Chapter 1: Introduction

1.1 Motivation

Any imbalance between the nutrients the body needs and the nutrients it receives is known as malnutrition, which may take the form of either under-nutrition or obesity (Das, 2010). Child nutrition has long been considered as a social issue, related to rights of children. However, it has been identified later that it is more of an economic concern. Child malnutrition in early years of life results in substantial losses later during adolescence and adulthood. From a human development perspective, good health and nutrition are inherently valuable, contributing to physical and cognitive development. Child malnutrition increases child’s susceptibility to several infections and delayed recovery, thus posing big burden of diseases in developing countries (Murray & Lopez 1997). Lack of proper nutrition also increases the incidence of non-communicable diseases, thus inflating the health care cost. Almost half of the global child death under the age five occurs due to malnutrition. It causes a loss of three million children every year. An estimate by the World Bank finds that child malnutrition causes 22 percent disease burden among the children on India (World Bank, 2006). Also, lack of nutrition in first 1000 days of the life makes a child stunted, which has a long-term impact through low productivity (UNICEF, 2015) and loss of work time due to absenteeism. The productivity losses are estimated as 10 percent of lifetime earnings of the stunted individual and 2 to 3 percent of gross domestic product of the nation (Swaminathan, 2008). Child malnutrition severely affects the school performance of the children too (Jamison 1986). Also, it is also said that lack of nutrition in first two years of life is irreversible and cannot be recovered, thus making the problem more nagging and persistent.

According to the definitions provided by World Health Organization, under-nutrition can be of two types: Protein Energy Malnutrition (PEM) and Micro Nutrients Deficiency (MND). PEM manifests early during the age of 6 months – 2 years, resulting from irregular or no breastfeeding, introduction to low protein food and different types of infections (FAO, 2004). It is measured by indicators like under-weight, stunting and wasting. Wasting represents the failure to receive adequate nutrition in the period immediately preceding the survey and may be the result of inadequate food intake or a recent episode of illness causing loss of weight and the onset of malnutrition. Children whose weight-for-height (WAZ) is below minus three standard deviations (-3 SD) from the median of the reference population.
are considered to be severely wasted and those below minus two standard deviation are called wasted. The height-for-age (HAZ) index is an indicator of linear growth retardation and cumulative growth deficits. Children whose height-for-age Z-score is below minus two standard deviations (-2 SD) from the median of the reference population are considered short for their age or stunted and are chronically malnourished. Similarly when this Z score is less than minus three standard deviation (-3SD), the child is called severely stunted. Stunting reflects failure to receive adequate nutrition over a long period and is also affected by recurrent and chronic illness. Weight-for-age is a composite index of height-for-age and weight-for-height. It takes into account both acute and chronic malnutrition. Children whose weight-for-age is below minus two standard deviations from the median of the reference population are classified as underweight. To capture the long-term malnutrition among children, normally stunting is considered as the most important measure and hence this paper focuses on height-for-age category. The measurement of the related z scores are calculated based on the reference population and it’s median. Normally, it is measured by specific software like ANTHRO provided by World Health Organization.

Normally, incidence and prevalence of child malnutrition is hypothesized to be strongly associated with poverty and lack of access to food. However, the widely accepted norms of the level of calorie intake required for eliminating under-nutrition is a debatable issue. It is said that poor diet is not the only reason of malnutrition; non-nutrient food attributes, privately and publicly provided inputs and health status are important too. That is why, Kerala and Tamil Nadu, where food calorie intake is very low, have low incidence of malnutrition and on the other hand, states like Rajasthan and Utter Pradesh with high calorie intake have higher burden of malnutrition (Radhakrishna and Ravi, 2004). The high prevalence of poorly balanced diet on one hand and of bacterial and parasitic diseases on the other hand contributes greatly to malnutrition (FAO 2004, Onis et al 1993).

Additionally, the type of food consumed is crucial. Medical literature calls for a balanced diet consisting of carbohydrates, protein, fat and minerals for optimum growth of the body. Wu et al. (2016) stressed on adequate consumption of high quality protein from animal products for optimal growth, development and health of human beings, especially children. Ghosh (2016) posits that particularly for first thousand days of life, consumption of good quality of protein is essential. The research shows at this time of life, protein consumption prevents the chance of stunting and helps the treatment of severe and moderate
malnutrition. Protein malnutrition from infancy to childhood and adolescence results in reduced bone-mass and strength. Pencharz et al. (2016) prescribes per day 1.5-2.2 gm high quality protein coming from animals for per kg body mass of a child. Semba et al. (2016) surveyed African children and contend that only micronutrient supplements cannot reduce child stunting. On the other hand, nine essential amino acids, present in animal protein, can solve the problem. Interestingly, the study by Torlesse et al. (2003) finds a negative correlation between rice expenditure and child nutrition in Bangladesh, which hints to the fact that when rice expenditure fell, households were able to spend more on non-rice food, especially protein and thereby increase the quantity and quality of their diet.

Statistics from different regions of the world posit that though stunting (height for age) rate is falling across the countries, 159 million children worldwide are still stunted (UNICEF 2015). Along with that, 50 million children are wasted (weight for age) throughout the world. Within 1990 and 2014, the stunting has fallen from 39.6% to 23.8% (UNICEF, 2015). Within this time span in Latin America and Caribbean countries, stunting has fallen from 24.5% to 11.7%, in Africa from 42.3% to 32%, in Asia from 47.6% to 25.1%, whereas in Oceania it increased from 35.9% to 38.1%. Thus, it is clear that in Asia the stunting has fallen by 52%. However, low-income countries perform badly compared to high-income countries in terms of reduction of malnutrition. Within this time span, there is 32% reduction of stunting in low-income countries whereas in high-income countries, the reduction is 77%. According to the World Bank reports, India is considered as lower middle-income country. These types of countries have less than half of under-five children of the globe, whereas they constitute two-third of all the stunted children of the world.

In 2013-14, among Indian children, 29.4% were found to be underweight, 38.7% were stunted, and 15.1% were wasted while 4.6% of her children were severely wasted children (UNICEF, 2015). India’s share of malnourished children is in fact higher than most of the poorest countries of Sub Saharan Africa. The 2015 Global Hunger Index (GHI)\(^1\) Report ranked India 20th amongst leading countries with a serious hunger situation. Strikingly, amongst the South Asian nations, India ranks third, behind only Afghanistan and Pakistan. Not only that, the gap in prevalence of underweight children among the rich and the poor households is increasing over the years with wide regional differences (Kanjilal et al

\(^{1}\)GHI was made by Centre for Development Research in 2001 to capture the several dimension of hunger situation of all the countries by a single indicator. The dimensions are i) proportion of undernourished as mentioned by FAO, ii) prevalence of underweight children under the age five and iii) the under five mortality rate. In GHI, all three indicators are equally weighted.
2010). However, researchers argue that India’s extremely high malnutrition situation emerges because of a faulty methodology of calculation introduced by World Health Organization (Panagariya 2013). They strongly contend that it is unlikely that India would have a higher proportion of malnourished children compared to African countries, in spite of significantly lower IMR and MMR.

Looking at the neighbouring countries of India, one finds relatively lower prevalence of child malnutrition compared to India. Among the neighbouring countries of India, let us compare India with three middle income countries namely Pakistan, Bangladesh and Bhutan. Among these three countries, Bhutan is a very small country in terms of population size as compared to other two countries and India as well. Thus, I have ignored Bhutan in my analysis. Figure 1.1 below reveals that countries like Pakistan and Bangladesh, even with lower per capita income as per estimates of World Bank (2015), have succeeded to reduce significant shares of overall burden of child malnourishment. Except percentage of stunting children in Pakistan, all the child malnutrition indicators of India’s neighbouring countries are better than India, even with lower per capita income. This directly questions several studies by Braveman et al., 2000; Swain et al., 2008; Larrea and Kawachi, 2005, which posit that income is the major determinant of child malnutrition.

**Figure 1.1: Child Malnutrition and per-capita income of India and neighbouring countries**

Like any other health outcomes, malnutrition among children is distributed unevenly across different states and regions in India. This can be captured by latest evidences of
stunting, wasting and underweight across the major non-EAG states in India, provided by District Level Health Survey (DLHS 4) 2013. Among these states, Kerala has least infant mortality rates, followed by Tamil Nadu, Karnataka and West Bengal (SRS, Census of India 2013). Table 1.1 provokes me to give a special attention to West Bengal where stunting (37.4%) and severely stunting (19.8%) is maximum among 9 major states. In terms of wasted children also, it occupies second highest position and first in terms of percentage of severely wasted children (15.2%). On the other hand, Punjab with higher IMR, performs better in terms of child nutrition. Given these figures, it would be interesting to focus on region-wise child nutrition status in India, while giving special focus on the state of West Bengal.

Table 1.1: child health from different angles for some major states of India

<table>
<thead>
<tr>
<th>States</th>
<th>Weight for height</th>
<th>Height for age</th>
<th>Weight for age</th>
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<tr>
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<td>-2SD -3SD</td>
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<tr>
<td>Andhra Pradesh</td>
<td>23.7 13.5</td>
<td>27.7 15.5</td>
<td>27.3 10.1</td>
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<tr>
<td>Haryana</td>
<td>32.3 18.6</td>
<td>31.9 15.4</td>
<td>36.2 15.2</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>21.6 10.0</td>
<td>32.4 18.1</td>
<td>28.5 9.6</td>
</tr>
<tr>
<td>Karnataka</td>
<td>26.4 13.8</td>
<td>29.9 16.0</td>
<td>29.7 11.7</td>
</tr>
<tr>
<td>Kerala</td>
<td>24.1 10.8</td>
<td>22.7 9.4</td>
<td>20.9 6.4</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>34.1 20.0</td>
<td>30.0 14.7</td>
<td>38.7 14.9</td>
</tr>
<tr>
<td>Punjab</td>
<td>21.1 10.1</td>
<td>28.8 12.2</td>
<td>25.2 8.2</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>28.3 13.9</td>
<td>27.3 11.8</td>
<td>32.5 10.7</td>
</tr>
<tr>
<td>West Bengal</td>
<td>28.2 15.2</td>
<td>37.4 19.8</td>
<td>37.4 15.4</td>
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</table>

Source: DLHS 4 (2012-13)

*Gujarat is not surveyed under DLHS 4.

In order to locate the trajectory of states in performance related to child stunting, Table 1.1A is added. Comparing NFHS 1 (1992-93) and NFHS 3 (2005-06), all states in fact recorded drop in incidence of child stunting. However, states like Maharashtra, Gujarat and Karnataka exhibited least drops, in spite of the fact they are supposed to be high-growth richer states in the country. Certain states exhibited a sudden rise in child stunting in NFHS 2 Round, and then again falling sharply (like Punjab, Rajasthan and Uttar Pradesh). Table 1.1B shows the relative ranks of different states across rounds. While Kerala continuing to be the top state with the least shares of stunted children across the rounds, Tamil Nadu and Himachal Pradesh marked significant improvements in relative position. Again, Gujarat remains a point of worry as its relative position dropped from 7th to 18th during the phase. Maharashtra, Haryana, Karnataka too performed relatively badly during the period. However, it was not just these richer states, but the poorest states like Rajasthan, Bihar, UP and Orissa...
all slipped down the ladder even more. West Bengal, Chhattisgarh, Andhra Pradesh retained their ranks throughout the period. The specific state efforts to manage ICDS program better might have pushed Tamil Nadu in a better position.

**Table 1.1A: Child-stunting across states in three rounds of NFHS**

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</tr>
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<td>52.0</td>
<td>49.2</td>
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<td>33.1</td>
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<td>Orissa</td>
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<td>43.9</td>
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<td>45.2</td>
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<td>40.1</td>
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<td>31.1</td>
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<td>39.6</td>
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<td>West Bengal</td>
<td>NA</td>
<td>50.4</td>
<td>41.8</td>
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<tr>
<td>India</td>
<td>52.0</td>
<td>51.0</td>
<td>44.9</td>
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*Source: NFHS I, NFHS II, NFHS III*
Table 1.1B: rank of states with respect to child stunting in different NFHS

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<tbody>
<tr>
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<tr>
<td>Arunachal Pradesh</td>
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<tr>
<td>Chattishgarh</td>
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<tr>
<td>Gujarat</td>
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<tr>
<td>Himachal Pradesh</td>
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<td>4</td>
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<tr>
<td>Jammu and Kashmir</td>
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<tr>
<td>West Bengal</td>
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Source: Table 1.1A

Malnutrition among children persistently remained one of the major concerns of many developing and less developed countries, owing to its long-term contribution on stagnating productivity and growth. With the general perception of child malnutrition being caused by lack of access to food at the household, world policy matrix has overwhelmingly attempted to tackle the problem by creating enhanced access to good food, especially energy rich food-grains. The programs across the countries have targeted to offer supplementary nutrition at community levels to children emanating from poorer households. These interventions have been often coupled with indirect multi-sectoral approach of awareness generation programs on breastfeeding, complementary feeding practices, hygiene behaviours etc. Several schemes like Public Distribution System (PDS), National Rural Health Mission (2005-06), Mahatma Gandhi National Employment Guarantee Scheme (2005-06), Midday Meal (2008-09), Integrated Child development Scheme (2008-09) and National Rural
Livelihood Mission (2010-11) are launched in this direction. While PDS, MDDM and ICDS are direct interventions for creating access to food, the rest are indirect ones to target the enabling environment and better assimilation of food. Among all, PDS is especially constructed to distribute the food among the needy section. Thus, it is expected to take care of the food availability and access components of the food security. However, there is a third or final step of food security, which is food absorption (Swaminathan, 2001). Food absorption depends on the manner of consumption of the food and the state of health of the individual. In a district level study of West Bengal in 2001, it is seen that there is severe gap between food access and food absorption. For example, Murshidabad, Midnapore and North 24 Parganas, who have good ranking in terms of food availability and food access, are very poor in terms of food absorption (Ghosh, 2007). Also, undernourishment is not rare to see among non-poor population group (Asthana, 2001). Programs like PDS really cannot take care of this issue as it primarily targets the poor. ICDS, on the other hand, targets all children to provide supplementary nutrition. The social planner believes that this program can free the children from shackles of child nutrition.

ICDS is a flagship programme organised in 1975 by Government of India in 33 districts. It represents one of the world’s oldest and largest child-care programme. It is a symbol of commitment of our country to the children and mothers for pre-school education and nutritional support (Kapil et al., 2002). The beneficiaries are children within the age group of 0-6 years, pregnant mothers and lactating mothers. It is largest outreach programme at the village level. The objectives of this programme are to provide supplementary nutrition at the community level and preschool education support to the 0-6 year children. The objective of the program is to reduce mortality, morbidity, school dropouts, to enhance the capability of mothers to look after their own and children’s health. Since 2008-09, this programme has been offered for all children under the target of universalization.

However, with so many programmes initiated, situation of India’s children malnutrition could not improve significantly over years. It is a paradox to find that India has high shares of malnourished children, coexisting with large stock of food grain. It may be due to lack of capacity to avail or access the food-grain or it may be due to limited absorption of food emanating from other health problems.

Given this background, several questions emerge. As many children are malnourished, how malnourished are they? Are they severely malnourished or just
moderately malnourished? What is the depth of malnutrition among them? Why are India’s children so vulnerable from the nutrition perspective? If income is not the sole determinant of child malnutrition, what are the factors that strongly correlate with levels of child malnutrition here for such a long time? Irrespective of government intervention, why is malnutrition level not falling significantly? Is there any supply side problem of those government interventions? Or is there any accessibility problem from demand side of those programmes? Is lack of control or intervention causes a failure of those programmes? To find out the answers of these questions I present my dissertation on child (mal) nutrition in India and the impact of ICDS on this malnutrition. The rest of the chapter is organised in the following way. After the first sub-section on motivation, the next section 1.2 outlines the literature review on several issues that I have discussed and analysed in the dissertation. Identifying the research gaps in literature, Section 1.3 focuses on the main objectives of my thesis. I discuss the data in section 1.4 and methodology used in Section 1.5.

1.2 Literature Survey

The literature survey is contextualized in three sub-sections:

A. Measurement of child malnutrition and its persistence and unequal distribution
B. Socio-economic factors that control child malnutrition
C. Policy intervention and its Impact

1.2.A.1: Measurements of Child Malnutrition and its persistence

Child Malnutrition is one of the crucial issues of any developing country of the world. Although the share of malnourished children is falling over last 30 years in the world, the absolute number of malnourished children is still increasing (Smith and Haddad., 2000). The problem of malnutrition in poor economies can be defined as a ‘syndrome of developmental impairment’, which incorporates growth failure; delayed cognitive and behavioural development, along with increased morbidity and mortality (Martorell, 1999). Fall in rate of reduction of child malnutrition is often found in association with other problems, such as vitamin A deficiency and anaemia. These clusters of nutritional problems flourish during the periods of vulnerability, and during the first three years of life, and affect at least a third of all young children in developing countries. The children who survived with malnutrition in early childhood suffer from functional disadvantages as adults, which include diminished intellectual performance, low work capacity, and increased risk of delivery
complications. Cross-sectional data from 241 nationally representative surveys were analysed by Onis et al. (2000) to produce comparable results of low height-for-age i.e. stunting. Multilevel modelling was applied to estimate the global trend of child stunting of those developing countries.

Half of the world's malnourished children reside in three South Asian countries: Bangladesh, India, and Pakistan (Ramalingaswami et al., 1997). The prevalence of stunting has fallen in developing countries from 47% in 1980 to 33% in 2000 (i.e. by 40 million), although progress has been uneven according to regions. Stunting has increased in Eastern Africa, but decreased in South-eastern Asia, South-central Asia and South America; Northern Africa and the Caribbean show modest improvement; and Western Africa and Central America show a little progress. Despite an overall fall of stunting in developing countries, child malnutrition remains a major public health problem in all these countries.

Under-nutrition levels in India exceed the figures for some poorer and lower-growth countries of sub-Saharan Africa. It is interesting to find that share of stunted children is higher in South Asian countries, compared to even sub-Saharan ones. Key factors underlying the higher prevalence of malnutrition in South Asia than in Africa are low birth weight, poor household hygiene, maternal health problems that jeopardize successful breastfeeding, early growth faltering due to delays in the introduction of complementary foods, and a poor quality of child care related to dynamics within the family. In case of South Asia, central to all these determinants is the inequality between men and women. Reductions in child malnutrition in South Asia require promotion of equal freedoms, opportunities, and rights for women-including the right to participate in decision making both within and outside the home. This, in turn, will result in better health, education, and nutrition for women; a reduced incidence of low birth weight; improved access to basic services; and increasing control over fertility (Ramalingaswami et al., 1997). In this region, what is important is a shift from a mere welfare to a human rights approach to the issue of malnutrition, with an emphasis on community empowerment. In addition, nutrition programs must seek to prevent children under 2 years of age from becoming malnourished rather than target only 3-5 year olds. Finally, communities must be supplied with the necessary information, confidence, and support to prevent and manage childhood illnesses in such a way as to protect growth.

According to the new WHO standards of 2006, 48 per cent of Indian children below five years of age are stunted, 43 per cent underweight and 20 percent wasted. 24, 16 and 6 per
percent of children below five years of age respectively suffer from severe forms of stunting, underweight and wasting (UNICEF, 2013). However, Nandy and Miranda. (2008) claim that standard measures understate the situation and thus they have calculated an alternative Composite Index of Anthropometric Failure (CIAF) and compared it with conventional indices. The CIAF examines the relationship between distinct subgroups of anthropometric failure, poverty and morbidity, showing that children with multiple anthropometric failures are at a greater risk of morbidity and are more likely to come from poorer households. While recognizing that stunting, wasting and underweight reflect biological processes of clear importance, the CIAF is the only measure that provides a single, aggregated figure of the number of undernourished children in a population. 59.8% of children of India (1998) have multiple anthropometric failures (Nandy and Miranda, 2008). According to this approach, wealth is one of the important factors for the determination of child malnutrition.

Johansson et al. (1992) claimed that chronic protein-energy malnutrition during the period of growth and development causes permanent disturbances of salivary gland function and tooth structure. Moderate protein-energy deficiency also causes impaired saliva secretion rate and composition. These impairments have coincided with an increased incidence of dental caries. They studied the effect of chronic malnutrition on saliva secretion rate and susceptibility to dental caries in Indian children. It was found that chronic malnutrition reduced the secretion rate of stimulated saliva, but not that of un-stimulated saliva. The salivary buffer capacity has continuously decreased as the secretion rate decreased with the level of malnutrition in the Indian children. The malnourished children developed increased caries. Thus, they suggested that chronic malnutrition in growing children enhances the cryogenic potential stemming from fermentable carbohydrates.

Recent estimates (Rice et al., 2000) suggest that malnutrition (measured as poor anthropometric status) is associated with about 50% of all deaths among children. They posit that although the association between malnutrition and all-cause mortality is well documented, the malnutrition-related risk of death associated with specific diseases is less well described. The strongest and most consistent relation between malnutrition and an increased risk of death was observed for diarrhoea and acute respiratory infection. The evidence, although limited, also suggests a potentially increased risk for death from malaria. A less consistent association was observed between nutritional status and death from measles.
1.2.A.2 The inequality measurement of (mal) nutrition

Incidence of any vulnerability might not be uniform across regions, economic groups and social classes. Thus, it is important not only to focus on the average incidence, but its distribution within different groups. Béteille (1983) has demarcated two aspects of inequality: the relational and the distributional. Relational inequalities considers social structure in the form of relations of ‘super ordination’ or ‘subordination’, distributional inequality implies interpersonal differences in wealth or outcome indicators like health or educational status. According to Kunst et al. (2004) in the statistical analysis, it is important that the measurement of socioeconomic inequalities would be based on both measures of “relative inequalities” (such as Rate Ratios) and measures of “absolute differences” (such as Rate Differences). However, relative measures are used in most analyses as they are generally considered to be of most analytical interest. Regidor (2004) opines that when the objective is to measure health inequality, it is necessary to use univariate measures of inequality in the distribution of health like, Gini index or index of dissimilarity. However, if the objective is to estimate socioeconomic inequality in health, there are two options. The first is to incorporate the socioeconomic dimension in the well known measures of inequality like Gini index. The problem with these measures is that they may give similar results even when the relation between health and socioeconomic status is different. The second option is to use the other three types of measures mentioned: association, potential impact, or based on the ranking of the socioeconomic variable. In this case, there is no unanimously accepted criterion about which measure is the most appropriate. According to him, limitation of most of these measures is that they can only be used to reflect socioeconomic inequalities in health when the socioeconomic variable is ranked hierarchically.

Wagstaff et al. (1991) outlined that the slope index\(^2\) and the concentration index of inequality are giving an accurate picture of socioeconomic inequalities in health in spite of range or Lorentz curve. They prove it through different empirical examples. In a paper Wagstaff (2000) used Achievement Index\(^3\) that captures both the average level and the absolute level of inequality of malnutrition and found thought provoking interesting results.

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\(^2\) Slope Index of Inequality (SII) is used to reflect socio economic dimension of inequality of health. It calculates the mean of each socio economic variable and then rank classes by their socio economic status. SII is the linear regression coefficient shows the relation between the level of health or the frequency of a health problem in each socioeconomic category and the hierarchical ranking of each socioeconomic category on the social scale.

\(^3\) Achievement Index is introduced by Wagstaff (2002) defined as weighted average of health levels of people in the sample where higher weights are attached to poorer people.
They found that stunting, focusing on the Achievement index, moves Egypt (a low-inequality country) from sixth position to fourth, higher than Brazil and Russia (two countries with high inequality).

However, before going into detailed discussions of measurement of inequality, it must be recognised that there should be no value judgement that inequality is always bad and equality is always good. A homogenous group performing worse economic indicators would show low values of inequality measure, which must not be accepted as good outcome.

*Slope Index of inequality*

Pamuk (1985) use a data on occupational and social class mortality published decennially for England and Wales to examine the trend in the size of class differentials in mortality from 1921 to 1972 for adult men, married women and infants. Using summary measures like rate-ratios, which take into account changes in the relative sizes of the social classes over time, it was found that absolute inequality in mortality increased among adult men and married women during the 1950s and 1960s and relative inequality increased for all three groups.

Economists have attempted to look at inequality in different ways. Murray *et al.* (1995) proposed a uni-variate approach to examine the distribution of health without considering other population characteristics which can influence this health distribution. They actually tried to analyse health inequality in terms of public policies only and thus uses the concept of regional inequality. On the contrary, Braveman *et al.* (2000) posit that health inequality occurs due to other socio-economic factors like poverty which makes a barrier to the people to be healthy. Thus, membership of specific social groups plays an important role.

According to Murray *et al.* (1999), both health inequalities and health differences across social groups are important aspects of measuring population health. Despite widespread recognition of their magnitude in many high and low-income countries, there is considerable debate about the meaning and measurement of health inequalities, social group health differences and inequities. According to them, the lack of standard definitions, measurement strategies and indicators has and will continue to limit comparisons between and within countries.
According to Clarke et al. (2002), in recent work on international comparisons of income-related inequalities in health, the concentration index has been used as a measure of health inequality. However, a drawback of this measure is that it is sensitive to whether it is estimated with respect to health or morbidity. An alternative would be to use the generalized concentration index that is based on absolute rather than relative health differences.

Anand (2002) posits that Indian economy has more unequal distribution in health than the inequality in income. Among different dimensions of health, inequalities in infant and child mortality are likely to be higher than it is for others. He mentioned that inequality across certain population groups, like socially backward classes, is likely to be greater than other categorization.

To find out the magnitude of mortality inequality across different social groups in some European countries, Kunst et al. (2004) used relative inequality measures and absolute difference measures through two steps. First, directly age-standardised death rates were calculated for each occupational class or educational level. Second, the magnitude of the mortality differences were summarised by inequality indices that facilitated comparisons over time. Relative inequalities and absolute difference measures express the extent to which the mortality burden is unequally distributed between socio-economic groups. Such a distributional measure is a useful complement to calculate the overall level of mortality in a country. This emphasis on distributional indices corresponding to the distinction that underlies many measures of relative income inequalities (e.g. the Gini coefficient) between the size of the total pie and the share of each group in this pie.

A Blinder–Oaxaca decomposition was applied by Van et al. (2009) to decompose the gap in children's average height-for-age z scores between SC and ST population, using data from the 1998/1999 Indian Demographic Health Survey. This decomposition is useful to study ethnic inequalities in health as it explicitly allows for discriminatory or behavioural effects. The results did not point to discrimination against ST/SC regarding health care or education. However, according to them, in the quest to increase health care use and education among ST/SC, policy makers will have to take into account all the barriers to these services, including those related to cultural sensitivity and acceptability. Swain (2008) has applied the framework of income poverty measure to analyse child under-nutrition in two villages of India. There he found no significant difference between the two villages.
According to Mishra and Mishra (2009), given the difference between head-count measure of poverty and measuring undernourishment among children, there arises a need for application of Foster Greer Thorbecke (FGT) criterion in assessment of undernourishment as well. This is helpful not only for assessing intensity and inequality aspects of malnutrition, but also can adjust the head count accounting for both to make a valid comparison on levels of undernourishment across situations.

Though there have been a large number of studies with respect to health inequality in general, not much analysis is located to identify the inequality in terms of child nutrition, within and across countries. One of the few exceptions is study by Mukhopadhyay (2011), mean of squared deprivation gaps (MSDG) captures the dimensions of level, depth and severity of under-nutrition. One can analyse group inequality in nutritional deprivation among the children using the subgroup consistency features of the MSDG for each wealth quartile. Joe (2015) also examines intersectional inequalities in immunization in India and also suggests a level-sensitive progress assessment method. The study uses group analogue of Gini coefficient for highlighting the magnitude of intersectional inequality and for comprehending its association with immunization level. The results unravel the plight of vulnerable intersectional groups and draw attention to disquieting shortfalls among female SC-ST (scheduled castes and tribes) children from rural areas. There is also some evidence to indicate leveraging among rural males in matters of immunization and it is further discerned that such gender advantage is greater among rural non-SC-ST community than the rural SC-ST group.

**Concentration Index of Inequality**

Using Concentration Index, one study on Ecuador shows that income is a crucial factor of health inequality (Larrea et al., 2005). Kakwani and Kakwani. (1997) have discussed how health inequality can be studied using grouped data, when groups are formed on the basis of socio economic status. They have used mainly two widely used indices of health inequality, namely, Gini coefficient and Concentration Index. It also develops asymptotic estimators for their variances and clarifies the role that demographic standardization plays in the analysis of socioeconomic inequalities in health.

Joe et al. (2009) have mentioned that the distribution of endowments and positive maternal characteristics are significant in widening the gap between the child malnutrition
among poor and non-poor households. They also examined the inter-group disparities in child malnutrition and made a conclusion that child groups privileged in terms of income, mother’s nutritional status and education have lower malnutrition, whereas the group adverse in all three characteristics endures the most. They suggested the policies to reduce malnutrition inequalities should recognize that endowment revisions can be more effective if appended with behavioural interventions.

Studies from several countries reported that the relative mortality gap between low and high socioeconomic groups widened during the 1970s and 1980s. Based on this, Kanbur (2006) made a study by using concentration index to find new estimates of changes in socioeconomic inequalities in mortality between the 1980s and the 1990s in different European countries. The estimates are given with the specific aim to illustrate large variations, both within and between countries, in the pace by which socioeconomic inequalities in mortality changed over time and the considerable degree to which the observed trends may be sensitive to data problems and methodological choices made. Trends in mortality were analysed by assessing trends in group-specific standardised mortality rates and summary measures of the magnitude of mortality differences between socioeconomic groups. However, important variations were observed in the pace of change, both between countries, and within countries among men and women, and among age groups. In addition, a wide relative inequality was found to concur with decreasing life expectancies of the disadvantaged groups in some cases, but increasing life expectancies in many other cases.

The economist’s conceptualisation of inequality in terms of interpersonal distribution of income or wealth, and the tradition of measurement of inequality that follows from this conceptualisation have not paid adequate attention to the need for reckoning inequality across social groups (Chakraborty, 2001). Sen et al. (2009) mentioned that there should be a method which measures inter-sectionality as for health policy there are multiple sources of disadvantage, such as class, gender, caste, race, ethnicity, and so forth, work together to influence health.

Using NFHS III unit-level data, Mazumder (2010) locates that there is strong association between inequality in malnutrition and income inequality and poverty. He has analysed the inequality by the concentration index, which is further decomposed to identify the factors associated with inequality in malnutrition. Poverty here, in terms of the wealth index, has considerable impact on average rates of malnutrition, indicating a disproportional
burden of malnutrition on the poor. At the macro-economic level, overall socio-economic inequality correlates moderately with the inequality in malnutrition. On decomposition, poverty alone explains more than half of the inequality in malnutrition, which justifies the poverty–nutrition inequality linkage.

Ataguba et al. (2015) found out social determinants of health of South Africa with the help of standard Concentration Index (CI). The analysis shows that increased government commitment in terms of budgetary allocations to key sectors (i.e. employment, social protection, education, housing, and other appropriate infrastructure). Attention should also be paid to equity in benefits from government expenditure. In addition, the health sector needs to play its role in providing a broad range of health services to reduce the burden of disease.

1.2. B Socio-economic determinants of child malnutrition

It has been identified earlier in this chapter that India has high shares of malnourished children, coexisting with large stock of food grain. It may be due to lack of capacity to avail or access the food grain or it may be due to prevalence of other health problems. The determinants of child malnutrition can be divided in three levels of causality-immediate, underlying and basic. Immediate causes are dietary and health status, which are influences by food security, health care of mothers and health environment quality. Among the underlying factors, women’s education and employment are crucial. Finally, the important factor is per capita national income (Smith & Haddad., 2000). It is also observed that child malnutrition has fallen marginally in India during 1990s, though the maximum gain of nutrition status has been seen among the upper socio-economic groups (Saxena & Srivastava 2009). Studies focus on economic and social environment and its inequality as most important reasons for malnutrition (Lokshin, et al. 2005, Swaminathan, 2008). These factors can be grouped in two broad sets: Household level and Intra-Household level.

i. Household-level Characteristics

1. Income and Ethnicity

There can be little doubt that household income is a crucial factor in determining both child health and nutrition. Comparisons among pre-school children, presumably well nourished but of different ethnic background indicate that differences in height and weight are relatively small—3% for height and about 6% for weight (Habicht et al., 1974).
A survey over 12 countries proved that increases in income at the household and national levels imply similar rates of reduction in malnutrition (Haddad et al., 2003). Using a four round panel data set from North-western Tanzania, Alderman et al. (2006) estimate the determinants of a child's nutritional status, including household income and the presence of nutrition interventions in the community. The results show that better nutrition is associated with higher income, and that nutrition interventions have a substantial beneficial effect. Policy simulations make clear that if one intends to halve malnutrition rates by 2015 (the MDG objective), income growth will have to be complemented by large scale program interventions.

Studies focus on economic and social environment and its inequality as most important reasons for malnutrition (Arrow et al. 2004, Swaminathan 2008). Hachett et al. (2009) made a study to find determinants of child anthropometrics on a sample of poor Colombian children living in small municipalities. They discussed the influence of household consumption, and public infrastructure, taking into account the endogeneity of household consumption using two different sets of instruments: household assets and municipality average wage. They found that both these are important determinants of child nutritional status. They also found out that the coverage of the piped water network positively influenced child health if the parents have some education.

Brekke et al. (2009) opines that Nordic countries appear to have a steeper income-health gradient than other countries. According to them, the correlation between income and health will be weaker, the more noise there is in terms of other determinants of income. If the Nordic countries have succeeded in reducing the impacts of other determinants of income, like social class, then the correlation between income and health will be stronger in these countries.

Based on the 2011 survey in Bangladesh (Chowdhury et al., 2016), multilevel logistic regression analysis showed that age, sex of the child, mother's body mass index, mother's educational status, father's educational status, place of residence, socioeconomic status, community status, religion, region of residence, and food security are significant factors of child malnutrition. Children with poor socioeconomic and community status were at higher risk of malnutrition. Children from food insecure families were more likely to be malnourished. Significant community- and household-level variations were found.
In contrast, differences between these children and those, often of similar ethnic and geographical background, which live in the poor, urban and rural regions of developing countries, approach 12% in height and 30% in weight. Thus, Habicht et al. (1974) held that differences in growth of pre-school children associated with social class can be attributed to ethnic factors alone. Thus, it is notable that income is not the only significant determinant of child malnutrition.

2. Place of residence

It has found (Ranger et al., 2004) that children living in urban locations are taller for their age. A better provision of healthcare in cities and towns relative to the countryside is likely to matter. Study by Bharati et al. (2008) finds that the spatial difference, especially the rural–urban difference, was very large and decreased substantially when the effects of age and socioeconomic variables were removed.

3. Household Infrastructure

Bassolé (2007) found that access to safe water improves the height-for-age of the lowest (10th) quintile and the effect of health facilities is significant for the 10th, 25th, 50th percentiles at the national level in India. However, in rural areas, only health facilities have a positive and significant effect on child health. Increased latrine coverage is effective for reducing exposure to faecal pathogens and preventing disease and in long run, reducing malnutrition. It is proved through a study in Orissa (Clasen et al., 2014).

ii. Intra-household characteristics

1. Birth order

Nutrients available to children are determined largely by intra-household allocations. One of such indicators is birth order of the child. A model is developed by Bahrman (1988) to estimate critical parameters of parental preferences regarding the allocation of nutrients among their children. Latent variable estimates for rural south India indicate that parental preferences have productivity-equity tradeoffs and parents favour older children. The productivity-equity trade-off, however, is much less for the lean season. Therefore, when food is scarce, parents follow more closely a pure investment strategy, exposing their more
vulnerable children to greater malnutrition risk. Study by Ranger et al., 2004 posits that absence of rival younger siblings also improves nutritional status.

2. **Sex of the child**

Another important intra-household determinant is sex of the child. Several studies locate that mothers prefer to offer better nutrients to sons, owning to societal preference mapping. Similar result is coming even from West Bengal in the study is done by Sen and Sengupta (1983) in Santiniketan. The studies of nutritional conditions of children below 5 years of age in the two villages of Sahajapur and Kuchli provide firm evidence of remarkably high incidence of undernourishment, even of the 'severe' and 'disastrous' types, and systematic sex bias reflected in higher deprivation of girls vis-a-vis boys. The gender bias is reflected both in the greater prevalence of undernourishment of various degrees among girls than among boys, and also in the lower growth dynamics of girls vis-a-vis boys. Interestingly enough, the village with the better over-all nutritional record has much sharper sex discrimination. The economic benefits accruing to the children of Kuchli through land reform, etc, seem to have primarily benefited boys vis-a-vis girls. The performance of girls in terms of nutritional criteria are broadly similar in the two villages, and it is the better position of boys in Kuchli that seems to make both the average nutritional record of Kuchli noticeably higher and also the extent of sex bias clearly greater.

In Pakistan, malnutrition is significantly higher among girls than boys, indicating child level gender issues to be crucial. It also depends on family income and breast-feeding practices (Arif et al., 2012). However, there is study on India by Bharati et al. (2008) on NFHS II data to assess the spatial distribution of nutritional status of children of less than three years through Z-scores of weight-for-age, height-for-age and weight-for-height. Regression results show that gender difference is not very pronounced and almost disappears when the effects of age and socio-demographic variables are removed.

Based on information collected on 496 children aged 6 to 24 months in the Ropar District of Punjab, Levinson (1974) calculated anthropometric measurements and dietary intake was determined by the 24 hour recall method. The children were mainly from the *Jats* and the *Ramdasias* castes; the *Jats* being the traditional land-owning class and the *Ramdasias* the landless agricultural labourers. He found that sex differentials in child mortality in rural Punjab persist unexpectedly despite relative wealth, socioeconomic development including rapid universalization of female education, fertility decline, and mortality decline. Multiple
regression analyses showed that intake of food was a far more important determinant of nutritional status among the Ramdasias than among the Jats. Among the Ramdasias, sex was a significant determinant of energy status. Given very tight income restraints and a premium placed on male children, even near adequate feeding of the girls was the exception. To improve the nutritional status of the Jats a nutrition education programme was suggested, whereas for the Ramdasias, higher income would appear to be a prerequisite for improved nutrition.

The most striking finding of a study done by Das Gupta (1987) shows that discrimination against girls is not generalized but highly selective in Punjab: sex differentials in mortality are affected far more by birth order than by socioeconomic factors. While mother's education improves quality of childcare, it does not reduce discrimination against higher birth order daughters. Fertility reduction appears to heighten such selective discrimination. Sex discrimination has often been attributed to lack of female participation in productive activities and also to economic hardship. This analysis emphasizes the role of women's structural marginalization in this male dominated society in explaining the existence as well as the persistence of sex discrimination.

3. Maternal characteristics

Parents, particularly mothers, are generally committed to providing every possible advantage of health care to their children and ensuring for better health status to fulfil their potential needs (Ettinger, 2004). Moreover, with respect to the child health, mother has been generally considered as a health care worker (Lee and Mason, 2005). Thus, there are certain reasons to expect the individual characteristics of women, particularly her education, employment status and health care behaviour to have an independent and predominant influence on their child health.

3.1 Maternal education

A large number of studies have been done on the impact of mothers’ education and employment status on the child nutrition status. The researchers, however, are divided on the evidence of impact of maternal characteristics on child malnutrition. Several studies proved that there is a positive linear association between mothers’ education and child nutrition level. It is increasingly recognized that mothers’ education helps to get better access of knowledge and awareness about right feeding practices and better hygiene (Moestue et al. 2007, Webb &
It is found that children of educated mothers are more nourished than illiterate ones (Mittal et al., 2007). A study on Indonesia shows that mothers’ education is a strong predictor of child nutritional improvement over time (Waters et al., 2004). Sahn and Stifel (2002) shows that mother's schooling has a larger impact on daughters than son's nutrition, and father's education favours son's nutrition in South Africa. A study on Nigeria posits that the policy to reduce child malnutrition should target women education program and public health programs to provide clean drinking water in rural areas (Ajieroh, 2009). Lindelow (2008) found that utilisation of health services is determined not solely by an individual's own education in Mozambique, but rather by a notion of effective education, which incorporates the educational attainment of other household members.

Barrera (1990) proved that maternal education positively affects child health as measured by height-for-age. There is a difference in its impact across child age groups, with preschoolers showing the greatest sensitivity. The pattern of interactions between maternal education and public health programs suggests that maternal education affects child health through an efficiency effect by affecting the productivity of health inputs and an allocate effect by lowering the cost of information.

Another study in India shows that grandmothers’ education is more important than mothers’ education (Spieker et al., 1994). He points out that mothers’ autonomy at the community level is more important than mothers’ education. Another study in Brazil shows that mothers’ exposure to media and general awareness are more important than mothers’ education for nutritional development of children (Webb and Block, 2004).

However, World Bank’s first community nutrition loan to Indonesia in 1970s significantly improved the nutrition status of 40 percent target children through nutrition education alone without any other change, proving mothers’ education does not necessarily have a linear relationship with child malnourishment (Moestue et al., 2007). This perhaps happens because of increased participation in workforce by educated women and hence this had negative consequences for children and breastfeeding practices, which outweigh the potential benefit of education. Then community level maternal literacy is far more important than individual education levels. Similarly, Glewwe (1999) finds that mothers’ education does not have a significant coefficient once health knowledge is controlled for. Fathers’ education, while less significant, also contributes to child nutrition.
Another study in South Africa (Mamabolo et al., 2007) shows that having a mother as a student increased the risk for stunting at 3 years by 18.21 times while having a working mother increased the risk for overweight by 17.87 times. There is a study done in the country Malawi in 1992 (Madise et al., 1997). There the influence of some socio economic factors is being checked on the child nutrition level. There no such significant relation is found between mothers’ education and child nutrition level.

3.2 Maternal employment status

Effect of maternal employment on child malnutrition is not at all unidirectional. On one hand more labour force participation by women would mean more empowerment for the mothers to take decisions about child’s feeding practices. Mother’s employment status, assumed to be synonymous with more empowerment, decision making and financial independence among women, is hypothesized to improve child’s malnourishment status by offering better access to food and medical care. However, studies do locate impacts, which are not always in tune with these expectations. Often this linkage gets truncated because of increased participation in workforce by women lead to worse children care and shortened breastfeeding practices, which outweigh the potential benefit of education.

Rizzo et al. (1997) showed that women from rural Kenya, who shifted from adequate employment to under-employment, had significantly lighter babies. León and Younger (2007) located that any transfer payment to the mothers did not make any significant change in child nutritional level in Ecuador. Based on a study in US, it is found that maternal employment makes very little difference to child health. If there is any positive effect, it is only through flow of money and a positive role model.

Researchers have concluded that modernization and urbanization lead to expanding the level of female employment and it improves the child’s health condition through decreasing the burden of child care cost. Berman et al. (1997) found that if the mother, particularly from poor household, get employed then it leads to increase the level of household income and hence this benefit attributed to affect child health positively. Maternal employment produces extra income in household that is available for food, cloth and medical care that have an optimistic advantage for child health.

Huston and Aronson (2005) addressed the question, how is maternal employment related to the amount of time mothers spend with their infants? They argued that the
employed mother spend less time with their infant than the unemployed mother. The quality of time that spent with the children is also different for employed and unemployed women. Thus on the whole, the negative effects of maternal employment is more than offset.

On the other hand, many researchers also argued that maternal employment is adversely associated with child health. They suggest that maternal employment leads to worsening the child health and increases the probability of dying among children. This primarily occurs due to shortage of time for their child care and breastfeeding (Kishor and Parasuraman, 1998, Sivakami 1997, Jatrana 2003).

A case study on Dhaka (Islam et al., 1994) shows a strong positive association between employment of mothers outside home and the risk of severe malnourishment of the children. This study also showed that full time maternal employment significantly reduces the chance of that child to obtain Vitamin A level, when the age of child is less than six years.

3.3 Mothers’ health awareness and child nutrition

Another set of variables is related to maternal health care utilization during the pregnancy period. A study in Morocco shows that mothers’ health knowledge is alone a crucial factor for a child health seeking behaviour (Joshua, 2012).

The antenatal care (including Titenus Toxoid Injection, Weight check up, Consumption of Vitamin A and Iron Tablets etc) is supposed to ensure not only safe delivery, but also results in better growth among children (UNICEF 2012). The use of professional antenatal care is supposed to be behavioural inputs to child health and change systematically with variation in educational attainment and exposure to media messages, among others. Given such endogeneity, Halim et al. (2011) utilizes estimates of the use of professional antenatal care and antenatal visits from the first-stage analysis to obtain the second stage estimates of the child malnourishment parameters to find that children are more likely to be healthy when their mothers maintain good health and seek antenatal care.

3.4 Other maternal characteristics

Ordered logistic regression analysis on the data of Botswana (Tharakan et al., 1999) shows the significance of some of the factors which covers biological, social, cultural, economic and morbidity factors: age, birth-weight, breast-feeding duration, gender of family head, education of mother and father, child caretaker, intake levels of milk and dairy
products, staple foods and cereals, and beverages and incidence of cough and diarrhoea. The influence of these factors can be used in the development of strategies of intervention for reducing child malnutrition.

David et al. (2004) found that maternal stature, age difference with an older sibling, household size and income are seen as the main determinants of anthropometric development. Within the more homogeneous communities of Western Honduras, woman's education is also related to the child's nutritional status. Another study in Nigeria also shows that the policy to reduce child malnutrition from the current significant level is to target the women with education program and clean drinking water and with healthy environment in rural areas (Ajieroh, 2009).

Another study on Bangladesh shows that maternal pregnancy intentions are associated with child stunting, wasting and underweight (Rahman, 2015). If these associations are causal, preventing unwanted pregnancies may help reduce the prevalence of childhood malnutrition in Bangladesh. There is an interesting study done in South India showing maternal mental depression at the time of pregnancy or low level of intelligence of mothers are significant factors of child malnutrition (Anoop et al., 2004).

4. Other factors

Domestic violence has harmful physical and psychological health correlates, but there is little evidence regarding a relation between domestic violence and malnutrition. To investigate this relation, the Ackerson et al. (2008) analyzed data from the 1998–1999 Indian National Family Health Survey. Physical domestic violence victimization was self-reported by the women. Aspects of nutritional status included in this study were anaemia and underweight. Anaemia was measured with a blood test for haemoglobin. Underweight was calculated from anthropometric measurements and was determined as body mass index for women, and it included stunting and wasting for children. Results indicate associations of multiple incidents of domestic violence in the previous year with anaemia and underweight in women and a suggested relation among children. Possible mechanisms for this relation include withholding of food as a form of abuse and stress-mediated influences of domestic violence on nutritional outcomes. These findings indicate that reducing domestic violence is important not only from a moral and intrinsic perspective but also because of the instrumental health benefits likely to accrue.
In short, the socio-economic determinants (including household factors like income, ethnicity, geographical location and intra-household parental and child level factors) play a crucial role in child nutritional status.

1.2 Policy intervention and its Impact

With continuous improvement in economic growth and overall development across economies, the share of stunted children is falling only slowly worldwide and there are still 165 million stunted children in the world in 2011. However, Global Nutrition Report (2015) by International Food Policy Research Institute is hopeful to predict that by 2030, there will be significant reduction in malnutrition of the children. There have been several strategies introduced by public and non-profit sectors to improve the maternal and child under-nutrition so that this persistent problem of stunting among children can be eliminated. Among those strategies, some important ones are promotion of breastfeeding, complementary feeding, micronutrients interventions, supplementary community feeding etc. They all come within the supply-side interventions and provision of care.

According to general belief, the prime cause behind children malnourished is related to lack of availability of proper food to the household emanating from low purchasing power and poverty. Thus, almost all public policy interventions to tackle child malnutrition in poorer countries have been directed towards creating enhanced access to good food, especially food-grains. Several studies so far have attempted to find the impact of such policy interventions across several developing countries. Using an ex-post cross-sectional survey of 6820 households in Bangladesh, Hossain et al. (2005) found no significant difference in the prevalence of either severe or moderate underweight (weight-for-age) in children aged 6–23 months in the Bangladesh Integrated Nutrition Project and non-project areas though mothers in project areas reported significantly better caring practices than in non-project areas. Bhutta et al. (2008) found that out of those strategies the most prominent impact came not from just supplementary nutritional programs, but interventions related to underlying non-food determinants of under-nutrition, namely poverty, poor education, disease burden and lack of women empowerment. Using a meta-analysis of 42 studies worldwide, the study also showed that nutritional education strategies alone were most beneficial in populations that had sufficient means to procure appropriate food i.e. food-secure society. Within the population without this security, nutritional educational interventions brought forth enough benefits when combined with food supplements. Using a systematic literature review to assess the
efficacy and effectiveness of supplementary feeding interventions, Dewey and Adu-Afarwuah (2008) found that such feeding interventions, by themselves, cannot change the underlying conditions of poverty and poor sanitation that contribute strongly to child undernutrition. They need to be implemented in conjunction with a larger strategy that includes improved water and sanitation, better health care and adequate housing. Study by Independent Evaluation Group of World Bank (2010), while observing that progress of childhood malnutrition elimination is very slow in developing countries, also could not locate any clear pattern of impacts across interventions. In every intervention group there are examples of programmes that did and did not have an impact on a given indicator, and with varying magnitude. The group has used impact evaluation technique on worldwide data to find whether there is any unique solution of this malnutrition problem and concluded that it depends on the various settings, cases and severity of malnutrition, duration of exposure to the program and the capacity for programme implementation. The study posits that the main reason behind this is large scale, complex projects are often implemented in low capacity setting, without full scope of scaling up. Additionally, wrong service delivery and low status of women of the society may also important reasons. A more recent study by Bhutta et al. (2013) suggests that current total death of children younger than 5 years can be reduced by 15% if population can access ten evidence-based nutrition interventions with 90% coverage. This paper suggests some of them like cash transfer programme, community based nutrition education and promotion, integrated management of childhood illness, school based delivery platform etc. According to them, community platform offers a unique opportunity to engage and reach poor and difficult to access populations through communication and outreach strategies. When access to these evidence based interventions is associated with nutrition sensitive approaches like poverty elimination, women empowerment, agriculture, food systems, education, employment, social protection and safety, accelerated progress can be seen in those areas.

Another study by Black et al. (2013) suggests that current total death of children younger than 5 years can be reduced by 15% if population can access ten evidence-based nutrition interventions with 90% coverage. Here, what is more important is the access to all of these interventions. For that, a proper delivery platform is important, which can channel the opportunities for scaling up and reaching large section of the society. They suggest some of them like cash transfer programme, community based nutrition education and promotion, integrated management of childhood illness, school based delivery platform etc. According to
them, community platform offers a unique opportunity to engage and reach poor and difficult to access population through communication and outreach strategies. When access to these evidence based interventions is associated with nutrition sensitive approaches like poverty elimination, women empowerment, agriculture, food systems, education, employment, social protection and safety, accelerated progress can be seen in those areas.

1.2.C.1 ICDS and child nutrition

ICDS program and its infrastructure

As already mentioned above, there is no doubt that India has a large number of malnourished children with significant level of inequality among them from several respects. There are many factors behind this. Given this, Indian government has developed several programs to solve it. For example, Public Distribution System (PDS), Food-for-work program, Midday Meal Scheme, Integrated Child Development Program (ICDS) etc. Among all those, ICDS is perhaps largest program of its type in the world. It is supposed to cater to the four basic rights of pre-school children: right to education, right of working mothers to have crèche facility, right of children of food security and right of children to health. Thus, the four main objectives of ICDS program are providing supplementary nutrition, pre-school education, and growth monitoring and referral health care for the ill children.

Studies identify there are quantitative gaps in coverage capturing the difference between the number of beneficiaries who should have been brought under the coverage of the programme and the number of beneficiaries who actually received the stipulated services (Planning Commission 2011). The gaps may arise in four different ways.

1. **Survey Gap**: This gap may arise due to discrepancy between the number of eligible beneficiaries and that captured in the survey register by AWW.

2. **Registration Gap**: This gap exists between the number on the survey register and the number registered to receive the stipulated benefits due to causes that may range from denial of access or extreme to lack of interest to claim the benefits provided under ICDS.

3. **Service Gap**: This gap is between those registered and those actually receiving the services.
4. **Delivery Gap**: The final gap is between beneficiary recorded in the delivery register and the actual number who receive the food services to be provided under ICDS.

Out of all these four gaps, the first three gaps occur due to inefficiency of the AWW and the lack of awareness among the general population, while the last one occurs due to sheer corruption among AWW. The study by Planning Commission identifies that West Bengal has low gaps in all the indicators. The Table 1.3 shows the performance of West Bengal, vis-à-vis other states and Indian average.

**Table 1.2: Shares of gaps in different states**

<table>
<thead>
<tr>
<th>States</th>
<th>Survey Gap</th>
<th>Service Gap</th>
<th>Delivery Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Bengal</td>
<td>18.2</td>
<td>29.5</td>
<td>18.1</td>
</tr>
<tr>
<td>All India</td>
<td>37.9</td>
<td>21.6</td>
<td>36.0</td>
</tr>
<tr>
<td>Best State</td>
<td>8.4 (Karnataka)</td>
<td>1.4 (Orissa)</td>
<td>8.5 (J&amp;K)</td>
</tr>
<tr>
<td>Worst state</td>
<td>54.5 (J&amp;K)</td>
<td>60.2 (Kerala)</td>
<td>59.4 (UP)</td>
</tr>
</tbody>
</table>

*Source: Planning Commission 2011*

Performance Audit of ICDS (www.cag.gov.in) also found some shortfalls of this scheme. Due to severe shortfall in fund utilization, lower than norm was spent on each beneficiary. In 2006-07, 2009-10 and 2010-11, per capita expenditure in West Bengal had a shortfall of 25% to 50%. Main reasons of this shortfall is non-assessment of requirement, short provision of fund in the budget, inadequate share of states, release of fund at the far end of the financial year etc.

AWCs maintain one growth card for every child to assess the weight-for-age as an indicator. Children up to the age of three years, are to be weighted monthly and children till six years are to be weighted quarterly. The growth card is analysed by Child Development Project Officer (CDPO). However, during 2006-07 to 2010-11, 33 to 47 percent children were not weighted. West Bengal is one of the four states, where available growth charts were not at all used during 2006-11. One of the reasons is lack of training to AWWs. Maintained growth charts are not being checked by CDPOs.

According to this Performance Audit report, the quantity of supplementary food provided to beneficiary was forced to be reduced in view of inflation in the price of food items, with per beneficiary per day expenditure remains same. There is a revised norm since 2009, February that two meals will be served to the children age group of three to six years, with one being snacks. However, it is implemented only in Gujarat. West Bengal is also a
state where Supplementary Nutrition days are lower than the stipulated days. That may be for delay of supply of food grain, non-availability of funds, and leave of AWWs etc.

Dutta (2014) finds that available infrastructure of ICDS in Kolkata district of West Bengal in inadequate and ill-maintained. Only 32.22 per cent of the AWCs appeared to have any toilet and out of them 31 per cent do not have any regular water supply during AWC hours. The study attempts to find a rough estimate for Delivery Gap, which is manipulated due to extreme corruption. The attendance manipulation and the effective leakage came out to be 65 per cent, which in simple terms refer to misappropriation of public money.

**Impact of ICDS**

There was a study in South India (Rahmathullah et al., 1990) involving 15,419 preschool-age children going to ICDS who received either 0.098 mg of vitamin A and 20 mg of vitamin E (the treated group) or vitamin E alone (the control group). Vitamin supplements were delivered weekly by community health volunteers who also recorded mortality and morbidity. They observed that 125 deaths occurred during one year, of which 117 were not accidental. The risk of death in the group treated with vitamin A was less than half that in the control group. The risk was lower among children less than 3 years of age and among those who were chronically undernourished, as manifested by stunting. They concluded that the regular provision of a supplement of vitamin A to children, at a level potentially obtainable from foods, in an area where vitamin A deficiency and under-nutrition are documented, public health problems contributed substantially to children's survival; mortality was reduced on average by 54 percent.

The Five Year Plan set out to achieve universalization of ICDS in all the 5.652 blocks of the country (Sinha, 2006). Later on a target was set that 70 percent of all children in the 0-6 year’s age group must be covered by the year 2000. The focus is shifted to children below three, opening hours of AWC have been extended, clearer and more efficient flow of fund has been outlined etc. However, in 2005 only about one fourth of such children are covered by ICDS.

Integrated Child Development Scheme (ICDS) is very popular and old scheme of India to fight against child malnutrition. However, several flaws of this scheme have been found from different surveys, mainly of the supply side. This can be explained from the fact that Government gives stress only on food supply, whereas there are many other gaps. ICDS
is one such supplementary nutrition program run in India with an attempt to reduce child malnourishment. However, mostly because of lack of data, assessments of the ICDS so far have only been able to evaluate the impact of the presence of an ICDS centre in a village on the child’s anthropometric outcome (Deolalikar 2005, Lokshin et al. 2005). They find limited evidence of its benefit. Instead of assuming that every child in the village with an ICDS centre received supplementary nutrition as in earlier studies, Jain (2015) used NFHS 3 unit level data to know exactly which section of children received supplementary feeding. Using advanced propensity score matching techniques, she found that girls of 0-2 years who receive supplementary feeding are at least 1 cm taller (around 0.4 standard deviation) than similar girls who did not receive it. The estimates are the same for boys 0-2 years, but less robust to different specifications. She also finds these effects for only the girls and boys who are receiving the supplementary nutrition intensely; the children who are receiving the benefits less often than daily are not better anthropometrically than those who did not receive any supplementation. Thus she differentiated the frequency of services received in ICDS and concluded that only when the children receive supplementary nutrition regularly tend to break the knot of stunting in the long run.

A national study conducted in 1992 by National Institute of Public Cooperation and Child Development confirmed positive impact of ICDS. UNICEF (2012) contends that ICDS had a positive impact on the survival, growth and development of young children. However, recent research shows that ICDS is not working properly in most parts of the country. NCAER (2011) stressed that about sixty percent of food meant for children was being siphoned off along the supply chain. The quality of items supplied by ICDS is also in front of big question.

According to Sundararaman (2006), evidence does not show malnutrition was significantly differing between areas that do and do not have ICDS programs. The ICDS program also suffers from serious under funding, an extremely centralized design, complete absence of monitoring, condemned the program to a failure (Maiorano 2013, Ghosh 2006). This will not only related with overall future growth of nation, but also would truncate the effectiveness of education program of the country. Additionally Anganwari Workers (AWW), who provide services at the ICDS centres, are inadequately trained, supervised and supported.
Fraker et al. (2013) concluded that in Bihar 53% of Supplementary Nutrition Programme (SNP) budget was missing due to leakage. Based on primary survey data on 200 anganwari centres (AWCs) and 200 children of 3 districts of Bihar, they found that 24% centres are closed, 73% stipulated ingredients are used, 23% open AWCs are not serving meal regularly. They estimated that 71% of funds the AWW receives for SNP are not spent on the beneficiaries. In case of nutritional intake, children received 77% of the norm amount per meal. However, they could not locate any correlation between AWCs’ performance variables and beneficiary nutrition. They concluded that there is no easy solution to reduce this type of leakages and suggested that such intervention should be piloted and rigorously evaluated to get some positive impact. This study also explains that just because malnutrition is more common among the poor does not mean that poor children will be disproportionately benefited from this intervention. They also found that children of educated mothers are getting most of the benefit of this scheme. Regarding impact evaluation technique, they suggest that analysis of nutrition impact evaluation need to take into account the sensitivity of the children of different ages to intervention. Thus according to them, what works is not important, rather under which condition it works is important.

The story that emanates from the literature survey about child malnutrition is summed up in the following way:

- There is high inequality in child stunting across countries and across states of India.
- The socio-economic factors play very significant role in controlling the incidence of child malnutrition. Maternal employment and health seeking behaviour are two under-focussed issues in this group.
- Policy intervention in supporting supplementary nutrition and awareness generation has not been successful everywhere. The characteristics of the setting make a big difference.
- Access to the policy does not guarantee proper support and hence deeper dive is called for.

1.3 Conceptual Framework

Given the above literature survey and objectives, the conceptual framework of my thesis is represented by Figure 1.5. Here, block A represents the child malnutrition status and its measurement discussed in Section 1.3A. The socio-economic characteristics, consisting of
household, maternal and child level characteristics are represented in block B (discussed in
details in Section 1.2.B) and they determine both incidence of child malnutrition (through
access and absorption of food and hygiene behaviour) and access to ICDS centres.

From the supply side, availability of ICDS centres in the neighbourhood (in block C.1) and the expenditures of the government per child determine the access to the Anganwari Centres (AWC) in block C.2. However, just access to ICDS has lower chance to alleviate the child from the trap of malnutrition as he/she does not necessarily receive all components of services at AWC (in block C.3). This fact, in turn, creates limited risk protection and impact of the program. Blocks C.1, C.2 and C.3 are all parts of policy intervention and its impact is to be located in block A.

In this thesis, I will explore to find the relative importance of the socio-economic factors across different clusters of states in determining the access to ICDS and the child malnutrition status. Finally, I will attempt to locate the crucial components of ICDS services that are instrumental in lowering child malnutrition. I present my objectives in far more detail in the next section.
Figure 1.5: Conceptual Framework of the thesis

- **Geographical Location**: Economic status, Religion, Caste, Fuel used
- **Household Characteristics**: Maternal characteristics, Child Characteristics
  - Mother’s education, Employment status, BMI, Anaemia, Health care behaviour, Age at 1st Birth
  - Maternal characteristics, Birth order, Breastfed, Preceding birth gap, Size at birth
- **Maternal Characteristics**: Child Characteristics
- **C.2 Access to ICDS**: Not every child reaches Angan Wari Centre
- **A. Child malnutrition Status**: Socio-economic determinants of child stunting, Impact of ICDS on level of child stunting
- **C.3 Depth of Services** received at Angan Wari Centres: Not every child receives all components of services
- **B. Socioeconomic Characteristics of the HH, parents child**
- **C.1 Physical Availability of ICDS centres (AWC) in the neighbourhood**
  - Expenditure per child
1.4 Objectives of study

With this literature background, one thing is very clear that as a developing country, India is currently facing a number of persistent and titanic barriers towards the developmental goals and among them a significant one is child malnutrition. In view of this, Indian government has introduced several steps to ensure better access to food for children. Among all those programmes, Integrated Childs Development Scheme (ICDS) is a flagship programme since 1975. Despite its presence for a long-time, child malnutrition is not falling here significantly. However, the level and depth of child malnutrition has varied across states and regions and thus for identifying the barriers towards better child development, we need to classify the states to create a kind of typology on the basis of child nutrition level. Only then, locating right control variables and hence right mix of intervention is possible. Once that is done, it would be easier to identify the determining factors behind the persistent child malnutrition. Finally, one should consider the breadth of coverage of ICDS program across these regions and also attempt to locate the impact of the supplementary feeding program on child nutrition.

Thus, my first objective is to get a detailed status report of child malnutrition across the country. Child malnutrition, measured by stunting, is expected to coexist with different socio-economic factors. Depending upon the share of stunted children in the total number of children, the states in India are to be classified to arrive at some kind of topology. In this connection, depth of malnutrition, as well as its concentration index vis-a-vis different economic and social groups, is to be identified.

After disaggregating the economy, next problem is to find out which factors determine the status of child malnutrition. The environment of household, the socio economic background of parents, their education levels, health consciousness- etc are very important here. Available literature does posit that income or wealth is not the single major determinant of child malnutrition. There are a number of non-economic factors, which play crucial roles in this (as discussed in Section 1.2.3). Given this background, it is extremely important to locate the factors actually responsible for Indian child malnutrition in different groups of states.

Thus, my second objective is to locate socio economic factors, which are strong barriers of proper nutrition level of the children. As the nature and degree of the influence of
these variables might change upon different group of states, here I aim to identify their relative importance across the clusters of states. Mother’s health care utilization and her education-employment status are focused among several other factors operating at household, mother and child levels.

Indian Government offers supplementary food through ICDS at the grass-root level since a long time and also there is excess supply of food in the country. However, the country is persistently burdened with serious child malnutrition and the coverage of the program is still limited. Thus, it is crucial to identify the major factors that determine the accessibility to ICDS centres, which is attempted in my dissertation.

My third objective is to check the accessibility barrier of the children to the nutrition services provided by the public authorities, represented by Integrated Child Development Scheme for the public services. Being the oldest of such nutrition-related universal programme with a vast network, the access to reach such programme needs to be identified to ease the barriers. This is also done at disaggregated state cluster levels, to give due attention to difference in nature of the determining factors.

It is extremely important to locate the impact of the program on child malnutrition. However, while doing that, one needs to cull out the impact alone from any other differences between the treatment (those who received the services) and control groups (those who did not receive the services). This way, one needs to nullify the sample bias among these two groups.

My final or fourth objective is to concentrate on quality and availability of ICDS services in a typical developing country scenario. Finally, an impact assessment of such a programme is attempted.

1.5 Data base

To find out the recent condition of child malnutrition at the state level, I have used the DLHS 4 (2012-13) factsheet data. Table 1.1 is based on the data of District Level Household and Facility Survey (DLHS 4) on 2012-13. This survey is undertaken by Ministry of Health and Family Welfare, Government of India with the objective to provide reproductive and child health related data base at the district level of India. This is the latest data available in India state wise on the child health status.
Unit level data of child age group in 0-5 years in nationally representing survey of National Family Health Survey (NFHS 3) third round (2005-06) is being used for the study. NFHS-3 covered all 29 states in India, which comprise more than 99 percent of India’s population and was designed to provide estimates of key indicators for India as a whole and for all 29 states by urban-rural residence. No sub-state level estimates for districts are done using this dataset, owning to its sampling framework. Unlike the earlier rounds of surveys in which only ever-married women age 15-49 were interviewed, NFHS-3 covered all women aged 15-49 and all men age 15-54, irrespective of their marital status. Information on nutritional status, including the prevalence of anemia, is provided in NFHS-3 for women age 15-49, men age 15-54, and young children. Though this dataset is a bit dated now, alternative secondary dataset representative at national level was not available during the dissertation period. The supply side picture of ICDS is also captured from the report of Ministry of Women and Child Development 2012 (www.wcd.nic.in). Here the major indicators used are percentage of areas covered of an Anganwari Centre, number of undernourished children per AWC and Expenditure per undernourished child per day by Government through AWC of the year 2005-06.

The primary data is collected from two districts (Howrah and Utter Dinajpur) of West Bengal on the basis of their backwardness index. The details of this sampling method will be discussed in Chapter 5.

1.6 Methodology

1.6.1 Inequality Index

In Chapter 2, I will discuss the depth of child malnutrition across regions as well as individually. Z score, the measure of child malnutrition as given by World Health Organization (WHO), gives the status of individual child in a certain region or in the economy. Share of children with z score less than -2 SD of the sample shows the share of severe malnourished children in the region, similar to the Head Count Measure of poverty. It never gives us the idea about the extent of child malnourishment i.e. how deep its root anthropometrically. In other words, one needs to have an idea whether the malnourished children are marginally stunted or stunted deep down. To find out this, I need different measures of inequality. As literature suggests, there are several measures of inequality like Gini coefficient, Concentration Index, Group Analogue of Gini coefficient etc.
In my study, first I will measure normalised malnutrition gap, similar to poverty gap. It helps to measure the severity of child malnutrition in the country as a whole as well as region wise depth of child malnutrition. However it cannot explain and compare how this depth varies across different socio economic sections like region, caste etc. Thus, I will concentrate on Gini coefficient and Concentration Index measures to find out the inequality across regions and across individuals for different socio economic variables. To find inter-regional inequality, I use Group Analogue Gini Coefficient (Subramanian, 2009), which captures the extent of inequality between groups defined by certain characteristics. The groups should be well defined, mutually exclusive and exhaustive.

In my case, the groups are formed on the basis of percentage share of stunted children in the states. Based on this I have divided 14 major states of the country into 4 regions- highest stunted, higher stunted, lower stunted and lowest stunted. Finally, 8 north eastern states are clubbed into one region called North-east. Thus my groups are well defined, mutually exclusive and exhaustive as well and they represent a kind of typology among the states.

To locate **interpersonal inequality**, I use Gini coefficient which captures a positive value if there is any mismatch between the cumulative proportion of malnourished children and cumulative proportion of population share. To find out inequality with respect to any socio economic variables like wealth, the commonly used method is Concentration Index. It assesses the distribution of a health variable against the variable measures income, wealth or living standard. I use this measure to find out inter group inequality vis-a-vis wealth and interpersonal inequality with respect to some socio-economic variables as well.

These measures of inequality are elaborated below:

**1.6.1A Malnutrition Gap Index**

To start with, in Chapter 2, initially I have used a measure named Malnutrition Gap Index which is very similar to the poverty gap index. Poverty Gap Index (PGI) is calculated as

$$ PGI = \frac{1}{N} \sum_{j=1}^{q} \frac{z - y_i}{z} $$
Here, N= total population, z= poverty line, \( y_i \)= income of \( i^{th} \) person, q= number of people living below poverty line. In my analysis, I have used the same formula with a change of the meaning of the notations. In my case N= total population in the area, z= value of HAZ below which a child is called stunted= -2SD, \( y_i \)= value of HAZ of \( i^{th} \) child, q= number of children stunted in this region.

\[ z \text{ score} = \frac{\text{observed value} - \text{median value of the reference population}}{\text{standard deviation value of reference population}}. \]

According to WHO, if z score is less than -2SD, he/she is classified as stunted. If the Z score is less than -3SD this particular child is called severely stunted.

### 1.6.1B Group Utilization Lorenz Profile (GULP) and Group Analogue of the Gini Coefficient

GULP is a graphical method to measure the extent of inequalities present between the groups where the groups are well defined by certain characteristics as mentioned earlier. Say, there are k sub groups (K\( \geq 2 \)) and the subgroups are mutually exclusive and exhaustive. Unlike rate ratios and rate differentials, GULP can make inequality if number of groups exceed two. Here groups should be ranked in a non-decreasing order i.e. child nutrition level will increase with increase in rank.

**Figure 1.2: Group Utilization Lorentz Profile (GULP)**

![Figure 1.2: Group Utilization Lorentz Profile (GULP)](image)

Source: Subramanian, 2009

Figure 1.2 shows a typical GULP which is the pictorial representation of the inter
group inequality. In the figure x-axis plots cumulative subgroup population share and y-axis plots cumulative sub-group share in total utilisation. The GULP in Figure 1.2 is a special case where k=4 since there are four regions. The interpretation of GULP is similar to Lorenz curve i.e. further the GULP from the diagonal higher is the degree of inter-group inequality. So if there are disparities in the distribution of the utilisation it will be captured by the curve in the contrary if the utilisation is equally distributed the curve will coincide with the diagonal.

This graphical device was used by Kondo et al. (2009) to obtain group analogue of Gini coefficient for the group poverty profile. The group analogue Gini coefficient G (h) is arrived at geometrically by measuring the area between the line of equality and GULP. It captures the group perspective of the inequality in the maternal healthcare utilization. Say the number of sub-groups be k, k≥2, then the formula of G (h) to capture the magnitude of inter group inequality is as follows:

\[ G(h) = 1 + \frac{k}{k-1} \sum_{j=1}^{k} \frac{t_j U_j - 2 \sum_{j=1}^{k} t_j T_j U_j}{U} \]

Here \( U_j \) is the health variable for the jth group, \( t_j \) is population share of jth group, \( T_j \) is the cumulative population share and U is the weighted average of the health variable. Here, \( = \sum_{j=1}^{k} t_j U_j \), where the group specific health variable (\( U_j \)) is multiplied by population share and then summed to arrive at U. The range of \( G(h) \) is from 0 to 1. 0 means there is no group inequality and any positive value shows inequality. Higher the value of \( G(h) \), higher is the inequality between the groups.

1.6.1C Gini Coefficient

Gini coefficient is used to measure the inequality in the utilisation and this inequality is measured at the individual level. Thus it is an individualistic approach. It gives inter personal inequality. Gini coefficient is also derived from the Lorenz Curve. In case of Lorenz curve, individuals are arranged in such a way that if rank increases the child nutrition level also increases. So the child with lowest Z score is ranked first and the child with highest Z score ranked last. The diagonal of the Lorenz curve is the line of equality. Further the curve from the diagonal more is the inequality. Gini coefficient is the area between the line of
equality and the Lorenz curve i.e. the proportion of area beneath the diagonal. The measure of \( G' \) is given below:

\[
G' = \frac{1}{N} \left( N + 1 - 2 \sum_{i=1}^{n} \frac{n + 1 - i}{n} U_i \right)
\]

\( G' \) is calculated taking into account all population. \( N \) is the total number of individuals in the population. \( U_i \) is the health variable of the \( i \)-th individual. The individuals of the population with \( U_i \) are indexed in a non-increasing order of their health (i.e. \( U_i \geq U_{i+1}, \ i=1, \ldots, k-1 \)). The \( G' \) ranges from 0 to 1. \( G' \) takes 0 when there is complete equality of the health variable and more the positive value, more the inequality.

**1.6.1D Concentration Index**

It is the most commonly used measure to access the extent of socio economic inequality in health outcomes such as child malnutrition. The concentration index is derived from the more fundamental idea of Concentration Curve, similar to Lorenz Curve that measures income inequality. The concentration curve is accessed the distribution of a health variable with respect to a variable measuring living standard like income or wealth. It plots the cumulative percentage of the health variable on the vertical axis and cumulative percentage of the sample on the horizontal axis. These two groups are matched on the line of equality, where all individuals are getting same health share. If poor groups are worse off than the richer groups in terms of health indicator, it is a ‘pro-rich inequality’. If there is pro-rich inequality in terms of ‘ill-health’ (like malnutrition, mortality etc.), the concentration curve lies below the diagonal. In my analysis, the variable is z score, which is a positive indicator. The more the value of \( z \), the better is the status of health. Thus it is not an “ill-health” variable. The further the curve lies above the line of equality, more the concentration of ‘ill-variable’ among the poorer section of the society. The Concentration Index is defined as twice the area between Concentration Curve and line of equality. If the concentration curve lies above the diagonal, the value of concentration index is negative. If there is perfect equality, the concentration curve lies on the line of equality; the value of concentration index is zero. The most convenient formula to measure the concentration index is

\[
CI = \frac{2\text{cov}(y_i, R_i)}{\mu}
\]
Where \( y \) is the health variable whose inequality is measured, \( \mu \) is the mean and \( R_i \) = rank of \( i^{th} \) individual in terms of the socio economic variable.

### 1.6.2 Bivariate Probit

In Chapter 3 and 4, Bivariate Probit regression will be used. As the name suggested, this regression is possible only when the dependent variable is binary i.e. \((0,1)\) type. Bivariate Probit Model is estimating the decisions that are interrelated not independent. The dissertation uses Bivariate probit model to capture the effect of maternal health care utilization on the possibility of child stunting or on the possibility of accessing ICDS centre.

Bivariate regression is commonly used in health economics to estimate the effect of a treatment on a binary health outcome. It has two equations for the two binary dependent variables. The first equation is taken in the form:

\[
Y_{1i}^* = \beta_1 X_{1i} + u_{1i} \tag{1}
\]

\( Y_{1i} = 1 \) if \( Y_{1i}^* > 0 \)

\( Y_{1i} = 0 \) otherwise

The second equation takes the form of

\[
Y_{2i}^* = \beta_2 X_{2i} + u_{2i} \tag{2}
\]

\( Y_{2i} = 1 \) if \( Y_{2i}^* > 0 \)

\( Y_{2i} = 0 \) otherwise

These two can be estimated independently. But the problem arises when the vector \( X_2 \) includes the variable \( Y_1 \) and there are some other common variables between \( X_1 \) and \( X_2 \). Statistically that means that errors in the two equations are inter-related. In those cases of seemingly unrelated regression model (SUR), Bivariate probit/ logit models assume that the “independent, identically distributed” errors are correlated (Greene 2003) and hence the probability of one will be dependent on the value or probability of the other and \( \rho \) is the tetrachoric correlation between \( Y_1 \) and \( Y_2 \). If \( \rho = 0 \), separate estimation of the first structural equation by a simple probit model identifies the structural treatment effect \( \beta_1 \). If \( \rho \neq 0 \), the treatment is said to be endogenous and joint estimation is required. The test of chi square confirms whether in the model \( \rho \) is significantly different from 0 or not. Thus in bi-variate probit model it is possible to estimate the joint probability of \( Y_2 \) given the values of \( Y_1 \).

In my Chapter 3, the dependent variable is whether the child is stunted or not. If the child is stunted, he or she gets the value 0, if non-stunted (or nourished), he values the rank 1. Since the dependent variable is \((0,1)\) type I will use bivariate probit model. Similarly, in
Chapter 4, the dependent variable is whether the child is having access to ICDS or not. If the child has the access, he or she gets the value 1, otherwise 0.

In order to capture the effect of mothers’ health seeking behaviour on nutrition level of children, in Chapter 3, I will use the variable Antenatal Care (ANC) with two categories: taken within the first trimester of pregnancy and not taken ANC timely. However, an endogeneity problem might arise as mothers’ health seeking behaviour is itself determined by her socio economic factors. To solve this problem, one way out is Instrumental Variable (IV). IV is a variable that does not itself belong in the explanatory equation, but is correlated with endogenous explanatory variable, conditional on the other covariates. In attempting to estimate some causal effect of some variable X on another Y, an instrument is the third variable Z which affects Y only through its effect on X. If u is the error term,

Standard regression shows: $\begin{align*}
X & \rightarrow Y \\
& \uparrow \\
u & 
\end{align*}$

But here the actual picture may be

$\begin{align*}
X & \rightarrow Y \\
& \uparrow \\
& \downarrow \\
u & 
\end{align*}$

Thus OLS estimator is biased and inconsistent estimator for the coefficient of X. This happens because of endogeneity of X, meaning that changes in X are associated not only with changes in Y but also with changes in error u. there we need a method to generate only exogenous variation in X. Instrumental Variable Z (IV) is associated with changes in X but do not led to change in Y. Thus

$\begin{align*}
Z & \rightarrow X \\
X & \rightarrow Y \\
& \uparrow \\
& \downarrow \\
u & 
\end{align*}$
Z is called IV in scalar regression model $Y = \beta X + u$ if Z is uncorrelated with error u and Z is correlated with regressor X. Since we are using the Limited Dependent Models (where both ANC variable and stunting are binary), we use a Bivariate Probit model to capture this endogeneity. Probit model is a type of regression where dependent variable can only take two values. The purpose of the regression is to estimate the probability that an observation with particular characteristics will fall into a specific one of the categories. Following Greene (2003), if Y is such a binary variable and X is a vector of regressors which are assumed to influence the outcome Y,

Then $\Pr (Y=1|x) = F (x, \beta)$

$\Pr (Y=0|x) = 1 - F(x, \beta)$; $\beta$ reflects the impact of changes in x on the probability.

$\text{Prob} (Y=1|x) = \int \phi(t)dt = \phi(x' \beta)$

The function $\phi(.)$ is a commonly used notation for the standard normal distribution.

1.6.3 Impact Evaluation and Propensity Score Matching

In Chapter 5, I will use the Impact Evaluation and Propensity Score Matching (PSM) to find out the impact of ICDS programme on the child nutrition level. There I will try to find out whether only attending the ICDS is sufficient or a continuous service flow from the centre with proper monitoring can reduce child stunting significantly. I will make different treatment variables based on different levels of intervention of ICDS. To find the impact of those on the child nutrition level the best technique is Impact Evaluation and Propensity Score Matching.

Propensity Score Matching was first implemented by Rosenbaum and Rubin (1983) to reduce the bias of estimation of treatment effect by observable data set. Impact evaluation assesses the changes that can be attributed to a particular intervention, such as a project, programme or policy, both the intended one as well as ideally the unintended one. Impact evaluation (IE) attempts to find out the answer of a question that how would the outcome changed if the intervention had not been undertaken. It is actually a counterfactual analysis i.e. a comparison between what actually happen and what would have happened in the absence of the intervention. IE is biased and incomplete when impact of a programme is assessed by the difference between status of participants vis-a-vis non-participants. Assessing
the impact of any intervention requires the making of an inference about the outcome that would have been observed for treated had they not been treated.

Say, $Y_1 =$ outcome conditional on treatment and $Y_0 =$ outcome conditional on non-treatment.

**Figure 1.3: Treatment effect**

\[
\begin{align*}
Y_1 & \quad \text{(Observed)} \\
Y_0 \\
T_0 & \quad T_1 \\
\end{align*}
\]

According to Figure 1.3, Treatment effect is $\Delta = Y_1 - Y_0$

As it is not possible for same person to be a participant and non-participant simultaneously, it is not possible to observe $Y_1$ and $Y_0$ by same individual. Thus we need counterfactual.

Then only we can determine the impact of the intervention. Thus there is a problem of non-observability of the treatment effect. Lets assume $D$ is 1 for group of individual who participated in the programme (treatment group) and 0 for the group of individual who do not participate in the programme (control group)

**Figure 1.4: Impact effect and counterfactual**

\[
\begin{align*}
Y_1 & \quad \text{(Observed)} \\
Y_1^* & \\
Y_0 \\
T_0 & \quad t_1 \\
\end{align*}
\]
One has to find out the average treatment effect

\[ \text{ATE} = \mathbb{E}(Y_1 | D=1) - \mathbb{E}(Y_0 | D=1) \]

First part of the RHS is estimated from the sample on treatment group, but last part of RHS is not observable and thus we need a proxy measure. It may possible that the sample is a non random one where part of the population has no chance of being included in the programme exante. It creates a selection bias and to avoid this problem, more emphasis is given to estimate treatment effect on the treatment (ATT)

\[ \text{ATT} = \mathbb{E}[Y_i(1) - Y_i(0) | w_i=1] \]

where \( w_i=1 \) isolates those who are likely to participate in the programme. That means the average value of the outcome variable will be compared across two groups:

1. Who are likely to participate and participated
2. Who are likely to participate but did not participate.

Outcome variable may depend on other covariates other than programme participation. Thus to estimate ATT, at first we have to match those observations from the sample who have equal chance to participate in terms of \( x \) or

\[ \text{ATT} = \mathbb{E}[Y_i(1) - Y_i(0) | x, w_i=1] \]

This function is called propensity score.

Thus impact of reform on individual can be measured through identification of region of common support which is the area of intersection between propensity density function of treatment and control group. So matching involves pairing the treatment and comparison units that are similar in terms of their observable characteristics under the assumption of ignorability of treatment. Actually PSM constructs a statistical comparison group that is based on a model of the probability of participating in the treatment, using observed characteristics. Participants are matched on the basis of this probability or propensity score to non participants. ATT is the mean difference in outcome across these two groups.

Validity of PSM depends on (Grilli and Rampichini, 2011):

1. Unco-foundedness: it is conditional independence i.e. unobserved factors do not affect participation.
2. Overlap or common support condition: Sizable common support across participants and non participant’s samples.
This method is particularly suitable to simulate an experiment and measure the treatment impacts in non-experimental studies, especially only observing the post-treatment effects. Simple comparison of mean anthropometric HAZ scores (height-for-age index calculated using WHO ANTHRO software) between those who received the program treatment (treatment group) and who did not (control group) will not do because self-selecting into the ICDS program might involve serious sample bias. In this case, the children from poorer households are expected to reach ICDS centres more, thus creating a possibility of a negative selection bias. On the other hand, there is a possibility of children belonging to more informed and educated households to enjoy more physical access to AWC and more services there. To address this issue, we first calculate the propensity of each individual to receive the treatment in the sample and then club one individual from treatment group with one individual from control group with similar propensity (by nearest neighbour matching) to compare their outcome variable (here HAZ score). The main feature of the technique is that it is expected to remove the selection bias by balancing the sample on the characteristics that potentially determine the possibility of selection of children into the treatment group. Balancing for selection bias was done using a probit model, whose estimates were used to obtain the propensity scores for selection into the program (Dehejia & Wahba 2002). Once the scores had been generated, we checked if the selection bias had been removed by performing bi-variate tests against the treatment variable on all the variables used to remove selection. Since the differences for treatment indicator was insignificant after balancing, we concluded that the selection bias had been successfully removed, and our subsequent models would be balanced.

1.7 Conclusion to the Chapter

Given the above backdrop of the problem of child stunting in India, it is imperative to explore the status of such stunting across regions, not only with respect to just simple share, but also with respect to depth and inequality. Once the states are grouped according to these criterion, it would be interesting to locate major determinants of child stunting embedded in household and parental levels. Similar analysis is also called for the barriers of accessing ICDS program, the largest program floated to reduce child stunting in India. Finally, I would attempt to locate the impact evaluation of ICDS program on child’s z score, based on a primary sample survey.
The dissertation will be divided in 4 chapters following this introductory one. Chapter 2 will deal with regional specification of stunting among states of India and estimation of region and inter-personal inequality of child malnutrition. Chapter 3 will attempt to find out socio-economic factors on child malnutrition across different regions. Chapter 4 will deal with socio-economic accessibility barrier to ICDS at the region level. With the help of a primary survey, Chapter 5 will attempt to explore the status and conditions of ICDS centres in two districts of West Bengal. Looking at the breadth of coverage, depth of services received and risk protection against child malnutrition, a comprehensive impact evaluation of the programme would be aimed at.