as visible in other parts of South Asia (Navaneetham and Josh 2005).

It is clear that climatic shock and its interaction with chronic shocks against which inhabitants struggling for years are bringing health shocks to aggravate undernutrition-morbidity vicious circle among children living in blocks even with better service delivery system. Thus health system becomes ineffective in front of multiple shocks on households

which are a unique finding in relation to the Sundarbans. It is also evident that, children from scheduled caste or scheduled tribe sub-groups are more vulnerable in blocks where service delivery is even better than healthcare system of other blocks. Thus marginalised section of the study area is more vulnerable to undernutrition and morbidity since they are less resilient to climatic shocks as visible in marginalised segment in climatic shock prone areas of African subcontinent (Bertlett 2009).

Confounding of narrow service delivery space in improving undernourished child's health by childcare and feeding practice as well as demographic factors is because better working service delivery system is ineffective to improve childcare and feeding practice and to remove age specific, gender specific and birth order specific variations in child health status due to poor monitoring on behaviour change communication (BCC) initiatives. This is a common scenario in other parts of India too where proper BCC initiatives are lacking; even if BCC is actively present those are not defined properly according to the need of specific communities as found the reason of not improving health and nutritional indicators in rural Uttar Pradesh (DoH&FW, UP 2008).

The prevalence of undernutrition among morbid children is found lower among educated mothers because the result follows the conventional hypothesis – mother's educational achievement helps to reduce under nutrition (Linnemayr et al. 2008). But with respect to the comparison of the possibility of morbidity among undernourished or normal does not differ by mother's education when families face climatic shock. Mother's education has no influence during and after the hit of climatic shock on household resource base and caring practice due to unavailability of care options during and after shock (Skoufias et al. 2011). Along with it, failure of service delivery system to bring back the stability after that crisis is one main reason why conventional underlying determinants fail to influence health and nutritional status of children in the Sundarbans and make them more vulnerable to undernutrition morbidity vicious circle through occurrence of repeated ailments. Earlier literature shows that chronic undernutrition among children does not depend on mother's

education when families face large covariate transient weather shocks in rural Mexico because mothers have similar resources available to adjust the care practices to climate shocks regardless of their educational status (Skoufias et al. 2011). But in the Sundarbans, failure of service delivery system is found another influencing factor which was not tested much earlier. Rosenzweig and Schultz (1982) in one of their previous study found that mother's education and service delivery are substitute to each other in determining child's nutritional and health status. Interestingly in the Sundarbans, due to absence of effective service delivery, health system is unable to complement positive effect of mother's education; hence supply side is not acting as substitutes for illiteracy either.

It is also clear that impact of mother's nutritional status on chronic undernutrition and related undernutrition-morbidity vicious circle of children becomes irrelevant if household experiences frequent erosion of resource base due to climatic shock as found in rural Mexico (Skoufias et al. 2011), but difficult health seeking on the part of the household coupled with inefficient service delivery system, improper childcare practice and poor family planning are additional predictors related to the Sundarbans.

Moderate poor families are found more vulnerable under frequent climatic shocks which work through the pathway of socio-cultural and demographic context. Because socio-culturally disadvantaged section of the population are more vulnerable to climatic shock which destroys their weak assets base, make them more susceptible to future destitution preceded by child health shocks and following vulnerabilities (Bertlett 2009). Small children, girls are more vulnerable to climatic shock and during that period childcare practice get hampered as found in World Bank's study (Skoufias et al. 2011).

Children of educated mothers are less vulnerable to undernutrition and related health problems which is also supported by many previous studies (Mosley and Chen 1984, Caldwell 1986, Lavy et al. 1996, Sahn and Alderman 1997). When a family becomes socioeconomically vulnerable due to erosion of resources after frequent climatic shocks,

while the service delivery of health facilities are inadequate and social acceptability of such services are low only children of educated mothers are less vulnerable to undernutrition and morbidity cycle. This finding is not in conformity with previous studies. But mother's education works through the pathway of child's socio-cultural background has also been found in works of Desai and Alva (1998). Controlling of demographic and childcare related heterogeneity proves that mother's higher level of education helps to follow good child feeding and care, limits age, gender, and number of children specific discrimination inside family (Linnemayr et al. 2008).

In relation to mothers educated up to primary level, the null hypothesis with respect to mother's education and child's undernutrition and morbidity is still supported when both natures of shock comes in the pathway of response factor and the predictor. As mentioned before, this result is not supported by any earlier study. So, this area needs deeper research on community level to understand why mother's education remains influential even during and after the climatic event.

Degree of influence of social acceptability of health seeking at government facility with difficulty in physical access is significant and increases in successive models. Social acceptability problem is higher in less socially disadvantaged sub-groups, those who are not aware about better feeding practice and about the negative impact of demographic discrimination among children. Such factors predominantly act as barriers to access healthcare and thus influence the health and nutritional status of the population (Anderson 1995, Ensor and Cooper 2004, Peters et al. 2008, Kanjilal et al. 2010).

However, supply side factor is confounded by demand side predictor. It implies blocks are susceptible to vicious circle of undernutrition and morbidity not only because healthcare supply failure; less aware families cannot take care of their children properly and when they fall sick along with their long term neglect (reflected through chronic undernutrition), supply side failure complement the situation. Thus to improve the health

and nutritional status of the Sundarbans, both demand and supply side barriers to access are to be removed (Jacobs et al. 2011).

Climatic shock and its impact via socioeconomic status, inaccessibility to and inadequacy of healthcare system affect less the comparatively better off section of the population due to their relatively stronger resource base (Calvo and Dercon 2005). However, socio-culturally underprivileged sub-group of the population come among least poor group marginally. In addition to this, least poor group can be less vulnerable if they follow appropriate feeding practice and make no discrimination between two children by their demographic attributes. Resembling with whole India context the analysis can be supported by another study which says, poverty is the main cause of undernutrition that works through mother' awareness about childcare and her position in the family which determines the degree of discrimination among two children living in the same house (Svedberg 2008).

Vulnerability to undernutrition-morbidity vicious circle among Muslim and other minor community are higher because of their poor feeding practice, and gender discrimination in intra-household allocation of resources. Moreover, good service availability of child healthcare will be successful only when socio-cultural heterogeneity disappears, households follow right feeding practice to all children without any discrimination. Therefore it is clear that, even in areas with good service delivery system, it cannot work properly unless demand side barriers are removed as mentioned in the work of Ensor and Cooper (2004) arguing why influencing the demand side is needed to increase coverage of health services.

VI. Conclusion

In the Sundarbans, context plays significant role in influencing the undernutrition-morbidity among children under the age of five. The major influencing factors prevailing in the area are chronic poverty, exposure to frequent climatic shock, physical access barrier,

and inefficient service delivery system, and cultural preferences, attitudes, norms followed by marginalised section. These factors are hindering the access to healthcare and mutually reinforcing shocks are strengthening all dimensions of access barriers. Our null hypothesis contextualising mutually reinforcing shocks in influencing child health hence cannot be rejected with respect to the Sundarbans.

Consequently, children living in frequent transitory shock prone area are susceptible to undernutrition-morbidity vicious circle in the short or medium run. In addition, it is more probable among low resilient families which make the population vulnerable to poverty deepening in the long run. Current and potential welfare loss following chronic and transient shocks in the Sundarbans delta region in terms of worse child health imposes huge cost to the economy. To reduce the multiple burden of vulnerability in different pockets of the Sundarbans, cluster specific study on climate and health shock vulnerabilities, resilience, coping strategies differentiated by service delivery status are required.

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Appendix

Table 1: Sample characteristics of the children in the study area

	North Sundarbans	South Sundarbans	Total
N	154	353	507
Socio economic status			
Most poor	43.5	36.3	38.5
Moderate poor	27.3	32.0	30.6
Least poor	29.2	31.7	31.0
Mother's Education			
Illiterate	29.2	25.2	26.4
Up to primary	53.3	63.2	60.2
Higher	17.5	11.6	13.4
Employment Status			
Employed	22.1	23.8	23.3
Unemployed	77.9	76.2	76.7
Mother's Nutritional Status			
Underweight	32.4	32.0	32.1
Normal	62.2	62.2	62.2
Overweight	5.4	5.8	5.7
Health service uptake index according to physical accessibility and nature of provider			
Easy service uptake	44.2	28.6	33.3
Moderate service uptake	24.0	37.4	33.3
Difficult service uptake	31.8	34.0	33.3
Service delivery gap index			
Wide service delivery space	46.1	24.9	31.4
Moderate service delivery space	36.4	34.8	35.3
Narrow service delivery space	17.5	40.2	33.3
Religion & Caste			

Other Hindu	11.7	22.4	19.1
SC & ST Hindu	46.8	47.6	47.3
Muslims & others	41.6	30.0	33.5
Child feeding practice			
Initiation of breastfeeding			
Initiation of breastfeeding within 1 hour of birth	36.4	42.8	40.8
Initiation of breastfeeding not within 1 hour of birth	63.6	57.2	59.2
Exclusive breast feeding			
Exclusive breastfeeding less than six months of age	39.6	29.5	32.5
Exclusive breastfeeding more than six months of age	60.4	70.5	67.5
Sex of the child			
Boy	53.3	51.6	52.1
Girl	46.8	48.4	47.9

Table 2: Prevalence of severe stunted, moderate stunted, diarrhoea, fever and diarrhoea or fever among children under the age of five in the Sundarbans

	Severely Stunted	Moderately Stunted	Diarrhoea	Fever	Either of the two diseases (Diarrhoea or Fever)
N	163	287	38	206	225
Socio economic status					
Most poor	33.9	59.0	9.7	44.1	48.2
Moderate poor	32.9	59.4	5.8	45.2	48.4
Least poor	29.3	51.0	6.4	31.9	35.7
Mother's Education					
Illiterate	39.6	63.4	10.5	44.8	47.8
Up to primary	30.8	55.1	7.5	40.7	45.6
Higher	23.5	50.0	1.5	32.4	32.4
Employment Status					
Employed	34.8	61.9	8.5	37.3	42.4
Unemployed	31.4	55.0	7.2	41.7	45.0
Mother's Nutritional Status					
Underweight	33.5	57.6	7.0	40.5	43.0
Normal	33.0	58.5	8.2	40.5	44.8
Overweight	25.0	42.9	7.1	50.0	57.1
Health service uptake index					
Easy service uptake	31.4	57.4	7.1	39.6	43.8
Moderate service uptake	34.3	59.2	8.9	40.2	44.4
Difficult service uptake	30.8	53.3	6.5	42.0	45.0
Service delivery gap index					
Wide service delivery space	30.2	57.2	6.3	36.5	39.6
Moderate service delivery space	32.4	53.6	7.3	38.6	41.9
Narrow service delivery space	33.7	59.2	8.9	46.8	51.5

Religion & Caste					
Other Hindu	22.7	39.2	5.2	36.1	38.1
SC & ST Hindu	32.9	60.4	7.9	38.8	42.5
Muslims & others	36.5	61.2	8.2	45.9	50.6
Initiation of breastfeeding					
Initiation of breastfeeding within 1 hour of birth	31.4	56.0	8.2	41.1	44.9
Initiation of breastfeeding not within 1 hour of birth	32.7	57.0	7.0	40.3	44.0
Exclusive breast feeding					
Exclusive breastfeeding less than six months of age	35.8	56.4	6.7	40.0	43.0
Exclusive breastfeeding more than six months of age	30.4	56.7	7.9	40.9	45.0
Sex of the child					
Boy	33.0	59.1	6.1	41.3	45.8
Girl	31.3	53.9	9.1	39.9	42.8

Table 3a: Determinants of undernutrition and morbidity among children from the study

(Relative Risk Ratios and p values obtained from multinomial logit regression model)

Undernourished and morbid vs. Undernourished and not morbid	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Chronic shock				
Physical, human and financial asset base				
Illiterate (Ref.)	1.00	1.00	1.00	1.00
Up to primary	1.09	1.13	1.10	1.09
Higher	*2.56***	*2.72***	*2.61***	*2.59***
Underweight (Ref.)	1.00	1.00	1.00	1.00
Normal	*0.62**	*0.61**	*0.61**	*0.60**
Overweight	*0.30**	*0.27**	*0.27**	*0.26**
Wide service delivery space (Ref.)	1.00	1.00	1.00	1.00
Moderate service delivery space	0.91	1.19	1.23	1.21
Narrow service delivery space	0.68	*0.24**	0.25	*0.24**
Number of observations	492	492	492	492
Chi2	24.13	34.70	72.77	100.48
Prob>chi2	0.2866	0.3866	0.0451	0.0264
pseudo R2	0.0204	0.0271	0.0524	0.0745

Table 3b: Determinants of undernutrition and morbidity among children from the study

(Relative Risk Ratios and p values obtained from multinomial logit regression model)

Undernourished and morbid vs. Normal and morbid	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Physical, human and financial asset base				
Illiterate (Ref.)	1.00	1.00	1.00	1.00
Up to primary	1.41	1.31	1.13	1.18
Higher	*2.59**	2.36	2.00	2.01

Underweight (Ref.)	1.00	1.00	1.00	1.00
Normal	*0.57**	*0.56**	*0.57**	*0.55**
Overweight	1.21	1.30	1.20	1.39
Transient shock				
Exogenous climatic shock		1.92	2.01	1.87
Most poor family experience frequent climatic shock (Ref.)		1.00	1.00	1.00
Moderate poor family experience frequent climatic shock		*0.48**	*0.46**	*0.44***
Least poor family experience frequent climatic shock		1.00	0.99	0.99
Background characteristics				
Other Hindu (Ref.)			1.00	1.00
SC & ST Hindu			*0.31****	*0.32****
Muslims & others			*0.33***	*0.33***
Number of observations	492	492	492	492
Chi2	24.13	34.70	72.77	100.48
Prob>chi2	0.2866	0.3866	0.0451	0.0264
pseudo R2	0.0204	0.0271	0.0524	0.0745

Table3c: Determinants of undernutrition and morbidity among children from the study (Relative Risk Ratios and p values obtained from multinomial logit regression model)

Undernourished and morbid vs. Normal and not morbid	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Physical, human and financial asset base				
Illiterate (Ref.)	1.00	1.00	1.00	1.00
Up to primary	1.55	*1.69**	1.49	1.45
Higher	*2.67***	*3.05***	*2.56**	*2.58**
Chronic shock				
Easy service uptake (Ref.)	1.00	1.00	1.00	1.00
Moderate service uptake	0.99	3.28	3.22	3.09
Difficult service uptake	1.22	*6.05***	*6.15***	*6.84***
Wide service delivery space (Ref.)	1.00	1.00	1.00	1.00
Moderate service delivery space	1.15	1.42	1.70	1.50
Narrow service delivery space	0.64	*0.17***	*0.20**	*0.17***
Transient shock				
Exogenous climatic shock		0.98	1.02	0.98
Most poor family experience frequent climatic shock (Ref.)		1.00	1.00	1.00
Moderate poor family experience frequent climatic shock		1.53	1.51	1.57
Least poor family experience frequent climatic shock		*2.09**	*2.08**	*2.15**
Easy service uptake possibility and climatic shock (Ref.)		1.00	1.00	1.00
Moderate service uptake possibility and climatic shock		0.57	0.55	0.56
Difficult service uptake possibility and climatic shock		*0.45***	*0.45***	*0.42***
Blocks with wide service delivery space faced climatic shock (Ref.)		1.00	1.00	1.00
Blocks with moderate service delivery space faced climatic shock		0.88	0.88	0.92
Blocks with narrow service delivery space faced climatic shock		*1.90**	1.80	1.89

Background characteristics				
Other Hindu (Ref.)			1.00	1.00
SC & ST Hindu			*0.34****	*0.34****
Muslims & others			*0.29****	*0.31****
Demographic characteristics				
Age of the child in completed months				*1.01**
Number of observations	492	492	492	492
Chi2	24.13	34.70	72.77	100.48
Prob>chi2	0.2866	0.3866	0.0451	0.0264
pseudo R2	0.0204	0.0271	0.0524	0.0745

(Ref. = Reference category in Table 3a, Table 3b and in Table 3c)

** p<.1; ** p<.05; *** p<.01*