CHILD UNDERNUTRITION IN INDIA
- AN INTER-STATE ANALYSIS

Thesis submitted for the degree of Doctor of Philosophy (Arts)
to Jadavpur University

by
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Certified that the Thesis entitled

"**Child Undernutrition in India- An Inter-State Analysis**" submitted by me for the award of the Degree of Doctor of Philosophy in Arts at Jadavpur University is based upon my carried out under the Supervision of Prof. Biswajit Chatterjee of Department of Economics, Jadavpur University, Kolkata, and that neither this thesis nor any part of it has been submitted before for any degree or diploma anywhere / elsewhere.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CIAF	Composite Index of Anthropometric Failure
EAR	Estimated Average Requirement
FAO	Food and Agricultural Organisation
GHI	Global Hunger Index
HAZ	Height-for-Age z-score
IYCF	Infant and Young Child Feeding
MND	Micro Nutrients Deficiency
NFHS	National Family Health Survey
NSDP	Net state Domestic Product
NSSO	National Sampling Survey Office
PEM	Protein Energy Malnutrition
PSU	Primary Sampling Units
RDA	Recommended Dietary Allowance
RBI	Reserve Bank of India
RDI	Recommended Dietary Intake
RNI	Recommended Nutrient Intake
RSoC	Rapid Survey On Children
SD	Standard Deviation
WAZ	Weight-for-Age z-score
WHO	World Health Organisation
WHZ	Weight-for-Height z-score
UNICEF	United Nations Children’s Fund

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BASUDHA MUKHOPADHYAY
Kolkata, 2022

Dedicated to my loving parents

Late Sova Roy Chowdhury

and

Late Benoy Lal Roy Chowdhury

Chapter 1

Introduction

1.1 Background

One of the continued concerns in the development discourses of the present times is the coexistence of affluences with deprivations. There are several dimensions of such asymmetries - *spatial, inter-temporal or even interpersonal*, and each such dimension merits specific investigations and critical analysis. One such dimension is the coexistence of nutritional deprivation or undernutrition with the success in development itself – *growth, prosperity, technological and social progress etc.* in many parts of the world. While there are debates with respect to the appropriateness or otherwise of the choice of indicators of undernutrition in a developing economy, and those of development outcomes, the coexistence of such deprivations with affluences on a large scale, tends to question the relevance and authenticity of the process of economic development in the global economy. This is however, not to deny that the incidence of undernutrition has diminished over time and space, but like the incidence of child labour in different part of the globe, the prevalence of undernutrition also poses serious questions on the functioning of developing economies. In particular, the question often asked is why even food surplus developing economies fail to steer clear the deficiency of food intake in the aggregate that undernutrition usually connotes. Is it a problem of distribution or of entitlement failure or something else? Also related is to identify the cluster or the group for which the incidence of undernutrition shows high or significant proportion among the population in developing economies.

According to the World Development Report, 1993, improved health contributes to economic growth of a nation in four different ways:(a) it reduces production losses caused by worker illness;(b) it permits the use of natural resources that had been totally or nearly inaccessible because of the prevalence of disease; (c) it increases the enrolment of children in school and make them better suited to learning; and (d) it frees resources that would have otherwise been spent on treatment of illness. While channel (a) signifies the importance of health and nutrition in improving the productivity of workers and their wages- the so-called 'efficiency wage' hypothesis and also enables employers to organise skill formation and specialisation through better training, channel (c) corresponds to human capital formation through intergenerational nutritional development, thus affecting the profile of future income streams of the nation in the upward direction. Channels (b) and (d), on the other hand, focus on the efficiency of resource allocation, and its acquisition in the current generation so as to enhance the productive base the developing nation in future periods. One must recognise the fact that the adverse impacts of ill health and nutritional deprivations are usually highest among the poor people, such that programmes of poverty alleviation in poor developing nations must be concomitantly associated with programmes for the betterment of health and nutritional status of the population. According to the estimates of the World Development Report 1993, strong statistical associations are observed between income growth and health status across a large sample of developing countries, and over time for a wide range of model specifications.

In the contemporary discourses on welfare economics and economic development, there has been a consensus to focus on the nutritional status and the state of morbidity of the people in developing countries. It is argued by researchers and policy makers including international agencies that health and nutrition are not only important as ends in themselves, but they may also constitute channels through which productivity enhancement and distributional goals may be effectively pursued in developing societies. Accordingly, in last five decades, economists have directed increasing attention towards exploring the determinants of and the impact of health and nutrition in the development process. Important issues discussed in this area include the extent of health and nutritional status, and their spread over time and space, the proximate determinants (socio-economic) of nutrient status , the impact of health and nutrition on incomes and other outcomes , and the choice of the appropriate indicator(s) to connote optimum nutrient intakes and the adaptation process involved. Different estimates of nutritional status of people in different countries and regions within countries are available in the empirical literature on nutritional status, but one has to be careful in the evaluation of these estimates. For example, if individuals with greater unobserved propensity towards illness are relatively sick despite using health-related inputs to a large extent, the failure to control for simultaneously determined health inputs in the estimate of health production function may underestimate the health impact of such inputs. Moreover, since health-nutrition relation varies across individuals even in the same household, and the distribution of inputs among individuals may not be uniform, the use of household average in the estimate may often be misleading. Further, if lagged responses in health to nutrients are not well represented, empirical estimates may understate the health impact of better nutrition.

1.2 Indicators and Measurement Issues

There have been differences in perceptions in the literature regarding the nutritional status of the population. The term *'Malnutrition'* was often used in the early literature to portray the deficiency or failure with respect of state of nutrition in a given society or region. But one should be clear about the exact connotation of the term typifying the status before using it for estimation of the extent of deprivations. Malnutrition is often associated with food scarcity, poverty, hunger, starvation etc— all of which are emotive and politically motivated issues. There have been a vast and emerging literature in the domain of applied development economics regarding each of the above forms and manifestations of nutritional inadequacy or deprivations, but form the point of drawing the exact scientific definitions, such characterisations are often inadequate and misleading. Many of these categories are overlapping in nature in both time and space, and therefore picking one as the cause of the other at the same time, would often lead to flawed inferences. One should not confuse between cause and effects, as for example, all undernourished people may not be hungry and all hungry persons may not necessarily be suffering from nutritional deficiency.

There is no consensus among biologists and nutritionists about how under-nutrition should be defined and by what standard it needs be measured .There is no widely accepted theory of, or evidence on, how personal characteristics, genetic heritage, environmental factors and work type and intensity tend to interact with nutritional requirements across individuals or households, scattered across space and time. However, for analytical purposes, one may distinguish between input-based and output-based indicators and measurements to characterise the phenomenon of under-nutrition. In input-based analysis, dietary intake is used for nutritional assessment, whereas in out-based analysis one considers the disorderly consequences (referred as *failures*) on the human body as indicators of nutritional inadequacies or deprivations thereof. In the input-based analysis, the perceived nutritional need of an individual is based on population constructs like Recommended Dietary Allowance (RDA), or Recommended Dietary Intake (RDI), Reference Nutrient Intake (RDI), Estimated Average Requirement (EAR). These indicators are defined as "the nutrient recommendations by age and gender for meeting the needs of almost all healthy individuals in a population group [Gibson, 2005], and they indicate the probability that an individual or household is adequately nourished [Devi Sridhar, 2008]. In each such construct, there have been debates with respect to the underlying assumptions, appropriateness of the choice, adaptation, and intra-household discrepancies etc. In the early period, the Food and Agricultural Organisation (FAO) used to provide approximations of per capita requirements as national averages, but now it provides the average intake per person in a given household. While physiological and metabolic factors (or even geographical and climatic ones) exert crucial impact on the assessment of energy requirement of an individual, the interactions between nutrients and dietary intakes do affect the estimates of requirements and therefore deviations thereof that under -nutrition typically indicates.

In particular, we may note three major drawbacks or difficulties associated with input-based measure like the Estimated Average Requirement (EAR). In the first place, in most cases, the EAR does not give accurate qualitative or quantitative measures of the adequacy of the diet. A diet sufficient in calorie intake may satisfy the protein requirement, but may not cover micro-nutrient deficiencies like those in iron and vitamin A in many parts of the world. Secondly, if dietary surveys are carried out at the household level, individuals are not often reliable in their reporting of the actual food intakes of different members of the household, and even when they do, the application of common conversion factor from food intake to nutrient distribution may be biased. The third difficulty with the input-based analysis arises when average intake is calculated at the household level, and the calorie intake of children is indirectly derived through application of coefficients based on the assumption that intra-familial distribution of food conforms to actual physiological need. In South Asia, for example, such distribution is rooted in economic, social and cultural patterns which actually determine the allocation according to factors like gender, age, and birth order, and not necessarily by physiological requirements.

Due to the above types of difficulties involved in using input-based analysis, the WHO,UNICEF and the World Bank have shifted to output-based analysis since the early 1980s, based on comparing measurement of anthropometric indicators with a specified reference in order to assess the nutritional status of the population. Based on biomedical and biological anthropological notions of the body and growth, this epidemiological tool of anthropometry is primarily used to assess the nutritional status of children and mothers. It is generally recognised that under-nutrition is a complex phenomenon covering a multitude of aspects, like body size and composition, physical activity, health outcomes, cognitive and motoring capacity and many other capabilities, which cannot be approximated by the use of singe one-dimensional composite indicator which can ever capture all these dimensions. The anthropometric approach hinges on the assumption that people's physical appearance reflects their nutrition status, and it is sufficient to work with such outcome indicators.

The desideratum of a good and reliable indicator or a measure of the prevalence of under-nutrition is that must satisfactorily address the following queries: (a) *what* is under-nutrition?; (b) *who* the undernourished are, and how many of them? ; (c) *where* the undernourished are concentrated in terms of geographical area and type of economic activity? ;(d) *when* are people undernourished – does the composition of undernourished population undergo change over time?; (e) to explore *why* people are undernourished, i.e, to find out the factors responsible of the under-nutrition of the population under reference[vide Svedberg, 2000]. In other words, to arrive at a reliable measure of the phenomenon in terms of which policy targets be fixed, there has to be an agreement on *what* constitutes under-nutrition and how it can be defined and measured, identification of *who* they are and how *many* of them exist , *where* they are- globally, nationally, regionally and by type of location and *when* they are undernourished. We also have to understand *why* they are under-nourished in a given set up. These are necessary preconditions (may not be sufficient though) for the success of a good and reliable indicator in terms of which policy targets may be set. Fortunately, the anthropometric measures of the prevalence of under-nutrition permit estimates of differences in nutritional status between rural and urban areas, for children of different age and sex and between children and adults. These measures, in combinations with other social and economic observations can be helpful in identifying the reasons for nutritional inadequacy in time and space, although there are some difficulties in arriving at the exact estimates for purposes of economic analysis. The principal indicators used under this category are height-for-age, weight-for-height, and weight-for age, and for the undernourished these are reflected in retardation of body size (stunting), low weight-for-height (wasting), and underweight for children under the age of 5 years. These *three* indicators are chosen to capture different aspects of child under-nutrition that have partly different aetiologies and time dimensions. The height-for-age indicator is mainly used for monitoring permanent or chronic under-nutrition in children, while the weight-for - height indicator is used to monitor wasting, which reflects temporary or short-term under-nutrition. The weight-for- age indicator is intended to capture both short-term and long-term under-nutrition, and it has been widely used by national and international agencies and researchers in developing countries.

Nutritional status of under-five children in particular is often considered as one of the most important indicator of a household's living standard and also an important determinant of child survival (Thomas D, Strauss J, Henriques MH: 1990). Chronic under-nutrition (stunting) refers to low height-for-age and is the effect of inadequate food intake over a long period. It is also defined as linear growth retardation (World Food Program, 2008). Acute under-nutrition (wasting) refers to low weight-for-height and the result of inadequate food intake over a short period. It could also be due to a recent incidence of an infection or disease (World Food Program, 2008). Another form of under-nutrition is reflected as being underweight that is low weight-for-age or being too thin for their age. Underweight is usually a manifestation of being either stunted or wasted or both (World Food Program, 2008).

1.3 Child Undernutrtition

Children are that group of population who are at greatest nutritional risk. Both the rate of morbidity and mortality of children are affected by undernutrition. This is because children are incapable to cope with nutritional deficiencies than adults (Senauer and Gracia, 1991). Researchers and development planners across the world are of the opinion that nutrition is the cornerstone of socio-economic development of the country. To quote UNICEF (2007), *nutrition* “is something that can drive economic growth, because children who are well nourished have been shown to have much higher income potential as adults”.

The India Health Report (2015) says that though India has shown significant improvements in agricultural productivity, household income and child survival, yet the rates of child under-nutrition is among the highest in the world. While cross-country comparative estimates vary across studies, the general fact remains that the incidence of under-nutrition in India is itself quite large, and needs careful attention in the design of policy. According to data from RSoC (2014), 38.7 percent of Indian Children under the age of five are stunted, 19.8 percent are wasted and 42.5 percent are underweight.

It is well recognized that the well-being of the population of any country cannot be solely determined by the level and growth of consumption and income only. Between 1990 and 2014, it is seen that the average Indian income rose by 4.7 percent, crop yields (kilograms/hectares) of all foodgrains rose by 2.3 percent and death of children below five years of age declined on an average of 2.5 percent. The rate of child under-nutrition also declined, at a slow pace from 1992 to 2006 and then at a faster rate from 2006 onwards. According to NFHS 3 more than 25 percent of Indian children, who suffer from under-nutrition, are from the top income quartile. This shows that child under-nutrition is indeed weakly correlated with income. The rate of decline in under-nutrition is less than the rate of decline of other indicators of child health namely, infant and child mortality. This paradox has been referred to as ‘Indian enigma’ where the incidence of child under-nutrition is high, while infant and child mortality rates are relatively low. Thus the long term human capital in India is severely affected as child under-nutrition may cause an intergenerational vicious cycle of under-nutrition. An undernourished girl child has the risk of becoming another undernourished mother who is prone to give birth to another undernourished baby with low birth weight. Children suffering from under-nutrition in the early years of their lifetime are prone to health risk during adolescence and adult age. Again, good health and nutrition are valuable as it contributes to physical and cognitive development. Under-nutrition during childhood also increases the susceptibility of the child to several infections and delayed recovery, and hence possess big burden of diseases (Murray & Lopez).

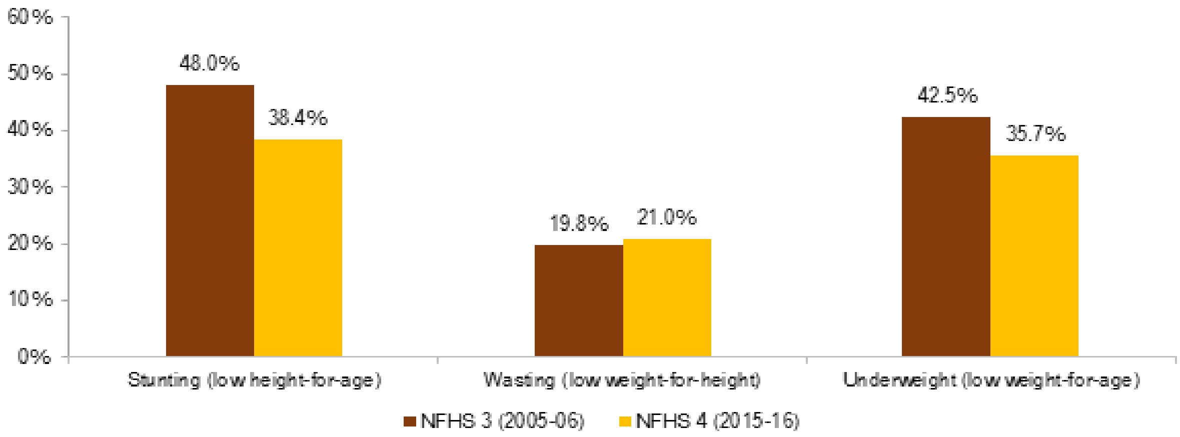
As reported by World Health Organization, there are two types of under-nutrition: Protein Energy Malnutrition (PEM) and Micro Nutrients Deficiency (MND). The indicators of PEM are stunting, wasting and under-weight. Stunting refers to compromised age-specific growth in height and is considered an indicator of long term deprivation and chronic illness. This height-for-age (HAZ) is an indicator of linear growth retardation. Children whose height-for-age z-score is below minus two standard deviation (-2SD) from the median of the reference population are considered as stunted or too short for their age. They are also referred to as chronically under-nourished. When the z-score is less than minus three standard deviation (-3SD), the child is referred to as severely stunted. Wasting reflects too thin for height and is due to acute food shortage or disease. It is also known as acute under-nutrition and is reflected by a rapid deterioration in nutritional status over a short period of time generally the period preceding the survey for children under the age of five. Those children whose weight-for-height (WHZ) is below minus three standard deviation (-3SD) from the median of the reference population are considered to be severely wasted and those whose (WAZ) score is less than minus two standard deviation are called wasted. Underweight or weight-for-age is a composite index of height-for-age and weight-for-height. Thus underweight takes into account both acute and chronic under-nutrition. Here too, children whose weight-for-age (WAZ) is below minus two standard deviation from the median of the reference population are considered as underweight.

According to Global Nutrition Report, 2018, the percentage of stunting across the globe for children less than five years of age declined from 32.6% in 2000 to 22.2% in 2017. That means the number of children who are stunted declined from 198.4 million to 150.8 million. Around 50 million children are wasted throughout the world. Statistics from different part s of the world shows that stunting in Asia has decreased from 38% to23 % since 2000. During the same period, stunting has fallen African countries from 38.3% to 30.3% as well as in Latin America and Caribbean countries from 16.9% to 9.6. %.

1.4 Indian Scenario

In India, according to National Family Health Survey-3 (NFHS-3) Report, the percentage of children below five years of age who are stunted was 48, percentage of underweight and wasted was 43 % and 20 % respectively. In NFHS-4, the percentage of stunting reduced to 38.7%, percentage children are underweight and the rate of wasting reduced 15.1 %. Despite this progress, it is said that the share of undernourished Indian children is higher than most of the poorest countries of the sub Saharan Africa. Panagariya(2013) contends that such a scenario of high under-nutrition rate in India is a result of faulty methodology of calculation introduced by World Health Organisation. The debate is inconclusive.

Figure:1.1 depicts the key indicators of undernutrition for children in India.



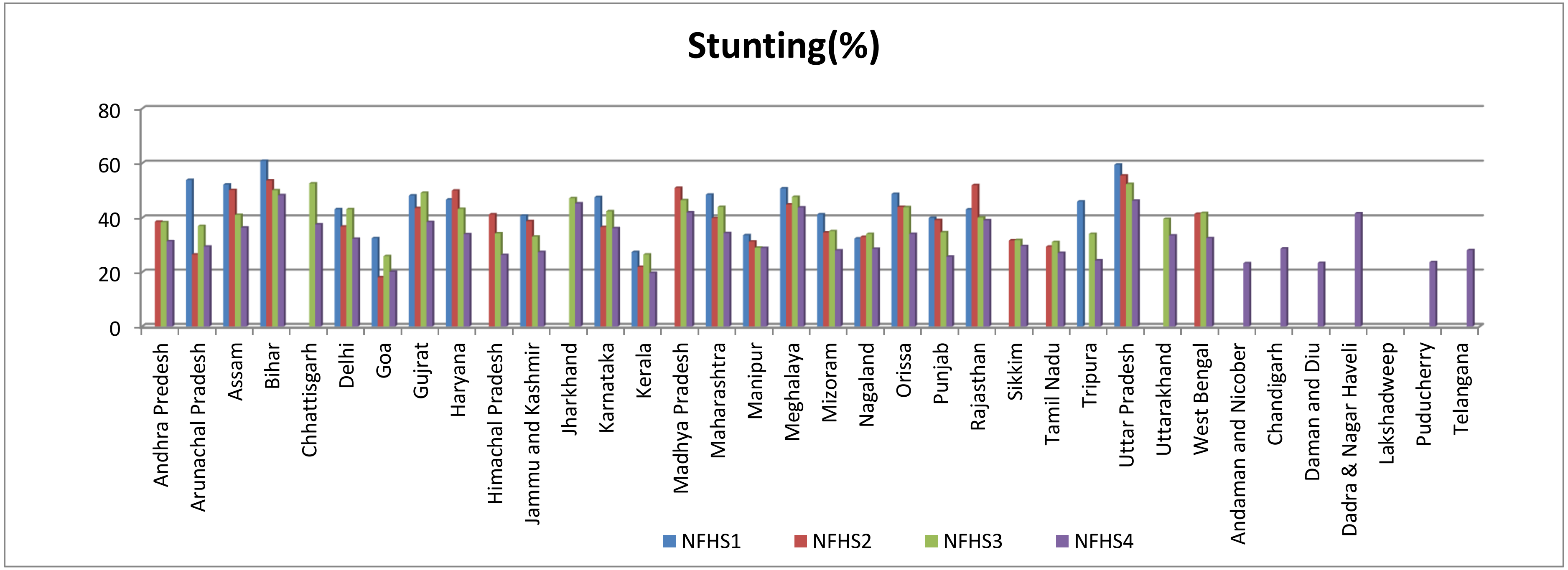
Sources: National Family Health Survey 3 & 4; PRS.

When we compare India with its neighbouring countries, we can find that India has higher prevalence of under-nutrition even though its per capita income is higher than other neighbouring countries. Pakistan, Bangladesh and Nepal with lower per capita income have made notable progress in reducing under-nutrition in recent years (Nisbett et al 2017; Cunningham et al 2017). Sri Lanka, has been able to reduce its rates of under-nutrition and hence has become an island of exception. The Global Hunger Index (GHI), 2019 ranked India 102nd out of 117 countries. GHI specifies that the condition of child under-nutrition is serious in India and it stands between Niger and Sierra Leone and far beyond other South Asian countries with the exception of Afghanistan. It was ranked 94th among 107 countries in GHI, 2020, and slipped down to 101st position among 116 countries in 2021 and is behind its neighbours Pakistan, Bangladesh and Nepal.

However, it is also true that child under-nutrition is unevenly distributed across different states in India. This is evident from the evidences obtained for stunting, wasting and underweight from four NFHS rounds in India. The following figures give a depiction of these under-nutrition parameters from the four rounds of NFHS in India.

It can be observed from the Figure: 1.2 that the level of stunting reduced in almost all the states of India. But there is a noticeable inter-state variation. Among the Northern states, it can be seen that in Punjab there is a sharp decline in stunting from 40% in NFHS-1 to 39.2 % in NFHS-2 to 34.7 % in NFHS-3 to 25.75 in NFHS-4. While in Rajasthan, it was 43.1 in NFHS-1, which increased to 52% in NFHS-2, but subsequently reduced to 40.1% in NFHS-3 and further to 39.1% in NFHS-4. Among the states situated in the central part of the country, in Madhya Pradesh the rate of stunting reduced from 52% in NFHS-2 to 42% in NFHS-4, while in Uttar Pradesh the rate declined from 59.5% in NFHS-1 to 46.3% in NFHS-4. In the state of West Bengal in the east, there is around 9% decline in the rate of stunting from 41.5 % in NFHS-2 to 32.5 % in NFHS-4. Among the north eastern states, a sharp decline is observed in the state of Assam from 52.2% inNFHS-1 to 50.2% in NFHS-2 to41.1% in NFHS-3 to 36.4 % in NFHS-4, while in Manipur it declined from 33.6% in NFHS-1 to28.9% in NFHS-4. In the west, the state of Gujarat shows a 10% decline in the rate of stunting from 48.2% in NFHS-1 to 36.2 % in NFHS-4 while in Maharashtra there is a remarkable decline from 48.5% in NFHS-1 to 34.4 % in NFHS-4.The southern states shows a slight decrease in the rate of stunting from 38.6% in NFHS-2 to 31.4% in NFHS-4 in Andhra Pradesh and 29.4% to 27.1 % in the state of Tamil Nadu.

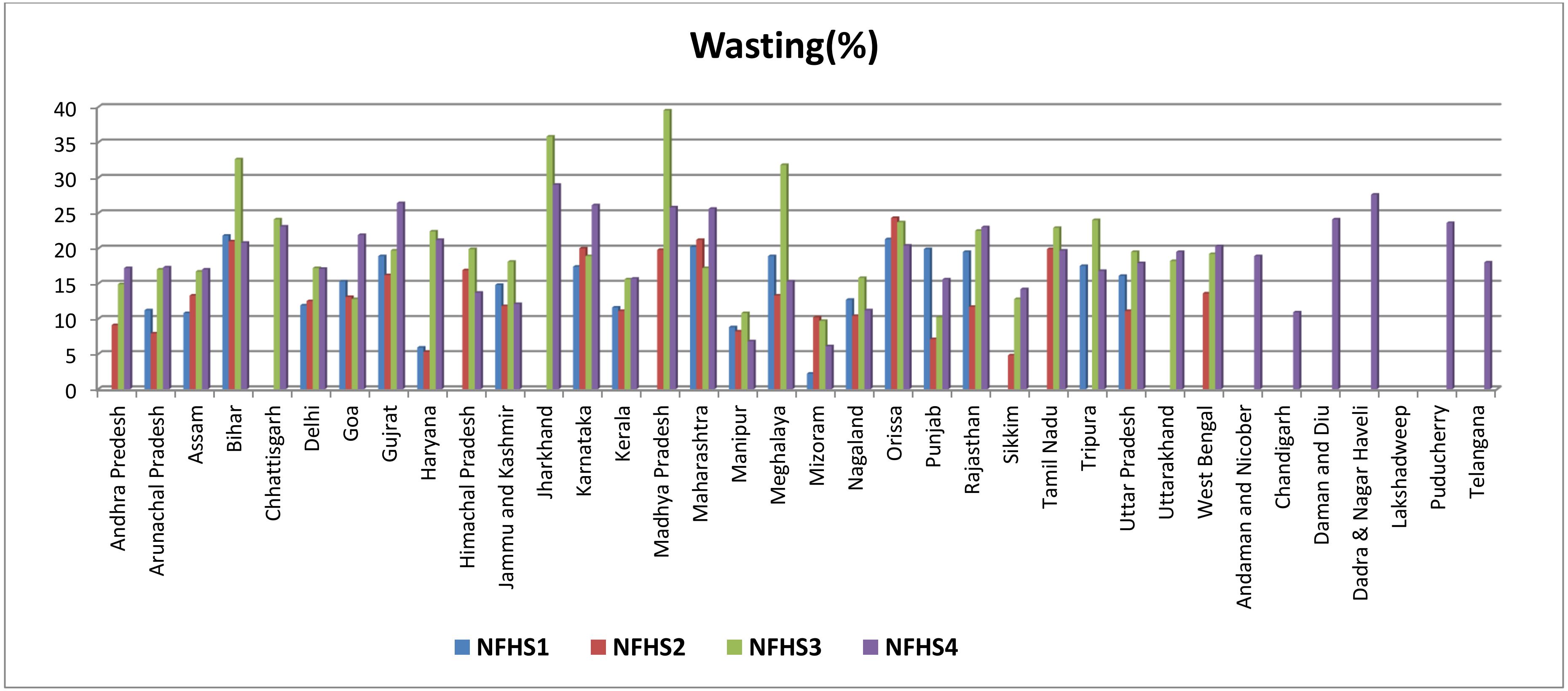
Figure:1.2: Pattern of stunting in different states in India



Sources: Compilation from NFHS-1, 2 3 and 4 factsheet data

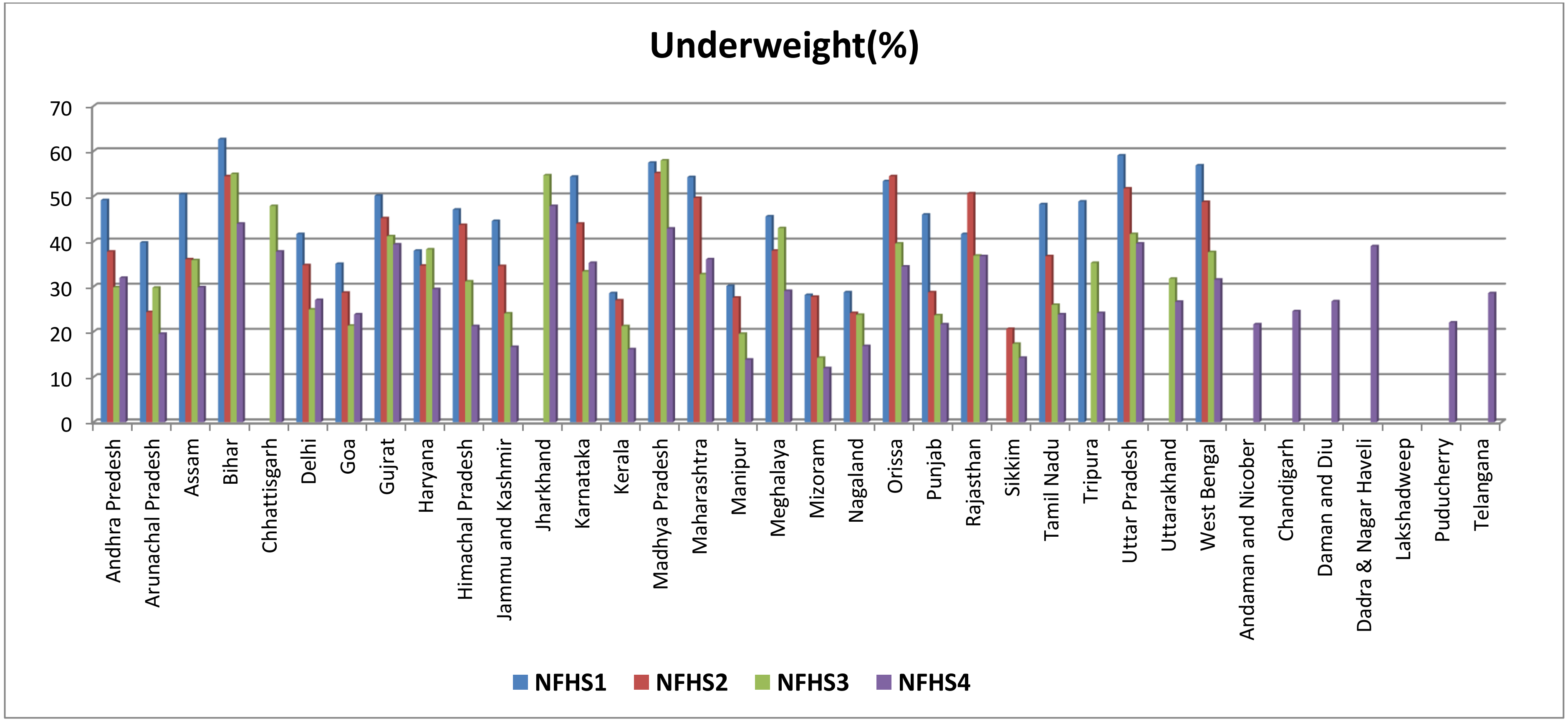
As can be observed from Figure:3 that the rate of wasting has increased has slightly increased in certain states like Andhra Pradesh, Arunachal Pradesh, Assam, Karnataka, Maharashtra, Rajasthan and West Bengal from NFHS-1 to NFHS-4. While certain states like Bihar, Jharkhand, Madhya Pradesh, Meghalaya, Tamil Nadu and Tripura had higher rate of wasting in NFHS-3, which got slightly reduced in NFHS-4. In terms of Underweight, it can be observed from Table 3 and Figure 3 that there had been a reduction in the rate in almost all the states of the country when compared from NFHS-1 to NFHS-4. Among the northern states, Delhi has shown a sharp reduction in the rate of Underweight from 41.6% in NFHS-1 to 34.7% in NFHS-2 to 29.9% in NFHS-3 to 27% in NFHS-4. But a reduction can be seen in case of Himachal Pradesh where the rate has decreased from 47% in NFHS-1 to 21.2% in NFHS-4. Among the states situated in the central part of the country, Uttar Pradesh has shown around 20% decline in Underweight from 59% in NFHS-1 to 39.5% in NFHS-4. A sharp decline can also be observed in Orissa in the eastern part of the country. Here, underweight percentage declined from53.3% in NFHS-1 to 34.4 % in NFHS-4. In the north eastern part of the country, the state of Arunachal Pradesh shows a 20% decline in Underweight percentage from 39.7% in NFHS-1 to 19.5% in NFHS-4. Among the western states, Gujrat has shown a decline in the rate from 50.1% in NFHS-1 to 41.1% in NFHS-3 to 39.3% in NFHS-4. Again, in Kerala, a state in the south has shown a dip in the rate from 28.5% in NFHS-1 to 16.1 % in NFHS-4.

Figure: 1.3: Pattern of wasting in different states in India



Sources: Compilation from NFHS-1, 2 3 and 4 factsheet data.

Figure: 1.4: Pattern of underweight in different states in India



Sources: Authors compilation from NFHS-1, 2 3 and 4 factsheet data

Thus it can be concluded that under-nutrition among children is a problem throughout India. Not only India, the other developing countries of the world is concerned with this issue. This is because child under-nutrition stagnates productivity and development of the country. The general perception is that, child under-nutrition is a result of paucity of food grains at the household level. Thus across the countries there had been programs to offer energy rich food grains at the community level to children belonging to poorer sections of the society. In India, various government initiatives have been launched over the years which seek to improve the nutrition status of children in the country. Schemes that had been undertaken in India are Public Distribution System (PDS), National Rural Health Mission, Mahatma Gandhi National Employment Guarentee Scheme, Midday Meal, Integrated Child Development Scheme and National Food Security Mission and others. PDS programme was specially constructed to facilitate distribution of food to the needy sections of the society.

The ICDS programme was initiated in 1975 by the then Government of India and is considered as the largest child care programme. But this ICDS programme was a failure and there had been serious debate to revamp so as create 'nutrition literate populace' (Rajivan, 2006) and not mere 'food dole programme' (Ghosh, 2006).

The dismal performance of India with respect to reduction of under-nutrition of its children is largely accredited to the failure of most of the above-mentioned programmes. This is a contradiction as on the one hand India has a high rate of child undernutrition and on the other hand there are a large of food grains available for the masses. The reason can be attributed to the inability of accessing and availing the food grains. One major objective of the National Food Security Bill introduced in September 2013, was to directly provide food to the masses by addressing the problem of hunger and undernutrion in India. Yet, even after the initiation of these schemes, India’s performance on key under-nutrition indicators is still unimpressive. According to UNICEF, 2019 India was at the 10th spot among countries with the highest number of underweight children, and at the 17th spot for the highest number of stunted children in the world. In lieu of this and due to long term effects of under-nutrition across generations, the NITI Aayog has released the National Nutrition strategy in September, 2017 which aims to reduce all forms of under-nutrition by 2030 as enumerated in the Sustainable development goals. It will enable a decentralized approach to promote greater flexibility in decision making at the state, district and national levels.

1.5 Motivation of the Dissertation

The present dissertation is titled 'Child Under-nutrition in India –An Interstate Analysis'. It tries to answer the *where*, *when* and the *why* questions mentioned above in the context of India and its major states. There is no doubt that the incidence of under-nutrition among under five children is high and like any other variables related to the behaviour of the Indian economy, there exist considerable interstate variations in nutrition and health related variables also. Some of these variables are directly related to diversity of nutritional intakes, food habits, climatic factors, social and cultural factors as well as macroeconomic variables like per capita income, annual growth rate of NSDP, per capita food availability and a host of household, social and contextual factors and health care practices across the states in India. One needs to understand the connection between such state level indicators and variables reflecting nutritional outcomes and the processes involved. Therefore, the study is placed in the context of development of the Indian economy, and tries to obtain directions for fresh policy interventions to achieve the target of lower incidence of under-nutrition among children and mothers. It is expected that the present study shall fill up the void in the existing literature: combine socio-demogrphic factors with health care practices, maternal resources for childcare and household resources, supported by community and government, the potential risks associated with high under-nutritional outcomes of children and mothers, and so on. It must be understood that the design, implementation and monitoring of effective health promotion interventions depend on the availability of high quality public health surveillance data to illuminate the epidemiological situation and help trace trends over time in health, risk factors and protective factors. In this regard, there remain vital knowledge gaps about child health in India that must be filled. Among these gaps, the long term trends in child health within social segments in the country have yet to be elucidated well enough; this is important to help guide better national and local health promotion policy-making and practice. Further, while home care is understood to be of vital importance to child health, too little is yet known about how childcare practices influence (are associated with) child health.

1.6 Objectives of the Study

The major source of data used in the present study is from National Family Health Survey (NFHS). So far this survey was conducted in four rounds: NFHS 1 (1992/93), NFHS 2 (1998/99) ,NFHS 3(2005/06) , and NFHS 4 (2015/16). In addition, in 2013/14, the Rapid Survey on Children (RSOC) was conducted by UNICEF with a focus only on children. We shall supplement these data by data from NSSO surveys, National Income Account Statistics, Census Data and Other government / semi- Government reports. We mainly use the econometric methodology- multi-stage or multi-level regression analysis, panel data econometrics etc, apart from the calculation of the z-scores ranking of the states and growth rates at various stages of the dissertation.

The objectives of the present dissertation are the following:

1. To understand the extent of inter-state differences in child undernutrition for 29 states in India.
2. To examine the position of different states in comparison to the nation as a whole with regard to various child undernutrition parameters.
3. To study the interplay of various socio-demographic variables and the status of child undernutrition in India using controls at individual, maternal, household and community characteristics.
4. To understand the position of different states of India with respect to its under-nutrition status on the basis of the determinants of Minimum Acceptable Diet.
5. To explore the relationships of Minimum Acceptable Diet to childhood under-nutrition parameters for different states in India, when control variables related to maternal, child and household characteristics are accounted for.
6. To examine the link between economic growth and nutritional outcomes of the few selected states in India.

1.7 Outline of Chapters

To meet these objectives, the present dissertation is presented in the following sequence of chapters:

Chapter 1: Introduction

Chapter 2: Data Sources and Methodologies

Chapter 3: Survey of Literature

Chapter 4: Patterns of Under-nutrition in different Indian States

Chapter 5: Influence of Socio Demographic Factors on Child Under-nutrition in India

Chapter 6: Dietary Pattern and Child Undernutrition in India

Chapter 7: Economic Growth and Child Undernutrition in India

Chapter 8: Conclusions

We address the first two questions on the extent of inter-state differences in different parameters towards child undernutrition and the associated position of individual states in comparison to the nation as a whole, in Chapter 4.

The third question on the interplay of various socio-demographic variables with the status of different child undernutrition parameters has been dealt with in Chapter 5.

The fourth and the fifth question on the position of different states of India with respect to the determinants of Minimum Acceptable Diet and its association with child undernutrition parameters is undertaken in Chapter 6.

The sixth objective on the link between economic growth and nutritional outcomes in selected states in India has been briefed in Chapter 7.

To highlight the major departures of the present dissertation from the earlier studies, it is important to note, firstly, that the present dissertation attempts to place the problem of child undernutrition in the context of development of the Indian economy and explain inter-state diversity in the pattern of child undernutrion in the Indian states.

Secondly, the present dissertation recognises the fact that need for appropriate combinations of socio-demographic factors with health care practices, maternal resources for childcare and household resources, supported by community and government, the potential risks associated with high under-nutritional outcomes of children and mothers, in analysing the factors underlying child undernutrition among the Indian states.

Thirdly, the present dissertation is an attempt to use large unit level comparable data from NFHS 3 and NFHS 4 in identification of determinants of child undernutrition in Indian states, role of dietary diversity and mothers' health conditions and many of the behaviorial results estimated would constitute an advancement from the existing literature and so on.

Finally, the dissertation makes an attempt to link the state level macroeconomic indicators like economic growth or GDP with the nutritional deprivation of children using panel data econometrics and this constitute a departure from the literature on existing studies.

1.8 A Sum Up

As there are growing evidences, the there are wide regional differences in child undernutrition in India, therefore this disseratation is a humble attempt to bring out a broad picture of the status of child undernutrition and its aspects in different states in India.

This dissertation has taken into consideration a huge individual level dataset from both NFHS 3 and NFHS 4, which is unique in its own way, and is quite distinct from previous studies on child undernutrition in India. Some of the results may conform with the ones in literature, while the others are certainly exclusive and noticeable, considering the robustness of the dataset considered. Again, the consideration of finding out a possible link between state level child undernutrition and economic growth, conducted over three decades for seventeen selected states in India, is an exceptional study, which is hardly found in literature.

Chapter 2

Data Sources and Methodologies

2.1 Introduction

It is important to delineate clearly the main data sources and the methodologies underlying a dissertation. While the data are often collected from different sources, it is necessary to cross check the compatibility and usefulness of such diverse data. Our choices of the sources of data and the methodologies adopted to arrive at meaningful conclusions are guided or conditioned by the broad research objectives of the study.

The present dissertation is titled 'Child Undernutrition in India –An Interstate Analysis'. It seeks to answer the *where*, *when* and the *why* child undernutrition prevails in the context of India and its major states. The study is placed in the context of development of the Indian economy, and tries to obtain directions for fresh policy interventions to achieve the target of lower incidence of under-nutrition among children and mothers.

2.2Data Sources

The major source of data used in the present study is from National Family Health Survey (NFHS). The Ministry of Health and Family Welfare (MOHFW), Government of India in collaboration with the International Institute of Population Sciences (IIPS) had conducted and initiated this large scale multi-round survey of sample households, to elicit state and national level information for India in respect of fertility, infant and child mortality, maternal and child health, nutritional status of children and mothers, practice ,utilization and quality of family planning, anaemia , and related socio-economic variables. The four completed rounds of such surveys- NFHS-1 for 1992-93, NFHS-2 for 1998-99, NFHS-3 for 2005-06 and NFHS-4 for 2014-15 constitute the primary basis of analyzing child under-nutrition in our country.

In the NFHS1, interviews were conducted with the nationally representative sample of 89,777 ever-married women in the age group 13-49, from 24 states and the National Capital Territory of Delhi. The NFHS provided information on maternal and child health and the prevalence of specific medical problems among members of the household. It was found that chronic and acute undernutrition is high in India. Around 53 percent of all the children under age four are underweight and around 52 percent are stunted. It was also seen that more than 21-29 percent of children are severely undernourished according to weight-for-age and height-for-age measures. Undernutrion among young children was relatively low in Kerala (29 percent are underweight and 27 percent are stunted). Other states like Manipur, Mizoram, Nagaland and Goa also recorded relatively low levels of child undernutrition. The states of Bihar and Orissa displayed the problem of wasting with highest infant mortality rate in the country.

The second National Family Health Survey (NFHS-2), conducted in 1998–99, provides information on fertility, mortality, family planning, and important aspects of nutrition, health, and health care. The International Institute for Population Sciences (IIPS) coordinated the survey, which collected information from a nationally representative sample of more than 90,000 ever-married women age 15–49. The NFHS-2 sample covers 99 percent of India's population living in all 26 states. This report is based on the survey data for 25 of the 26 states. NFHS-2 used three internationally recognized standards to assess children's nutritional status, mainly, weight-for-age, height-for-age, and weight-for-height. Children who are more than two standard deviations below the median of an international reference population are considered underweight (measured in terms of weight-for-age), stunted (height-for-age), or wasted (weight for-height). Based on international standards, 47 percent of children under age three years in India were found to be underweight, down slightly from 52 percent at the time of NFHS-1. 46 percent of children are stunted and 16 percent are wasted. Undernutrition is much higher in rural areas than in urban areas, and is particularly high among children from disadvantaged socioeconomic groups.

The *three* anthropometric indicators, namely height-for-age, weight-for-height, and weight-for age, are chosen to capture different aspects of child under-nutrition that have partly different etiologies and time dimensions. The validity of these indices is determined and influenced by many factors, including the coverage of the population of children and the accuracy of the anthropometric measurements. In the NFHS-1 Survey, in 1992-93, both height and weight measurements for all children below the age of four years were to be obtainable, but in the first phase, in states like Andhra Pradesh, Himachal Pradesh and West Bengal , only the weights were recorded , because the boards for measuring heights were not available. For children below the age of 2 years, estimates of height /length were based on adjustable boards with children lying down, while for elders, the measurements were taken in a standing position. The complete sample of children under 5 years' age was not chosen in NFHS-1 in any stage. Some such deficiencies in scale were rectified in NFHS-2, but the target sample group was under 3 years in some states and under 4 years in some other states. In the NFHS-2 survey, it was admitted that often it was not possible to measure the height and weight of all eligible children, usually because the child was not at home at the time of the health investigator's visit or because the mother refused to allow the child to be weighed and measured. In India, NFHS-2 did not measure 13 percent of children under age three, and also excluded from the analysis were children whose month and year of birth were not known and those with grossly improbable height or weight measurements. It is clear that changes in methodology and/or measurement scales during the first two rounds of NFHS Surveys make the outcome data strictly non-comparable and the possibility of errors creeping in could not be ruled out. Moreover, in both NFHS-1 and NFHS-2, unit level data were not released and only aggregative estimates at the State level were provided and therefore such estimates are often non-comparable and often non-compatible with NFHS-3 and NFHS-4 estimates. We have, therefore ,mainly used the data from National Family Health Survey (NFHS-3) 2004-2005 and NFHS-4) 2015-2016.

Both NFHS-3 and NFHS-4 have been designed to provide National and State level estimates on population, health, fertility, pregnancy care, child feeding practices, etc.

While NFHS-3 provides state level estimates, for the first time, NFHS -4 provides district level estimates of all the key indicators, and we have unit-level data for both NFHS-2 and NFHS-3. In addition to the indicators covered in NFHS-2, NFHS-3 provides information on several new and emerging issues. NFHS-3 adopted a two-stage sample design in most rural areas and a three-stage sample design in most urban areas. In each state, the rural sample was typically selected in two stages: the first stage involved selection of Primary Sampling Units (PSUs), i.e., villages, with probability proportional to population size (PPS); the second stage involved the systematic selection of households within each PSU. Interviews were conducted with 1, 24,385 women age 15-49 and 74,369 men age 15-54 from all 29 states. Fieldwork for NFHS-3 was conducted in two phases from November 2005 to August 2006. 1, 09,041 households were selected from the entire country. The NFHS-4 report for India 2017, states that each district is initially separated into rural and urban areas for the purpose of stratification. Within each rural stratum, villages were selected from the sampling frame with probability proportional to size (PPS). Again, each rural stratum is stratified into six sub-strata of approximately equal size. This is created based on estimated number of household in each village and also on the basis of the percentage of population of scheduled castes and scheduled tribes (SC/ST). The selection of PSUs from each rural stratum is also based on the literacy rate of women age 6+ years that area. For urban stratum the PSUs is selected according to the percentage of population of scheduled caste and scheduled tribes. Also in urban areas, the Primary Sampling Units are the Census Enumeration Blocks (CEB). A village or CEB is selected only if there are more than 40 households, otherwise it is linked to the nearest neighbouring PSU. 6, 28,892 households were selected from the whole of India for survey during the NFHS-4.

2.2.1 Variables Chosen

The three anthropometric indicators of undernutrition used in this are outcome variables .The measurements of height and weight of children under the age of five, and for women aged between 15-49 years, and for men aged 15-54 years of age are obtained from the NFHS surveys These three indicators are expressed as standard deviation units (z-scores) from the median of the International reference population (WHO 2006). The computation of z-scores was done in order to get appropriate anthropometric indicator relative to the International reference population with respect to particular age:

$\mathbf{Z_i = (A_i - \mu)/\sigma}$, Where Z_i mentions the z-score for the specific indicator for the child. μ and σ are the median and standard deviation of the International Reference Population. The indicators are:

Height-for-age or Stunting: It is an indicator of chronic malnutrition, as it allows information regarding linear growth retardation of children. Children with the height-for-age z-score < -2 SD (Standard Deviation) from the median of the International reference population are regarded as short for their age (Stunted) and those with z-scores< -3SD from the median are considered severely stunted. Children are stunted when they are deprived of receiving adequate nutrients over a long period of time. Stunting is also an effect of chronic or repeated illness, and is not affected by improper recent dietary intake.

Weight-for-height (Wasting): It is an indicator of acute malnutrition. It occurs when the child is unable to receive inadequate nutrition during the time period immediately preceding the survey. Wasting is also an effect of recent episode of illness experienced by the child. If weight-for-height z-score <-2SD from the median of the International Reference population, a child is said to be thin for his/her height or wasted. Again, if the z-score <-3SD from the median of the WHO population, a child is severely wasted.

Weight-for-age (Underweight): It is a composite indicator of chronic as well as acute undernutrition which takes into consideration both height-for-age as well as weight-for-height. Children with weight-for-age z-score <-2SD from the median of the reference population are classified as underweight, and those having z-score<-3SD are severely underweight with respect to the International WHO Reference Population.

While looking for the input factors responsible for child undernutrition, we have considered socio-economic and demographic characteristics of children like rural and urban place of residence, child age (in months), sex of the child, size of child at birth and birth order, and also duration of breastfeeding (started breastfeeding within one hour, and who are exclusively breastfed for the last 6 months) and other child feeding practices. The underlying factors for child undernutrition are often attributed to maternal characteristics like maternal age, maternal educational & working status, and nutritional status. Mother level characteristics included mother's educational status, status of anemia, place of delivery of child, status of BMI, whether the child uses mother and child protection card (NFHS-4) and mother's decision making power in terms of autonomy for taking medical help. The household level characteristics includes ethnicity of the household members, the source of drinking water in the household , the type of toilet used by the household, sex of the household head , BPL card holding households , household with regular income and whether the household has a house of their own. Information about all these variables are obtainable from the NFHS surveys. It may be noted the agro-climatic regions are also calculated for NFHS-3 and NFHS-4 separately.

We have supplement the above data by data from National Income Account Statistics, Census Data and Other government / semi- Government reports, like the RBI's Data Base of the Indian Economy. We have used per capita net state domestic product, as a measure of a state's economic development. These data are obtained from Reserve Bank of India, for the years 1998, 2005 and 2014 and measured in 2005 base prices. We have also calculated percentage change in per capita state domestic product to measure economic growth as $((x_t - x_{t-1}) / x_{t-1}) * 100$. That means we considered per capita NSDP in a particular year minus the per capita NSDP in the previous year divided by per capita income of the previous year, expressed as a percentage. For this we considered 1998-99 and 1999-2000 for NFHS-2, 2004-2005 and 2005-2006 for NFHS-3 and 2013-2014 and 2014-2015 for NFHS-4.

The data for state female literacy is obtained from Census 2001 and 2011. The data for mother's anaemia for the states in India is taken from NFHS-3 and NFHS-4 published reports.

2.3 Methodologies

We mainly have used the econometric methodologies- multi-stage or multi-level regression analysis, panel data econometrics etc, apart from the calculation of the z-scores and growth rates, at various stages of the dissertation. The z-score is calculated through WHO Anthro Survey Analyser.

The **formula** for **calculating** a **z-score** is

z = (x-μ)/σ,

where, x is the raw **score**, μ is the populations mean, and σ is the population standard deviation. As the **formula** shows, the **z-score** is simply the raw **score** minus the population mean, divided by the population standard deviation.

Z-scores are a way to **compare results** to a "normal" population. The z-score in the center of the curve is zero. The z-scores to the **right of the mean are positive** and the z-scores to the left of the mean are negative. If we look up the score in the z-table, we can tell what percentage of the population is above or below your score.

The Minimum Acceptable Diet is calculated using the following formula:

Proportion of children 6–23 months of age, who receive a minimum acceptable diet (apart from breast milk) =

(*Breastfed children 6–23 months of age who had at least the minimum dietary diversity and the minimum meal frequency during the previous day*) / (*Breastfed children 6–23 months of age*)

and

(*Non-breastfed children 6–23 months of age who received at least 2 milk feedings and had at least the minimum dietary diversity not including milk feeds and the minimum meal frequency during the previous day*) / (*Non-breastfed children 6–23 months of age*)

2.3.1 Multi-level Regression Model

Multilevel analysis is considered as a suitable approach when there is a need to into account the social contexts and individual respondents or subjects.

In NFHS, the data are collected on social and other health related factors which are clustered or hierarchical in nature. That means that the children are nested into mothers, mothers are nested into households, household are nested into Primary Sampling Units (PSUs) and PSUs are nested into states. Hence we use the multi-level regression model in order to evaluate the parameters for nutritional status among children. Therefore, such a hierarchical type of data structure consisting of units grouped at different levels should be analyzed using Multilevel Modelling.

Multilevel Regression Models or hierarchical linear model is a type of regression analysis for multilevel data where the dependent variable is at the lowest level.

Multilevel regression Models are also referred to as Random Coefficient Models. (Longford, 1993). We know that in simple linear regression model with y as a dependent or response variable and x as independent variable can be defined as follows:

$$y = \beta_0 + \beta_1 x + \varepsilon \qquad (1)$$

Where β_0 represents the intercept term, β_1 is the slope and the error term ε is assumed to follow a normal distribution with constant mean 0 and variance σ^2.

In multilevel random intercept model, let y be the response variable. Therefore, y_{ij} is the ij th observation of the variable. Let x be the independent or the corresponding explanatory variable and x_{ij} is the ij^{th} observation (i – level 1 unit: j-level 2unit).

Therefore, a linear regression model describing a relationship between y and x can be written as

$$y_{ij} = \beta_{0j} + \beta_{1j}x_{1j} + \varepsilon_{ij} \qquad i = 1,2,\ldots..,n \quad \text{and} \quad j = 1,2,\ldots..,k \qquad (2)$$

The parameters to be estimated (β_{0j} , β_{1j}); j = 1,2,….,k & σ_e^2

Let β0j, β_{1j} be the random variables such that

$$\beta_{0j} = \beta_0 + \mu_{0j} \qquad (3)$$

$$\beta_{1j} = \beta_1 + \mu_{1j} \qquad (4)$$

where, μ_{0j} and μ_{1j} are unexplained random variables of β_{0j} and β_{1j} respectively;

and
$E(\mu_{0j}) = E(\mu_{1j}) = 0$
$Var(\mu_{0j}) = \sigma^2_{\mu 0}$ $\mu_{0j} \sim N(0, \sigma^2_{\mu 0})$
$Var(\mu_{1j}) = \sigma^2_{\mu 1}$
$\mu_{1j} \sim N(0, \sigma^2_{\mu 1})$
$Cov(\mu_{0j}, \mu_{1j}) = \sigma_{\mu 01}$
By using (3) and (4) we can re-write (2) as:

$$y_{ij} = \beta_0 + \mu_{0j} + \beta_1 x_{ij} + \mu_{1j}x_{ij} + \varepsilon_{ij}$$
or
$$y_{ij} = \beta_0 + \beta_1 x_{ij} + \mu_{0j} + \mu_{1j}x_{ij} + \varepsilon_{ij}$$

where $\beta_0 + \beta_1 x_{ij}$ is the fixed part of the multi-level model and $\mu_{0j} + \mu_{1j}x_{ij} + \varepsilon_{ij}$ is the random part.

In order to estimate the model, there are two fixed parameters β_0 and β_1 that is required to be estimated. Along with that there are four random parameters $\sigma^2_{\mu 0}$, $\sigma^2_{\mu 1,}$ and $\sigma_{\mu 01}$and σ^2_e = var (ε_{ij}). For calculating for the estimates least square method is applied. This model is popularly known as Variance Components Model.

The Intra class correlation (ICC) measures correlation measures correlation between observations in the same level or higher. For a simple 2-level random effect model the intra-class correlation is given by

$\rho = (\sigma^2_{\mu 0})/ (\sigma^2_{\mu 0}+ \sigma^2_{e})$

The Variance Partition Coefficient (VPC) explains the proportion of variation and is calculated using the variance estimates of random effects $\sigma^2_{\mu 0}$, σ^2_{e}. For a two-level model, VPC is same as ICC, but for higher-level models, the result is different.

To estimate if variance estimates are significantly different from zero, for each level, Wald's z-test was applied. Rejection of hypothesis favors the random effect model against the fixed effect model.

2.3.2 Multi level Linear Regression

Here we used the variance component model, which corrects the problem of correlated observations in a cluster. That means the subjects within the same cluster are permitted to have the same random intercept. In the paper, we considered two clusters which are community and household. Therefore, the regression equation becomes,

$$z_{ij} =\beta' x_{ij} +\delta_1 +\mu_{ij}$$

where z_{ij} is the z-score for the child from the j^{th} household in the i^{th} community. β is the vector of regression coefficients analogous to the outcome of the fixed control variables $x_{ij.}$ These control variables are the observed characteristics of the child, household and the community. Here 'i' is the random community outcome denoting the deviation of community i's mean z-score from the grand mean, and 'j' is the random household outcome that constitute the deviation of household ij's mean z-score from thr i^{th} community mean. δ_1 and μ_{ij} are the error terms that are assumed to be normally distributed with zero mean and variance σ^2_{c} and σ^2_{h} respectively. These terms are non-zero and estimated by variance component model.

In order to understand the appropriateness of multi-level model, we then test whether the variances of the random part are different from zero over households and community. Hence the resulting estimates from the model are used to assess the Intra class correlation (ICC) to understand the extent of correlation of child undernutrition parameters and household and community covariates. If the value of ICC is significantly different then it authenticates the random effect models. The correlation between the undernutrition parameters or anthropometric outcomes of a child in the same community and from the same household is given by

$$\rho_c = (\sigma^2{}_c)/\ (\sigma^2{}_c + \sigma^2{}_h)$$

The total variability in the z-scores is then divided into variance in child's nutritional status among household within communities and variance among communities. Since the covariates which are included at each level, therefore the variance component model allows to evaluate the extent of observed differences in anthropometric z-scores are ascribable to factors functional at each level. Here we have taken a random intercept model with constant effect of the covariates covering the clusters.

2.3.3 Multi- level Logistic Regression

The logit models or logistic regression models gives the relationship between categorical dependent variable and various independent variables. The model which is fitted is binary in nature is binary when the outcome variable is of two categories. Logistic regression allows the explanatory variable to predict the logit transformation of the dependent variable. In order to define the logit model, we first define the odds of an event

Odds(event)= (p) / (1-p)

Where p is the probability of occurrence of event and (1-p) is the probability of non-occurrence of the event. The log of odds is defined as logit function.

logit(y) = ln (odds) = ln (p/(1-p))

hence in order to calculate the probability of occurrence of an event over the probability of non-occurance of the event we use logistic regression. The effect of explanatory variables is explained in terms of odds.

If there are multiple variables, then the model is written as

Logit (y) = ln (odds)= ln (p/(1-p) = $\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_m X_m$

When we have binary dependent variable and a single independent variable then the logistic regression equation becomes:

$\ln(p/(1-p)) = \beta_0 + \beta_1 X_1 \qquad (1)$

if there is increase in in the independent variable by one unit

$\ln(p^{/} / (1- p^{/})) = \beta_0 + \beta_1(X_1+1) \qquad (2)$

$= \beta_0 + \beta_1 + \beta_1 X_1$

From (1) and (2) , we can write:

$\beta_1 = \beta_0 + \beta_1(X_1+1) - \beta_0 - \beta_1 X_1$

$= \ln (p^{/} / (1- p^{/})) - \ln(p/(1-p))$

$= \ln (odds^{/} / odds)$

$e^{\beta 1} = (odds^{/} / odds)$

Therefore the regression coefficient can be interpreted as log of odds ratio (OR). OR give the measure of association between the independent and dependent variable. If the explanatory variable is categorical in nature, then the odds ratio compares the odds on one category with the chosen reference category. If the odds ratio is equal to one, then the predictor variable has no effect on the odds of an outcome. But if the odds ratio is greater than one then that implies that the predictor variable is associated with higher odds of the outcome, which indicates that the predictor is a risk factor. On the other hand, when the odds ratio is less than one, it indicates that the predictor variable does not pose risk to the outcome variable.

But the logistic regression model should follow certain assumptions. The first assumption is that the outcome variable should be binary in nature. The second assumption is that since the logistic regression is binary in nature, hence the desired outcome should be coded as 1. The third assumption is that each observation should be independent of each other. The fourth assumption says that there should not be multi-collinearity problem. The fifth assumption is that the explanatory variables are linearly related to log of odds of the response variable. And the last assumption is that the sample size should be large.

In logistic regression the chi-square test is used to measure the goodness of fit. After the test of goodness of fit, significance of each of the covariates used in the model is tested.

The Likelihood Ratio test and Wald statistic are the for the odds ratio used to test the significance of each predictor in the model. The 95% Confidence Interval (CI) are also used to assess the significance of each predictor variable in the model.

In the study, for measuring the effect on complementary feeding practices on child health the outcome variables are stunting, wasting and underweight. These outcome variables can be considered as binary in nature. Hence multilevel regression analysis was performed.

Multilevel regression models are a statistical technique that allows one to properly analyze multilevel data . Such models incorporate cluster-specific random parameters that account for the dependency of the data by partitioning the total individual variance into variation due to the clusters. From a statistical perspective, in case of conventional regression analyses, conditional on the covariates (or predictor variables), the outcomes are independent across subjects. If the observed outcomes are not independent of one another, the effective sample size decreases, and hence the failure to account for the intra-cluster correlation in conventional analyses falsely increases the precision of the estimates.

However, in Multi-level logistic regression model, we allow the magnitude of individual level associations to vary across clusters. This helps in understanding of the underlying heterogeneity in the data than is possible from a conventional regression analysis.

In the thesis, we introduced the basic random intercept logistic regression model. The model derives its name from the fact that the intercept is allowed to vary randomly across clusters through the introduction of cluster-specific random effects. In the formulas that follow, let Y_{ij} denote the binary response variable measured on the *i*th subject within the *j*th cluster ($Y_{ij} = 1$ denotes success or the occurrence of the event, while $Y_{ij} = 0$ denotes failure or lack of occurrence of the event). Furthermore, let X_{1ij}, through X_{kij} denote the k predictor or explanatory variables measured on this subject. Finally, let Z_{1j}, through Z_{mj} denote the m predictor variables measured on the *j*th cluster.

The conventional multilevel logistic regression model incorporates cluster-specific random effects to account for the within-cluster correlation of subject outcomes:

$\mathrm{logit}(\Pr(Y_{ij} = 1)) = \alpha_0 + \alpha_{0j} + \alpha_1 x_{1ij} + \cdots + \alpha_k x_{kij} + \beta_1 z_{1j} + \cdots + \beta_m z_{mj}$

where $\alpha_{0j} \sim N(0, \tau^2)$. The assumption is made that the random effects are independent of the model covariates (X,Z).

The VPC represents the proportion of the total observed individual variation in the outcome that is attributable to between-cluster variation. The higher this proportion, the higher is the general contextual effect.

All analysis were carried out using the STATA (release 9), employing the xtmixed and xtlogit routines for the multilevel analysis.

2.3.4 Panel Data Regression

The panel data have both the cross-sectional and time series dimensions. Cross-sectional dimension of panel data implies that the data have been collected from a number of cross-sectional units. The time point may refer to year or month or week or even day. Thus, to generate a panel data set, we need to have a number of time points for a set of cross-sectional units. These data when presented in a systematic manner we can generate the panel data set.

Panel data can used to deal with heterogeneity among the cross-sectional units. By combining time series with cross-sections, panel data enhance both quantity and quality of data. In this process, panel data create more variability in the data, less collinearity among the variables, and more degrees of freedom. As a consequence, more efficient estimation of unknown parameters of the model becomes possible. Panel data are better able to study complex issues of dynamic behaviour. Panel data are able to identify and measure effects that are simply not detectable in pure cross-sectional or time-series data.

Any panel data set can be expressed in terms of algebraic model.

$Y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + \ldots + \varepsilon_{it}$

Where i= 1, 2,…., N

And t= 1, 2, 3,…., T

In the model, all the variables have *it* as subscript. Here *i* and *t* refer to the cross-sectional and time series aspects of data, respectively. As the number of the cross-sectional units (N) and number of years is T, we have altogether NT observations on each variable. For the purpose of hypothesis testing, we also assume that ε_{it} is normally distributed. Finally, all the explanatory variables of the model are assumed to be non-stochastic, and none of these are correlated with the disturbance term. In order to estimate the model, we used Fixed Effects Model and Random Effects Model. These models differ with regard to the assumptions that are made about the intercept, the slope coefficients and the disturbance term of the model.

The Fixed Effect Model considers the intercept as a variable and uses dummy variablesto account for differences among the individuals with regard to the value of intercept. Thus, if there are N cross-sectional units, we use N number of dummy variables and the fixed effects model is written as

$Y_{it} = \alpha_1 D_{1t} + \alpha_2 D_{2t} + \ldots \alpha_N D_{Nt} + \beta X_{it} + \varepsilon_{it}$

Here the value of D_{1t} =1 for first cross-sectional unit and 0 for all others, D_{2t} = 1 for second cross-sectional unit and 0 for all others and so on. α_1 is the intercept of first cross-sectional unit, α_2 is the intercept of the second cross-sectional unit and so on.

In this model, although the intercept term is allowed to vary across cross-sectional units, but for each cross-sectional unit the intercept is assumed to remain constant over time, that is, the intercept of each cross-sectional unit is time-invariant. The Fixed effect model is estimated by using OLS method, as in regression model, we apply the usual *t*-test to examine whether an individual intercept is zero.

However, there are some problems with this approach. In the process of transforming the variables, apart from the dummy variables, the time-invariant explanatory variables get wiped out from the model. Again the disturbance term of the Fixed Effects First – Difference Model suffers from autocorrelation problem. These problems are avoided in the Random Effects Model.

The Random Effects Model (REM) does not use dummy variables to capture the presence of individual effect. It rather assumes the individual effect is a random variable. Here we are assuming the cross-sectional units in our data set have a common intercept. The individual differences in the intercept values of cross-sectional units are reflected by the random error term. The Random Effects Model is specified as

$$Y_{it} = (\alpha_1 + u_i) + \beta X_{it} + \varepsilon_{it}$$
$$= \alpha_1 + \beta X_{it} + \omega_{it}$$

Here ω_{it} $(= u_i + \varepsilon_{it})$ is the composite random error term that has two components, u_i which represents the cross-section or individual-specific random error component, and ε_{it}, which is combined time series and cross-section random error component, sometimes called the idiosyncratic random term because it varies over cross-sectional units as well as over time.

As this model considers the individual effect as random variable, hence it is called Random Effects Model.

Here, $\sigma_u^2 = Var(u_i)$ + and $\sigma_\varepsilon^2 = Var(\varepsilon_{it})$

These assumptions imply that individual error components are not correlated with each other and are not correlated across cross-section and time-series units. That means the Random Effects Model supposes that $\omega_{it,}$ which is the error term, is not correlated with any explanatory variables included in the model. But, since u_i is a component of ω_{it}, sometimes this error term is correlated with the explanatory variables included in the Random Effects Model. In such a situation, the Random Effects Model may provide with inconsistent estimation of regression coefficients. This can be checked through the Hausman test.

The Hausman test assume that there are two estimates $\beta^{\wedge FE}$ and $\beta^{\wedge RE}$ of the parameter of vector β. The two hypothesis are

H_N : Both $\beta^{\wedge FE}$ and $\beta^{\wedge RE}$ are consistent, but $\beta^{\wedge FE}$ is inefficient

$H_{A:}$ Both $\beta^{\wedge FE}$ and $\beta^{\wedge RE}$ are efficient, but $\beta^{\wedge RE}$ is inconsistent

The Hausman test statistic is given by

$H = q^{\wedge\prime}[\, Var(\beta^{\wedge FE}) - Var(\beta^{\wedge RE})]^{-1}\ q^{\wedge\prime} \sim \chi^{2\,(k)}$

where k is the number of explanatory variables.

The decision rule is that, if the computed value of Chi-square ($\chi^{2\,*}$) is greater than the theoretical Chi-square value at a chosen level of significance λ and degrees of freedom k, i.e., $\chi^{2\,*} > \chi_\lambda{}^{2\,(k)}$ we reject H_N which implies that REM is consistent, and accept the Fixed Effect estimator. Again, we do not reject H_N if $\chi^{2\,*} \leq \chi_\lambda{}^{2\,(k)}$ and prefer the Random Effects estimator.

The results of Panel Data Regression is used usinfg the EViews software.

2.4 A Sum up

In this chapter, we have outlined the main data base and different econometric methods used in the present dissertation. The discussions have been guided by the objectives of the dissertation and the context in which these methods have been used. We have noted that the principal source of data for the study of child undernutrition for both input- based as well as output based indicators is the National Family and Health Surveys 1,2,3,4. We have delineated the characteristics of these four rounds of NFHS survey samples and the coverage and have pointed out certain shortcomings of the round 1 and 2surveys of NFHS, which make our detailed inter- state analysis of the socio-economic factors contributing to child undernutrion, as well as dietary patterns across the states of India , many confined to the NFHS 3 and 4 survey data. We have also mentioned about Census data and RBI data on statewise per capita NSDP that are used in different chapters of the dissertation. As for the methodogy part, we have, apart from calculating growth rates, z-scores and percentage deviations, briefly described the Multi-level Regression analysis, Muti-level Linear Regression, Muti-level Logistic Regression, and the Panel Data Regression methods , that have been used in the dissertation.

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Chapter 3

Survey of literature

In the contemporary discourses on development economics, issues on nutritional deficiency /disorder in large number of countries in the world have attracted the attention of analysts and policy planners including international agencies, who argued that health and nutrition are not only important as ends in themselves, but these may also constitute channels through which productivity enhancement and distributional goals may be effectively pursued in developing societies. Accordingly, in last five decades, economists have directed increasing attention towards examining the nature, spread and reasons of endemic under-nutrition among children and mothers and possible escape routes thereof in the development process. Important issues discussed in this area include the extent of health and nutritional status, and their spread over time and space, the proximate determinants (socio-economic) of nutrient status , the impact of health and nutrition on incomes and other outcomes , and the choice of the appropriate indicator(s) to connote optimum nutrient intakes and the adaptation process involved. We now have alternative estimates of nutritional status of people in different countries and regions within countries, and there have been studies to find out underlying reasons for such deprivations. The literature is large and evolving and in what follows, we shall be selective and *not comprehensive* in presenting a review of the theoretical and empirical literature on the subject.

Broadly, one may distinguish between an input-based approach and an output-base outcome approach in describing the prevalence of under-nutrition or nutritional deprivations in different parts of the globe. In input-based analysis, dietary intake is used for nutritional assessment, whereas in out-based analysis one considers the disorderly consequences (referred as *failures*) on the human body as indicators of nutritional inadequacies or deprivations thereof. In the input-based analysis, the perceived nutritional need of an individual is based on population constructs like Recommended Dietary

Allowance (RDA) or Recommended Dietary Intake (RDI), Reference Nutrient Intake (RDI), Estimated Average Requirement (EAR), while there are analytical and practical difficulties associated with the use of either constructs as adequate explanation of the state of under-nutrition, the output-based analysis adopted by international agencies like WHO, UNICEF, and the World Bank since the early 1980s, use anthropometric indicators with a specified reference in order to assess the nutritional status of the population. This epidemiological tool of anthropometry is primarily used to assess the nutritional status of children and mothers. Discussions and debates on both types of discourses on under-nutrition constitute important component on contemporary development economics. In the present chapter, we present the literature review under the following two sub- categories:

1. Global Estimates of Child Nutritional Status
2. Studies on Child Nutritional Status in India

In each sub-category, we try to cover measurement related issues, socio-economic factors of under-nutrition , and the link between dietary diversity and undernutrition.

Global Scenario

3.1 Estimates of Child Nutritional Status

Adequate nutrition in early childhood is considered essential to ensure healthy growth, proper organ formation and function, a strong immune system, and neurological and cognitive development. Child malnutrition impacts cognitive function and contributes to poverty through impeding individuals' ability to lead productive lives. In addition, it is estimated that more than one-third of under-five deaths are attributable to under-nutrition. Nutrition has increasingly been recognized as a basic pillar for social and economic development, particularly to the achievement of the Millennium Development Goals (MDGs) - particularly those related to the eradication of extreme poverty and hunger (MDG 1) and child survival (MDG 4).

The World Bank, 2006 pointed out that the health and nutrition of children are central to capital formation and economic development of a country, and that attaining nutritional security is also fundamental for sustainable poverty alleviation programmes (FAO, IFAD and WFP, 2013; The World Bank 2006). The 2004 *Human Development Report* of the UNDP shows that out of the 831 million people who were undernourished in 2000, sub-Saharan Africa, East Asia , and South Asia, respectively accounted for 185 million, 212 million, and 312 million. Naturally, the global estimates of the status of child under-nutrition have undergone changes over the years, and across the countries.

The Joint Child Malnutrition Estimates of UNICEF-WHO-The World Bank (2012) indicate the levels & trends in Child Malnutrition in the world.The key facts that emerge from this report are the following:

Stunting

Globally, an estimated 165 million children under-five years of age, or 26%, were stunted (i.e, height-for-age below –2 SD) in 2011 — a 35% decrease from an estimated 253 million in1990. High prevalence levels of stunting among children under-five years of age in Africa (36% in 2011) and Asia (27% in 2011) remain a public health problem, one that often goes unrecognized. More than 90% of the world’s stunted children live in Africa and Asia.

Underweight

Globally, an estimated 101 million children under-five years of age, or 16%, were underweight (i.e., weight-for-age below –2SD) in 2011 — a 36% decrease from an estimated 159 million in 1990.

Although the prevalences of stunting and underweight among children under-five years of age worldwide have decreased since 1990, overall progress is insufficient and millions of children remain at risk.

Wasting

Globally, an estimated 52 million children under-five years of age, or 8%, were wasted (i.e.weight-for-height below –2SD) in 2011 — a 11% decrease from an estimated 58 million in1990;

Seventy percent of the world's wasted children live in Asia, most in South-Central Asia.These children are at substantial increased risk of severe acute malnutrition and death.

Overweight

Globally, an estimated 43 million children under-five years of age, or 7%, were overweight (i.e. weight-for-height above +2SD) in 2011 — a 54% increase from an estimated 28 million in 1990;

Increasing trends in child overweight have been noted in most world regions, not only developed countries, where prevalence is highest (15% in 2011). In Africa, the estimated prevalence under-five overweight increased from 4% in 1990 to 7% in 2011. The prevalence of overweight was lower in Asia (5% in 2011) than in Africa, but the number of affected children was higher in Asia (17 million) than in Africa (12 million).

Proper nutrition contributes significantly to declines in under-five mortality rates. Improving nutritional status is essential for achieving the Millennium Development Goals (MDGs).

The above estimates of the prevalence of stunting and underweight among children under-five years of age worldwide suggest that there have been decreases since 1990. The progress, however, has remained insufficient—leaving millions of children at risk of lower chances for survival. If current trends continue, UN regional projections for 2015 indicate that the goal of halving the 1990 underweight prevalence levels is unlikely to be achieved on a global level or in all developing countries. The same holds for stunting, for which the new target — a 40% reduction in the global number of children under-five years of age who are stunted by 2025 (since 2010) — remains out of reach under current rates of decline. Nonetheless, the declines in prevalence of underweight and stunting translate into substantial decreases in the number of affected children with a forecasted decrease of 11–13 million children by 2015.

Since 1990 the global prevalence of stunting has decreased 36%, from an estimated 40% (95% confidence limits: 38%, 42%) in 1990 to 26% (24%, 28%) in 2011 with an average annual rate of reduction of 2.1% per year during this period.

The number of stunted children under-five years of age in the world has declined from an estimated 253 million (241, 265 million) in 1990 to 165 million (151, 179 million). The global prevalence of underweight has declined 37% from 25% (23%, 28%) in 1990 to 16% (13%, 18%) with an average annual rate of reduction of 2.2% per year. Estimates from 2011 suggest stunting prevalence reductions of more than 40% in Asia and Latin America and the Caribbean since 1990. Reductions in Africa and Oceania have been more modest (10- 15%). During the same period, reductions in the prevalence of underweight were 56% in Latin America and the Caribbean (overall prevalence <10%), 41% in Asia, 28% in Oceania and 22% in Africa. In Least Developed Countries (LDCs) the prevalence of underweight decreased from 41% (32%, 52%) in 1990 to 23% (21%, 26%) in 2011 (Figure 4)—a 21% decrease from 37 million underweight children in 1990 to 29 million in 2011. While underweight prevalence is decreasing, increases in the under-five population in the LDCs counteracts this trend and results in stagnation in the proportion of the underweight burden numbers accounted for by LDCs since 2005.

Similarly, the prevalence of stunting in LDCs decreased from 60% (52%, 67%) in 1990 to 38% (35%, 42%) in 2011 (Figure 4). This decline accounts for an estimated decrease from 53 million stunted children in 1990 to 48 million in 2011 (an 11% decrease). Again, while stunting prevalence is decreasing, the increase in under-five population in the LDCs results in a continuing increase in the number of stunted children in LDCs. Across World Bank income groups as of 1 July 20125 (Figure 5),estimates of prevalence of stunting are highest among the low income country group and lowest among the upper middle income group.

Estimated prevalence of underweight are similar among the low and lower middle income groups yet remain consistently higher than those for the upper middle-income group. For overweight, the low and high-income country groups increase at a similar rate, but at different levels. Current estimates for the low and high-income country groups are 4% (3%, 6%) and 8% (6%, 12%) respectively. The low-income group is currently catching up with the lower middle-income group.

There is also an emerging face of malnutrition: childhood overweight and obesity. There are now 38.3 million overweight children globally, an increase of 8 million since 2000. The emergence of overweight and obesity has been shaped, at least in part, by industry marketing and greater access to processed foods, along with lower levels of physical activity.

The joint estimates, published in March 2020, cover indicators of stunting, wasting, severe wasting and overweight among children under five years of age, and reveal insufficient progress to reach the World Health Assembly targets set for 2025 and the Sustainable Development Goals set for 2030. According to the 2020 edition of the joint report, globally, 144.0 million children under five suffer from stunting, 47.0 million children under five were wasted of which 14.3 million were severely wasted, and 38.3 million were overweight.

According to WHO (2008) report, low body mass index (, 18.5kg/m^2) and/or short stature (height < 145cm) are prevalent among women in low-income countries. As a result, these women are prone to give birth to low birth weight baby. Due to this the mortality rates are higher among low birth weight children and these children are susceptible to various communicable diseases such as type 2 diabetes during adulthood.

Improving children's nutrition requires effective and sustained multi-sectoral nutrition programming over the long term, and many countries are moving in the right direction. Regular data collection is critical to monitor and analyse country, regional and global progress going forward.

3.2 Debates Relating Methodology and Measurement of Undernutrition

For the world with the prevalence of more than 850 million undernourished people, it is only natural to seek adequate explanation. Not only why such a staggering number of under-nourished prevails and persists , but also the nature of its distribution in different parts of the globe among different communities , caste gender and religion, have evoked keen interest among economists, medical scientists and policy planners in different corners of the globe, and there is a vast and expanding literature on the subject, which is too large to be reviewed extensively within the canvas of a single chapter. We shall, therefore, have to be selective and not exhaustive while reviewing the literature on under-nutrition, particularly in developing countries.

To begin with, let us consider that Nichter, M and C.Kendall (1991) have noted that health problems cannot be solved by either technology or a prescribed agency—one has to explore the importance of local structures- social, economic and symbolic- understand the dynamics of gender, class, ethnicity and community behaviour in order to understand the factors that govern health and nutrition of the people, particularly in the developing societies. Three main features of such a political economy approach to health and nutrition are worth noting (Roseberry, W,1988). First, it is historically and geographically specific where the behaviours of the local community which governs the extent of nutrition are influenced by social, political, economic and cultural processes. Second, it outlines the intersections of local interactions and relationships with larger domain of the actions of the state. Third, it concerns with the impacts of social interactions and structures that constrain daily life of individuals. In the literature on development economics, a holistic political economy framework have been used to gauge the influence of several micro and macro variables in influencing the status of under-nutrition of under 5 children. In such a framework, econometric methodologies have been developed with alternative types of specifications, using both unit level and macro level aggregative data.

Broadly speaking, we may distinguish between an input-based approach and an outcome based approach to our understanding of the causes and effects of under-nutrition .In the input-based approach, under-nutrition or nutritional deprivations were viewed as equivalent to intake deficiency, food insecurity, poverty and even hunger and famines, and in this thread, there have been vast literature relating nutritional status to each such category that constitutes the core of development discourse. There is no doubt that for policy planners, all these categories are important concerns. Expansion in the supply of food was one such concern, and the Green Revolution strategy was viewed as the solution to the food deficit economies facing deficiency in food intakes, entitlement failures, hunger and even famines. But by the early 1970s, the optimism gradually faded away and it was realised that although adoption of this strategy had dramatically increased food grain yields and reduced the dependency on food imports and food aid, this aggregate self sufficiency masked a substantial extent of individual food insecurity, defined as lack of access to sufficient food at the individual level, throughout. Inequality both between and within households, which implies a major failure in the distribution of food, marred the very purpose of ensuring food security to all which the Green Revolution strategy aimed at. Naturally, under-nourishment or nutritional failure continued in different parts of the globe, while debates on what is adequate food intake, what is optimal, and so on etc., continued. The Indian case was a pointer to this. In the early 1980s, food insecurity became linked to insufficient entitlements and lack of purchasing power for the poor (Sen, Amartya 1981) , and it was argued that under-nutrition was not a consequence of inadequate food supply, but rather due to his/her inability to participate in the market mechanism and claim entitlements of food. Due to social and economic inequality certain portion of the human race are denied access to entitlements of food and adequate nutrition and the institutions fail to protect the vulnerable and the hungry. The emergence of the entitlement approach led many state governments in India to undertake funding of food for programmes under various names. The mid day meal programme is a variant of such programmes (Devi Sridhar, 2008).

One major controversy in the literature on nutritional deficiency has been regarding the choice of the input-based vis-a-vis output oriented approach of measurement of under-nutrition. Some studies prefer to emphasize the nutrient intakes as coterminous with nutritional status, while others refer to health outcomes. In the first approach which was popular with the international agencies and researchers during the 1960s and 1970s, failure of adequate food intake was viewed as synonymous with undernutrition. Thus hunger, poverty , under nutrition or famine were conceived as the result of insufficient food supply, intake or entitlement failures. Certain difficulties were noted for the use of input-based measure like the Estimated Average Requirement (EAR).Firstly, a diet sufficient in calorie intake may satisfy the protein requirement, but may not cover micronutrient deficiencies like those in iron and vitamin A in many parts of the world. Secondly, when dietary surveys are carried out at the household level, there are serious under-reporting of the actual food intakes of different members of the household, and even when they report correctly, the application of common conversion factor from food intake to nutrient distribution are often found to be biased and unsatisfactory. The third difficulty with the input-based analysis arises when average intake was calculated at the household level, and the calorie intake of children was indirectly derived through application of coefficients based on the assumption that intra-familial distribution of food conformed to actual physiological need. Most striking studies in this regard had been by Reutlinger and Selowsky (1976), and Berg (1981), that characterized malnutrition for large groups of people based on a comparison of their average nutrient intakes with average nutrient requirements. Since there were sufficient intra-household variations in the distribution of nutrient intakes, it would be misleading to use average data as the true picture. Such distribution is often rooted in economic, social and cultural patterns which actually determine the allocation based on factors like gender, age, and birth order, and not necessarily by physiological requirements.

Due to the above types of difficulties involved in using input-based analysis, the WHO,UNICEF ,and the World Bank have shifted to output-based analysis since the early 1980s, based on comparing measurement of anthropometric indicators with a specified reference in order to assess the nutritional status of the population. This approach recognised that under-nutrition is a complex phenomenon covering a multitude of aspects, like body size and composition, physical activity, health outcomes, cognitive and motoring capacity and many other capabilities, and all these could not be approximated adequately by the use of singe one-dimensional composite indicator. The anthropometric approach hinges on the assumption that people's physical appearance reflects their nutrition status, and it is sufficient to work with such outcome indicators. Three main indicators are used under this approach – height-for –age, weight –for –height, and weight-for-age, and failures to satisfy the prescribed norm are indicated by stunting, wasting and underweight. Children below 5 years of age are judged for their nutritional status in terms of indicators of stunting, wasting and underweight in the literature on output-oriented measures for different parts of the globe. It may be noted that there are also some difficulties associated with the output based indicator of anthropometric measures, mainly due to their subjective and technical nature and failure to gauge hunger but this approach dominates the contemporary literature on child undernutrition.

There have been a large and contentious literature in nutritional anthropology on whether there should be a fixed standard or variability within the standard due to adaptation or other evolutionary mechanisms. Here we come across two opposing theories on human nutrition. The first theory of fixed anthropometric standard notion relies on the premise that a person's long-term nutritional requirements are predetermined and that variation in requirements across similar people is due to differences in their innate physiological characteristics. The second line of thinking argues that variability within a given standard are often conditioned by the fact that, within a wide range, a lower nutrient intake often triggers an auto-regulatory mechanism which permits an individual to adapt to the reduction in a costless manner (Dasgupta and Ray, 1990). While the adaptation theory received the backseat in the 1990s, it had been revived in the subsequent decade as the 'Indian paradox'.

Prior to 1985, the first theory on fixed physiological requirements was advocated primarily by the FAO and used by the World Bank and the WHO (FAO/WHO/UNU,1985).The nutritional requirement of 3,000 kcal/day for a 'reference man' was set by FAO in 1973, with 2,600 kcal/day for maintenance and 400 kcal/day for 'moderate activity' stipulated. The 'reference man' was conceived to be an adult male aged 20-39 years, weighing 65kg and living in an environment of 10^0 C. The FAO varied the requirements for different populations based on variance in innate physiology and in environmental conditions. Compared to the 3,000 kcal/day for the reference man, for the 'Indian man', the requirement was set by FAO at 2,800 kcal/day based on the understanding that an Indian man, on average, weighed less and lived in an ambient climate of 25^0 C. For many years, the FAO continued with fixed nutritional requirement approach, which varies among populations. However, in 1985, the FAO, the WHO, and the United Nations University, indirectly recognised the fact that men often adapt to different nutritional and environmental conditions. They created new energy requirement tables reflecting the wide range in body size and patterns of physical activities among individuals, as well as the additional energy needs for compensatory growth of malnourished children.

The adaptation hypothesis was advocated by P.V.Sukhatme and David Seckler in the early 1980s.Sukhatme argued that an individual's requirement for any day or period is not fixed, but dynamic adapting itself to intake over a range from 60 to 140 per cent of the average daily dietary allowance. This hypothesis, known as the 'Small but Healthy' hypothesis states that when faced with nutritional constraint , the child's body initiates a process of adaptation, which may reduce its growth- thus *stunting* allows the child to better cope with the nutritional constraints. Sukhatme's assertion that reduction in nutritional requirement following adaptation by the child does not necessarily act as a detriment to the child's well-being, led to debates. In fact, within this framework, Sukhatme lowered the nutritional requirement of the reference 'Indian Man' to 2300 kcal/day – 500 kcal/day lower than the requirement set by FAO. Sukhatme (1977) estimated that the incidence of poverty in India would decline from 50 percent to 25 per cent in urban areas, and from 40 to 15 per cent in rural areas, if allowances were made for variations in individual calorie requirements instead of using a fixed poverty line based on average calorie requirements. Thus, it is important to recognise that, given considerable inter-household variations in the conversion of nutrients into nutritional achievements, also sizeable 'intra-household' variations of intakes over time, it would be an exaggeration to identify all those falling below a pre-determined calorie norm as being under-nourished. Further, there may exist multiple equilibria, with the same person achieving different states of balance at different levels of average nutritional intakes.

Body size, level of activity one engaged in etc could be basis of adjustments and adaptation, but such a process might also be costly.

Seckler, like Sukhatme, also supported the adaptation hypothesis and propounded two theories of the growth of the child's requirements. The first is the 'Deprivation Theory of Growth', which states that every individual is born with a given, genetically determined, potential growth curve, and the ideal standard against which to compare communities is the growth curve of well nourished children. Any growth, which is significantly below this curve, is considered as ill health or under-nutrition. The underlying assumption of this theory is that there is no difference in the genetic potential of different population, and anything less than the full genetic potential implies prevalence of under-nutrition. Seckler himself discounted this theory and formulated his alternative theory of growth, known as the 'Homeostatic Theory'. According to the 'Homeostatic Theory of Growth', there is a range of adaptive growth in response to environmental influences. Seckler made three submissions in support of this position. First, the regulation of the rate of growth is likely an important defence mechanism against functional impairments due to caloric deficiency , a proposition which is akin to Sukhatme's claim of small body size without detriment to child well being. Secondly, Seckler argued that international standards such as the NCHS (1977) yield gross overestimation of the incidence of under-nutrition in developing nations like India by overestimating growth and energy requirements. Third, indigenous standards could be used so that under-nutrition is defined as the minimum size below which functional impairments are likely to occur. Since majority of individuals in developing nations have a body size adapted to local conditions, one need not characterise them as undernourished. He argued that Indian in general have a small body size due to their environmental circumstances, and that from ecological viewpoint, smallness has advantages.

This argument is often applied to nutrition of females in India, e.g. females can survive with less food because they have smaller body sizes than their male counterparts and therefore their nutritional requirements are less. Seckler argued that female members of a typical Indian household could be slightly better off than the males because they have less nutritional requirements. The counterpoint of this gender adaptation hypothesis is that deprivation in food intakes by the female often results in reduced longevity and quality of life. Female child malnutrition is arguably the main factor behind excessive female child mortality rates, especially for the under five age group (Sen, A.K., 1990).

There have been strong opposition to the ‘small but healthy’ hypothesis of Sukhatme and Seckler. Sven Williamson (2001) argued that even though genetic influences are important determinants of individual variation in height, differences in average height across populations are almost entirely the product of environmental influences, not genetics. Different studies in parts of northern India, Sri Lanka and Nepal indicate that preschool children from elite subgroups are anthropometrically similar to the NCHS (1977) reference population and are both heavier and taller than less advantaged children in the same region. R.S.Osmani (1992) states that although adaptation could be designed to avoid some adverse consequences, such as mortality, it does not preclude any adverse consequences of its own. The ‘small but healthy’ hypothesis did not take into account consequences like increased morbidity or lower probability of survival, both widespread among Indian population. In fact, the increased morbidity of Indian children is partly due the greater susceptibility to infection and disease, which is mainly due to their fragile state of nutrition. However, the most powerful and cogent critique of the ‘small but healthy’ hypothesis is provided by C.Gopalan, President of the Nutrition Foundation of India who argued that to accept Seckler’s views is to ‘acquiesce in the preservation the status-quo in poverty, ill-health, under-nutrition, and socio-economic deprivation’(Gopalan, C, 1992). Gopalan mentions the results of the study by the National Institute of Nutrition in 1973 that found that in an under-nourished community, an additional provision of 310 kcal could bring about significant improvements in the nutritional status and a reduction in protein-energy malnutrition. He argues that if standards are used to determine the magnitude of the problem, it is perverse to tailor them such that the sufferings could be minimised to manageable level. The ‘Indian Paradox’ phenomenon refers to the fact that with high rates of low weight-for-age,India as well as other South Asian Countries experience lower mortality rates than expected (David Pelletier et al (2001). Despite India having the highest rates of low birth weight infants, this was attributed to low risk factors like low maternal stature and low maternal body weight, and therefore the relation between smallness of the child body and child mortality, was found to be weak.

A threshold level of nutritional status was advocated by Payne (1992/2000) to be considered as reference period. Anyone falling below the threshold level will have nutritional deficiencies and so will be considered as undernourished. But these reference standards were later questioned as it may lead to over or underestimation of the number of children who are undernourished. An assessment of actual nutritional performances in comparison with the standard reference was considered necessary. R.S Osmani (1992) refuted the idea of fixed calorie intake as lower intake in one period may be compensated by higher intake in some other period- thus leading to possible miscalculation of children who are actually undernourished. There may be intra-personal variations in calories intake on individuals. It is argued that a person copes with nutritional constraints in the long run through the process of adaptation through changes in the process of human metabolism.

After fixed calorie intake approach was replaced by outcome based anthropometric measures of nutritional deficiency by the international agencies, came the three measures of undernutrition according to the Waterlow classification scheme. These measures are stunting or low height-for-age, wasting or low weight-for-height and underweight which is low weight-for-age (Svedberg, 2000/2002). The anthropometric indicators are expressed in standard deviation units (z-scores) from the median of the reference population. Stunting is the indicator of permanent or chronic undernutrition. Wasting measures body mass in relation to body length. It indicates current or short-term nutritional status. Underweight captures the long term and short term indicator of child undernutrition.

According to the Bulletin of WHO (2000), the nutritional status can be assessed using clinical signs of undernutrition, biochemical indicators and anthropometry. It said that anthropometry has an important advantage over other nutritional indicators. Biochemical and clinical indicators are useful only in cases of extreme cases of undernutrition. Again, anthropometric measurements are inexpensive and relatively easier to obtain. But there is a major disadvantage of anthropometric indicators. This is because changes in body measurements are sensitive to factors such as infection, attitude, stress and genetic background.

Svedberg also pointed out that the anthropometric indicators cannot provide exact estimate of children's nutritional status. He suggested a disaggregated plan of classification called composite index. According to him, the underweight indicator which captures low weight-for-age is a product of the other two predictors of undernutrition, namely stunting (low height-for-age) and wasting (low weight-for-height). So underweight includes children who are undernourished by several criteria.

In the late 1970s, The World Health Organisation (WHO) recommended the use of US National Center for Health Statistics (NCHS) standards for assessment of children nutritional status. Here the reference sample was the bottle or formula-fed infants of United States (Garza and de Onis, 2004). This standard was criticized because breastfed babies did not grow in a manner not conforming to the standards. Accordingly, in 2006, WHO presented a new Child Growth Standards to replace NCHS standards. This new WHO standard is based on children from Brazil, Ghana, India, Norway, Oman and United States) who are exclusively breastfed for the first 6 months and then are fed with recommended complementary food from 6 to 23 months.

It was pointed out that poor anthropometric status is responsible with around 50% of all deaths among children. The study of Rice et al.,(2000) also pointed out that malnutrition caused deaths with diseases like diarrhea and acute respiratory infections, but there was less association between nutritional status and death due to measles.For children with lower nutritional status, increased risk of death from malaria were also reported. Johansson et al.(1992) pointed out due to protein energy undernutrition, there is a possibility of disfunctioning of salivary gland and which may cause problem in the formation of proper tooth structure. They emphasized that undernutrition reduces the secreation rate of stimulated saliva which increases the possibility of children more susceptible to dental carries.

3.3 Factors Influencing Undernutrition

Factors influencing under-nutrition of children below 5 years of age are many , and different studies at different points of time at different parts of the globe have pointed out these factors. Most of these factors are socio-economic in nature, apart from the biological factors that govern the innate undernourishment of the children. Apart from food intakes, their availability and access, factors like income, inequality in asset-holding or income, educational level, primarily of mothers, mothers' health conditions like BMI or incidence of anaemia, social factors like gender bias, caste, even places of residence-rural or urban, and even the prevailing social practices of bringing up children, and the care given to them – are all considered important by various groups of researchers.

3.3.1 Household Income

Household income is considered as one of the most important factor affecting child health and nutrition. In a survey for 12 countries conducted by Haddad et al.(2000), found that there is a reduction in the rate of undeernutrition as the national income and income of the household increased in these countries. Using a four round panel data set from North –western Tanzania it was estimated by Alderman et al. (2006) that household income played an important role in predicting the degree of undernutrition. Also studies by Hachett et al.,(2009) found that household assets were the determinants of child undernutrition parameters in many countries. They emphasized that household assets and municipality average wage were the important predictors of child nutritional status. The study also emphasized that piped water availability influenced the child health. They conducted the study on a sample of poor Columbian children living in small municipalities. Chowdhury et al.,(2016), using multilevel logistic regression analysis showed that the age, sex of the child, the body mass index of the mother, educational status of the mother, religion, place of residence, and food security are important determinants of child undernutrition. The study was conducted using 2011 survey in Bangladesh. It was found that children from lower socioeconomic and community status and food insecure families were more prone to be iundernourished. Bassole (2007) found that provision for safe drinking water improves the height-for-age z-scores for Indian children of lowest income quantile. Also , it was argued by many studies that household income, assets , and access to safe drinking water , together not only improves the status of nutrition among under 5 children and mothers, but also contributes to achieving food security.

A descriptive, cross-sectional study in schools of Kaski district of Western Nepal among 786 students was conducted by Joshi et al.(2007). The study found than 26% of the students were underweight, 13% was stunted and only 1% was both stunted and wasted. It was found that the maternal socio-economic status and occupation are important determinants of the nutritional status of this group of school going children.

Place of residence

Several studies conducted all over the world emphasizes the influence of rural-urban place of residence on child health. According to Skinner AC et al., (2007) children belonging to the rural areas are more likely to have less access to health care facilities due to transportation difficulties and non-availability of health-care facilities. In a study by Antai D., et al.,(2011), it was found that children in rural areas in Nigeria, are deprived from full immunization and individual vaccines. This problem is also pointed in a study by Singh P.K. (2013), that rural children in India are disadvantaged in receiving full immunization. But Mahajan H, Sharma B. (2014), pointed that maternal and related child health care services were neglected in both urban and rural areas in India.

Again, the place of residence influences breastfeeding. According to Thu HN et al.,(2012), in Vietnam, exclusive breastfeeding is more common in rural areas. The duration of breastfeeding is also more in rural areas. However, it is found in the same study, that that the early initiation of breastfeeding is more often in the urban areas compared to thyeir rural counterpart. It was pointed out by Spark PJ(2010) that it is mother’s race or ethnicity and poverty status that influes the differences in the initiation of breatfeeding.

3.3.2 Diet and Undernutrition

Both diet and nutrition play important roles in the maintenance of health and prevention of disease.. An important source of essential nutrients is dietary supplements. This is because dietary supplements often contain 100% or more of the daily value, of one or more nutrients (Ervin, et al., 20004; Radimer et al,. 2004). Though it is true that in addition to nutrition, there are many life style and environmental factors which influence both health and wellbeing, but nutrition is a major and powerful factor in promoting health, preventing and treating diseases and improving quality of life.

The patterns of food consumption or diet are changing throughout the world and are driven by increasing income changes in individual preferences and other social factors (Kearney, 2010). Due to globalization of the countries and subsequent improvement in communication, dietary transitions were inevitable. It was identified by Popkin that there are five stages of nutrition transition based on signs of changes in food consumption pattern (Popkin, 2001a, 2001b). The changes in diet were recognized in countries with higher income. But eventually these changes were observed across the globe over time (Popkin, 2011). The transition related to nutrition has its base in the process of globalization though enlargement of transboundary food companies and super markets and through liberalization of foreign direct investments. Again advertising of different types of food items on a global scale as also commercialization of domestic agricultural markets (Hawkes, 2007) led to the changes with related to nutrition. This nutrition transition was first observed in United States as it developed through various stages of transition from traditional to totally modern diet (Popkin, 2011). It was found that In England, consumption of fat and refined carbohydrates increased five to tenfold in the late 1990s. At that time, the consumption of fibre rich grains declined (Uusitalo et al., 2002). Similar diversity was also observed in other countries. An increase in consumption of sugar, dairy products and meat and decrease in the consumption of cereals and legumes was observed in Chile (Vio et al., 2000).

The nutrition transition is also observed in the Latin American countries. It is found that globalization and urbanization had dramatic effects on dietary patters of Latin American countries. The traditional Latin American population experienced increased prevalence of overweight and obesity (Ivanova, 2010). A shift from dietary deficit to dietary excess was found in Brazil. This was possible due to urbanization and the emergence of market economy in the country (Monteiro et al.,2004). The nutrition transition practiced by developing nations of the world was outlined by expansion in domestic production and through import of oilseeds and vegetable oil. Since there was an increase availability of food products and as a result of changes in eating patterns, there was a reduction in under-nutrition but increase in childhood obesity (Drewnowski et al., 1997).

Indian Scenario

3.3.3 Estimates

The estimates by the World Bank (2009) were that India is one of the highest-ranking countries in the world in terms of child undernutrition. The estimate revealed that India has the highest previledge of underweight children in the world. According to WHO estimation, 34% of the world's stunted children, 49% of world's underweight children and 46% of the wasted children in the world reside in India. These prevalence rates vary across the states of India and its various demographic and socio-economic groups. The Report also revealed that states of Madhya Pradesh, Bihar and Jharkhand had the highest prevalence of child undernutrition. Considering the new WHO standards of 2006, it is found that 48 percent of the children in India below five years of age are stunted, 43 percent are wasted and 24, 16 and 6 percent of Indian children below five years of age respectively suffer from severe stunting, underweight and wasting (UNICEF, 2013).

According to National Family Health Survey (2005-2006) around 48% of children under the age of five are undernourished. The survey states the rate of underweight varies from 20% in Sikkim and Mizoram to 60% in Madhya Pradesh. Jharkhand and Bihar contributes around 50% of underweight children whereas Meghalaya, Chattisgarh, Gujarat, Uttar Pradesh and Orissa contribute more than 40% of underweight children.

The survey also reports that 48% of children under the age of five are stunted and one out of five children under the age of five years are wasted. Chakraborty, (2011) found that one-third of the children in Chattisgarh, Jharkhand and Madhya Pradesh had the highest prevalence of stunting, wasting and underweight. These states also reported poor dietary intake and lack of complete immunization of children.

A cross sectional study by Srivastava et al. (2011) revealed that the mean height and weight of slum residing school-age boys and girls was lower than Centres for Disease Control and Prevention standard 2000 standards. It was found that prevalence of stunting and underweight was highest in age group of 11 to 13 years, and the prevalence of wasting was predominant in the age group of 5 to 7 years. Regarding nutritional status of women and children in selected areas of Jharkhand, Kane, 2011 found that 29% of the children are wasted, 23% are severely wasted, 22% of children are stunted and around 23% are severely stunted.

Nandy et al. (2008) claimed that the standard measures of child undernutrition undervalue the actual situation and calculated an alternative Composite Index of Anthropometric Failure (CIAF) and found that children with multiple anthropometric failure are at a higher of morbidity. Nandy and Miranda. (2008) are of the opinion that standard measures of undernutrition parameters understate the actual figures and hence the alternative CIAF should be used. They calculated the CIAF taking data from India Human Development Survey data and compared the same with conventional indices. The CIAF is used to examine the connection between the direct subgroups of anthropometric failure, poverty and morbidity, explaining the fact that those children who suffer from multiple anthropometric failure are at a greater risk of morbidity and are children from low income households. Though stunting, wasting and underweight cast different biological processes, the CIAF gives a specific cumulative measure of undernourished children of a country. According to Nandy and Miranda, 2008, the CIAf measure of Indian children is around 60%.

3.4 Indian Debates on Methodology and Measurement of Undernutrition

The Indian debates on malnutrition followed closely the general debate at the international level between input-based approach and the outcome-based approach. During the 1970s, the Indian debates on under- nutrition were intertwined the debates on poverty in the country. Dandekar and Rath's seminal work on *Poverty in India*(1971), used consumption expenditure survey data of the National Sample Survey Organisation (NSSO) to estimate the incidence of rural and urban poverty in India on the basis of poverty lines which were rooted in per capita per day calorie requirements as were suggested by the nutritionists. Along the line of average nutritional requirement of 3,000 kcal/day for a 'reference man'engaged in 'moderate activity', as was set by FAO in 1973. Dandekar and Rath (1971) set the average calorie requirement of 2780 Kcal for the consumer unit of rural India as whole to estimate the cost of the poverty line basket to determine the incidence of rural poverty in India in 1971-72, using the NSS Consumption expenditure data and the calorie intake distribution. The "adaptationist' like Sukhatme and Seckler considered such estimates as utterly over-estimates and argued in favour of much lower average intake requirement per capita per day, on the ground that people adapt and that composition of the diet also matters. Dandekar (1981) countered the above arguments of Sukhatme and others by pointing to distinction between *poverty* and *malnutrition* [the former connoting to the inability to command a consumption basket that might be deemed as necessary minimum by some criterion, and the latter concept referring to the inability of a person to attain nutritional standard by allowing the possible source of variations in energy intakes between persons and within a person, depending on a set of factors] and enunciated the following proposition that *all under-nourished people may be poor, but all poor may not be undernourished.* It is important to recognise the fact that average calorie requirement need not necessarily be the minimum requirement for the typical Indian reference man. While it is one thing to identify the extent of malnutrition by suitably adjusting the cut-off level for the dynamic nutritional process, the real issues of nutritional deprivation should be judged in terms of much broader concepts like capabilities and functionings as suggested by Sen (1987), and elaborated by Dreze and Sen (1989).

Efforts to rank households by both energy intake and monthly expenditure per consumer unit using NSS data for Indian states continued and one such attempt was due to Kakwani (1989), who estimated that alternative head- count measures of under-nutrition by assuming average calorie norm of 2780 Kcal per consumer unit with a 15% / 30 % coefficients of variation around this value for both uniform distribution as well as normal distribution of calorie requirements. We may note certain propositions following such exercises. First, there exists substantial under-estimation when the estimates are derived from data based on expenditure ranking vis-a-vis rankings by calorie intakes. Secondly, the average calorie norm approach provides estimate that are very close to those obtained by using the entire distribution of calorie intakes, normal or uniform. Finally, the estimates of under-nutrition are not found to be very much sensitive to variations in coefficient of variations. When calorie intake and calorie requirements are correlated, the degree of under-nutrition is found to monotonically diminishing with the correlation coefficient in rural areas, but in urban areas, the relationship was found to be monotonically rising. More important, however, is to note that the nutritional deprivation in our country on an average is quite high and available evidences (for example, the actual intake data released by National Nutritional Monitoring Bureau for the rural areas of nine Indian states for the period 1975-82) reveal much lower intakes than the national average, and that the incidence of under-nutrition did not show much improvements over the period.

The NSS Consumer expenditure survey data for the 38th Round (1983) covered quantity estimates of each of the food items consumed by each of the households in the sample of 123, 000 people spread over rural and urban areas in India. These quantity estimates were converted into their equivalent intakes of calories with the help of appropriate conversion factors. B.S. Minhas (1991) had estimated that in 1983, 37.4% of the rural and 43.71% of the urban households remained below 2,430 caloric level (90% of the norm).The corresponding percentage below the 80% level, i.e. 2,160 calories were 35.09 and 29.29 respectively in rural and urban India. Moreover, the proportion of households having meal-adjusted calorie intake of less than 2160 Kcal varied in the rural sector from 11.15 % to 38, 39 , and 43 per cent, respectively in West Bengal,Tamil Nadu and Kerala, the average proportion for rural India as whole being 25%. Similar picture was also found in urban areas of India in 1983. Thus, we not only experienced significant under-nutrition in rural and urban sector of India during that period, but there were also considerable interstate diversity with respect to such nutritional deprivations.

Chatterjee (1996) used the NSS consumption expenditure survey data for the 27th and 38th rounds to estimate the incidence of under-nutrition in the state of West Bengal, took the recommended minimum calorie intake of a reference man engaged in moderate activity and then calculated Sukhatme's modified head-count measure of under-nutrition, namely (C-3σ)**,** where **σ** stand for the standard deviation of inter-individual and intra-individual variations in nutritional requirements depending upon height, body weight, metabolic absorption, type of activities engaged, age, environment etc. and C is the recommended calorie requirement of the reference man per day. Similar exercises were made with respect to protein deficiency of the people in rural and urban areas of the state of West Bengal. General findings were that compared to the corresponding estimates of calorie and protein deficiency, the state of West Bengal experienced between 27 th and 38th rounds- roughly a decade – a decline in the incidence of under-nutrition, particularly in the rural areas, albeit for the urban areas, the calorie deficiency showed a slight increment. For cereal consumption in West Bengal during this period, Chatterjee (1996) also estimated the intake deficiency index for people below the poverty line, and shown that for the rural areas in the state the average intake deficiency index for the poor recorded significant decline between these time periods-1973 to 1983.

The Indian literature on under- nutrition points to a puzzle posed by the detailed household consumption expenditure surveys conducted by the National Sample Survey Organisation (NSSO) every five years in India .The puzzle is that despite rising incomes, there has been sustained decline in per capita nutrient intake. Deaton and Dreze (2009) offered an analysis of the decline in nutrient intake over the period 1983 to 2004. Their principal findings are: (i) Average calorie consumption was about 10% lower in rural areas in 2004–05 than in 1983. The proportionate decline was larger among the more affluent sections of the population, and negligible for the bottom quartile of the per capita expenditure scale. In urban areas, there was a slight change in average calorie intake over this period.(ii) Proteins and other nutrients also experienced a drop in per capita consumption, whereas that of fat has increased in both rural and urban areas. (iii) As incomes rose over this period, these declines were puzzling. A contentious view offered by them is that the declines are not attributable to changes in relative prices as an aggregate measure of the price of food — treated synonymous with the price of calories — changed little during this period. So the puzzle boils down to this: per capita calorie consumption is lower at a given level of per capita household expenditure, across the expenditure scale, at low levels of per capita expenditure as well as high, i.e. there is steady downward shift of the calorie Engel curve. (iv) They argued that the downward shift of the calorie Engel curve was due to lower calorie 'requirements', associated mainly with better health and lower activity levels. This curve denotes a relationship between calorie intake and income proxied by expenditure.

Deaton and Dreze (2009) argued that in India the per capita real income and per capita consumption have risen steadily over the years and poverty level has also declined. Yet the per capita calorie intake on Indian population has not increased. Around 75 percent of Indian population resides in households where the per capita calorie consumption is below 2100 in urban areas and below 2400 in rural areas. Thus this set of population cannot meet the minimum calorie requirements in India. The authors refuted the idea of fixed calorie intake as reference standard of nutritional status. They have shown that on the one hand rise in real income has lead to a rise in calorie consumption, but on the other hand in health status through access better sanitation and hygiene practices have led to reduction in calorie intake. Hence, the authors contended that the reduction in calorie intake cannot necessarily lead to decline in child nutritional status.

Deaton and Dereze (2009) questioned the use of international anthropometric indicators in the Indian context. They argued that in state of Kerala, the percent of stunting, wasting and underweight of children below three years of age are 25, 16 and 23 respectively. Sub-Saharan African children have more or less similar levels of child under-nutrition but the infant mortality rate is much higher than that of the Indian state of Kerala. The authors also opined that child under-nutrition is quite high among the wealthier classes of the population. The study showed that the mean z-scores for all the three anthropometric parameters are negative for all wealth classes. Panagariya (2013) also pointed out that the child under-nutrition rates in India gives a wrong representation of the reality. He argued that by the methodology of calculating child under-nutrition rates is faulty and through appropriate corrections, India will certainly fare better rates of nutritional status than Sub-Saharan Africa.

3.5 Factors Influencing Undernutrition in India

Recent studies have drawn attention to the high prevalence of stunting among children in rural India. In fact, these estimates point to more pervasive deprivation than conventional measures of poverty based on income or consumption expenditure shortfalls imply. Since stunting reflects cumulative nutritional and health deprivation, it is likely to persist despite higher incomes. While income matters, other factors acting independently of it matter too. These include household size, whether household head is male, caste affiliation, mother's age at marriage, mother's age, age composition of children, male–female wage differences, hygiene and sanitation facilities, and prices of food items. So, while higher incomes will help mitigate stunting, careful attention must also be given to enhancing women's autonomy through more remunerative employment opportunities for them, enabling households to improve hygiene and sanitation facilities, and facilitating more competitive local markets for food. Thus, there have been plethora of studies on each of the three indicators of under-nutrition and their proximate determinants in India and the states, and most of such studies have relied on explicit econometric/ statistical formulations like multiple regression analysis, logistic regression and even panel data analysis to drive home the strength of alternative social economic factors influencing malnutrition among children and mothers in our countries. Some examples of such studies are the following:

There is a great deal of variability between low capabilities, such as undernourishment, and low incomes, and this relationship is conditional, differing by community, families and individuals. Deaton & Dreze (2002) show that improvements in income poverty went hand in hand with a decline in female–male ratio among children, from 945 girls per 1000 boys (in the 0–6 age group) in 1991 to 927 girls per 1000 boys in 2000.

The so-called Barker hypothesis posits that maternal dietary imbalances at critical periods of development in the womb can trigger an adaptive redistribution of fetal resources (including growth retardation). Such adaptations affect foetal structure and metabolism in ways that predispose the individual to later cardiovascular and endocrine diseases. In a meticulous review of available evidence, Svedberg (2000) cautions against hasty generalisations. He points out, for example, that the link between chronic undernutrition in childhood, as reflected in short stature, and work capacity in adulthood is far from straightforward. Although there is some evidence linking shortness to low maximum physical work capacity, this is so only among those who are considerably below the norm. Besides, tallness is an advantage only in some activities such as sugar and timber cutting, carrying heavy loads, digging or shovelling earth. In several other activities, tallness may not matter much. These activities include household tasks, and light agricultural work, in which quickness, flexibility and mobility matter more. A more recent review by Behrman *et al.* (2004) is, however, more emphatic on the link between stunting and productivity lost through lower school achievements. Of particular interest is a study by Alderman *et al.* (2003), based on a cohort of Zimbabweans over two decades. They report that, had the median pre-school child in the sample achieved the stature of a median child in a developed country, by adolescence she would be 4.6 cm taller, would have completed an additional 0.7 grades of schooling and started school seven months earlier. The loss of 0.7 grades of schooling and the seven-month delay translate into a 12% reduction in life-time earnings.

In India, NCHS reference population was used in NFHS-1 and NFHS-2, while the new WHO standards had been used in NFHS-3 and NFHS-4.

3.6 Socio- economic factors of child undernutrition

A longitudinal study was conducted by Devi P.Y and Geervani P (1994) in four villages of Medak district of Andhra Pradesh. 197 children up to 4 years old were selected from low-income households in the study area. Structured interviews were conducted to collect information on child-related, maternal, paternal, and socioeconomic factors from the households. It was found that incidence of diarrhea and inadequate calorie content in the diet are highly significant factors affecting a child's nutritional status. The results of this study showed a strong influence of socioeconomic status and parental care on the control of infectious diseases and food intake. These two factors are considered as two major causes for under-nutrition among children in developing countries.

Vinod K. Mishra et al (1999) examined the prevalence of chronic and acute malnutrition among Indian children. The lower prevalence of wasting than stunting or underweight indicates that chronic under-nutrition is more persistent in India than acute under-nutrition. Multivariate analysis of the effects of selected demographic and socio-demographic factors on child under-nutrition was done. The results indicated that the strongest predictors of child nutrition in India are child's age, child's birth order, mother's education, and household standard of living.

Irudaya Rajan and Navaneetham (1994), assessed the impact of mother's education on utilization of maternal and child health services using the data sources from three districts of Kerala. Acoording to the study, educated mothers use better antenatal and post-natal care, which results in better health of the mother and child. The study proved that 41 % mothers with no education received tetanus injections during pregnancy, whereas this was 82 percent among mothers who received 10+ years of education.

Mahapatra, A (2000) studied anthropometrical and clinical signs of nutritional deficiencies among a sample of pre-school children in Kalahandi district. The findings of the study revealed that thetre was nosignificant difference between boys and girls regarding nutritional status. It was also founfd out that children below one year of age had a relatively lower prevalence of undernutrition than the other age groups.

George, K.A. et al (2000) in their study, revealed that there is not much difference in the percentage of anaemic children among male and female. Statistical analysis showed that female children are more prone to anaemia.

Siddartha Ramaji (2011) observed that female child mortality is one and half times more than male child mortality in urban areas. He also pointed out that in India more attention is required in areas of female literacy, female empowerment and female socio-economic independence.

In a cross-sectional study by Srivastava et al. (2011) it was revealed that the mean height and weight of slum residing school-age boys and girls was lower than Centers for Disease Control and Prevention standard 2000 standards. It was found that prevalence of stunting and underweight was highest in age group of 11 to 13 years, and the prevalence of wasting was predominant in the age group of 5 to 7 years.

In a study by Chakraborty, (2011) on "Determinants of nutritional status in children under 5 years in India: a multilevel approach", the factors associated with nutritional status of children aged < 3 years were estimated by using data from NFHS 2. The result was that more than 50% of the mildly undernourished or severely undernourished children were from households with poor socio-economic status. Shoba Rao (2001) found that high prevalence of low birth weight, high morbidity and mortality and poor maternal nutrition were the major nutritional concerns in India. The study emphasized the relationship between maternal nutrition and fetal growth. Maternal nutrition also had a long term effect on early life under-nutrition. Interactions of prenatal nutritional experiences and post-natal undernutrition were some of the major issues, which was discussed in the paper.

Undernourished children are more susceptible to various illnesses. In a study by Gulati (2003) with a sample of 176 children attending pediatrics O.P.D., it was found that 75% of the children were undernourished according to Indian Academy of Pediatrics. Out of these undernourished children 50% of them were suffering from Acute Respiratory infections.

In an article, it was pointed out by Jean Dreze (2006) that about half of all Indian Children are undernourished and more than half suffers from anaemia and a similar proportion of children escape full immunization. He advocated an urgent need to re-examine the policies taken by India with regard to child survival and child well-being. The study addressed the structural rootds of child deprivation. The study also advocated making ICDS a lively political issue.

According to a study by Nirmala Lakshman (2006), India had a staggeringly high rate of children suffering from undernutrition. The study pointed out that one in three undernourished children of the world lives in India.

Mini.P.Jose et al (1999) in their study carried out in seven panchyaths of Ollukkara block of Thrissur district of Kerala. The children were categorized in to three groups based on maternal employment i.e., causal labourers, housewives and employment mothers from each group. It was found that the anthropometric indicators were independent of maternal employment. Here the study indicated that maternal employment had no significant positive or negative impact on the nutritional status of preschool children. This result had great social relevance as the women are being accepted in their role of wage earners to improve the economic status of the family.

George K.A (2000) conducted a study on relationship between anaemia and nutritional status among 3633 preschool children of 108 selected from anganwadi centers in rural areas of Kerala State during the period 1996 to 1998. Weight and height of children were measured for assessing their nutritional status. Chi square test was used to assess the relationship. It was found that the prevalence of anaemia was 11.4 %. Statistical analysis revealed that women are more susceptible to anaemia. It was found that among the 12% of mildly undernourished children were anaemic and around 16% of moderately undernourished children were anaemic

Demographic and epidemiological transition was also experienced by India. The process of globalization began in India from the year 1991 (Vepa, 2004). The surveys conducted by NSSO suggested that the per-capita cereal consumption in India has been declining from 1970s, though there was a significant increase in per-capita cereal production. In 1980s it was found that there was a substantial icrease in the consumption of dairy products and vegetables in India. In the 1990s, India saw an increase in the consumption of animal fats and less of consumption of vegetables (Pingali et al., 2004). The decrease in the consumption of cereal consumption was ascribed to modification of consumer preferences from food to non-food items. India also observed a shift from cereals to non-cereal food items (Radhakrishna, 2006). It was pointed out by Mittal (2003) that due to increase in per capita income and a decrease in the prices of cereal substitutes, people from low income strata of the population declined the cereal consumption to a substantial amount.

The consequences of such transition were chronic diseases and obesity, particularly in the urban areas (Shetty, 2002). Several other studies also indicated the implication of nutrition transition. The current food consumption pattern in India shows a decrease in the portion of food grain production and increase in non-foodgrain crops, animal products, beverages and other types of processed products. Gradually, food consumption pattern changed over the years in both rural and urban areas of our country. Through increased availability of cereal substitutes, growth of the middle class, more involvement of women in the workforce, inception of nuclear families, age-divide in preferences for food, blooming of supermarkets and fast-food outlets – all these have led to an increase in the general consumption of processed foods (Gaiha et al, 2012).

It was analysed by Pauscal (1971) that social and cultural factors influence the food habits and causes of undernutrition. The paper discussed the importance of socio-cultural factors like customs, beliefs food habits and traditions that affect the nutritional status of the population. On assessing the nutritional status of 941 adolescent girls belonging to scheduled caste communities in rural Rajasthan, it was found by Chaturvedi et al., (1994) , that the majority of the girls were defiant in calories, proteins, iron and vitamins.

3.7 Dietary Diversity

The distribution of food expenditure demonstrates the changes in food consumption pattern. It is income which is considered as the key factor in determining the distribution of expenditure between food and non-food items. As income increases, then people have more choices for spending. But since the food is the basic necessity, hence food gets the priority in the expenditure pattern of the poor. it is also true that the distribution of the food expenditure may vary according to food production and availability in different regions of our country. In India, we have wide variations in agro-climatic regions within the country.

Variations in food consumption pattern have an effect on the quality of diet. Hence to examine the quality of diet it is important to use dietary diversity indicators. According to Parappurathu et al., 2015, household dietary diversity may be used to measure the diet quality and understand how nutritional needs of household are met with. The study reported that there is an increase in dietary diversity of the households that availed the Public Distribution System (PDS).

According to Saaka etal, (2013), the household dietary diversity scores (HDDS), and food consumption scores (FCS) are most significantly associated with the BMI of mother and stunted growth of children.

In a study by Hackett etal, (1998), it was found that only vegetarian and macrobiotic diets are not adequate for young children.

A number of studies have found that the causes of undernutrition among children are diverse, but it is poor feeding practices which is the most important factor determining undernutrition. Meshram etal., 2013., found that too early or delayed initiation of complementary feeding and the quality, quantity and frequency of complementary feeding are responsible for undernutrition among infants and young children.

Breast-feeding has immunological properties and provides infant's nutritional requirements for the first 6 months of life. According to Madise et al., 1997; Froste, 2000, the age at weaning has a significant association with nutritional status. A study by Agrasada et al., 2011, those infants who are exclusively breastfed from birth to six months are likely to be protected from diarrhea as well as respiratory diseases. In another study by Onyango, 1998, it was observed that after controlling household economic and breastfeeding status, those children who had varied diet had better anthropometric measurements than those with limited diet.

A study by Mushaphi et al., 2008 reported that early initiation of complementary feeding is associated with the perception that mothers are sometimes not satisfied with breast feed alone and feel that their infants remain hungry if they arte not given infant complementary food. The study also reported that stunting and wasting are considerably higher among the bottle-fed infants.

It was agreed by Arimond etal., 2004, that dietary diversity in young children is associated with improved nutritional status. There are several studies which have considerably established that breastdfeeding significantly reduces the risk of both under and over nutrition. Thus, according to AVV/SCN, 2000, improving breast feeding and complementary feeding practices will help to improve the nutritional and survival status of children and also contribute to the well-being of future generations. Similarly, Esfarjani et.al. 2013 are of the opinion that adherence to dietary patterns which is rich in proteins and carbohydrates contribute to the reduction of the likelihood of children being stunted.

There is certain contradictory literature associated with the influence of prolonged breastfeeding on the nutritional status of children. Based on a nutrition survey in China, Taren et al., 1993, suggested that in populations where food was introduced late during infancy, better nutritional status of children was observed with prolonged breastfeeding. A study by Cousens et al.,1993 and Molbak et al.,1997, suggested that prolonged breastfeeding along with other supplements does not increase the risk of undernutrition. It also added that prolonged breastfeeding may reduce the risk of clinical underrnuitrition for those children who are already undernourished. This fact was also reported by Simondon et al., 1998 that low nutritional status of children may be a cause rather than a consequence of prolonged breastfeeding.

Borra et al., 2012 opined that breastfeeding might be a significant route for the intergenerational transmission of human capital. Poor nutrition starts before birth and extends into adolescent and adult life. Nandan et al., 2009 reported that insufficient nourishment continue into adulthood and passes on to the next generation.

It has found in literature that parents, especially mothers play an important role in what children actually eat. It had been rightly mentioned by Nankumbi et al., 2012 that the critical behaviours and practices of child caregivers related to breatfeeding, dietary diversity, food frequency and meal frequency affect health and development outcomes of children. In the Indian context, the mothers are the prime caregivers for her child. Hence, the food consumption pattern of mother is associated with the feeding practices of the child at very young ages and later when they grow-up.

3.8 Dietary Diversity in India

There is no denying the fact that diversity in the pattern of diets in India has its bearing on the state of under-nutrition among children and mothers.Given the large diversity of Indian population spread across the different states and regions, the socio-cultural factors also influence the type of diets taken by Indians. In the dietary pattern of a particular state, there may be bias in favour of cereal based calories, while in that of another state, there may be relatively larger weightage to protein diets. The crucial factor is the diversity conditioned by relative access to nutritious food by mothers and children of all expenditure groups. There have been studies on these aspects of child nutrition in India. For example, (Jha, R. et al 2008) made an interesting reference to the pattern of dietary diversity in Indian states and the connection between such diversity and child under nourishment.

The Indian economy is undergoing a rapid demographic transition. There is an accelerated economic during 1990s which raised the percapita income. As a result, a change in food consumption pattern is visible across all sections of the society irrespective of social hierarchy (Pingali, 2006; Popkin et al, 2012). Hence a study to understand the diversity in food consumption specially for infants is required so as to identify how the the feeding practices has evolved with time. It is also observed that regardless of the recent economic development and increase in food availability, India's performance in reducing undernourishment among children has not been satisfactory. There is a high prevalence of child underrnutrition and the country is scoring much less than other Asian countries, which are at similar levels of economic development. (UNICEF, 1990; Gragnolati et al., 1996; Ramalingaswami et al, 1996; Mariam et al., 2000; Svedberg, 2007; Kanjilal et al., 2010; Das and Bose, 2011; Mangeshkar, 2012). So not only food consumption pattern, but diversity in food consumption pattern is equally important for improvinfg the nutritional status of children.

Gaiha, Jha and Kulkarni (2010) reviewed the evidence on nutrient intake and dietary changes in India, particularly the downward shift in calorie, protein and other nutrient intake over the period 1993–2004 and provided a demand based explanation of this shift.

Their main findings are as follows:

(i) In rural India, except for calorie intakes up to 1300, there was worsening of calorie deprivation in terms of all FGT indicators;

(ii) In urban India too, there was worsening of calorie deprivation over a wide range of calorie norms;

(iii) Assessments of protein deprivation in both rural and urban India over the period 1993–2004 are dismal;

(iv) Except very low fat intake, there was a clear deterioration in rural (as well as urban) India in terms of the FGT class of deprivation indicators.

Thus, they argued that there was conclusive evidence of a sharp deterioration in nutritional deprivation over the period 1993–2004. Datt and Ravallion (2009) concurred with this view arguing that there had been a trend decline in all three FGT class indices of poverty over a period of 50 years, including 15 years of economic reforms. Both urban and rural poverty measures have declined.

The diversity in diet is not independently associated with nutritional status of children, it is influenced by several factors at the child, mother and household level. The individual preference of food along with the agro-climatic region in which the state falls, determines the diversity in diet, which in turn affects the nutritional status of children. For a healthy start to children from the early ages, the child feeding practices are absolutely crucial. This depends upon the nutritional knowledge of mothers. Therefore, diversity in feeding practices will determine the nutritional status of children.

In India, there is a significant inter-state variations in the nutritional status of children, hence the problem of child under-nutrition in India is quite complex. The feeding practices vary across regions, religions and income groups. Although there are studies that have been conducted to examine the changes in food consumption pattern, there are hardly any studies related to child feeding practices and its diversity and socio-economic differentials. Therefore, there is a need to explore the association between nutritional status and feeding practices of Indian children.

India experienced rapid economic and demographic transformation since the 1980s, whence the average living standards have undergone sustained and rapid rise, with GDP per capita rising by a trend rate of 4% annually, and poverty declined at an annual rate of 0.88% during 1983–94, and at 0.77% during 1993–05. Between 1980– 2000 the share of the urban population rose from 23 to 28 percent. It is also observed that regardless of the recent economic development and increase in food availability, India's performance in reducing undernourishment among children has not been satisfactory. There is a high prevalence of child underrnutrition and the country is scoring much less than other Asian countries, which are at similar levels of economic development. (UNICEF, 1990;

Gragnolati et al., 1996; Ramalingaswami et al, 1996; Mariam et al., 2000; Svedberg, 2007; Kanjilal et al., 2010; Das and Bose, 2011; Mangeshkar, 2012). So not only food consumption pattern, but diversity in food consumption pattern is equally important for improvinfg the nutritional status of children.

A key feature of the economic transformation has been the change in the nature of the Indian diet. As Indian and global markets integrated and communication improved, diet transitions become unavoidable resulting in a move away from inferior to superior foods and a substitution of traditional staples by primary food products that are more prevalent in western diets. These shifts were reflected in higher consumption of proteins, sugars, fats and vegetables. Some of the underlying factors behind this dietary transition were expansion of the middle class, higher female participation in labour markets, emergence of nuclear two-income families, a sharp age divide in food preferences (with younger age groups more susceptible to new foods advertised in the media), and rapid growth of supermarkets and fast-food outlets. In the 1980s, these dietary changes included (i) a sharp rise in consumption of both animal and vegetable products. (ii) the consumption of milk has the largest proportional increase among animal products. (iii) rice, pulses, wheat, spices, and oils constitute the largest increases among vegetable products. During the 1990s, significant changes in the pattern of food consumption included: (i) a marked increase in the consumption of animal products (especially animal fats), a relatively modest increase in consumption of vegetable products; (ii) among vegetable products, a large increase in the consumption of wheat, starchy roots, vegetable oils, sugar and sweeteners, and fruits (while that of rice, pulses and other cereals declined); (iii) among starchy roots, a sharp increase in potato consumption, given its predominance in energy-dense food products (e.g. fries and potato chips); (iv) a change in the use of wheat due to a move away from the traditional chapatti to more commercialized and westernized bread products. The health implications of such dietary transition are, however, unclear. There is a trade-off as more energy-dense foods are linked to higher incidence of diet-related non-communicable diseases (NCDs) such as diabetes, coronary heart disease and certain types of cancer. Although India lags behind other developing countries in the epidemiological transition — decline in infectious disease mortality compensated increasingly by higher mortality from chronic degenerative NCDs — there is some evidence of this transition taking place. The downward shifts in the calorie and protein intakes over the period 1993–2004 were associated with changes in diets. A demand-based explanation [Gaiha, Jha and Kulkarni (2010)] is often offered in which higher food prices and near stagnant expenditure/income in rural India played significant roles, while allowing for lower calorie 'requirements' due to less strenuous activity patterns, life-style changes and improvements in the epidemiological environment.

The diversity in diet is not, however, independently associated with nutritional status of children only, it is influenced by several factors at the child, mother and household levels. The individual preference of food along with the agro-climatic region in which the state falls determines the diversity in diet, which in turn affects the nutritional status of children. For a healthy start to children from the early ages, the child feeding practices are also absolutely crucial. This depends upon the nutritional knowledge of mothers. Therefore, diversity in feeding practices determines the nutritional status of children. In India, there is a significant inter-state variations in the nutritional status of children, hence the problem of child undernutrition in India is quite complex. The feeding practices vary across regions, religions and income groups. Although there are studies that have been conducted to examine the changes in food consumption pattern, there are hardly any studies related to child feeding practices and its diversity and socio-economic differentials. Therefore, there is a need to explore the association between nutritional status and feeding practices of Indian children.

3.9 Summing Up

The purpose writing a review of literature is to bring fore the issues relating to the study of a phenomenon. In this chapter, we have reviewed the research works on economics of child under-nutrition in the Indian Economy with special reference to the socio-economic factors affecting undernutrition among under five children in India and the states. Beginning with the general debate between input based estimates and outcome based estimates at the global level, we moved on to review the major contributions of the literature on child under nutrition in Indian economy, role of socio-economic factors, dietary diversity, level and growth of income, and mothers'contributions in understanding the incidence and persistence of under nutrition among children in the Indian states.

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Chapter 4

Patterns of Child Undernutrition in Indian States

4.1 Introduction

Improvements in child health are a key indicator of progress towards the third goal of the United Nations' Sustainable Development Goals: A universal guarantee of a healthy life and well-being at all ages. Undernutrition puts children at a greater risk of disease vulnerability, also adversely affects their physical, cognitive, and mental development, may adversely impact productivity in later life, and increase economic inequality. Globally, India performs poorly across standard child nutritional measures. For child malnutrition, India ranked 114 out of 132 countries, slightly ahead of Afghanistan and Pakistan. Data from India's nationally representative National Family Health Survey (NFHS), from 1992–1993 to 2015–2016, paint a bleak picture of child nutrition. Although the prevalence of stunting among under-five children decreased from 52% to 38% and underweight declined from 53% to 36% between 1992 and 2016, their prevalence is still alarmingly high. In 2016, India had 62 million stunted children, accounting for 40% of the global share of stunting. Large regional and interstate differences also exist with stunting over 46% and 48% in the states of Uttar Pradesh (India's most populated state) and Bihar.

The Global Hunger Index (2018) report, published by International Food Policy Research Institute (IFPRI) reveals that India has slipped from 95th rank in 2010 to 102nd in 2019 with the prevalence of wasting (low weight for height) among children under five mainly due to the poor performance of the country in controlling measures during the time period. The improvement from 38.9 % in 2005 to 32 % in 2010 was followed by a change from 32 % to 30.3 % between 2010 and 2019. The report also reveals that wasting among children in India rose from 16.5% in 2008-2012 to 20.8 % in 2014-2018. It also claims that 9.6% of all Indian children between 6 to 23 months of age are fed a minimum acceptance diet. The child wasting rate in India is the highest at 20.8% among all 117 countries. The persistent inequality in access to quality food is accentuated by stark inter-state disparities in nutritional status coupled with poor health infrastructure in most of the states.

The high prevalence of undernutrition among children under five years of age, adolescent girls and reproductive age women, was identified as the predominant risk factor for death in children younger than five years of age in every state of India in 2017 , and been considered as one of the leading factors restricting the growth potential of the country (GoI,2019). India is home to more than one-third of the world's malnourished children - 40 million children are stunted (height-for-age), 17 million are wasted (weight-for- height), half of the children under the age of three are underweight and a third of wealthiest children are overweight.

Till recently, child under-nutrition was considered endemic in South Asia. But the situation is different now. Both Bangladesh and Nepal had made significant progress in reducing child under-nutrition (Nisbett et al 2017: Cunnigham et al 2017). The performance of Sri Lanka has also been impressive in the last decade. It is India which is still lagging behind among the South Asian countries with respect to reduction of child under-nutrition. According to a report by UNICEF, 2013, India has more undernourished children than the whole of Africa.

But the Indian economy had an extraordinary GDP growth rate during first fifteen years of the present millennium and was considered as one of the fastest-growing economies of the world. But the anthropometric indicators of child under-nutrition in India were among the worst in the world. The latest Global Hunger Index (GHI), 2019 report points that the position of India is 102 among the 117 countries. The condition of India is considered as 'serious' as it ranks much below the other South Asian countries. The GHI is based on four parameters of which two are child under-nutrition indicators, namely, stunting and underweight. The GHI, 2019 also reports that India has the highest level of wasting (20.8%). India's position in GHi worsened over the years and according to GHI 2021, its position slipped down to 101st position among 116 countries compared to its 2020 position of 94th and is behind the neighbouring countries of Nepal, Pakistan and Bangladesh.

In order to understand whether India made any decent progress in reducing under-nutrition in the last two decades, and due to the fact that different states of India are at different levels of economic and social development, it would be of considerable interest to carry out a detailed analysis of inter-state differences in child undernutrition in India. An attempt has been made in this chapter to understand the extent of inter-state differences in child under-nutrition.

4.2 Interstate variations

Malnutrition refers to both undernutrition and overnutrition (obesity/overweight). The phenomenon of malnutrition refers to 'an abnormal physiological condition caused by inadequate, excessive or imbalanced intake in macronutrients: carbohydrates, protein, fats- and micronutrients', whereas under-nutrition is condition where the body does not have adequate amounts of one or more nutrients and usually reflects as outcomes the various anthropometric indicators of human body. The principal indicators used under this category are height-for-age, weight-for-height, and weight-for-age, and for the undernourished these are reflected in retardation of body size (stunting), low weight-for-height (wasting), and underweight for children under the age of 5 years. These three indicators are chosen to capture different aspects of child under-nutrition that have partly different etiologies and time dimensions. The height-for age indicator is mainly used for monitoring permanent or chronic under-nutrition in children, while the weight -for -height indicator is used to monitor wasting, which reflects temporary or short-term under-nutrition. The weight-for- age indicator is intended to capture both short-term and long-term under-nutrition, and it has been widely used by national and international agencies and researchers in developing countries. There have been asymmetries in the levels of development in Indian states, and no set pattern of association between high growth performance and nutritional status of under five children could be discerned. Like asymmetries in the levels of development in Indian states, the three anthropometric outcome indicators of child under-nutrition also exhibit inter-state variations and also changes over time. The three summary indices of nutritional status, namely, weight-for-age; height-for-age, and weight-for-height also show considerable inter-state variations ,between different nutritional survey rounds. Hence, the relative ranking of the states have also undergone changes. For example, the states having high percentage of stunted and underweight children under the age of five, include not only states like Bihar, Jharkhand, Uttar Pradesh, Madhya Pradesh and Rajasthan, but also Gujarat which contributes highly to national GDP and total exports of the country, and tops the list after Jharkhand for having children wasted and severely wasted less than five years of age. The present chapter offers an analysis of such inter-state variation in child under-nutrition in India.

Poor nutrition has several dimensions, of which stunting (the percentage of children, aged 0 to 59 months, whose height for age is below minus two standard deviations (moderate and severe stunting) and minus three standard deviations (severe stunting) from the median of the WHO Child Growth Standards);wasting (Percentage of children below five years whose weight for height z-score is less than 2 SDs below the median compared to the WHO child growth standards.); underweight (weight at birth of < 2500 grams (5.5 pounds); overweight/obese(A person with a BMI of 30 or more is generally considered obese. The z-score is calculated with the help of the following formula:

$$Z_i = (A_i - \mu)/\sigma$$

where z_i mentions the z-score for the specific indicator for the child.

μ and σ are the median and standard deviation of the International Reference Population

Children with the height-for-age z-score < -2 SD (Standard Deviation) from the median of the International reference population are regarded as short for their age (Stunted). Children whose weight-for-height z-score <-2SD from the median of the International Reference population, is said to be thin for his/her height or wasted. Since weight-for-height (underweight) is composite indicator of chronic as well as acute under-nutrition, it which takes into consideration both height-for-age as well as weight-for-height. Children with z-score <-2SD from the median of the reference population are classified as underweight.

The Ministry of Health and Family Welfare (MOHFW), Government of India in collaboration with the International Institute of Population Sciences (IIPS) had conducted a large scale multi-round survey of sample households, the National Family Health Survey(NFHS) since 1992-93 to elicit state and national level information for India in respect of fertility, infant and child mortality, maternal and child health, nutritional status of children and mothers, practice, utilization and quality of family planning, anemia , and related socio-economic variables. So far, four rounds of NFHS surveys have been completed and the Fifth round of survey started and was stopped due to the outbreak of the Corona pandemic last year. The four completed rounds of such surveys- NFHS-1 for 1992-93, NFHS-2 for 1998-99, NFHS-3 for 2005-06 and NFHS-4 for 2014-15 constitute the primary basis of analyzing child under-nutrition in our country.

Table 4.1: Three Anthropometric Indicators of Child Undernutrition in Indian states in terms of NFHS-1 and NFHS-2 surveys (With Ranks)

Name	NFHS-1	NFHS-2	Rank-1	Rank-2	NFHS-1	NFHS-2	Rank-1	Rank-2	NFHS-1	NFHS-2	Rank-1	Rank-2
Delhi	43.2	36.8	8	11	11.9	12.5	7	12	41.6	34.7	8	11
Haryana	46.7	50.0	10	18	5.9	5.3	2	2	37.9	34.6	6	10
Himachal Pradesh	U	41.3	-	14	U	16.9	-	17	47.0	43.6	12	16
Jammu Region of J&K	48.8	38.8	13	12	14.8	11.8	9	11	44.5	34.5	9	9
Punjab	40.0	39.2	5	13	19.9	7.1	16	3	45.9	28.7	11	8
Rajasthan	13.1	52.0	7	21	1935	11.7	15	10	41.6	50.6	8	21
Madhya Pradesh	U	51.0	-	20	U	19.8	-	18	57.4	55.1	22	24
Uttar Pradesh	59.5	55.5	17	23	16.1	11.1	11	9	59.0	51.7	23	22
Bihar	60.9	53.7	18	22	21.8	21.0	19	21	62.6	54.4	24	23
Orissa	48.2	44.0	12	16	21.3	24.3	18	23	53.3	54.4	18	23
West Bengal	U	41.5	-	15	U	13.6	-	15	56.8	48.7	21	19
Arunachal Pradesh	53.9	26.5	16	3	11.2	7.9	5	4	39.7	24.3	7	3
Assam	52.2	50.2	15	19	10.8	13.3	4	14	50.4	36.0	17	12
Manipur	33.6	31.3	4	5	8.8	8.2	3	5	30.1	27.5	4	5
Meghalaya	50.8	44.9	14	17	18.9	13.3	14	14	45.5	37.9	10	15
Mizoram	41.3	34.6	6	8	2.2	10.2	1	7	28.1	27.7	1	6
Nagaland	32.4	33.0	2	7	12.7	10.4	8	8	28.7	24.1	3	2
Tripura/ Sikkim	46.0	31.7	9	6	17.5	4.8	13	1	48.8	20.6	14	1
Goa	32.5	18.1	3	1	15.3	13.1	10	13	35.0	28.6	5	7
Gujarat	48.2	43.6	12	16	18.9	16.2	14	16	50.1	45.1	16	18
Maharashtra	48.5	39.9	13	12	20.2	21.2	17	22	54.2	49.6	19	20
Andhra Pradesh	U	38.6	-	10	U	9.1	-	6	49.1	37.7	15	14
Karnataka	47.6	36.6	11	9	17.4	20.0	12	20	54.3	43.9	20	17
Kerala	27.4	21.9	1	2	11.6	11.1	6	9	28.5	26.9	2	4
Tamil Nadu	U	29.4	-	4	U	19.9	-	19	48.2	36.7	13	13
India	**52.0**	**45.4**	-	-	**17.5**	**15.5**	-	-	**53.4**	**47.0**	-	-

Source: NFHS –1 & NFHS-2 Published Reports.

In Table 4.1, we have portrayed the nutritional status of under five children in Indian states as are revealed through NFHS 1 and NFHS 2 Surveys, with ranking of the states. With respect to the first indicator that is used to reflect stunting, states like Kerala, Nagaland ,Goa, Manipur, Mizoram , Punjab , Rajasthan and Delhi exhibit better performance compared to worse performing states like Bihar, Uttar Pradesh, Assam, Arunachal and even Maharashtra during the NFHS -1 survey period , i.e., 1992-93. During the NFHS-2 survey period of 1998-99, States which improved their ranking in terms of the indicator for Stunting –some dramatically, and some moderately, included Arunachal, Goa, Tripura & Sikkim, but those states whose ranking worsened dramatically included Bihar, Uttar Pradesh , Rajasthan, Assam , Punjab and Haryana, Secondly, with respect to the second indicator of Weight-for-Height (Wasting), between the first two NFHS Survey rounds, the diversity across states were also visible , and the states that could improve their standing with respect to wasting included Punjab, Tripura, U.P. and Rajasthan, whereas Karnataka, Maharashtra, Gujarat, Goa, Assam, Orissa, Bihar worsened their relative positions. In both these indicators, the data on West Bengal was not recorded for the NFHS-1, so we could not report their inter-temporal changes in rankings with respect to these two indicators of child under nutrition. With respect to the third indicator, namely, weight-for-age (Underweight) , the states which worsened their relative positions between the two rounds were Delhi, Haryana, Himachal Pradesh, Rajasthan, Madhya Pradesh, Orissa, Gujarat and Maharashtra, with Bihar, U.P. Tamil Nadu remaining more or less stable. Improvements in some other states also were moderate in order.

The reason for picking up the first two rounds of NFHS surveys for starting the analysis of inter-state variation in nutritional outcomes and their inter-temporal changes need be made explicit at this stage. The validity of these indices is determined and influenced by many factors, including the coverage of the population of children and the accuracy of the anthropometric measurements. Some such factors are state-specific, while others are general in nature. When the NFHS-1 Survey was launched in 1992-93, both height and weight, measurements for all children below the age of four years were to be obtainable, but in the first phase, in states like Andhra Pradesh, Himachal Pradesh and West Bengal, only the weights were recorded, because the boards for measuring heights were not available. For children below the age of 2 years, estimates of height /length were based on adjustable boards with children lying down, while for elders, the measurements were taken in a standing position. The complete sample of children under 5 years' age was not chosen in NFHS-1 in any stage. It is true that in the NFHS-2, such deficiencies in scale were rectified, but the target sample group was under 3 years in some states and under 4 years in some other states. Moreover, in the NFHS-2 survey, it was admitted that often it was not possible to measure the height and weight of all eligible children, usually because the child was not at home at the time of the health investigator's visit or because the mother refused to allow the child to be weighed and measured. In India, NFHS-2 did not measure 13 percent of children under age three, and also excluded from the analysis were children whose month and year of birth were not known and those with grossly improbable height or weight measurements.

Thus, the changes in methodology and/or measurement scales during the first two rounds of NFHS Surveys make the outcome data strictly non-comparable and the possibility of errors creeping in could not be ruled out. Moreover, in both NFHS-1 and NFHS-2, unit level data were not released and reliance on aggregative estimates makes such estimates non-comparable and often non-compatible with NFHS-3 and NFHS-IV estimates that have much more comprehensive coverage, and are based on rigorously selected samples. We have therefore focused our subsequent analysis of inter-state variations in nutritional outcomes of under 5 years children on NFHS-3and NFHS-4 surveys using the unit level data as the basis of our analysis of not only of such state level averages, but also on their proximate determinants, which we shall attempt in subsequent chapters.

There have so far been four rounds of such surveys- NFHS-1 for 1992-93, NFHS-2 for 1998-99, NFHS-3 for 2005-06 and NFHS-4 for 2014-15. Since different states of India are at different levels of economic and social development, it would be of considerable interest to carry out a detailed analysis of inter-state differences in child under-nutrition in India We now focus on NFHS-3 and NFHS-4 for the purpose of comparing all the states in India on the basis of unit-level information on child undernutrition collected in these two rounds because the data in these two rounds are strictly comparable in terms of statistical significance and correctedness in the choice of the sample households of much larger numbers. In total, 29 states in India are considered in both NFHS 3 and NFHS 4. A subset of 36,066 children from NFHS 3 and a subset of 1,71,029 from NFHs 4 was considered from all the 29 states in India. We use the three anthropometric indicators of child undernutrition as mentioned earlier. In the first stage, we calculate the z-score of all the three indicators of undernutrion , namely, stunting, wasting and under weightage, and then calculate UN, defined as the percentage of children under five years of age who are stunted, wasted and underweight in NFHS-3 and NFHS 4. The relative measure $RUN_{STATE} = 100 * (UN_{STATE} / UN_{NATION})$. The state relatives RUN are the degree of undernourishment among children in the state compared to the national average between the two rounds of NFHS Surveys. These are reported in Tables: 4. 2, 4. 3, and 4. 4 below respectively.

Table 4.2: Height-for- Age z-scores with rank

States	z-score NFHS-3	z-score NFHS-4	Change*	Rank NFHS-3	Rank NFHS-4	Change Rank
Haryana	-1.75	-1.19	0.56	21	12	5
Himachal Pradesh	-1.46	-1.21	0.26	8	13	22
Punjab	-1.42	-1.18	0.25	7	11	24
Rajasthan	-1.52	-1.30	0.22	10	20	26
Uttaranchal	-1.61	-1.27	0.34	11	18	20
Chattisgarh	-2.14	-1.52	0.62	26	26	4
Madhya Pradesh	-2.17	-1.49	0.68	27	25	3
Uttar Pradesh	-2.25	-1.76	0.49	29	29	11
Bihar	-2.18	-1.72	0.46	28	28	14
Jharkhand	-1.97	-1.62	0.35	23	27	19
Orissa	-1.76	-1.37	0.39	22	22	24
West Bengal	-1.62	-1.38	0.24	12	23	25
Arunachal Pradesh	-1.63	-1.09	0.54	15	6	6
Assam	-1.73	-1.29	0.44	19	19	16
Manipur	-1.35	-1.17	0.18	4	10	27
Mizoram	-1.66	-1.15	0.52	16	9	7
Nagaland	-1.36	-1.07	0.29	5	5	21
Gujrat	-2.12	-1.33	0.79	24	21	2
Maharashtra	-1.72	-1.25	0.47	18	16	13
Andhra Pradesh	-1.69	-1.24	0.45	17	15	15
Karnataka	-1.74	-1.26	0.48	20	17	12
Kerala	-1.07	-0.57	0.50	1	1	9
Tamil Nadu	-1.08	-0.98	0.10	2	4	28
Delhi	-1.62	-1.20	0.42	13	13	17
Meghalaya	-2.12	-0.87	1.25	25	3	1
Sikkim	-1.49	-1.43	0.06	9	24	29
Tripura	-1.62	-1.11	0.51	14	7	8
Goa	-1.21	-0.71	0.50	3	2	10
Jammu & Kashmir	-1.40	-1.14	0.26	4	8	23
Change* = z-score of NFHS4 – z-score of NFHS3 & Rank = Rank of states in ascending order						

Source: NFHS-3 & NFHS- 4 Surveys.

Table 4.3: Weight-for-Height z-scores with rank

States	z-score NFHS-3	z-score NFHS-4	Change*	Rank NFHS-3	Rank NFHS-4	Change Rank
Haryana	-1.07	-0.81	0.26	18	11	6
Himachal Pradesh	-1.02	-0.69	0.33	17	9	4
Punjab	-0.62	-0.63	-0.01	5	7	18
Rajasthan	-1.19	-1.19	0	24	24	17
Uttaranchal	-0.81	-0.99	-0.18	11	17	23
Chattisgarh	-1.16	-1.21	-0.05	22	25	20
Madhya Pradesh	-1.55	-1.22	0.33	29	26	4
Uttar Pradesh	-0.72	-1.06	-0.34	8	19	26
Bihar	-1.35	-1.18	0.17	27	23	9
Jharkhand	-1.42	-1.35	0.07	28	29	14
Orissa	-1.17	-1.08	0.09	23	21	13
West Bengal	-0.86	-1.05	-0.19	13	18	24
Arunachal Pradesh	-0.65	-0.61	0.04	6	5	16
Assam	-0.88	-0.78	0.1	14	10	11
Manipur	-0.55	-0.39	0.16	4	2	10
Mizoram	-0.26	-0.16	0.1	1	1	12
Nagaland	-0.48	-0.42	0.06	2	4	15
Gujrat	-1.09	-1.29	-0.2	19	28	25
Maharashtra	-0.82	-1.27	-0.45	12	27	29
Andhra Pradesh	-0.68	-1.07	-0.39	7	20	27
Karnataka	-1.01	-1.15	-0.14	16	22	21
Kerala	-0.89	-0.65	0.24	15	8	8
Tamil Nadu	-1.12	-0.88	0.24	21	14	7
Delhi	-0.53	-0.96	-0.43	3	15	28
Meghalaya	-1.34	-0.62	0.72	26	6	1
Sikkim	-1.11	-0.41	0.70	20	3	2
Tripura	-1.26	-0.84	0.42	25	13	30
Goa	-0.79	-0.97	-0.18	10	16	22
Jammu & Kashmir	-0.76	-0.81	-0.05	9	12	19
Change*= z-score of NFHS-4 – z-score of NFHS-3 & Rank = rank of states in ascending order						

Source: NFHS-3 & NFHS- 4 Surveys.

Table 4.4: Weight-for-Age z- scores with rank

States	z-score NFHS-3	z-score NFHS-4	Change*	Rank NFHS3	Rank NFHS4	Change Rank
Haryana	-1.73	-1.35	0.38	19	15	9
Himachal Pradesh	-1.62	-1.19	0.43	15	8	6
Punjab	-1.25	-1.20	0.05	7	9	24
Rajasthan	-1.75	-1.67	0.08	20	24	21
Uttaranchal	-1.69	-1.32	0.37	18	13	10
Chattisgarh	-1.89	-1.73	0.16	25	26	18
Madhya Pradesh	-2.41	-1.86	0.55	29	29	2
Uttar Pradesh	-1.78	-1.65	0.13	22	23	19
Bihar	-2.25	-1.72	0.53	28	25	3
Jharkhand	-2.23	-1.81	0.42	27	28	7
Orissa	-1.79	-1.45	0.34	23	18	12
West Bengal	-1.68	-1.44	0.24	17	17	15
Arunachal Pradesh	-1.37	-1.06	0.31	10	6	13
Assam	-1.57	-1.36	0.21	13	16	16
Manipur	-1.28	-0.86	0.42	8	4	8
Mizoram	-1.12	-0.75	0.37	2	1	11
Nagaland	-1.22	-0.96	0.26	5	5	14
Gujrat	-1.76	-1.64	0.12	21	22	20
Maharashtra	-1.62	-1.73	-0.11	15	26	29
Andhra Pradesh	-1.51	-1.49	0.02	12	19	25
Karnataka	-1.60	-1.53	0.07	14	21	23
Kerala	-1.18	-1.16	0.02	4	7	26
Tamil Nadu	-1.29	-0.81	0.48	9	2	4
Delhi	-1.39	-1.22	0.17	11	10	17
Meghalaya	-2.07	-1.50	0.57	26	20	1
Sikkim	-0.92	-0.84	0.08	1	3	22
Tripura	-1.81	-1.33	0.48	21	14	5
Goa	-1.18	-1.24	-0.06	4	12	28
Jammu & Kashmir	-1.25	-1.23	0.02	7	11	27
Change*= z-score of NFHS 4 – z-score of NFHS 3 & Rank = rank of states in ascending order						

Source: NFHS-3 & NFHS- 4 Surveys.

Table 4.2: presents the height-for-age z scores for children less than five years for NFHS 3 and NFHS 4. It can be observed that India had made progress in reducing the prevalence of stunting over a period of ten years. Given this endured progress in stunting, it is important to find out whether this reduction in stunting is experienced by all states of India.

We can observe that Kerala has retained its position at number one among all the other states in both the NFHS. Tamil Nadu, which was in position 2 in NFHS 3 moved to 4th position in NFHS 4. The position of the states of Haryana, Rajasthan, Arunachal Pradesh, Mizoram, Tripura and Meghalaya improved in NFHS 4 compared to NFHS 3. The position of other southern states apart from Kerala has deteriorated. A sharp deterioration is observed for the state of West Bengal, Rajasthan and Sikkim. There are few states that have retained their positions at the same place in both the NFHS. These states are Bihar, Uttar Pradesh and Chhattisgarh.

When we rank the changes in height-for-age z scores, it can be observed that Meghalaya is able to make maximum changes, followed by Gujarat, Madhya Pradesh, Chhattisgarh, Haryana, Arunachal Pradesh and Mizoram. Though Kerala registered lowest level of stunting, it ranks in the 9th position among the other states in terms of improvement in the z-scores of height-for-age child undernutrition parameter. States of West Bengal, Tamil Nadu and Sikkim fared lowest in term improvement in stunting from NFHS3 to NFHS 4. It is striking to observe that though the position of Gujarat is at a lower end in both the NFHSs, but in terms of improvement in the z-scores for stunting, the state is at second position among the other states of our country. On the contrary, Goa and Kerala are the states, which recorded better anthropometric score in both the NFHSs, but the position in terms of improvement of the score is quite low. The position of Punjab and Nagaland are on a better end for both the NFHS. But in terms of improvement in stunting rates, both the states have fared very low.

Thus, a comparison between the two NFHS report brings out a myriad picture of the position of different states of our country. It can be seen that the z-scores have improved for all the states of our country from NFHS 3 to NFHS 4. When we compare the positions of the states in the two NFHS it can be seen that some states have improved their position considerably from NFHS 3 to NFHS 4. Some states like the state of Kerala, Tamil Nadu, and Sikkim maintained the top position in both the NFHS, other states like Bihar, Uttar Pradesh, Madhya Pradesh, Chattisgarh, Jharkhand, Orissa, Gujarat and Maharashtra retained their lower rank in both the NFHS. In terms of change in z-scores over a period of ten years from NFHS 3 to NFHS 4, it can be observed that while some states have taken strides to improve their position, others have been lagging behind.

Table 4.3: shows the position of different states in India in terms of weight-for-height z scores. A look into the table will show that Mizoram has maintained the first rank in both NFHS 3 and NFHS 4. It can also seen that two other north eastern states have interchanged their positions in the two NFHSs. Manipur has improved to second position in NFHS 4 from the 4th rank in NFHS 3 . Nagaland which was in 2nd position in NFHS 3 has gone down in 4th position in NFHS 4. The state of Kerala which has performed outstandingly in terms of its position in stunting, has not fared well in terms of wasting. It can be seen from the above table that Kerala ranks 15th in NFHS 3 among all the other states in India. It has improved its position to 8th in NFHS 4.There are certain states which have improved their position in NFHS 4 compared to their position in NFHS 3. These states are Haryana, Himachal Pradesh, Bihar, Madhya Pradesh, Assam and Tamil Nadu. Remarkable improvement in rank is observed for the states of Meghalaya and Sikkim. While there are certain states whose position has deteriorated in NFHS 4 from their position in NFHS 3. These states are Uttaranchal, Uttar Pradesh, West Bengal, Gujarat, Maharashtra, Andhra Pradesh, Karnataka, Delhi and Goa. There are still certain states, which have retained same ranks in both the NFHSs. These states are Chattisgarh, Jharkhand and Orissa.

When we consider the changes in ranks of the states in terms of changes in z-scores, it can be observed that Meghalaya, Sikkim and Tripura have made great strides to improve their status of wasting among children. Madhya Pradesh, Himachal Pradesh, Bihar and Tamil Nadu have also taken steps to improve their sates of wasting as compared to other states of our country. It can be also observed that in certain states the rate of wasting has increased in NFHS4 compared to NFHS3. These states are Punjab, Uttaranchal, Chattisgarh, Uttar Pradesh, West Bengal, Gujarat, Maharashtra, Andhra Pradesh, Karnataka, Delhi, Goa and Jammu and Kashmir. As a result, Gujarat, Maharashtra, Andhra Pradesh, West Bengal, Uttar Pradesh, Delhi and Karnataka are the states, which are found to occupy the bottom level ranks in terms of changes in z-scores in the two rounds of Health Family Survey.

Table 4.4: shows the position of different states in terms of weight-for-age z scores. It can be seen from the table that state of Mizoram, which was ranked second in NFHS 3, has occupied the first position in NFHS 4. On the other hand, Sikkim, which was ranked first in NFHS 3, bagged the 3rd rank in NFHS 4. There are several states of India who have improved their position from NFHS 3 to NFHS 4. These states are Himachal Pradesh, Arunachal Pradesh, Manipur and Tamil Nadu. Again there are certain states whose position deteriorated from NFHS 3 to NFHS 4. These states are Rajasthan, Assam, Maharashtra, Andhra Pradesh, Karnataka, Goa and Jammu & Kashmir. Madhya Pradesh and Nagaland remained at the same rank in both the NFHSs. In terms of changes in z-scores, it can be observed Meghalaya has made the maximum effort to reduce the state's child weight-for-age z scores among all the other states of our country. Though Madhya Pradesh remained at the lowest rank in both the NFHSs , it has tried to make a huge effort to reduce its rate of child underweight z-scores. Again, though Bihar is ranked at the lower end in both the NFHSs, it has made significant strides with regard to improvement in child underweight rates. Again, Tamil Nadu, which has improved its position from NFHS 3 to NFHS 4, it is among the first four states in terms of improvement in child underweight rates. The states of Goa, Sikkim, Kerala, Maharashtra, Jammu and Kashmir and Andhra Pradesh are at the lower end of ranking among all other states in India in terms of changes in z-scores among the two rounds of NFHSs.

In order to examine the position of different states in comparison to the nation as a whole with regard to the extent of child under-nutrition in terms of stunting, wasting and underweight, we now calculate the RUN, the state relatives for the three under-nutrition parameters in order have a better view of the extent of child under-nutrition over time.

Table 4.5: State Relatives RUN of Child Stunting in India, NFHS-3 and NFHS-4

Sl.No.	STATE	Value of RUN(stunting)		Percentage change in RUN (stunting)
		NFHS-3(in %)	NFHS-4(in %)	
1	Haryana	90.21	87.50	-2.71
2	Himachal Pradesh	71.46	65.36	-6.1
3	Punjab	72.29	67.97	-4.32
4	Rajasthan	83.54	104.69	21.15
5	Uttaranchal	82.50	91.67	9.17
6	Chattisgarh	109.58	97.14	-12.44
7	Madhya Pradesh	96.88	113.28	16.4
8	Uttar Pradesh	109.17	122.92	13.75
9	Bihar	104.38	127.86	23.48
10	Jharkhand	98.33	121.61	23.28
11	Orissa	91.46	87.50	-3.96
12	West Bengal	87.08	81.51	-5.57
13	Arunachal Pradesh	81.25	78.13	-3.12
14	Assam	85.63	96.61	10.98
15	Manipur	64.58	72.66	8.08
16	Mizoram	73.13	74.48	1.35
17	Nagaland	71.04	74.48	3.44
18	Gujrat	102.50	100.78	-1.72
19	Maharashtra	91.67	91.41	-0.26
20	Andhra Pradesh	80.00	82.03	2.03
21	Karnataka	88.33	95.57	7.24
22	Kerala	55.21	52.60	-2.61
23	Tamil Nadu	64.79	71.61	6.82
24	Delhi	86.67	83.85	-2.82
25	Meghalaya	82.29	82.24	-0.05
26	Sikkim	78.75	78.39	-0.36
27	Tripura	76.88	59.11	-17.77
28	Goa	54.38	51.04	-3.34
29	Jammu & Kashmir	71.25	70.83	-0.42

Source: NFHS-3 and NFHS-4 data

Table 4.6: State Relatives, RUN of Child Wasting in India, NFHS-3 and NFHS-4

Sl.No.	STATE	Value of RUN(wasting)		Percentage change in RUN (wasting)
		NFHS-3 (in %)	NFHS-4(in %)	
1	Haryana	113.13	98.57	-14.56
2	Himachal Pradesh	100.51	62.86	-37.65
3	Punjab	51.52	77.62	26.1
4	Rajasthan	113.64	112.86	-0.78
5	Uttaranchal	200.00	98.57	-101.43
6	Chattisgarh	121.72	119.52	-2.2
7	Madhya Pradesh	199.49	124.29	-75.2
8	Uttar Pradesh	98.48	86.67	-11.81
9	Bihar	164.65	105.24	-59.41
10	Jharkhand	180.81	134.29	-46.52
11	Orissa	129.80	94.76	-35.04
12	West Bengal	96.97	98.81	1.84
13	Arunachal Pradesh	85.86	86.19	0.33
14	Assam	84.34	81.90	-2.44
15	Manipur	54.55	32.86	-21.69
16	Mizoram	48.99	24.76	-24.23
17	Nagaland	79.80	55.71	-24.09
18	Gujarat	99.49	127.62	28.13
19	Maharashtra	86.87	124.76	37.89
20	Andhra Pradesh	75.25	84.29	9.04
21	Karnataka	95.45	128.57	33.12
22	Kerala	78.79	72.38	-6.41
23	Tamil Nadu	115.66	90.95	-24.71
24	Delhi	81.82	72.86	-8.96
25	Meghalaya	159.60	76.67	-82.93
26	Sikkim	51.52	56.19	4.67
27	Tripura	110.61	77.14	-33.47
28	Goa	68.18	19.52	-48.66
29	Jammu & Kashmir	71.72	55.71	-16.01

Source: NFHS-3 and NFHS-4 data

Table 4.5 gives the values of RUN (stunting) for the 29 states in India in NFHS 3 and NFHS 4. It is obtained by the percentage change in RUN (stunting) for each state between two points of time. It can be seen that Goa is the better-off among all Indian states in terms of child stunting in NFHS-3. The percentage of stunted children in the state is almost half than that for the nation as a whole. It is followed by the state of Kerala and then Manipur and then Tamil Nadu. The worst relative position in terms of child stunting in NFHS-3 is that of Meghalaya where the percentage of undernourished children in terms of stunting is 12 per cent more than that for India as a whole. It is followed by the states of Chattisgarh, Uttar Pradesh, Bihar and Gujarat where the percentage contribution to child stunting is quite high. Jharkhand, Madhya Pradesh, Maharashtra, Orissa and Haryana contributed more than 90 percent of the total percentage of child stunting in NFHS -3. Rajasthan, Uttaranchal, Arunachal Pradesh, Assam, Andhra Pradesh and Karnataka contributed to 80 percent of the total child stunting of the country in NFHS -3.

In NFHS 4 too, it can be observed that Goa has retained its position at number one among all the other Indian states. It is followed by Kerala where the percentage of stunted children is around half than that of the nation taken together. The states of Tripura, Himachal Pradesh and Punjab contribute around 60 percent of the total child stunting of the country. The worst performance can be observed by the states of Bihar, followed by Uttar Pradesh and Jharkhand. These states have rates of child stunting more than 20 percent of the nation as a whole. The state of Meghalaya is also not far behind. From the Table it can be also seen that six states have more percentage of stunting that the country average. The states of Gujarat and Maharashtra retain the same percentage of contribution to child stunting in the two NFHSs.

In terms of improvement in the percentage of child stunting Tripura tops the list, followed by Chattisgarh. The worst result is observed in the states of Rajasthan, followed by Jharkhand and Bihar. The performance of Madhya Pradesh and Uttar Pradesh are also quite poor. The South Indian states of Tamil Nadu and Karnataka also joined the group of states which showed poor performance. The states, which have shown improvements are

Haryana, Himachal Pradesh, Punjab, Chattisgarh, Orissa, West Bengal, Arunachal Pradesh, Gujarat, Maharashtra, Kerala, Delhi, Meghalaya, Sikkim, Tripura, Goa and Jammu and Kashmir.

In terms of wasting, it can be observed from Table 4.6 that in NFHS-3, the best performance has been shown by Mizoram, whose percentage contribution is less than half than that of the nation as a whole. Mizoram is followed by Punjab and Sikkim. Manipur has also performed better than other remaining states of the country. Goa's contribution in NFHS-3 was around 68 percent than that of the nation as a whole. The states, which contributed around 70 percent towards child wasting in NFHS-3, are Kerala and Jammu and Kashmir. Arunachal Pradesh, Assam, Maharashtra and Delhi are the states, which contributed nearly about 80 percent of that of the nation as a whole. West Bengal, Gujarat, Uttar Pradesh and Karnataka are the states whose rates of wasting are more than 90 percent of the rate of wasting of the country as a whole. Uttaranchal has the worst performance in child wasting whose percentage contribution is more than 100 percent than that of the entire country. It is followed by Madhya Pradesh, Jharkhand and Bihar . The performance of these states is much poor than other remaining states of the country. Haryana, Himachal Pradesh, Rajasthan, Chhattisgarh, and Uttar Pradesh are the states whose performance in NFHS-3 is quite high.

In NFHS-4 the best performance in terms of reduction in child wasting is observed in the state of Goa, followed by the north eastern states of Manipur and Mizoram. Sikkim, Nagaland and Himachal Pradesh performed better than other remaining Indian states with respect to child wasting of the country as a whole. The deterioration of the relative rates of child wasting is observed for the states of Punjab, Maharashtra, Gujarat and Karnataka. These states contributed more than 20 percent of the total child wasting than that of the country as a whole. A massive improvement is shown by Uttarakhand whose relative contribution improved to a considerable extent. But its contribution towards child wasting of the country is still quite high.

Hence, it can be seen that maximum and remarkable improvement is observed for the state of Goa. Equally good performance in terms of improvement is observed in Meghalaya, Uttaranchal, followed by Mizoram, Manipur, Nagaland, Madhya Pradesh, Tripura and Tamil Nadu. Hence is can be said that other than the north-eastern states, the states which are considered less developed in terms of child under-nutrition like Uttarakhand, Madhya Pradesh, Uttar Pradesh, Bihar , Jharkhand and Orissa had made great strides in reducing the percentage of child acute under-nutrition. Not much improvement is observed for West Bengal and Assam, while the industrially developed states like Maharashtra, Gujarat and Karnataka have failed miserably to improve on child wasting.

Table4. 7: State Relatives, RUN of Child Underweight in India, NFHS-3 and NFHS-4

Sl. No.	STATE	Value of RUN (underweight)		Percentage change in RUN (underweight)
		NFHS-3 (in %)	NFHS-4(in %)	
1	Haryana	78.76	80.95	2.19
2	Himachal Pradesh	64.12	61.90	-2.22
3	Punjab	48.66	57.98	9.32
4	Rajasthan	75.88	103.92	28.04
5	Uttaranchal	65.36	76.19	10.83
6	Chattisgarh	98.56	104.20	5.64
7	Madhya Pradesh	119.38	117.37	-2.01
8	Uttar Pradesh	85.77	114.01	28.24
9	Bihar	113.20	123.81	10.61
10	Jharkhand	112.58	133.05	20.47
11	Orissa	81.44	97.20	15.76
12	West Bengal	77.53	87.39	9.86
13	Arunachal Pradesh	61.24	53.50	-7.74
14	Assam	73.81	85.99	12.18
15	Manipur	40.21	36.97	-3.24
16	Mizoram	29.28	35.29	6.01
17	Nagaland	48.87	45.38	-3.49
18	Gujrat	84.74	115.13	30.39
19	Maharashtra	67.42	98.60	31.18
20	Andhra Pradesh	61.44	89.92	28.48
21	Karnataka	68.66	104.20	35.54
22	Kerala	43.71	43.98	0.27
23	Tamil Nadu	53.40	64.15	10.75
24	Delhi	52.99	73.95	20.96
25	Meghalaya	102.06	82.07	-19.99
26	Sikkim	41.44	48.74	7.3
27	Tripura	83.09	65.83	-17.26
28	Goa	50.72	64.71	13.99
29	Jammu & Kashmir	53.81	45.10	-8.71

Source: NFHS-3 and NFHS-4 data

Table 4.7: represents the values of RUN (underweight) for 29 states of our country during NFHS-3 and NFHS-4. It also gives the percentage change in RUN (underweight) in each state between the two health surveys, that is, between two points of time. Table 7 shows that in NFHS-3 Mizoram are better off among all the Indian states in term of child underweight. Manipur, Sikkim, Kerala, Nagaland and Punjab follow it. The percentage of undernourished children is much less when compared to that of the nation as a whole. The other better performing states are Goa, Delhi, Jammu & Kashmir, and Tamil Nadu whose percentage contribution is nearly half than that for the nation taken together. The worst performing state in terms of child underweight is Madhya Pradesh, whose percentage stunting is around 20 percent than that of the entire country. The states of Bihar and Jharkhand are not far behind. Even Meghalaya performed quite poorly in child undernourishment (underweight) in NFHS 3.

In NFHS-4, Mizoram has maintained its position as the best performing state in child underweight among all the other states in India. The state of Manipur is not lagging behind. But it can be observed that the percentage contribution in Mizoram has increased in NFHS4 from NFHS-3. On the other hand, the percentage has decreased in case of Manipur. The states of Kerala, Nagaland, Jammu and Kashmir, and Sikkim also performed quite well as their percentage contributions show less than half than that of the country as a whole. Good performance in NFHS-4 in terms of percentage contribution in child underweight in NFHS-4 for the states of Arunachal Pradesh and Punjab. The performance of Himachal Pradesh, Tripura and Goa is also far better than the remaining states of the country. The performance by the states of Maharashtra, Orissa, Andhra Pradesh and West Bengal is almost equal to the country average The worst performing state in terms of child undernourishment is observed for the state of Jharkhand, whose percentage contribution to child underweight is 33 percent more than the country as a whole. It is followed by the states of Bihar, Madhya Pradesh , Uttar Pradesh, Chhattisgarh and Rajasthan. The percentage contribution in these states are more than the country overall percentage.

When we consider the relative percentage improvement it can be observed from Table:4. 7 that maximum improvement has taken place in the state of Tripura, followed by Meghalaya, Jammu & Kashmir and Arunachal Pradesh. The other states which have recorded certain percentage of improvements are Manipur, Himachal Pradesh, Madhya Pradesh, and Nagaland. There is not much improvement for the state of Kerala. The worst improvement percentage is by Karnataka, followed by Andhra Pradesh , Maharashtra, Delhi , Meghalaya and Gujarat. Equally poor performance can be observed for the states of Goa, Assam, Sikkim, Jharkhand, Bihar, Orissa, Mizoram, Tamil Nadu, Uttar Pradesh, Rajasthan, Punjab and Uttaranchal.

Thus, the states position in terms of child under-nutrition can be summarized as follows:

Haryana:

The northern state of Haryana has made an improvement in its status of child stunting and child wasting, but its status in terms of child underweight has deteriorated. In terms of z-scores ranking, it was ranked 21st among all the other states of our country in NFHS-3. It improved its ranking to 12 the position in NFHS-4 and the ranked 5th in terms of improvement in rank calculated through z-scores. In terms of its percentage contribution of child stunting, there had been a slight improvement (3%) from NFHS-3 to NFHS-4.

In terms of child wasting, its z-score rank improved from 18 in NFHS 3 to 11 in NFHS 4 and 6 in terms of change in rank. Similarly in terms of percentage contribution in wasting, it has made 15% improvement between the two survey periods.

On the other hand, in terms of child underweight its percentage contribution increased by more than 2% between the two time periods, although its rank improved in terms of z-scores dropped from 19th to 15th among the 29 states of our country.

Himachal Pradesh:

The northern state of Himachal Pradesh showed deterioration in rank among all the 29 states in India in terms of its rank in z-scores. It was ranked 8th in NFHS-3 but came down to 13 in NFHS-4. But, in terms of its improvement in percentage contribution towards the country, the state has registered 6% reduction in child stunting.

The state has made a remarkable improvement in child wasting, and could register a drop in rank from 17 in NFHS-3 to 9 in NFHS-4 and ranked 4th in terms of improvement in rank in z-scores. Its percentage contribution of child wasting to the country dropped by more than 37%.

The state also made improvement in child underweight whose position in terms of z-scores among all the states has improved from 15 to 8 among the 29 states of the country. It has also registered 3% reduction in its contribution to child underweight to the country.

Punjab:

The state of Punjab has not shown any improvement with regards to child stunting. The state was ranked 7th in NFHS-3 in terms of child z-score. Its rank deteriorated to 11 among the other states of our country. The states scored low in terms of improvement in z-scores too. But its contribution towards the country's percentage of child stunting reduced by around 8%.

Punjab has shown a deterioration in its status in terms of child wasting compared to other states of India. There has been no changes in terms of changes in z-scores over the two time period. But the state's percentage contribution of child wasting to the country as a whole increased by 50%.

No improvement has also been observed in terms of child under-weight when we compare the z-scores in NFHS-3 and NFHS-4. But its contribution to the country's overall percentage of child underweight increased by about 19%.

Rajasthan:

The state of child under-nutrition parameters have not shown any decline in Rajasthan. Its position with respect to child stunting has declined from 10 th position in NFHS-3 to20th position among the other 29 states of our country in terms of child z-scores. Its percentage contribution to the country's overall rate of child stunting increased by 25 %.

No improvement is also observed with respect to child wasting. But its contribution towards overall percentage of child wasting has declined by 1%.

The state has shown an upward in terms of child underweight. Its position declined from 20th position in NFHS-3 to 24th in NFHS-4 in terms of z-scores. Along with z-scores the percentage contribution of child underweight to the country as a whole increased by more than 37% of the country average.

Uttarakhand:

Uttarakhand has experienced a rise in child stunting. The state ranking in terms of z-scores declined from 11th position in NFHS-3 to 18th position in NFHS-4. The overall contribution of the state of Uttaranchal towards the overall country's percentage of child stunting increased by 11%.

But the state has shown considerable improvement with respect to child wasting whose percentage contribution to the country has declined by around 51%. But the state experienced a 17% increase in child underweight.

Chattisgarh:

The state remained in a worse position with regard to child stunting in both the rounds of NFHs. With regard to z-score, the state occupied 26th position in both the NFHS. but if we consider its percentage contribution to the country as a whole, the state offered a 11% decrease in the percentage contribution.

With regard to child wasting, the position of the state deteriorated. In terms of z-scores, it had occupied 22nd position in NFHS-3 but slipped down to 25th position in NFHS-4 among all the states of our country. But the country a 2% decline in child wasting towards the country.

The state maintained worse position in child underweight occupying 25th and 26th position in the two NFHS respectively. Its contribution to the percentage of child underweight to the country also increased by 6% over the time period.

Madhya Pradesh:

The position of child stunting for the state of Madhya Pradesh with respect to z-scores is quite low compared to the other states of our country. But the state tried to improve its z-score status and hence is ranked 3rd in terms of improvement in z-scores among all the other 29 states of India. But the percentage contribution to the country increases bu about 16% to the country as a whole.

In terms of child wasting, the state had scored the lowest in NFHS-3 and at the lower end in NFHS-4. But it had made efforts to improve its position in terms of z-scores and hence is ranked 4th among the other states as improvement in rank. The state has made great effort in reducing the score of wasting and thereby could reduce its contribution to the country by 38%.

The state had the lowest rank in both the NFHS in terms of z-scores for child underweight, but in terms of improvement it scored the 2nd rank among the other states of the country. It can be seen that the state's contribution to the country's child underweight percentage reduced by 2%.

Uttar Pradesh:

The state of Uttar Pradesh scored the lowest rank in z-scores for child stunting in both the NFHS. Its rank in terms of improvement in child stunting z-scres is 11th among the other 29 states of the country. It is also observed that the percentage contribution of child stunting towards the country as a whole increased by 13%.

The state had a better rank in terms of child wasting in NHHS-3 but slipped down to 19th position in NFHS-4. The state has also scored very poor in terms of improvement in child wasting and is ranked 26th among the other states of our country. But in terms of percentage contribution to the country over the years have reduced by 12%. The state hardly tried to improve its child underweight score. Moreover the contribution to the country average over the years increased by 33%.

Bihar:

The state scored second last position after Uttar Pradesh with regard to z-score for child stunting. The state also had not shown any steps to improve either as it ranked 14th in terms of improvement in rank for z-scores. It is observed that the percentage contribution of child stunting to the country as a whole also increased by 23%.

In terms of z-scores in child wasting, the state ranked 27th and 23 in NFHS-3 and NFHS-4 respectively. The state has tried to improve its prevalence of child wasting and accordingly it was ranked 9th for its effort on improvement. The state also improved its overall contribution of child wasting to the country and reduced the percentage by 36 points towards the country average.

For child underweight the position of the state is quite low and ranked 28th and 25th in z-scores for child underweight among the other starts of India. But here too, the country took steps to improve and hence is ranked 7th in terms of improvement in ranks in z-scores. The state has recorded 9% increase in its contribution to child underweight towards the country as a whole.

Jharkhand:

This state has recorded 23rd position in NFHS-3 in terms of z-score in child stunting. The position of the state slipped down to 27th position in NFHS-4 among the 29 states of our country. It has not even recorded any willingness to improve and recorded 19 th position in terms of improvement in z-scores in child stunting. The state has also recorded 24% increase in its percentage contribution to the country towards child chronic undernourishment.

The state's performance is worse with respect to child wasting. In term of z-scores it was 28th in NFHS-3 and 29th in NFHS-4. But the percentage contribution to the country reduced by 26%.

No difference can be observed with respect to child underweight. It was ranked 27th and 28th in NFHS-3 and NFHS-4 respectively. Its percentage contribution to the country increased by 18%.

Orissa:

This state remained in the same position in rank with respect to z-scores in child stunting and recorded 22nd position in both the NFHS. It has not cven made any efforts to improve its position and consequently was ranked 24th among all the other states of India. But the state has recorded4% decline in its contribution to the overall stunting position of the country.

In terms of child wasting, we can observe that the rank of the state among the other states is not good. But steps towards improvement were taken up by the state and consequently it recorded a 27% decline in its overall contribution to child wasting to the country as a whole.

With regard to child underweight, the state recorded 23rd position in NFHS-3, but improved to 18th position in NFHS-4 when the z-score is compared. Its contribution to the country's overall percentage to child underweight increased by 19% over the time period.

West Bengal:

West Bengal occupied 12th position among all the 29 states in terms of z-scores for child stunting but dropped to 23th position in NFHS-4. In terms of improvement in z-score, the state recorded 25th position. But its contribution to the country reduced by 6% towards the overall percentage of the country child stunting.

In terms of child wasting the state recorded 13th position in NFHS-3 but slipped down to 18th position in NFHS-4. No steps towards improvement can also be observed for the stte . but the percentage contribution to the country reduced by 3%.

In terms of child underweight, the state maintained the same rank of z-scores in both the NFHs. The rank is 17 in both cases; the state has recorded 13% increase in child underweight to the country as a whole.

Arunachal Pradesh:

This north-eastern state scored 15th position in NFHS-3, but made great improvement and thereby recorded 6th position in terms of z-scores in child stunting. Moreover, the state also recorded 4% decline in the overall percentage of child stunting towards the country as a whole.

In terms of child wasting the state made strides to remain in the same rank among the other states and made less improvement to reduce the rate of child acute undernutrition. Its contribution to the country's overall level of wasting increased by less amount (0.39%).

In terms of child underweight the state which recorded 10th position in NFHS-3 improved to 6th position in NFHS-4 and has recorded12 % decline in overall child underweight of the country as a whole.

Assam:

The state occupied the 19th position in both the NFHSs in terms of z-scores for child stunting. Moreover, the state has contributed 13% more to the country's average. The state recorded a 3% decline in its contribution to child wasting to the country as a whole and has improved its rank in terms of z-scores from 14th position in NFHS-3 to 10th position in NFHS-4.

But with respect to child underweight, the state has faied poorly and contributed 16% more than the overall average of child underweight in the country as a whole. The position of the state in terms of z-scores also deteriorated from 13 th position in NFHS-3 to 16th position in NFHS-4.

Manipur:

This north-eastern state of India was ranked in terms of z-scores in NFHS-3 towards child stunting. But the rank dropped to 10th in NFHS-4. Again terms of improvement in rank, the state has occupied 27th position. This shows that the state has not tried to improve its status of child stunting and as a result its percentage contribution to the country average increased by 12%.

With regard to child wasting, the state was ranked 4th in NFHS-3 but improved its position to 2nd in NFHS-4. The state also recorded tremendous improvement and was able to reduce its percentage contribution by 40% to the country as a whole.

For child underweight too, the state has taken steps to improve the status of child undernourishment and thereby improved its rank from 8th position in NFHS-3 to 4th position in NFHS-4. The state reduced its overall contribution to child underweight by 8%.

Mizoram:

Mizoram was ranked 16th in NFHS-3 with regard z-score for child stunting, but improved its position to rank 9 in NFHS-4. The state has recorded 2% increase in overall rate of child stunting.

Mizoram is ranked 1st in both the NFHSs with regard to z-scores in child wasting. That shows that the state has the lowest incidence of child wasting in India and is been able to retain the same rank in both the time period. The state also recorded aremarkable improvement in reduction in child wasting and contributed to 49% reduction of child wasting to the country as a whole.

With regard to child underweight the state recorded 21% increase in percentage contribution . but its performance as compared to other states of the country is superior as it recorded 2^{nd} position in rank in NFHS=3 and 1^{st} position in NFHS-4 in terms of z-scores.

Nagaland:

The state has recorded 5^{th} position in terms of z-scores in child stunting in both the NFHSs. It has also recorded 5% increase in child wasting over the time period.

The state which was 2^{nd} in NFHS-3 with regard to child wasting, was ranked 4^{th} in NFHS-4. But the state could record a 30% improvement in reduction in child wasting to the country as a whole.

With respect to child underweight the state was ranked 5^{th} in both the NFHSs among the 29 states of our country. The state has takes to reduce the percentage of child underweight and therefore could record 7% decline in the overall country percentage of child underweight.

Gujarat:

The state was ranked 24^{th} among all the state states of our country with regard to z-scores in child stunting. It has improved its ranking and was ranked21st in NFHS-4 and could record 2% decline in the country's overall percentage of child stunting.

But in terms of child wasting, the state which was ranked 19^{th} in NFHS-3, slipped down to 28^{th} position in NFHS-4. It had not taken steps to improve its rate of wasting, and thereby the percentage of child wasting to the country as a whole increased by 28%. The state has also recorded an increase in the percentage of child underweight by 36% and was ranked 21^{st} and 22d in NFHS-3 and NFHS-4 respectively, among the rest of the states of our country.

Maharashtra:

The state occupied 18th position in NFHS-3, improved its position to 16th position in NFHS-4 in terms of z-scores of child stunting. Consequently, the state recorded a slight reduction in the overall percentage of stunting.

In terms of child wasting, the state, which had 12th position in NFHS-3 slipped down to 27th position in NFHS-4 in terms of z-scores of child wasting. The state recorded 44% increase in overall percentage of child wasting over the time period.

In terms of child underweight, it can be observed that the state recorded 15th position in NFHS-3, but dropped down to 26th position in NFHS-4. The state has also not made any effort to improve its position as it is ranked 29th among all the 29 states of our country. Consequently, the state recorded maximum increase in the percentage of child underweight and showed 46% increase in overall percentage of child underweight.

Andhra Pradesh:

This state is ranked 17th position in NFHS-3 in terms of z-scores in child stunting. The rank got better in NFHS-4 and thus recorded 15th rank among all other states in the country. The state recorded an overall 3% increase in percentage of child stunting towards the country as a whole.

Andhra Pradesh was in a better position in NFHS-3 in terms of z-scores in child wasting. It was ranked 7th in NFHS-3 but deteriorated to rank 20th in NFHS-4. The state aldo recorded a 12 % increase in overall percentage of the country child wasting.

In terms of child underweight the state was ranked 12 yth in NFHS-3 but slipped down to 19th position in NFHS-4 and also recorded 46 % increase overall child underweight.

Karnataka:

The state which was ranked 20th in terms of z-scores in child stunting, improved its rank to 17th NFHS-4. It contributed to 8% increase in the overall child stunting for the country as a whole.

In terms of child wasting the country which was ranked 16th in NFHS-3 dropped down to 22nd position in NFHS-4 and also recorded 35% increase in overall country's child wasting over the years.

In terms of child underweight, the state was ranked 14th in NFHS 3, but in this respect too, the state deteriorated its rank and consequently recorded 21st position in NFHs-4 among all the other states of our country. It has recorded a tremendous increase in the overall percentage of child wasting and contributed to an increase in this parameter of child undernourishment by 52%.

Tamil Nadu:

The state was in a very good position in terms of child stunting in NFHS-3 and thus was ranked 2nd among all the other states of our country. The position slipped down to 4th in NFHS-4 and thus there was a increase by 11% to the percentage of child stunting for the country as a whole.In terms of child wasting, the state was ranked 21st in NFHS-3, but improved its position to 14th in NFHS-4 and also contributed to the decline in the country's overall percentage of child wasting by 21%.In terms of child underweight, the state was ranked 9th among all the other 29 states of our country in NFHS-3. It improved its position to 2nd in NFHS-4 in terms of z-scores in child underweight. But the state recorded an overall 20 % increase in child underweight to the country as a whole.

Delhi:

The state maintained 13th rank in both the NFHSs for z-scores for child stunting. But the state contributed to 3% decline in overall percentage of the country's child stunting.

In terms of child wasting the state was ranked 3rd in NFHS-3, but dropped down to 15th position in NFHS-4. But the state recorded 11% decline in overall child wasting.

The state occupied 11th position in NFHS-3 and 10th position in NFHS-4 in terms of z-scores child underweight. In this parameter of child undernourishment, the state recorded 40% increase overall percentage of child underweight to the country as a whole.

Meghalaya:

The state has made tremendous improvements in all the three parameters of child undernourishment. The state has made maximum efforts to reduce all the undernourishment parameters and is thus ranked 1st in terms of changes in rank.In terms of child stunting the state which was ranked 25th in NFHS-3 , improved its position to 3rd in NFHS-4 among the other states of our country. Towards reducing the percentage contribution the state is minimal (-0.05%).With regard to child wasting, the state was ranked 26th in NFHS-3 but improved to 6th position in terms of z-scores in child wasting. The state has also recorded 52% decline in overall rate of child wasting.

The stare was ranked 26th in terms of z-scores in child underweight in NFHS-3. It improved its position to 20th in NFHS-4. The state has thus recorded 20% decline in child underweight to the overall percentage of the country as a whole.

Sikkim:

The state was ranked 9th among all the other state in NFHS-3 with regard to child stunting. But the rank dropped down to 24th in NFHS-4 ,and the state has not made any effort to improve its position in terms of change in rank. Its percentage contribution to the country's average was reduced by a minimal amount (0.46%).

In terms of child wasting, the state was ranked 20th in NFHS-3, but improved to 3rd position in NFHS-4. It has tried to improve its position to a great extent, but its percentage country to the country average increased by 9%.In terms of z-scores in child underweight, the state was ranked 1st in NFHS-3 but slipped down to 3rd position in NFHS-4 and contributed 18% more to the country average of child underweight.

Tripura:

In terms of z-scores in child stunting, the state was ranked 14th among all the other states in NFHS-3. The rank improved to 7th in NFHS 4 and also recorded 23% decline in the overall percentage of child stunting to the country as a whole.

The state was ranked 25th in NFHs-3 but improved to 13th position in nFHs-4 in terms of z-scores in child wasting. The state also recorded 30% decline in the overall percentage of child wasting of the country as a whole.

In terms of child underweight, the state which was ranked 21st in NFHS 3 improved its rank to 14th in NFHS-4 and contributed to the overall reduction in child underweight to the country average by 28%.

Goa:

The state is ranked 3rd in nFHS-3 and 2nd in NFHS-4 with regard z-scores in child stunting. The state has also recorded 6% decline in child stunting to the country average. In terms of child easting, the state was ranked 10th in NFHS-3 but dropped down to 16th position in NFHS-4, but contributed to 71% decline in child wasting to the country average as a whole. The state was ranked 4th in terms of z-scores in child underweight in NFHS-3, among all the other states of our country. Its position dropped down to 12th NFHS-4 and the state also increased its percentage contribution to child underweight to the country by 27%.

Jammu& Kashmir:

The state was ranked 4th in NFHs-3 in terms of z-scores in child stunting, but slipped down to 8th position in NFHS-4 among all the states of our country.

In terms of z-scores in child wasting, the state was ranked 9th and 12th position in NFHS-3 and NFHS-4 respectively. It has also recorded a22% decline in overall percentage of child wasting to the country average as a whole.

4.3 Combined Indicator

Recent literature increasingly realizes that like the multi-dimensionality of poverty, health status of individuals in modern society also has various dimensions, which the conventional anthropometric measurement of height, weight, skin-fold thickness (or subcutaneous fat) and age often fail to capture adequately. The conventional indicators of malnutrition indicators used are mainly stunting (low height for age), wasting (low weight for height) and underweight (low weight for age). Stunting is an indicator of chronic undernutrition as a result of prolonged food deprivation and/or disease or illness; wasting is a indicator of acute undernutrition caused due to recent food deprivation or illness; underweight is used as a composite index to indicate both acute and chronic undernutrition, but undernutrition cannot distinguish between them. Each indicator provides valuable information about quite distinct biological processes (World Health Organization, 1995) , which in turn require different clinical responses. These indicators are compared against an international reference population developed from anthropometric data collected in the United States by the National Center for Health Statistics (NCHS). Children whose measurements fall below –2 z-scores of the reference population median are considered undernourished, i.e. to have stunting, wasting or to be underweight. These indicators reflect different aspects of anthropometric failure.

It may be noted that each measure seeks to capture specific aspects of undernutrition. A child may be underweight because of chronic or acute deprivation of food and/or health care. Stunting, on the other hand, is a consequence of chronic deprivation of food and/or a prolonged or frequent illness. Wasting is an indicator of acute deprivation of food and/or illness. This is referred to as the standard Waterlow 3-tier scheme.

There is a growing literature that there is a possibility of overlapping between the three child undernutrition indicators. This is because few children who are stunted may also be wasted and/or underweight. Again, some children who are wasted may also be stunted or and/or underweight. Hence, the three conventional child undernutrition parameters may not always provide a true picture of the overall estimate of undernutrition among children. But such information is required by policy makers and planners, so that they can decide where to allocate resources and design programmes and interventions to reduce malnutrition in a given region or country (Nandy and Miranda 2008).

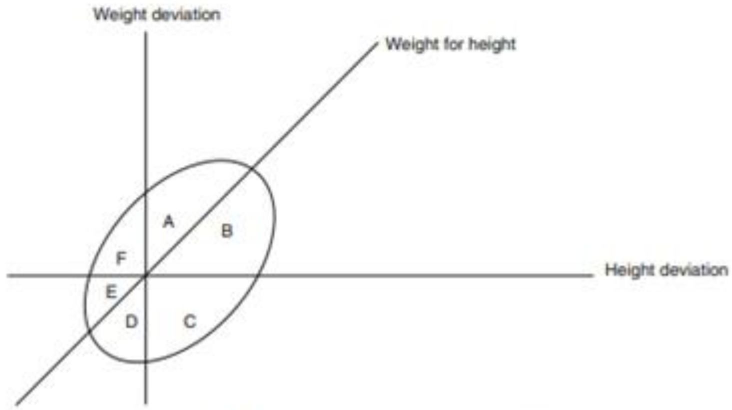
Svedberg (2000) emphasized that the conventional indices of anthropometric failure were not sufficient for measuring the overall prevalence of child undernutrition. Since underweight (having low weight for age) is a product of stunting and wasting and not their sum, it misses some children who are considered undernourished by the other indices, so produces an underestimate. So if children with wasting, stunting or who are underweight are all considered undernourished then a new aggregate indicator is needed that encompasses all undernourished children, be they wasted and/or stunted and /or underweight.

This index is referred to as a Composite Index of Anthropometric Failure (CIAF). This will provide a more comprehensive measure of child undernutrition. Towards fulfilling this objective, Svedberg's model identifies six groups of children. These groups include children with height and weight appropriate for their age (i.e. who are not in anthropometric failure) and also children whose height and weight for their age are below the norm and thus are experiencing one or more forms of anthropometric failure.

Figure 4.1 below depicts the CIAF in some details. In this figure, the vertical axis represents the deviation of weight; wheras the horizontal axis indicates height deviation. The diagonal line presents the amalgamation of weight for height. All these indices of undernutrition and norms there of are logically secured in their sectional position in the circle of this graph.

Figure: 4.1: Svedberg (2000) CIAF

The overall prevalence of malnutrition is then ascertained by summing all of the groups together, but excluding the children in Group A (i.e. those not experiencing any form of anthropometric failure). In operationalising the CIAF for the first time, an additional group, Group Y, containing children who are only underweight, was identified and added to Svedberg's model (Nandy et al. 2005).



Source: Svedberg (2000). By Permission of Oxford University Press, Inc.

After the graphical presentation and detecting acceptable and non-acceptable state among the three categories of undernourished children, Svedberg (2000) has formulated an estimation depending on the capability of all anthropometric indicators, which was termed as the Composite Index of Anthropometric Failure (CIAF).1 The estimating formula for detecting overall undernutrition among children is:

CIAF = (1-A)/(A+B+C+D+E+F)=(1-A)/1= 1-A,

where the group A indicates Children whose height and weight are above the age-specific norms (i.e. above -2 z scores) and do not suffer from any anthropometric failure. The following table 8A summarizes the groups of anthropometric failure among children.

Table 4.8 A: Groups of anthropometric failure among children

Group Name	Description	Wasting	Stunting	Underweight
A	No Failure: Children whose height and weight are above the age-specific norms (i.e. above -2 z scores) and do not suffer from any anthropometric failure	No	No	No
B	Wasting only: Children with acceptable weight and height for their age but who have subnormal weight for height	Yes	No	No
C	Wasting and underweight: children with above norm heights but whose weight for age and weight for height are too low	Yes	No	Yes
D	Wasting, stunting and underweight: Children who suffer from anthropometric failure on all three measures	Yes	Yes	Yes
E	Stunting and underweight: Children with low weight for age but who have acceptable weight, both for their age and for their short height.	No	Yes	Yes
F	Stunting only: Children with low height for age but who have acceptable weight, both for their age and for their short height.	No	Yes	No
Y	Underweight only: Children who are only underweight.	No	No	Yes
Source: Based on Nandy et al. (2005), Nandy and Svedberg (2012).				

It may be noted that since all the three conventional anthropometric indicators as such, only serve as proxies for evaluating the prevalence of undernutrition among children, they may over- and underestimate undernutrition in different dimensions. They miss, for example, the possibility that children can be undernourished by being too physically inactive for a healthy life, even if they are not stunted or underweight. Sometimes, anthropometric failure can be the outcome of disease unrelated to nutrition (e.g. Crohn's disease, Celiac disease). Moreover, these three conventional indicators cannot provide a single figure of the overall estimate of malnutrition among children in a population; although such information should be useful to policy makers and planners, whose task it often is to allocate resources and design programmes and interventions to reduce malnutrition in a given region or country (Nandy and Miranda 2008). The CIAF, on the other hand, is useful to predict morbidity risk, and in its disaggregated form provides a more useful picture of the relationship between ill health and malnutrition. It can also be used to examine the relationship between different forms of malnutrition and poverty (Nandy and Svedberg, 2012).

In this chapter, we have used data from the 2005-06 National Family Health Survey (NFHS 3) and 2014-15 National Family Health Survey (NFHS 4) for the country India. The NFHS 3 and 4 is a nationally representative survey, collecting demographic and health data on over 109041 and 5,68,200 households in India respectively(5); In these health surveys, detailed data were collected on 46,665 children less than 5 year old from NFHS 3 and 2,19,796 children less than 5 years NFHS 4. Anthropometric measurements were not taken for approximately 23% of children in NFHS 3 and 22% children from NFHS4. The data were then converted into z-scores. Those children with absurd z-scores were identified and rejected. Thus, the final sample included a total of 36,066 children less than 5 year old from NFHS3 and 1,71,029 children less than five year old from NFHS 4. Data from 29 states were considered. Data was based on children who stayed in the household the night before the interview and who had valid dates of birth and valid measurement of height and weight. Tables 4.8 A, 4.8 B and 4.8 C provide the pictures for India as a whole as well as for different sub-groups of children as are covered in NFHS 3 and NFHS 4.

Table 4.8 B: Groups of Anthropometric Failure in NFHS-3 & NFHS-4 (in %)

Groups	Total (NFHS-3)	Total (NFHS-4)
Underweight	41.15	33.78
Stunting	47.23	37.26
Wasting	18.94	20.39
CIAF	60.88	56.46

Source: Unit Level data from NFHS- 3 & NFHS- 4

The pervasiveness of children being stunted and underweight is relatively high in both the National Family Health Surveys. The prevalent rate is higher for stunting than for underweight. But it can be distinguished from the following two tables that the rate of stunting and underweight has come down from NFHS 3 to NFHS 4. But strikingly the rate of wasting, though low as compared to the other two common measures, has increased over the years. It can be observed that the severity of underweight and stunting has reduced over the years but the rate of severity of wasting has, on the other hand, increased.

Table 4.8C: Subgroups of Child Undernutrition and CIAF (NFHS 3)

Sl. No.	Groups	Share of Under five Children (%)
1	No failure	**39.12**
2	Wasting only	**5.2**
3	Wasting and Underweight	**6.7**
4	Wasting, Stunting and Underweight	**7.89**
5	Stunting and Underweight	**22.2**
6	Stunting only	**13.59**
7	Underweight only	**5.3**
CIAF (=2+3+4+5+6+7) = 60.88 or 100- (1)		

It can be observed from the above table that for NFHS-3, those children under the age the age of five, who are stunted and underweight occupies a major percentage (22.2%) among the different groups of anthropometric failure. Those who are stunted accounted for the second highest (13.59%). The lowest share is accounted by Underweight only.The CIAF was calculated by adding the percentages from group (2) to group (7) or by subtracting (1) from 100. The CIAF accounted for 60.88 %.

Table 4.8D: Subgroups of Child Undernutrition and CIAF (NFHS 4)

Sl. No.	Groups	Share of Under five Children (%)
1	No failure	**43.54**
2	Wasting only	**8.1**
3	Wasting and Underweight	**5.2**
4	Wasting Stunting and Underweight	**6.76**
5	Stunting and Underweight	**20.23**
6	Stunting only	**11.07**
7	Underweight only	**5.1**
CIAF (=2+3+4+5+6+7) = 56.46 or 100- (1)		

Following the identical route, it can be spotted from the above table that for NFHS 4, the group stunting and underweight accounted for over one-quarter of the children (20.23%) followed by stunting (11.07%) backing the trend of NFHS3. Here again, Underweight only accounted for the lowest share. The proportion of CIAF is high to about 56.46 %.

We have mentioned that CIAF measures of undernutrition can be used for various purposes. Here again, we use the compatible data from NFHS 3 AND NFHS 4 for children less than five years old to estimate the CIAF z-scores for the 29 states of India to gauge the pattern of inter-state variations in under five child undernutrition data in terms of the CIAF (Table:4. 9 below). We have not only calculated the CIAF z-scores of individual states and have ranked them for both NFHS-3 and NFHS-4, we have also found the change in the values of CIAF z scores between these two rounds and again ranked the states as per the changes (+/-) for these 29 states.

Table 4.9: CIAF z-scores of 29 states of India for NFHS 3 and NFHS-4, Changes in Z-scores and Ranks

States	z-score NFHS 3	z-score NFHS 4	Change*	Rank NFHS 3	Rank NFHS 4	Change Rank
Haryana	-2.53	-2.47	0.06	12	14	16
Himachal Pradesh	-2.87	-2.74	0.13	23	24	9
Punjab	-2.60	-2.41	0.19	15	11	7
Rajasthan	-2.94	-2.68	0.26	24	20	5
Uttaranchal	-2.97	-2.88	0.09	26	25	13
Chattisgarh	-2.55	-2.51	0.04	14	16	17
Madhya Pradesh	-3.02	-2.93	0.09	28	27	13
Uttar Pradesh	-2.98	-2.95	0.03	27	28	18
Bihar	-3.11	-3.03	0.08	29	29	14
Jharkhand	-2.95	-2.91	0.04	25	26	17
Orissa	-2.52	-2.43	0.09	11	12	13
West Bengal	-2.61	-2.57	0.04	16	18	17
Arunachal Pradesh	-2.68	-2.65	0.03	17	19	18
Assam	-2.74	-2.70	0.04	18	22	17
Manipur	-2.43	-2.39	0.04	9	10	17
Mizoram	-2.76	-2.69	0.07	19	21	15
Nagaland	-2.79	-2.72	0.07	21	23	15
Gujarat	-2.81	-2.52	0.29	22	17	3
Maharashtra	-2.77	-2.50	0.27	20	15	4
Andhra Pradesh	-2.54	-2.44	0.1	13	13	12
Karnataka	-2.51	-2.39	0.12	10	9	10
Kerala	-1.78	-1.44	0.34	1	1	1
Tamil Nadu	-2.09	-1.97	0.12	7	7	10
Delhi	-2.01	-1.89	0.12	5	6	10
Meghalaya	-2.55	-2.26	0.29	14	8	3
Sikkim	-1.81	-1.67	0.14	2	2	8
Tripura	-1.99	-1.88	0.11	4	5	11
Goa	-1.92	-1.72	0.2	3	3	6
Jammu & Kashmir	-2.24	-2.16	0.08	8	8	14

Change*= z-score of NFHS 4 – z-score of NFHS 3 & Rank = rank of states in ascending order

The above table shows that Kerala ranks first among all the other states of our country. It has taken the lead not only in NFHS-3 and NFHS-4, but also in terms of changes in the z-scores. It shows that the state has even taken initiatives to improve child undernutrion. The state of Sikkim has taken the second position in both the NFHSs, and in terms of improvement it is ranked 8th among all the other 29 states of our country. Next comes the state of Goa and Himachal Pradesh, which are jointly ranked third in both the NFHSs. Both the states hav taken efforts to reduce the child undernourishment and thus is ranked 6th among the other states of India. Tripura was ranked 4th in NFHS 3, but slipped down to 5th position in NFHS-4. Thus in terms of improvement it is ranked 11th. Delhi is ranked 5th and 6th in NFHS 3 and NFHS 4 respectively and 10th in terms of improvement in rank. The north-eastern state of Meghalaya is ranked 6th in NFHS-3 and 4th in NFHS 4. But in terms of improvement in rank it scored the 2nd position. Manipur has scored 9th and 10th position in the two NFHSs respectively and 17th terms of improvement. But the scores of the other north –eastern states like Mizoram, Nagaland, Assam and Arunachal Pradesh are at the lower end of ranking. Apart from Kerala, the other south- Indian states of Tamil Nadu and Karnataka also ranked better than the other states. Andhra Pradesh is in the middle position with rank 13th in both the NFHSs. The western states of Gujrat and Maharshtra have fared poorly in terms of z-score of child CIAF. But the states have taken efforts to improve this child undernutrition parameter and thus in terms of change in rank they are placed in the 3rd and 4th position respectively. The worse performing states as is evident from the above table are Bihar, Uttar Pradesh, Madhya Pradesh, Uttaranchal, Rajasthan and Himachal Pradesh. The position of West Bengal is 16 in NFHS 3 and 18 in NFHS 4. It shows the state has not taken much initiative to improve the nutrition of the children of the state. The state of child CIAF in Orissa and Chattisgarh is better than that of West Bengal.

4.4 Comparative Analysis between the States

As child undernutrition is internationally recognized as an important public health indicator for monitoring nutritional status and health in populations, therefore the devastating results of undernutrion, as seen from the pattern of child undernutrition disparity among the states of our country, in different rounds of NFHSs calls for an identification of those states where more progress in required. This might give an insight for policy implementation working for the betterment of child health situation in our country. Here, the percentage of different conventional parameters of undernutrition is taken from the four rounds of NFHS published reports, in order to maintain the parity across all the four rounds.

We tried to pick out those states, which have progressed topmost and those which discharged an awful performance within and across the four rounds of NFHSs. Then we calculated the range between these states and also tried to understand whether there had been any decline in the range as well as national average across the various rounds of NFHSs for all the three conventional parameters of child undernutrition.

Table 4.10: Percentage of Child Undernutrion in different states in different rounds of NFHSs

States	NFHS 1			NFHS 2			NFHS 3			NFHS 4		
	HAZ %	WHZ %	WAZ %	HAZ %	WHZ %	WAZ %	HAZ %	WHZ %	WAZ %	HAZ %	WHZ %	WAZ %
India	52.0	17.5	53.4	45.6	15.5	47.0	48.0	19.8	42.5	38.4	21.0	36.7
Delhi	43.2	11.9	41.6	36.8	12.5	34.7	42.2	15.4	26.1	31.9	15.9	27.0
Haryana	46.7	5.9	37.9	50.0	5.3	34.6	45.7	19.1	39.6	34.0	21.2	29.4
Himachal Pradesh	--	--	47.0	41.3	16.9	43.6	38.6	19.3	36.5	26.3	13.7	21.2
Jammu & Kashmir	40.8	14.8	44.5	38.8	11.8	34.5	35.0	14.8	25.6	27.4	12.1	16.6
Punjab	40.0	19.9	45.9	39.2	4.1	28.7	36.7	9.2	24.9	25.7	15.6	21.6
Rajasthan	43.1	19.5	41.6	52.0	11.7	50.6	43.7	20.4	39.9	39.1	23.0	36.7
Madhya Pradesh	--	--	57.4	51.0	19.8	55.1	50.0	35.0	60.0	42.0	25.8	42.8
Uttar Pradesh	59.5	16.1	59.0	55.5	11.1	51.7	56.8	14.8	42.4	46.2	17.9	39.5
Bihar	60.9	21.8	62.6	53.7	21.0	54.4	55.6	27.1	55.9	48.3	20.8	43.9
Orissa	48.2	21.3	53.3	44.0	24.3	54.4	45.0	19.5	40.7	34.1	20.4	34.4
West Bengal	--	--	56.8	41.5	13.6	48.7	44.6	16.9	38.7	32.5	20.3	31.5
Arunachal Pradesh	53.9	11.2	39.7	26.5	7.9	24.3	43.3	15.3	32.5	29.3	17.3	19.4
Assam	52.2	10.8	50.4	50.2	13.3	36.0	46.5	13.7	36.4	36.4	17.0	29.8
Manipur	33.6	8.8	30.1	31.3	8.2	27.5	35.6	9.0	22.1	28.9	6.8	13.8
Meghalaya	50.8	18.9	45.5	44.9	13.3	37.9	55.1	30.7	48.8	43.8	15.3	28.9
Mizoram	41.3	2.2	28.1	34.6	10.2	27.7	39.8	9.0	19.9	28.1	6.1	12.0
Nagaland	32.4	12.7	28.7	33.0	10.4	24.1	38.8	13.3	25.2	28.6	11.3	16.7
Tripura	46.0	17.5	48.8	--	4.8	20.6	35.7	24.6	39.6	24.9	16.8	24.1
Goa	32.5	15.3	35.0	18.1	13.1	28.6	25.6	14.1	25.0	20.1	21.9	23.8
Gujrat	48.2	18.9	50.1	43.6	16.2	45.1	51.7	18.7	44.6	38.5	26.4	39.3
Maharashtra	48.5	20.2	54.2	39.9	21.2	49.2	46.3	16.5	37.0	34.4	25.6	36.0
Andhra Pradesh	--	--	49.1	38.6	9.2	37.7	42.7	12.2	32.5	31.4	17.2	31.9
Karnataka	47.6	17.4	54.3	36.6	20.0	43.9	43.7	17.6	37.6	36.2	26.1	35.2
Kerala	27.4	11.6	28.5	21.9	11.1	26.9	24.5	15.9	22.9	19.7	15.7	16.1
Tamil Nadu	--	--	48.2	29.4	19.9	36.7	30.9	22.2	29.8	27.1	19.7	23.8

Source: NFHS Published Reports

When we consider NFHS 1, it can be seen that in terms of percentage of stunted under five children the lowest percentage is seen in the state of Kerala (27.4%), while the highest percentage in Bihar (60.9%), while the average percentage of the entire country is 52.0%. Hence the range of percentage contribution towards child stunting is (60.9% - 27.4% = 33.5%). Similarly, in case of wasting, the all India average is 17.5%. The state with the lowest percentage of child wasting was found in the state of Mizoram (2.2%), while the highest percentage is found in Bihar (21.8%). Hence the range in the percentage of child wasting in NFHS 1 is (21.8% - 2.2% = 19.6%). Again for Child underweight, the lowest percentage is observed in Mizoram with 28.1%, while the highest is Bihar with 62.6%. Hence the range of child underweight as can be seen in NFHS 1 is (62.6% - 28.1% = 34.5%), the country average child underweight being 53.4%. Hence, it is observed that during NFHS 1, the range of child stunting and child underweight is quite high. In case of child wasting, the range between the states is higher than the country average. This implies that NFHS 1 depicts a lofty picture of our country with respect to all the conventional child undernutrition parameters.

In NFHS 2, the state with highest rate of child stunting is Uttar Pradesh with 55.5%, followed by Bihar with 53.7%. Here the state of Goa recorded the lowest with 18.1%. Hence the rage of Child stunting between the states of our country is (55.5% - 18.1% = 47.4%), while the country average being 45.6%. Hence, the difference between the range of child stunting and the country average is nominal. In case of child wasting, the state with the lowest percentage is Tripura (4.8%), while the state with the highest is Orissa with 24.3 %. The range of child wasting in NFHS 2 comes to (24.3% - 4.8% = 19.5%). Here again, the range of child wasting between the states of our country is higher than that of the average percentage in India (15.5%). In case of child underweight, the country average is 47.0%. Here, the state of Bihar and Orissa has the highest percentage of child underweight with 54.4%. Again, Tripura has the lowest percentage of child underweight in NFHS 2 is 20.6%. Therefore, the range of child underweight between the states is (54.4% - 20.6% = 33.8%).

In NFHS 3, the state with highest percentage of child stunting is Uttar Pradesh with 56.8%, while the state with lowest percentage is the state of Kerala with 24.5 %. Hence the range of child stunting in NFHS 3 is (56.8% -24.5% = 32.3%), the country average being 48.0%. Again for Child wasting the average percentage for India as a whole is 19.8%, while the state with highest percentage of child wasting is Bihar with 27.1% and the one with the lowest percentage is the north-eastern state of Mizoram with 9.0%. Hence the range of child wasting between the states is (27.1% - 9.0% = 18.1%), which is more or less same as the average all India percentage of child wasting. Similarly, for child underweight, the all India average in NFHS 3 is 42.5%. The state with the highest percentage level of child underweight is Madhya Pradesh with 60.0% and the state with the lowest is again the state of Mizoram with 19.9%. Hence the range of child underweight is (60.0% - 19.9% = 40.1%). It shows that there is not much difference between the percentage range of child underweight and the Overall percentage of child underweight in the country.

In NFHS 4, it can be seen that the state with highest percentage level of child stunting is the state of Bihar with 48.3%, and the state with the lowest percentage is the state of Kerala with 19.7%. Hence the percentage range of child stunting between the states is (48.3% - 19.7% = 28.6%), which is lower than the country average child stunting percentage which is 38.4%. Again, in case of child wasting the average percentage of the country as a whole is 21.0%, while the states with the highest and lowest percentage of child wasting are Gujrat (26.4%) and Mizoram (6.1%). Hence, the range in this case is (26.4% - 6.1% = 20.3%). Here too, we can observe that the range of child wasting between the states in NFHS 4 and the overall average percentage is more or less similar. In case of child underweight, the state with the highest percentage is Bihar with 43.9%, and the one with the lowest percentage is Mizoram with 12.0%. The range comes down to (13.9% - 12.0% = 31.9%), which is close to all India average of 36.7%.

The picture can be better understood from the following table.

Table 4.11: Comparative Status

Particulars	NFHS 1			NFHS 2			NFHS 3			NFHS 4			Comparative Status		
	HAZ %	WHZ %	WAZ %	HAZ %	WHZ %	WAZ %	HAZ %	WHZ %	WAZ %	HAZ %	WHZ %	WAZ %	HAZ %	WHZ %	WAZ %
Range %	33.5	19.6	34.5	47.4	19.5	33.8	32.3	18.1	40.1	28.6	20.3	31.9	Declined	Stagnant	Declined
National Average %	52.0	17.5	53.4	45.6	15.5	47.0	48.0	19.8	42.5	38.4	21.0	36.7	Declined	Stagnant	Declined
State with Lowest %	Kerala	Mizoram	Mizoram	Goa	Tripura	Tripura	Kerala	Mizoram	Mizoram	Kerala	Mizoram	Mizoram	--	--	--
State with highest %	Bihar	Bihar	Bihar	Uttar Pradesh	Orissa	Bihar and Orissa	Uttar pradesh	Bihar	Madhya Pradesh	Bihar	Gujrat	Bihar	--	--	--

Source: Calculated from NFHS published Reports

Now, if we look across all the four rounds of NFHSs, it is quite evident that the undivided state of Bihar is the most vulnerable state with regard all the different conventional parameters of undernutrition. Again, the state of Madhya Pradesh and Uttar Pradesh and to some extent Orissa is not far behind. The state of Gujrat, which is considered as one the most economically advanced state, performed miserably in NFHS 4 towards child wasting. These are the states, which contributes maximum population burden of the country. While it can also be seen that there are few states, especially Kerala, Mizoram, Goa and Tripura have performed relatively prudently in almost all the rounds, yet, these states could not contribute efficiently towards bringing down the average rates of undernutrition in the country.

Again, considering the range of different parameters of child undernutrion between the states in each individual round, it can be observed, that overall child stunting and underweight rates of the country is high, though there is a gradual decline in the rates across the various rounds of NFHSs. The rate of child wasting of the country as a whole with that range in each round is more or less same, implying that the country has failed to cure short term child undernutrition problem of the country.

Hence, it can be deduced that mostly the middle and upper gangetic plains are the areas which is posing enormous challenge to the country towards reducing the burden of child undernutrition in the country. Hence, better and effective nutritional programmes specific to these areas needs to be executed. This exercise of finding out the states where extra progress is needed, is important from the prespective of policy making of the country.

This evidence of leisurely decline of child undernutrition rates in different states and that of the overall country, calls for an exploration towards understanding the various determinants affecting child undernutrion in our country.

4.5 Conclusions

Hence, the Pattern of child undernutrition in different states in India shows that the best performing state is Kerala, followed by Tamil Nadu, Haryana and Himachal Pradesh. The performance of Punjab is more por less consistent over time. But it is also observed that the rank of Himachal Pradesh in terms of CIAF is quite poor. On the other hand, the contribution of child undernutrition by the states of Gujrat and Maharashtra hjas increased over the years. The so= called Bimaru states, hads high rates of child undernutrition. Yet, certain distinctions can also be observed. Chattisgarh has improved its position with respect to child stunting. Some improvement in child wasting is observed in Uttarakhand. Efforts for improvement are also observed for Madhya Pradesh. The percentage contribution of the states of Bihar and Jharkhand has increased for child stunting and underweight, but reduced for child wasting. The performance by Uttar Pradesh is still quite poor for all the conventional and CIAF child undernutrition parameters. West Bengal has not improved its position over the two NFHSs.

The anthropometric indicators of child under-nutrition in India were among the worst in the world. To understand whether India made any decent progress in reducing under-nutrition among the under five children in the last two decades, and due to the fact that different states of India are at different levels of economic and social development, it is necessary to know the nature of inter-state differences in child under-nutrition in India. Like asymmetries in the levels of development in Indian states, the three anthropometric outcome indicators of child under-nutrition also exhibit inter-state variations and also changes over time. The three summary indices of nutritional status, namely, weight-for-age; height-for-age, and weight-for-height also show considerable inter-state variations, and between nutritional survey rounds, the relative ranking of the states have also undergone changes. For example, the states having high percentage of stunted and underweight under five children include not only states like Bihar, Jharkhand, Uttar Pradesh, Madhya Pradesh and Rajasthan, but also Gujarat which contributes highly to national GDP and total exports of the country, and tops the list after Jharkhand for having children wasted and severely wasted for children less than five years of age.

The *three* anthropometric indicators, namely height-for-age, weight-for-height, and weight-for age, are chosen to capture different aspects of child under-nutrition that have partly different etiologies and time dimensions. The height-for age indicator is mainly used for monitoring permanent or chronic under-nutrition in children, while the weight –for –height indicator is used to monitor wasting, which reflects temporary or short-term under-nutrition. The weight-for- age indicator is intended to capture both short-term and long-term under-nutrition, and it has been widely used by national and international agencies and researchers in developing countries. The present chapter offers an analysis of such inter-state variation in child under-nutrition in India.

The Ministry of Health and Family Welfare (MOHFW), Government of India in collaboration with the International Institute of Population Sciences (IIPS) had conducted and initiated a large scale multi-round survey of sample households, the National Family Health Survey (NFHS) since 1992-93 to elicit state and national level information for India in respect of fertility, infant and child mortality, maternal and child health, nutritional status of children and mothers, practice ,utilization and quality of family planning, anaemia, and related socio-economic variables. So far, four rounds of NFHS surveys have been completed and the Fifth round of survey started and was stunted due to the outbreak of the Corona pandemic 2020. The four completed rounds of such surveys- NFHS-1 for 1992-93, NFHS-2 for 1998-99, NFHS-3 for 2005-06 and NFHS-4 for 2014-15 constitute the primary basis of analyzing child under-nutrition in our country.

In Table 1, we have portrayed the nutritional status of under five children in Indian states as are revealed through NFHS 1 and NFHS 2 Surveys, with ranking of the states. With respect to the first indicator that is used to reflect stunting, States like Kerala, Nagaland ,Goa, Manipur, Mizoram , Punjab , Rajasthan and Delhi exhibit better performance compared to worse performing states like Bihar, Uttar Pradesh, Assam, Arunachal and even Maharashtra during the NFHS 1 survey period, i.e., 1992-93. During the NFHS 2 survey period of 1998-99, states which improved their ranking in terms of the indicator for Stunting some dramatically, and some moderately, included Arunachal, Goa, Tripura

& Sikkim, but those states whose ranking worsened dramatically included Bihar, Uttar Pradesh , Rajasthan, Assam , Punjab and Haryana, Secondly, with respect to the second indicator of Weight-for-Height (Wasting), between the first two NFHS Survey rounds, the diversity across states were also visible , and the states that could improve their standing with respect to wasting included Punjab, Tripura , U.P. and Rajasthan, whereas Karnataka, Maharashtra, Gujarat , Goa, Assam, , Orissa, Bihar worsened their relative positions. In both these indicators, the data on West Bengal was not recorded for the NFHS-1, so we could not report their inter-temporal changes in rankings with respect to these two indicators of child under nutrition. With respect to the third indicator, namely, Weight-for-Age (Underweight), the states which worsened their relative positions between the two rounds were Delhi, Haryana, Himachal Pradesh, Rajasthan, Madhya Pradesh, Orissa, Gujarat and Maharashtra, with Bihar, Uttar Pradesh, Tamil Nadu remaining more or less stable. Improvements in some other states also were moderate in order.

The validity of these indices is determined and influenced by many factors, including the coverage of the population of children and the accuracy of the anthropometric measurements. Some such factors are state-specific, while others are general in nature. When the NFHS 1 Survey was launched in 1992-93, both height and weight measurements for all children below the age of four years were to be obtainable, but in the first phase, in states like Andhra Pradesh, Himachal Pradesh and West Bengal, only the weights were recorded, because the boards for measuring heights were not available. For children below the age of 2 years, estimates of height /length were based on adjustable boards with children lying down, while for elders, the measurements were taken in a standing position. The complete sample of children under 5 years' age was not chosen in NFHS 1 in any stage. It is true that in the NFHS 2 , such deficiencies in scale were rectified , but the target sample group was under 3 years in some states and under 4 years in some other states. Moreover, in the NFHS 2 survey, it was admitted that often it was not possible to measure the height and weight of all eligible children, usually because the child was not at home at the time of the health investigator's visit or because the mother refused to allow the child to be weighed and measured. In India, NFHS 2 did not measure 13 percent of children under age three, and also excluded from the analysis were children whose month and year of birth were not known and those with grossly improbable height or weight measurements. Thus the changes in methodology and/or measurement scales during the first two rounds of NFHS Surveys make the outcome data strictly non-comparable and the possibility of errors creeping in could not be ruled out. Moreover, in both NFHS-1 and NFHS-2, unit level data were not released and reliance on aggregative estimates makes such estimates non-comparable and often non-compatible with NFHS-3 and NFHS-4 estimates that have much more comprehensive coverage, and are based on rigorously selected samples. We have therefore focused our subsequent analysis of inter-state variations in nutritional outcomes of children under five years of age mainly on NFHS-3 and NFHS-4 surveys using the unit level data as the basis of our analysis of not only of such state level averages, but also on their proximate determinants, which we shall attempt in subsequent chapters.

When we focus on NFHS-3 and NFHS-4 for the purpose of comparing all the states in India on the basis of unit-level information on child under nutrition collected in these two rounds because the data in these two rounds are strictly comparable in terms of statistical significance and correctedness in the choice of the sample households of much larger numbers. We use the three anthropometric indicators of child under-nutrition as mentioned earlier. In the first stage, we calculate the z-score of all the three indicators of undernutrition , namely, stunting, wasting and under weightage, and then calculate UN, defined as the percentage of children under five years of age who are stunted, wasted and underweight in NFHS-3 and NFHS 4. The relative measure

$RUN_{STATE} = 100 * (UN_{STATE} / UN_{NATION})$.

The State relatives RUN is the degree of undernourishment among children in the state compared to the national average between the two rounds of NFHS Surveys. These are reported in Table No 4.5, 4.6, and 4.7 respectively.

It can be observed that India had made progress in reducing the prevalence of stunting over a period of ten years. Given this endured progress in stunting, it is important to find out whether this reduction in stunting is experienced by all states of India.

We observe that Kerala has retained its position at number one among all the other states in both the NFHS. Tamil Nadu, which was in position 2 in NFHS 3 moved to 4th position in NFHS 4. The position of the states of Haryana, Rajasthan, Arunachal Pradesh, Mizoram, Tripura and Meghalaya improved in NFHS 4 compared to NFHS 3, while the position of other states apart from Kerala have deteriorated. A sharp deterioration was observed for the state of West Bengal, Rajasthan and Sikkim. There are few states that have retained their positions at the same place in both the NFHS. These states are Bihar, Uttar Pradesh and Chattisgarh.

When we rank the chages in z-scores for child stunting, it can be observed that Meghalaya is able to make maximum changes, followed by Gujarat, Madhya Pradesh, Chattisgarh, Haryana, Arunachal Pradesh and Mizoram. Though Kerala registered lowest level of stunting, it ranks in the 9th position among the other states in terms of improvement in the z-scores of height-for-age child undernutrition parameter. States of West Bengal, Tamil Nadu and Sikkim fared lowest in term improvement in stunting from NFHS 3 to NFHS 4. It is striking to observe that though the position of Gujarat is at a lower end in both the NFHSs, but in terms of improvement in the z-scores for stunting, the state is at second position among the other states of our country. On the contrary, Goa and Kerala are the states, which recorded better anthropometric score in both the NFHSs, but the position in terms of improvement of the score is quite low. The position of Punjab and Nagaland are on a better end for both the NFHS. But in terms of improvement in stunting rates, both the states have fared very low.

Thus a comparison between the two NFHS report brings out a myriad picture of the position of different states of our country. It can be seen that the z-scores have improved for all the states of our country from NFHS 3 to NFHS 4. When we compare the positions of the states in the two NFHS it can be seen that some states have improved their position considerably from NFHS 3 to NFHS 4. In terms of change in z-scores over a period of ten years from NFHS 3 to NFHS 4, it can be observed that while some states have taken strides to improve their position, others have been lagging behind.

Recent literature increasingly realizes that like the multi-dimensionality of poverty, health status of individuals in modern society also has various dimensions, which the conventional anthropometric measurement of height, weight, skin-fold thickness (or subcutaneous fat) and age often fail to capture adequately. each measure seeks to capture specific aspects of undernutrition. A child may be underweight because of chronic or acute deprivation of food and/or health care. Stunting, on the other hand, is a consequence of chronic deprivation of food and/or a prolonged or frequent illness. Wasting is an indicator of acute deprivation of food and/or illness.There is increasing relisation that there is a possibiliy of overlapping between the three child undernutrition indicators, because few children who are stunted may also be wasted and/or underweight. Again, some children who are wasted may also be stunted or and/or underweight.Therefore, the three conventional child undernutrition parameters may not always provide a true picture of the overall estimate of undernutrition among children, which may be required by policy makers and planners, so that they can decide where to allocate resources and design programmes and interventions to reduce malnutrition in a given region or country. Svedberg (2000) suggested a new aggregate indicator that encompasses all undernourished children, be they wasted and/or stunted and /or underweight.This index is referred to as a Composite Index of Anthropometric Failure (CIAF). When we use the compatible data from NFHS 3 AND NFHS 4 for children of less than 5 years old to estimate the CIAF Z-scores for the 29 states of India to gauge the pattern of inter-state variations in under five child undernutrition data in terms of the CIAF, we find that overall the incidence of child undernutrion is higher through CIAF compared to three separate indicators in both NFHS 3 and NFHS 4. After checking for CIAF indicator for 29 states of India the two NFHS rounds and their ranking, we have also reranked the states in terms of changes in the CIAF Z-scores between the two rounds per the changes (+/-) for these 29 states.

We find that Kerala ranks first among all the other states of our country-- it has taken the lead not only in NFHS-3 and NFHS-4, but also in terms of changes in the z-scores. It shows that the state has even taken initiatives to improve child undernutrion. The state of Sikkim has taken the second position in both the NFHSs, and in terms of improvement it is ranked 8^{th} among all the other 29 states of our country. Next, comes the state of Goa, which is ranked third in both the NFHSs. The state has taken efforts to reduce the child undernourishment and thus is ranked 6^{th} among the other states of India. Tripura was ranked 4^{th} in NFHS-3, but slipped down to 5^{th} position in NFHS-4. Thus in terms of improvement it is ranked 11^{th}. Delhi is ranked 5^{th} and 6th in NFHS-3 and NFHS-4 respectively and 10^{th} in terms of improvement in rank. The north-eastern state of Meghalaya is ranked 6^{th} in NFHS 3 and 4^{th} in NFHS 4. But in terms of improvement in rank it scored the 2^{nd} position. Manipur has scored 9^{th} and 10^{th} position in the two NFHSs respectively and 17^{th} terms of improvement. But the scores of the other north –eastern states like Mizoram, Nagaland, Assam and Arunachal Pradesh are at the lower end of ranking. Apart from Kerala, the other south- Indian states of Tamil Nadu and Karnataka also ranked better than the other states. Andhra Pradesh is in the middle position with rank 13^{th} in both the NFHSs. The western states of Gujrat and Maharshtra have fared poorly in terms of z-score of child CIAF. But the states have taken efforts to improve this child undernutrition parameter and thus in terms of change in rank they are placed in the 3^{rd} and 4^{th} position respectively. The worse performing states as is evident from the above table are Bihar, Uttar Pradesh, Madhya Pradesh, Uttaranchal, Rajasthan and Himachal Pradesh. The position of West Bengal is 16 in NFHS-3 and 18 in NFHS-4. It shows the state has not taken much initiative to improve the nutrition of the children of the state. The state of child CIAF in Orissa and Chattisgarh is better than that of West Bengal.

In order to understand which states require aggressive nutritional intervention, it was required to find out the states, which made maximum progress in curbing nutritional deprivation and those which discharged an awful performance. For this, we included all the four NFHS rounds, and found the range of undernutrition percentage within and between the rounds. It was found that the HAZ and WAZ percentage has declined over time. The national percentage for these indicators, namely stunting and underweight have also shown certain percentage reduction. But the percentage of WHZ has remained stagnant not only over time, but also the national average. Hence, it could be concluded that India is yet to take the control of acute undernutrition problem of children under five years of age. It was also revealed that the state of Bihar still needs maximum childcare intervention with respect to mainly child stunting and child underweight. More intervention is also required for the states of Gujarat, Uttar Pradesh and Orissa to control the problem of child wasting.

The fact sheets released by the NFHS 5 in 2020 prior to the imposition of lockdown show that there has been a stagnation, and even increase in some states, in the prevalence of malnutrition among children. While this data pertains to the period before the lockdown, it can only be expected that the situation is much worse after. One of the startling revelations in the first-phase data of the NFHS 5 for the year 2019-20 released by the Union Ministry of Health and Family Welfare recently shows that several states in India have either witnessed meagre improvements or sustained reversals on child (under 5 years of age) undernutrition parameters such as child stunting; child wasting; share of children underweight and child mortality rate. According to the report, 16 states recorded an increase in underweight and severely wasted for children under five years of age among 22 states that were surveyed during the first phase of the NFHS report. Similarly, 13 states and UTs of the 22 surveyed registered a surge in the percentage of stunted children under five years of age in comparison to NFHS 4 (2015-16).

Several states such as Telangana, Kerala, Bihar, and Assam as well as the UT of J&K have witnessed an increase in child wasting, while states like Maharashtra and West Bengal have been stagnant on this front. With respect to the proportion of underweight children, again, several big states, Gujarat, Maharashtra, West Bengal, Telangana, Assam and Kerala, have seen an increase. Reversal in the downward trend has happened in child stunting as well states like Telangana, Gujarat, Kerala, Maharashtra, and West Bengal — all saw increased levels of child stunting.

The natural question to ask is what causes/influences such huge asymmetry in child undernutrition in Indian states? We need to look beyond the indicators and search for the socio-economic variables that possibly influence such huge magnitude as well as variations across the states in India. We undertake such tasks in chapter 5 below.

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Chapter 5

Influence of Socio Demographic Factors on Child Undernutrition in India

5.1 Introduction

Although there is no consensus among biologists and nutritionists about how undernutrition is to be defined, and by what standard it needs to be measured, it is generally recognized that both undernutrition and overnutrition are serious problems of the human race. Undernutrition is a condition where the body does not have adequate amounts of one or more nutrients and usually reflects as outcomes of the various anthropometric indicators of human body. For analytical purposes, one may distinguish between input-based and output-based indicators and measurements to characterize the phenomenon of under-nutrition. In input-based analysis, dietary intake is used for nutritional assessment, whereas in out-based analysis one considers the disorderly consequences (referred as *failures*) on the human body as indicators of nutritional inadequacies or deprivations thereof. Since the early 1980s, the WHO, UNICEF ,and the World Bank have shifted to output-based analysis, based on comparing measurement of anthropometric indicators with a specified reference in order to assess the nutritional status of the population. The anthropometric approach hinges on the assumption that people's physical appearance reflects their nutrition status, and it is sufficient to work with such outcome indicators. The principal indicators used under this category are height-for –age , weight-for-height, and weight-for age, and for the undernourished these are reflected in retardation of body size (stunting), low weight-for-height(wasting) , and underweight for children under the age of 5 years.

5.2 Factors Influencing Undernutrition in India

Recent studies have drawn attention to the high prevalence of stunting among children in rural India. Since stunting reflects cumulative nutritional and health deprivation, it is likely to persist despite higher incomes. While income matters, other factors acting independently of it matter too. These include household size, whether household head is male, caste affiliation, mother's age at marriage, mother's age, mother's education, age composition of children, male–female wage differences, hygiene and sanitation facilities, and prices of food items. So, while higher incomes will help mitigate stunting, careful attention must also be given to enhancing women's autonomy through more remunerative employment opportunities for them, enabling households to improve hygiene and sanitation facilities, and facilitating more competitive local markets for food. Thus, there have been numerous studies on each of the three indicators of under-nutrition and their proximate determinants in India and the states, and most of such studies have relied on explicit econometric/ statistical formulations like multiple regression analysis, logistic regression and even panel data analysis to drive home the strength of alternative social, demographic and economic factors influencing undernutrition among children and mothers in our countries.

India has a population of 1.3 billion and ranks high among the undernourished countries of the world. India now has landed up in a position where acute undernutrition among under 5 children and mothers pose a danger to our declared goal of Sustainable development (SDG) , and cannot be ignored or set aside as an artifact. It is well established that undernutrition is responsible for the occurrence of large array of diseases and disabilities, leading to lower brain development among the children, which lower their potentials as individuals. The consequences of poor nutrition are affecting the country's socio-economic growth and productivity.

A longitudinal study conducted by Devi P.Y and Geervani P (1994) in four villages of Medak district of Andhra Pradesh, showed a strong influence of socioeconomic status and parental care on the control of infectious diseases and food intake. These two factors are considered as two major causes for under-nutrition among children in developing countries. Vinod K. Mishra et al (1999) used multivariate analysis of the effects of selected demographic and socio-demographic factors on child under-nutrition and found that the strongest predictors of child nutrition in India are child's age, child's birth order, mother's education, and household standard of living. According to the study by Irudaya Rajan and Navaneetham (1994), educated mothers use better antenatal and post-natal care, which results in better health of the mother and child. The studies by Mahapatra, A (2000), and George, K.A. et al (2000) also tend to support the importance of mothers' education in influencing the extent of under-nutrition among children below 5 years. In a study by Rajaretnam and Hallad (2000), it was found that Indian children become less and less underweight but more and more stunted after reaching 2 years of age. It also found out that the sex of the child, birth weight, order of birth, mother's education, antenatal care and incidence of illness are important predictors of child undernutrition. In a study by Chakraborty, (2011) on "Determinants of nutritional status in children under 5 years in India: a multilevel approach", the factors associated with nutritional status of children aged < 3 years were estimated by using data from NFHS 2. The result was that more than 50% of the mildly undernourished or severely undernourished children were from households with poor socio-economic status. Shoba Rao (2001) found that high prevalence of low birth weight, high morbidity and mortality and poor maternal nutrition were the major nutritional concerns in India. The study emphasized the relationship between maternal nutrition and fetal growth. Maternal nutrition also had a long term effect on early life under-nutrition. Interactions of prenatal nutritional experiences and post-natal undernutrition were some of the major issues discussed in the paper. There are certain studies, which say that disease and diet are one of the important determinants of child nutritional status. This is because a child with inadequate diet is more prone to poor nutritional status. This further leads to the risk of disease and recurrent illness caused by disease can damage child nutritional status. Again inadequate diet makes the child receptive to diseases and infection. Infection in turn leads to loss of appetite, impairs the absorption capacity of nutrients from food and thus impairs the possibility of growth of the child. There is enough evidence in literature that disease and dietary intake are self-supported and are responsible for poor nutritional status of children. Again, care for mother is vital, because the well-being of the child depends upon the well-being of the mothers. Some study identified certain categories of care for mothers, namely, mother's physical health, reproductive health support, autonomy and respect in the family and educational opportunities. These factors are important for the promotion of health and well-being of both the mother and the child. The importance of supporting mothers to obtain extra high quality foods, reduce their workload at home , ensuring that they attend antenatal care clinics and receive professional care during childbirth, are taken up in a number of literature on child health. Again poor maternal nutrition can lead to low birth weight of children in developing countries. Anaemic mothers are found to be less active care givers to children. This adversely affects the nutritional status of children.

The social and demographic determinants of child undernutrion are the factors that characterize the environment, which influences the lifelong development and heath outcome of a child. These determinants act at different levels of influence of child nutritional status and interact with one another. These arrays of determinants are not always of biological and genetic in nature. But they firmly establish their influence in the interaction between individuals and social and physical environment of the child. That is why government and policymakers are attempting to understand the social determinants of child undernutrition.

It has been recognized in the literature that education increases the ability of the mother to understand the importance of giving good care to the children. Educated mothers play an important role in the family towards the use of better family planning services, prenatal care and child immunization. However there are studies which reveal that educated mothers are likely to be involved in various economic activities, for which they have to stay away from home, and this reduces the time available for child care. Thus literature discloses that maternal education has both positive and negative effect on child undernutrition. It is also known that breastfeeding practices along with complementary feeding norms also play an important role on child survival, growth and development. Studies have shown that infant feeding practices has a significant association on child nutritional status. However, there are studies which reveal that prolonged breastfeeding have reverse association with the growth of a child. In terms of household factors, better hygiene practices affect the cleanliness of the environment. This reduces the possibility of children ingesting infectious food and contaminated water. Studies reveal that children residing in households with proper hygiene practices play a notable role in reducing the level of stunting. Again, children in households with poor hygiene practices are more susceptible to higher episodes of diarrhea, which in turn raises the possibility of the risk of under-nutrition and proneness to other diseases. Health practices at home, which include immunization of children, play a significant role towards child growth and development. There is enough evidence in literature that children who are fully immunized tend to have better growth status than those who are not.

In India, it is observed that there is a decline in the prevalence of undernutrition from NFHS 3 to NFHS 4. But this decline looks unimpressive when we into the wide inequality in child undernutrition status across the various states and also the socio-demographic groups. There are evidences in literature, which shows the extent and type of under nutrition differ sharply due to variation of socio-demographic factors, levels of literacy, climate, religion and cultural beliefs. Studies by Rajaram et al. (2003) and Rao et al. (2004) showed that mortality and morbidity rates differ among the socio-demographic groups across the world. There are also growing evidences which suggest that in India there exists gap in the prevalence of undernutrition among children between the rich and the poor. The present chapter is an attempt to study the interplay of socio-demographic variables and the status of child undernutrition in India using controls for various traditional and accepted predictors of undernutrition at individual, maternal, household and community characteristics. The conceptual framework of the study is based on the econometric methodology of different forms for analyzing determinants of undernutrion operating at community, household, maternal and child level covariates.

5.3 Methodology

5.3.1 Data

This study used a nationally representative unit-level dataset from National Family Health Survey- 3 and 4. These are publicly available data. This data set was chosen because they are the most recent data available on important maternal and health care indicators including nutritional status for children under five-years of age, following standard anthropometric components. These surveys follow the stratified two-stage sampling techniques. The 2001 and 2011 census served as the sampling frame for the selection of PSUs. Details on the sampling procedure can be found at IIPS, 2007 and 2014. The two NFHS surveys have been conducted under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India.

5.3.2 Study Sample

Of the total 46,665 children from NFHS-3 and 2,19,796 children from NFHS 4, a subset of 36,066 children from NFHS 3 and a subset of 1,71,029 from NFHS 4 was considered from all the 29 states in India. Ten thousand five hundred and nine-nine children (22.7%) from NFHS 3 and forty-eight thousand and seven hundred and sixty-seven children (22%) were excluded who were missing either antropometric data or were not included among the 29 states considered for the study. Three indices of nutritional status were calculated for children: height-for-age, weight-for-height and weight-for-age. The first indicator, which is height-for-age look into linear growth retardation and is a signal for chronic under-nutrition. The weight-for-height indicator juxtaposes body mass to body length and indicates acute under-nutrition. The weight-for-age is a composite measure of both chronic and acute under-nutrition. These three indices of nutritional status are expressed in z-scores within the range of -5 to +5 standard deviation from the WHO reference population.

NFHS-3 and NFHS-4 used the new International Reference Population released by the World Health organization in 2006. This new standard is constructed based on children from Ghana, Norway, The United States of America, India, Brazil and Oman who are raised in healthy situations following recommended feeding practices and whose mothers could avail proper nutrition and other childcare facilities.

These three indicators of child undernutrition are expressed as standard deviation units (z-scores) from the median of the International reference population (WHO 2006). The computation of z-scores was done in order to get appropriate anthropometric indicator relative to the International reference population with respect to particular age.

The z-score is calculated with the help of the following formula

$z_i = (A_i - \mu)/\sigma$

where z_i mentions the z-score for the specific indicator for the child. μ and σ are the median and standard deviation of the International Reference Population.

Children with the height-for-age z-score < -2 SD (Standard Deviation) from the median of the International reference population are regarded as short for their age (Stunted). Children whose weight-for-height z-score < -2SD from the median of the International Reference population, a child is said to be thin for his/her height or wasted. Since weight-for-height (underweight) is composite indicator of chronic as well as acute undernutrition, it which takes into consideration both height-for-age as well as weight-for-height. Children with z-score <-2SD from the median of the reference population are classified as underweight.

5.3.3 Methods used

To address the study objective we apply alternative econometric technique. We initiate multi level regression of height-for-age, weight-for-height and weight-for-age on selected proximal and intervening covariates. We employ multi- level linear regression model by allowing cluster level random effects. Possible correlation of undernutrition parameters between children is allowed in multi-level approach by including a community/ household effect.

However, the NFHS data is stratified in nature. That means that the children are nested into mothers, mothers are nested into households, household are nested into Primary Sampling Units (PSUs) and PSUs are nested into states. Hence we use the multi-level regression model in order to evaluate the parameters for nutritional status among children. Previous studies have shown that there is a possibility of under-estimation of parameters if single level model is used for stratified field type of data. It is natural that siblings are likely to share certain common characteristics of the mother and that of the household, (for example, education of the mother and rural or urban household). A child from a particular community is also likely to have in common the community level factors, notably the availability of health facilities etc. Therefore, it can be inferred that the unobserved heterogeneity in the outcome variable is also correlated at the cluster-level. Hence, that may result to an estimation problem if we consider the OLS technique of estimation. The OLS technique is useful and provides correct estimates only when the community level covariates and the household level covariates are uncorrelated with individual and maternal level covariates.

We test variance component or random intercept model following the trend and practice of contemporary literature. We introduced the model covariates in stages. The subsequent changes in the model fit were then observed through log-likelihood values. The analysis was carried out using STATA for hierarchical linear models using maximum likelihood for multilevel analysis.

The usefulness of the variance component model is that it corrects the problem of correlated observations in the cluster, by introducing random effect at each cluster. That implies that subjects within the same cluster are allowed to have a shared random intercept. The two clusters which we have considered are community and household. This is because NFHS give details on children of one mother chosen from a particular household. Hence, we consider the following regression equation,

$$\mathbf{z_{ij} = \beta^{/} x_{ij} + \delta_i + \mu_{ij}} \qquad \text{……….(1)}$$

Where $\mathbf{z_{ij}}$ is the height-for-age, weight-for-height and weight-for-age for the child(ren) from the j^{th} household in the i^{th} community. The vector of the regression coefficients is represented by β corresponding to the effects of fixed covariates x_{ij} . x_{ij} are the observed characteristics of the child, the household and the community. The random community effect 'i' denoted the deviation of community i's mean z-score from the grand mean. Likewise, 'j' is a random household effect that denotes the deviation ij household's mean z-score from the ith community mean. The error term are $\mathbf{\delta_i}$ and $\mathbf{\mu_{ij}}$**.** It is assumed that the error terms are normally distributed with zero mean and variances σ^2_c and σ^2_h of community and household respectively. These terms are nonzero and are estimated by the variance component models. σ^2_c and σ^2_h is likely to be larger when there is greater homogeneity of within-cluster observations and are not explained by the observed covariates.

We need to affirm the appropriateness of the multi-level model. For that, we test whether the variances of the random part of the model are different from zero over the households and communities. We then assessed the Intra-Class correlation (ICC), which shows the extent of correlation between child undernutrition and household and communities. A significantly different ICC from zero suggests the appropriateness of random effect models. The ICC coefficient describes the proportion of variation. The correlation between nutritional status of children in the same community and in the same household is

$$\rho c = \sigma^2 c / (\sigma^2 c + \sigma^2 h) \qquad \ldots\ldots(2)$$

The total variability in the individual height-for-age, weight-for-height and weight-for-age z-scores is then divided into two separate parts, namely, variance in children's nutritional status among households within communities and variances among communities. The objective of introducing covariates at each level in the variance component model is that, it helps to examine that the observed differences in anthropometric scores are attributable to factors at each level.

As already mentioned, a subset of 36,066 children from NFHS 3 and a subset of 1,71,029 from NFHS 4 was considered from all the 29 states in India, for the analysis from the hierarchically clustered NFHS 3 and NFHS 4 data set, respectively from 29 states in India. It was considered not necessary to include the mothers separately as NHFS provides information on children from one mother chosen from a particular household.

The analysis is presented in the following tables. Four models are used for the analysis in addition to the conventional OLS model, which does not take into consideration the cluster random effects.

The OLS model, we usually fit $z_i = \beta_0 + \beta_1 x_i + e_i$ **where** $e_i \sim N(0, \sigma^2)$

Here z_i is the z score of the ith individual and X_i are the children, mother and household specific variables. But when the data is clustered, using this model causes problems. If we fit this model to the clustered data we do not get correct answers. This model does not show how much variation is there at each level of cluster. By using this model we cannot find out how much effect household has on the community after control of individual child, mother and household level variables.

Specifically, the OLS equation becomes

$z_i = \beta_0 + \beta_1 RU + \beta_2 CA + \beta_3 CS + \beta_4 CB + \beta_5 CSz + \beta_6 CI + \beta_7 CIL + \beta_8 CBf + \beta_9 ME + \beta_{10} MBmi + \beta_{11} MAn + \beta_{12} MC + \beta_{13} MIn + \beta_{14} MAu + \beta_{15} HEn + \beta_{16} HPw + \beta_{17} HOh + \beta_{18} PCNSDP + \beta_{19} STATES + e_i$

where $ei \sim N(0, \sigma^2)$

Here,

RU= rural- urban place of residence

CA= Child's age in months

CS= Sex of the child

CB= Birth order of the child

CSz= Size of the child at birth

CI= Complete doses of immunization

CII = Suffering from recent illness

CBf= Breastfeeding for infants below six months of age

ME= Mothers in terms of number of years of education

MBmi= Mother's body mass index

MAn= Mother's status of anemia

MC= Mother's availing Mother and Child Protection Card

MIn= Mother's availing Institutional Delivery

MAu= Mother's Autonomy in decision making

HEn= Ethnicity of the household

HPw= household with piped water facility

HOh= Household owns a house of its own

PCNSDP= percapita NSDP

STATES= All the states in India

Model 1 is the null model where the height-for-age z scores is the dependent variable with no covariates.

$\mathbf{z_i = \beta_0 + \delta_i + \mu_{ij}}$ where $\mu_{ij} \sim N(0, \sigma^2_e)$ and $\mu_{ij} \sim N(0, \sigma^2_u)$

In the later models along with rural urban place of residence, other covariates are introduced in a phase wise manner. Model 2 introduces the predictors specific to the child (individual attributes).

The equation is as follows:

$z_i = \beta_0 + \beta_1 RU + \beta_2 CA + \beta_3 CS + \beta_4 CB + \beta_5 CSz + \beta_6 CI + \beta_7 CIL + \beta_8 CBf + \beta_9 PCNSDP + \beta_{10} STATES + \delta_i + \mu_{ij}$ where $\mu_{ij} \sim N(0, \sigma^2_e)$ and $\mu_{ij} \sim N(0, \sigma^2_u)$

Model 3 introduces the predictors specific to the mother. The equation is as follows:

$z_i = \beta_0 + \beta_1 RU + \beta_2 CA + \beta_3 CS + \beta_4 CB + \beta_5 CSz + \beta_6 CI + \beta_7 CIL + \beta_8 CBf + \beta_9 ME + \beta_{10} MBmi + \beta_{11} Man + \beta_{12} MC + \beta_{13} MIn + \beta_{14} MAu + \beta_{15} PCNSDP + \beta_{16} STATES + \delta_i + \mu_{ij}$ where $\mu_{ij} \sim N(0, \sigma^2_e)$ and $\mu_{ij} \sim N(0, \sigma^2_u)$

Model 4 is the full model that introduces all the model covariates at the respective level. The equation is as follows:

$z_i = \beta_0 + \beta_1 RU + \beta_2 CA + \beta_3 CS + \beta_4 CB + \beta_5 CSz + \beta_6 CI + \beta_7 CIL + \beta_8 CBf + \beta_9 ME + \beta_{10} MBmi + \beta_{11} MAn + \beta_{12} MC + \beta_{13} MIn + \beta_{14} MAu + \beta_{15} HEn + \beta_{16} HPw + \beta_{17} HOh + \beta_{18} PCNSDP + \beta_{19} STATES + + \delta_i + \mu_{ij}$ where $\mu_{ij} \sim N(0, \sigma^2_e)$ and $\mu_{ij} \sim N(0, \sigma^2_u)$

These models are three-level random intercept models with two clusters: community and households.

5.3.4 Variables used in the regression model

This paper uses height-for-age, weight-for-height and weight-for-age as the key outcome variable. The height-for-age (stunting) is the indicator of chronic undernutrition due to long term deprivation of food, while weight-for-height (wasting) is an indicator of acute undernutrition due to recent illness or food deprivation. Weight-for-age (underweight) is a composite of the previous two measures of nutritional status. These measures are expressed in the form of z-scores standard deviation (SD) from the median of the 2006 WHO International Reference Population. This continuous standard deviation of z-scores provides expected changes in the value of the regressand variable due to one unit change in the regressors no matter whether the child is stunted/wasted/underweight or not. This approach differs from the conventional approach of employing dichotomous variable on probability of a child being undernourished (0= otherwise, 1= stunted/ wasted/underweight). This study attempts to develop a deterministic model instead of modeling the probability of stunting/wasting/underweight. This paper attempts to find out the influencing role of household socio-demographic variables on child under-nutrition status in twenty-nine states in India.

5.3.5 Explanatory variables

The causes of stunting, wasting and underweight are multiple and often interdependent. It is observed from various literatures that there is a tendency of socio-demographic clustering of risk factors for poor health. Association is observed between rural living conditions and poor health and that is why rural health has become a new arena of research. On the other hand, urban environments may pose threat to health that is less salient in rural environments. Hence rural and urban living environments have a tendency to place different kinds of demand on their inhabitants. It has been observed in various literatures that in developing countries including India, the rural children tend to be comparatively poorer than their urban counter-part and socio-economic status is strongly associated with health. Overall living standards and health standard are poorer in rural children than the urban children. Hence, rural- urban place of residence (RU) is considered as an explanatory variable in the study.

The other explanatory variables are chosen based on available literature on the subject. Here we consider certain individual characteristics of a child as the impending determinant of child under-nutrition. We considered square of child's age (CA), sex of the child (CS), birth order (CB), size of the child at birth (CSz), complete doses of immunization (CI), child suffered from recent illness mainly from diarrhea or acute respiratory disorder (CIL) and recommended feeding practice denoted by exclusive breastfeeding for more than six months (CBf).

Apart from the child level covariates, we considered the mother level controls. These includes : education of mothers in terms of number of years of education (ME), mother's body mass index(MBmi) (BMI base = 18.5), mother's status of anemia(MAn), mother's availing Mother and Child Protection Card (MC), place of birth of the child (MIn), mother's decision making power in terms of autonomy for taking medical help(MAu).

The household level factors that are considered, except for rural-urban differences (RU), controls are included for ethnicity of the household (HEn), i.e., whether they belong to scheduled casters and scheduled tribe households, either the household has the piped water facility (HPw), and whether the household owns a house of its own (HOh). The last two factors are used as an indicator of the nature of asset the household has. Since the community characteristic is regarded a distant covariate of child undernutrition in the model, hence the percapita NSDP and different states are considered in each of the models as controls or as fixed effects of the multilevel model.

5.4 Results

5.4.1 Role of Socio-demographic Conditions

Table 1 shows significant association between socio-economic status and child nutritional status. Here the dependent variable is the continuous standard deviation of HAZ score. Given this form of dependent variable, a higher coefficient recommends better nutritional status of children among children living in the urban areas as compared to those living in rural areas.

From the OLS Model it is revealed that better nutritional outcome is observed from the children living in urban areas than rural areas. It can be seen that nearly 40 percent better nutritional status (0.25-(-0.13)) among children living in urban areas compared to those living in the rural areas. All the variance component models also support these finding. As we introduce the covariates at each level, the results of variance component models depicts the extent to which observed differences in HAZ scores are allocated to predictors operating at each level. Here we observe that after the introduction of the child level covariates with state level fixed effect, the impact of rural- urban place of residence becomes a bit stronger. The result is around 53 percent (0.40-(-0.13)) higher incidence of inferior nutritional status among children residing in rural areas than the ones coming from urban areas. But it is interesting to observe that the gap between rural-urban places of residence gradually gets reduced when we introduced the mother level covariates and other household-level covariates. Model 4 and 5 show similar estimates as that of OLS, which shows almost 40 percent better nutritional status of children residing in urban areas than their counterparts in the rural areas.

The results of the OLS model indicate that better nutritional outcomes in terms of higher height-for-age values are significantly associated with being male and among children of larger than average size at birth. It can also be withnessed from the above table that there is an apparent inverse association between duration of breastfeeding and height-for age nutritional status. It is observed that those children whose duration of breastfeeding is more than a year, has increased incidence of stunting. In this respect, let us mention that the available literature mentions (Mazumdar 2012) about the nonlinear effect of breastfeeding duration and nutritional status. Prolonged breastfeeding signals delayed onset of weaning, which in turn may lead to nutritional deprivations that may lead to chronic under-nutrition.

It is found that mothers who have certain years of education, have normal BMI values, possess Mother and Child Protection Card and have given birth in an institution are found to be benefitting from better nutritional status. Among the household level characteristics, it seems that there is an inverse association between those belonging to SC and ST ethnic group and long-term under-nutrition. A clear positive association is also observed between availability of piped water and height-for-age z-scores. This implies that those communities belonging to SC and ST and non-availability of piped water are more probable from suffering from long-term under-nutrition.

From the state level characteristics, it is clear that that states with higher per capita NSDP have a significant position association with height-for-age z scores. This finding is unique and is not observed by studies conducted earlier. State-specific fixed effects are found to be significant except Arunachal Pradesh, Karnataka, Tripura, Goa, Sikkim, Meghalaya and Jammu & Kashmir.

The results of OLS are more or less consistent with the results of the others models where the covariates are introduced in phased manner.

By phased manner, we mean that in the rest of the models along with rural-urban differences, all the other covariates are introduced step-by step where the null model does not include any covariates. In Model 2 first the child –level covariates are introduced and Model 3 and 4 includes mother-level covariates and all the covariates respectively.

The calculated Intra-Class Correlation coefficient (ICC) values presented in Table 2 differs from zero. The immediate implication is that child height-for age z scores are correlated with households and communities (PSUs). It can also be withnessed that Intra-Class Correlation coefficient values for household level are much higher than the ICC values of PSUs.

The lower panel of Table 5.2 helps us to infer that the residual variance is distributed across the PSUs and households. The estimates from Model 1 (null model), indicate that the variation in height-for-age has a substantial group level components. Incidentally, the null model contains no observed covariates. If we combine the community (PSUs) and Household level estimates, the total variance is .505 of which 61 Percent is attributed to household level variation in anthropometric scores. We can also observe that the variance decomposition pattern in Model 2, Model 3 and Model 4, are consistent to the observations on null model variance decomposition. The pattern is similar across PSU and household levels. Further, it can also be discerned that the household heterogeneity is partially accounted by the covariates of the model. The values of $\boldsymbol{\sigma^2_c}$ and $\boldsymbol{\sigma^2_h}$ are significantly different, which indicates that the homogeneity of within cluster observations is not explained by the observed covariates used in the model. A look on the intra-household correlation shows that it is quite large around 0.219 (Model 4). It is also seen that this value is large in all the other models too. This result suggests that the height outcomes of two individual children who belong to the same family are more homogeneous. As can be seen in all the models that the overall higher values of σ^2_h, that is, the variance at the household level gives the indication that there is higher homogeneity at the household level. From these results, it can also be inferred that the choice of one-level model with a similar set of data might not have yielded the desired result.

Table 5.3 shows significant association between socio-demographic status and child nutritional status. Here the dependent variable is the continuous standard deviation of Weight-for- age z-score. It is evident from the above table that that the nutritional status of children living in urban areas is much better than those living in the rural areas of India. From the OLS model it can be seen that 50 percent better nutritional status (0.391-(-0.104)) is enjoyed by the children living in urban areas compared to those living in the rural areas. All the variance component models also support these finding.

Once we introduce covariates at each level, the results of various variance component models shows the expanse of the pronounced differences in weight-for-age z-scores are allocated to covariates operating at each level. The introduction of the child level covariates with state level fixed effect depicts a similar picture of the impact of rural-urban place of residence. It shows a similar 50 percent (.396-(-.104)) higher incidence of poor nutritional status among children residing in rural areas. As in HAZ score results, it can be observed that the gap between rural-urban places of residence gradually gets less with the introduction of the mother level covariates and other household-level covariates. Around 41 percent better nutritional status for children residing in urban areas are observed in Model 4 and 5.

The results of the OLS model and the other models with separate covariates reveal that better nutritional outcomes in terms of higher weight-for age values are significantly associated with being female, duration of breastfeeding and complete immunisation. An inverse association is observed between duration of breastfeeding and weight-for age nutritional status. It is observed that those children whose duration of breastfeeding is longer than 6 months, has increased incidence of underweight. The results are similar to the observations we found from Table 1. This affirms that prolonged breast feeding does not increase the nutritional status of children. It can be also concluded that female children are more prone to adverse nutritional status than their male counterpart. This implies that girl children are still relatively neglected in our country. Again complete immunization is also an essential component to better nutritional standard of the child population of our country. It is imperative that children obtaining all the required vaccines enjoy a better nutritional outcome than those deprived from complete immunization doses.

Among the mother level variables, it can be observed that mothers having normal BMI positively influence the nutritional score of children. Here too, the mother possessing with Mother and Child Protection Card can ensure their children with better nutritional outcome. It can also seen that mothers who has the power of taking her own decision in terms of autonomy in taking decision for medical help, can give their children a healthier nutritional life.

A look into the household level predictors, reveals that those households having access to piped water and owns their own house have a positive association with weight-for age z-scores. Again, a negative association is observed with SC and ST ethnic group and the nutritional status. That means those households belonging to SC and ST ethnic groups contribute to worse nutritional status of children in India.

From the state level characteristics, it can be observed that there is a positive association between per capita NSDP and weight-for-height z-scores. Again, this is a unique result, not observed by any other study before. That means states with higher per capita NSDP contribute to better nutritional status of children in our country.

State-specific fixed effects are found to be significant except Arunachal Pradesh, Karnataka, Tripura, Goa, West Bengal and Delhi.

The results of OLS are more or less consistent with the results of the other models where the covariates are introduced in phased manner. Here too, the calculated Intra-Class Correlation coefficient values presented in Table 4 differs from zero. The implication is similar to the earlier height for age z scores. Indeed the weight for height z scores are correlated with households and communities (PSUs). The higher values of ICC for household level indicate that the z-scores are more correlated to predictors at the household level than the community (PSUs).

The lower panel of Table 5.4 shows that the residual variance is distributed across the PSUs and households. A look at Model 1 (null model), indicates that the total variance is 0.528 of which 76 percent is attributed to household level variation in anthropometric scores. In Model 2, the variance decomposition pattern that is observed is that the total variance is 0.536, of which 90 percent is variation in household level. In Model 3 and Model 4, the variation attributed to household level are 90 percent and 93 percent respectively, which only confirms that the results are consistent to the observations on null model variance decomposition. The pattern is similar across PSU and household levels. The values of σ^2_c and σ^2_h are significantly different which indicates that the homogeneity of within cluster observations is not explained by the observed covariates used in the model. A look on the intra-household correlation shows that it is quite large around 0.184 (Model 4). It is 0.196 in the null model. It is also seen that this value is large in all the other models too. This result suggests that the weight-for age outcomes of two individual children who belong to the same family are more homogeneous. A higher value of σ^2_h indicates that there is higher homogeneity at the household level. The results proved that the choice of one-level model with a similar set of data might not have yielded the desired result.

The results of Table 5.5 indicate significant association between household socio-demographic profile and nutritional status of children. Here the dependent variable is the continuous standard deviation of weight-for-height z-score. As explained earlier, this continuous standard deviation of weight-for height z score is effective of furnishing expected change in the value of the dependent variable due to one unit changes in the regressors regardless of whether a child is wasted or not. This form of dependent variable enables to understand that a higher coefficient represents a better nutritional status of children living in the urban areas as compared to those living in rural areas.

From the OLS Model it is revealed that better nutritional outcome is observed from the children living in urban areas than rural areas. It can be seen that nearly 36 percent better nutritional status (0.269-(-0.095)) among children living in urban areas compared to those living in the rural areas. In Model 2, it is 36 percent (0.266-(-0.099)), in Model 3 it is 37 percent (0.269-(-0.099)) and in Model 4 it is37 percent (0.271-(-0.095)). Hence, all the variance component models also support these finding. As we introduce the covariates at each level, the results of variance component models depicts the extent to which observed differences in weight-for-height z scores are allocated to predictors operating at each level. It is observed that after the introduction of the child level covariates with state level fixed effect, the impact of rural- urban place of residence remains the same. Further, from the results of the OLS model, it can be inferred that better nutritional outcomes in terms of higher weight-for-height values are significantly associated with being male and among those children who suffered from major illness like diarrhea or acute respiratory diseases. Here we find that unlike the previous two cases of child stunting and child underweight in NFHS 4, the weight-for-height z scores are positively associated with the duration of breastfeeding of the children. It can be observed that those children whose duration of breastfeeding is longer than 6 months, has decreased incidence of wasting. Prolonged breastfeeding is therefore not a cause of acute under-nutrition.

From all the models in Table 5.5, it can be observed that mothers who have certain years of education, possess Mother and Child Protection Card, and had given birth in at institutions can keep their children secured with comfortable nutritional status. Among the household level characteristics, it can be observed that there is an inverse association between those belonging to SC and ST ethnic group and acute under-nutrition. A clear positive association is also observed between availability of piped water and weight-for-height z-scores. This implies that those communities belonging to SC and ST and non-availability of piped water are more probable from suffering from wasting.

From the state level characteristics, again it is confirmed that that states with higher Per capita NSDP have a significant position association with weight-for-height z scores. State specific fixed effects are found to be significant except Jharkhand, Odisha, Tripura, Goa, West Bengal, Assam and Delhi.

The results of OLS are more or less consistent with the results of the other models where the covariates are introduced in phased manner.

The calculated Intra-Class Correlation coefficient values presented in Table 6 are different from zero, implying that weight for height z scores are correlated with households and communities (PSUs). Here too the values of household level ICC are higher. This indicates that the z scores are more correlated to the covariates at the household level than the community (PSUs) . The lower panel of Table 5.6 shows that the residual variance is distributed across the PSUs and households. A look at Model 1 (null model), indicates that the total variance is 0.534 of which 68 Percent is attributed to household level variation in anthropometric scores. In Model 2, the total variance is 0.541 of which 75 percent is variation in household level, whereas in Model 3 and Model 4, the variation attributed to household level are 85 percent and 81 percent respectively. The results are thus consistent to the observations on null model variance decomposition.

Since the values of σ^2_c and σ^2_h are significantly different, hence the homogeneity of within cluster observations is not explained by the observed covariates used in the model. A look on the intra-household correlation shows that it is quite large around 0.219 (Model 4). It is 0.206 in the null model. It is also seen that this value is large in all the other models too as shown in table 6. This result suggests that the Weight-for height outcomes of two individual children who belong to the same family are more homogeneous. A higher value of σ^2_h indicates that there is higher homogeneity at the household level.

Table 5.7 also shows significant association between socio-economic status and child nutritional status in NFHS 3. The dependent variable is the continuous standard deviation of HAZ score. Higher coefficients are observed among children living in the urban areas as compared to those living in rural areas. This implies children in the urban areas enjoy better nutritional status than children living in the rural areas.The OLS model reveals that nearly 32 percent better nutritional status (0.211-(-0.109)) among children are living in urban areas compared to those living in the rural areas. All the variance component models also support these findings.

We introduce the covariates at each level. We observe that after the introduction of the child level covariates with state level fixed effect, the impact of rural- urban place of residence becomes stronger. The result is around 41 percent (0.296-(-.111)) higher incidence of poor nutritional status among children residing in rural areas. But it should also be observed that the gap between rural-urban places of residence gradually gets reduced when we introduced the mother level covariates and other household-level covariates. In Model 3, it is seen to 31 percent (.202-(-.112) and in Model 4 it is also 31 percent (.199-(-.113)). Hence, these models show similar estimate as that of OLS. So, it can be concluded that children living in the rural areas are suffering from worst nutritional outcome.

It can be observed from the results of the OLS Model, that better nutritional outcome in terms of higher height-for-age values are significantly associated with being female

(0.016) and among children of larger than average size at birth (0.189). Children who suffered from recent illness (-0.051) and longer duration of breastfeeding (-0.075) portrays an inverse association with height-for age z scores. It can be observed that those children whose duration of breastfeeding is longer than 6 months, has increased incidence of stunting. Hence, prolonged breastfeeding does not imply superior nutrition to the children. The results are equally significant in the other models, where we introduced the covariates in a phased manner. Again complete immunization helps children to have better nutritional status. The values are found to be significant in all the models.

Once we introduce the mother level covariates, the effect of health of mothers on the child's height-for-age z-scores can be observed. Mothers who have certain years of education, have normal BMI values, had given birth in at institutions, and those mothers who are capable of taking their own decisions can give their children the benefit of better nutritional status .The results of OLS model is consistent with Model 2 and Model 4.

Among the household level characteristics, it can be observed that there is an inverse association between those belonging to SC and ST ethnic group and Height-forage z scores. A clear positive association is also observed between availability of piped water and height-for-age z-Scores. Those households who owns their own house also shares the benefit of higher nutritional status. This implies that those communities belonging to SC and ST and non-availability of piped water and owns house is more likely to contribute to worse nutritional outcome.

It can be also observed from the state level characteristics that states with higher per capita NSDP has a significant position association with height-for -age z scores. That means those states having higher per capita NSDP positively impacts the nutritional status of the children. From the table, it is observed that states of Rajasthan, Uttarakhand, Bihar, Jharkhand and Gujarat experience negative impact Height-for-age z scores. Again in certain states, there are positive impact on the HAZ scores. These states are Himachal Pradesh, Odisha, West Bengal and Tamil Nadu. This result is consistent across all the models including OLS Model.

The calculated Intra-Class Correlation coefficient values presented in Table 5.8 differs from zero. That implies that the height-for-age z scores are correlated with households and communities (PSUs) in NFHS 3. The higher value of ICC for household level (0.277) indicates that the z-scores are more correlated to predictors at the household level than the community (PSUs).The lower panel of Table 5.8 shows that the residual variance is distributed across the PSUs and households. A look at Model 1 (null model), indicates that the total variance is 0.575 of which 65 Percent is attributed to household level variation in anthropometric scores. In Model 2, the total variance is 0.511 of which 88 percent is variation in household level. In Model 3 and Model 4, the variation attributed to household level are 92 percent and 88 percent respectively. That shows the results are consistent to the observations of null model variance decomposition. The pattern is similar across PSU and household levels. The values of σ^2_c and σ^2_h are significantly different which indicates that the homogeneity of within cluster observations is not explained by the observed covariates used in the model. A look on the intra-household correlation shows that it is quite large around 0.243 (Model 4). It is 0.277 in the null model. It is also seen that this value is large in all the other models too. This result suggests that the Height-for-weight outcomes of two individual children who belong to the same family are more homogeneous. A higher value of σ^2_h indicates that there is higher homogeneity at the household level.

In Table 5.9 too, there is a significant association between socio-demographic status and child underweight status. Here the dependent variable is the continuous standard deviation of Weight-for- age z-score from NFHS 3. The result is similar as earlier. The nutritional status of children living in urban areas is much better than those living in the rural areas of India. From the OLS model it can be seen that 43 percent better nutritional status (0.325-(-0.101)) is enjoyed by the children living in urban areas compared to those living in the rural areas. All the variance component models also support these finding.
The introduction of the child level covariates with state level fixed effect depicts a similar picture of the impact of rural- urban place of residence. It shows a similar 44 percent (.341-(-.102)) higher incidence of poor nutritional status among children residing in rural

areas. As in HAZ score results, it can be observed that the gap between rural-urban places of residence gradually gets less with the introduction of the mother level covariates and other household-level covariates. Around 40 percent better nutritional status for children residing in urban areas are observed in Model 3 and 4.

It can be observed from the results of the OLS model and the other models with separate covariates that better nutritional outcome in terms of higher weight-for age values are significantly associated with child age, female child, duration of breastfeeding and complete immunisation. Negative association between child age and weight-for-age z-scores implies that older children are likely to be underweight. It can be also observed that female child is more undernourished than the male counterpart. The inverse association between duration of breastfeeding and weight-for-age z scores again affirms the fact that prolonged breastfeeding leads to worst nutritional status. The result of OLS is consistent with other models where the covariates are introduced in a phased manner.

The result of Table 5.9 also states that complete immunization is an essential component, which ensures better nutritional status among the children of our country.

From the results obtained in Table 5.9, it can be said that mother's education plays a significant role in assessing the nutritional status of the child. It can be said that more the number of years of mother's education, better is the nutritional status of the child. These studies highlighted the importance of human capital investment which is instrumental in improving the health of a child. It is found that educated mothers are better aware about the nutritional requirements of their children and are capable of providing improved health care to the child. Also mother's with normal BMI, mother's giving birth at institutions and mother's who has the power to take her own decision can provide their child with better nutritional status.

Among the household level predictors, those households having access to piped water and owns their own house have a positive association with weight-for age z-scores. Hence access to clean piped water and children belonging to households who owns a house of their own can help in improving the nutritional status of the child. A negative association is observed with SC and ST ethnic group and the nutritional status. That means those households belonging to SC and ST ethnic groups contribute to worse nutritional status of children in India.

From the state level characteristics, it can be observed that there is a positive association between per capita NSDP and weight-for-height z-scores. That means states with higher percapita NSDP contribute to better nutritional status of children in our country.

Again, the calculated Intra-Class Correlation coefficient values presented in Table 5.10 differ from zero. The implication is similar to the earlier results. It shows that the residual variance is distributed across the PSUs and households. A look at Model 1 (null model), indicates that the total variance is 0.546 of which 67 Percent is attributed to household level variation in anthropometric scores. The results are similar in all the other models. Here too, σ^2_h is higher. A higher value of σ^2_h indicates that there is higher homogeneity at the household level.

Table 5.11 show significant association between household socio-demographic profile and nutritional status of children. Here the dependent variable is the continuous standard deviation of weight-for-height z score for the data taken from NFHS 3. Here too, the OLS model it is revealed that better nutritional outcome is observed from the children living in urban areas than rural areas. It can be seen that nearly 30 percent better nutritional status (0.275-(-0.021)) among children living in urban areas compared to those living in the rural areas. In Model 2, it is 30 percent (0.277-(-0.020)), in Model 3 it is 30 percent (0.279-(-0.019)) and in Model 4 it is28 percent (0.268-(-0.016)). Hence, all the variance component models also support these finding. It can be seen that after the introduction of the child level covariates with state level fixed effect, the impact of rural- urban place of residence remains the same. Undernourishment is more if the child is female, which again implies that female children are neglected in India.

The inverse association between duration of breastfeeding and weight-for-age z scores again affirms the fact that prolonged breastfeeding leads to worst nutritional status. The result of OLS is consistent with other models where the covariates are introduced in a phased manner.

The result of Table 5.11 also states that those children who suffered from recent illness contributes negatively to the z scores. Again, complete immunization contributes positively to nutrition status of children of our country.

It can be observed from all the models in Table 5.11 that mothers who have certain years of education and had given birth in at institutions can keep their children secured from acute undernutrition. In addition, mothers suffering from anemia contribute negatively towards weight-for-height z scores in NFHS 3. These results are consistent across all the models in Table 5.11 when the covariates are introduced in a phased manner.

Among the household level characteristics, it can be observed that there is an inverse association between those belonging to SC and ST ethnic group and acute under-nutrition. A clear positive association is also observed between availability of piped water and weight-for-height z-scores. This implies that those communities belonging to SC and ST and non-availability of piped water contributes to the suffering from wasting.

It is also observed from the state level characteristics that states with higher per capita NSDP have a significant position association with weight-for-height z scores.

Among the states, the states of Haryana, Rajasthan, Madhya Pradesh, Uttar Pradesh, Bihar, Jharkhand, Odisha, West Bengal, Arunachal Pradesh, Assam, Maharashtra, Gujarat and Andhra Pradesh show negative impact on weight-for-height z scores of children of our country. The results of OLS are more or less consistent with the results of the others models where the covariates are introduced in phased manner.

5.5 A Sum Up

The NFHS provides data that reflects the fact that there is widespread undernutrition among the children in our country. The estimation provided by the latest NFHS 4 emphasizes the persistent overall levels of child undernutrition in our country. In this chapter, we find that child undernutrition in India is widely varied across the rural urban areas of the states in India. From the variance component models we find that there is clustering of observations at the community and at the household level. That means in the 29 states of India, children in the households who shared similar communities showcase similar nutritional status. The result is true for all the measures of undernutrition namely, stunting, wasting and underweight. Intra-household correlation is more prominent as compared to intra-community correlation. Hence, it can be understood that children from a cluster or community do not share stronger correlation in terms to their nutritional status. Nevertheless, the observations at the household level are not independent. That proves the fact that children belonging to a particular household share common characteristics in the process of their growth. This is a distinctive observation not carried by most of the studies conducted earlier. It is also seen that children from the households in the rural areas of all the states in our country have higher prevalence of worst nutritional status. That also suggests that children belonging to households in the urban areas show better nutritional status. These findings are supportive of the earlier studies based on NFHS data. Such association is consistent across the different variance component models applied in this study. This reaffirms the fact that better nutritional status are enjoyed by the children living in urban parts of the country having favorable socio-demographic background. This is true in all the models where there are controls at the individual, maternal and community characteristics. This also emphasizes that the differences in the availability of resources to the families in urban and rural parts of the country act as an important determinant to child undernutrition. Hence, we can infer that the prevailing socio-demographic status is an important determinant of the level of nutritional achievement among children of our country. If we look forward to the betterment of such socio-demographic condition, then it is expected to improve nutritional growth of the children through better nutritional intake and reduced morbidity.

In most of the cases, the state specific fixed effects are found to be statistically significant except for a few states.

The results of OLS are more or less consistent with the results of the other models where the covariates are introduced in phased manner.

The uniqueness of this chapter is the consideration of huge set of individual level data set for both NFHS 3 and NFHS 4. This chapter observed certain distinctive results not observed by most of the studies in literature. Here, we have seen that percapita NSDP significantly influences all the conventional undernutrition parameters both for NFHS 3 and for NFHS 4. Also, the result that intra-household correlation is more prominent to intra-community correlation, is also quite discrete from studies conducted on earlier.

Table 5.1: Association (βs) from Ordinary Least Squares and Multilevel Linear Regression Models (Main Effects) between (Height for Age) and rural-urban place of residence, controlling for various other covariates; twenty-nine Major States, India, NFHS-4

Predictors	OLS	Model1	Model2	Model3	Model4
Exp(B)(SE)					
Urban Residence	0.247*** (0.026)		0.391*** (0.040)	0.212*** (0.023)	0.212*** (0.023)
Rural Residence	-0.131*** (0.020)	-	-0.139*** (0.020)	-0.136*** (0.020)	-0.135*** (0.021)
Controls					
Individual Characteristics					
Child age (months)	-0.079 (0.002)	-	-0.074 (0.006)	-0.078 (0.002)	-0.089 (0.002)
Sex (base : male) Female	-0.005*** (0.001)	-	-0.025*** (0.001)	-0.015*** (0.002)	-0.005*** (0.001)
Order of birth	-0.021 (0.008)	-	-0.019 (0.018)	-0.022 (0.008)	-0.021 (0.008)
Size at Birth	0.245* (0.022)	-	0.258* (0.023)	0.245* (0.022)	0.215* (0.021)
Suffered (*base: no illness*)recent illness	-0.022 (0.025)	-	-0.022 (0.025)	-0.022 (0.025)	-0.020 (0.022)
Duration of Exclusive Breastfeeding (*base: less than 6 months*)	-0.039* (0.016)	-	-0.035* (0.012)	-0.033* (0.015)	-0.031* (0.011)
Completed Immunization	0.001 (0.012)	-	0.001 (0.012)	0.001 (0.012)	0.001 (0.012)
Mothers' Characteristics					
Years of Education	0.035*** (0.005)	-		0.032*** (0.004)	0.034*** (0.007)
BMI of mother≥ 18.5 (*base= 18.5*)	0.022** (0.005)	-		0.019** (0.005)	0.020** (0.004)
Suffers from anemia	0.152 (0.064)	-		0.147 (0.061)	0.149 (0.064)
Mother and Child Protection Card	0.025** (0.002)	-		0.022** (0.002)	0.023** (0.002)
Institutional delivery(*base = home delivery)*	0.084*** (0.021)	-		0.082*** (0.020)	0.081*** (0.023)
Decision making Power	-0.051 (0.032)	-		-0.051 (0.032)	-0.050 (0.038)
Household Characteristics					
Ethnicity SC ST	-0.101*** (0.019)	-	-0.101*** (0.019)	-	-0.111*** (0.012)
Water Source(Piped Water)	0.021** (0.001)	-	0.022** (0.001)	-	0.024** (0.001)
Owns a house	0.210 (0.021)	-	0.216 (0.022)	-	0.211 (0.021)

(-------------------------*in continuation of Table 5.1)*

Predictors	OLS	Model1	Model2	Model3	Model4
States					
Per capita NSDP	0.172*** (0.022)	-	0.315*** (0.029)	0.216*** (0.027)	0.191*** (0.027)
Haryana	-0.152* (0.085)	-	-0.147* (0.082)	-0.149* (0.085)	-0.150* (0.084)
Himachal Pradesh	0.163* (0.091)	-	0.161* (0.088)	0.162* (0.085)	0.163* (0.090)
Punjab	0.131 (0.077)	-	0.133 (0.073)	0.130 (0.072)	0.130 (0.077)
Rajasthan	-0.145*** (0.042)	-	-0.144*** (0.043)	-0.143*** (0.044)	-0.141*** (0.040)
Uttarakhand	-0.255* (0.102)	-	-0.245* (0.112)	-0.250* (0.102)	-0.250* (0.102)
Chattisgarh	0.131* (0.071)	-	0.129* (0.068)	0.130* (0.069)	0.133* (0.070)
Madhya Pradesh	0.013* (0.060)	-	0.016 (0.061)	0.014 (0.056)	0.017* (0.059)
Uttar Pradesh	-0.165* (0.063)	-	-0.164* (0.063)	-0.163* (0.063)	-0.165* (0.063)
Bihar	-0.129* (0.065)	-	-0.129* (0.065)	-0.129* (0.065)	-0.129* (0.065)
Jharkhand	-0.255 (0.052)	-	-0.254 (0.052)	-0.255 (0.051)	-0.254 (0.051)
Odisha	0.213*** (0.085)	-	0.211*** (0.084)	0.210*** (0.084)	0.210*** (0.082)
West Bengal	0.163** (0.066)	-	0.161** (0.062)	0.162** (0.060)	0.162** (0.065)
Arunachal Pradesh	0.025 (0.056)	-	0.024 (0.053)	0.026 (0.056)	0.022 (0.056)
Assam	0.035* (0.065)	-	0.031* (0.063)	0.034 (0.063)	0.033 (0.064)
Manipur	0.288* (0.054)	-	0.284* (0.051)	0.285 (0.050)	0.287 (0.051)
Mizoram	0.301* (0.024)	-	0.302* (0.022)	0.302 (0.023)	0.303 (0.022)
Nagaland	0.024* (0.002)	-	0.023* (0.001)	0.022 (0.002)	0.020 (0.002)
Gujrat	-0.298*** (0.063)	-	-0.297*** (0.061)	-0.296*** (0.060)	-0.295*** (0.061)
Maharashtra	-0.102** (0.045)	-	-0.103** (0.045)	-0.103** (0.045)	-0.101** (0.045)
Andhra Pradesh	0.045* (0.066)	-	0.046* (0.065)	0.042* (0.064)	0.044 (0.063)

(--------------------------*in continuation of Table 5.1)*

Predictors	OLS	Model 1	Model 2	Model 3	Model 4
States					
Tamil Nadu	0.327** (0.061)	-	0.326** (0.061)	0.322** (0.062)	0.325** (0.060)
Karnataka	-0.035 (0.066)	-	-0.034 (0.067)	-0.034 (0.065)	-0.033 (0.064)
Delhi	-0.023* (0.088)	-	-0.025* (0.088)	-0.022 (0.087)	-0.021 (0.085)
Meghalaya	0.075 (0.068)	-	0.076 (0.065)	0.073 (0.065)	0.073 (0.069)
Sikkim	0.021 (0.078)	-	0.022 (0.079)	0.025 (0.074)	0.025 (0.074)
Tripura	0.030 (0.082)	-	0.031 (0.83)	0.032 (0.084)	0.035 (0.080)
Goa	0.009 (0.074)	-	0.005 (0.073)	0.008 (0.072)	0.005 (0.071)
Jammu &Kashmir	- 0.041 (0.081)	-	-0.041 (0.079)	-0.044 (0.081)	-0.045 (0.079)
Constant	-1.119*** (0.076)				
N	1,90,156	1,91,200	1,90,952	1,90,952	1,90,921
Log likelihood	R^2 0.177				
X^2 Statistics	151.270		3926.7	4097.6	3922.9
P value	0.000		0.000	0.000	0.000
*Significant at ***p<0.001, **p<0.01,*p<0.05*					

Source: Calculation from NFHS 4 unit data

Table 5.2: Random coefficients, Intra-class correlation and Variance Decomposition estimates (Height for Age) NFHS 4

Random coefficients, Intra-class correlation and Variance Decomposition estimates				
	Model 1	**Model 2**	**Model 3**	**Model 4**
Random Effects				
σ^2_c Community- PSU	0.196	0.085	0.065	0.049
(S.E)	(0.022)	(0.017)	(0.010)	(0.009)
Proportions of overall (null model) explained by the covariates of the model (in %)		51.546	69.145	69.001
σ^2_h (Household)	0.309	0.496	0.456	0.412
(S.E)	(0.021)	(0.035)	(0.034)	(0.031)
Proportions of overall (null model) explained by the covariates of the model (in %)		-31.112	-22.072	-27.551
Residual^2	1.755	1.502	1.509	1.510
(S.E)	(0.025)	(0.019)	(0.021)	(0.024)
Intra-class correlation				
ρ(PSU)	0.081*	0.039*	0.021*	0.024*
ρ(household)	0.215*	0.243*	0.244*	0.219*
Variance Decomposition (in %)				
PSU	35.2	14.7	9.9	10.3
Household	64.8	85.3	90.1	89.7

Source: Calculation by author from NFHS 4 unit data

Table 5.3: Association (βs) from Ordinary Least Squares and Multilevel Linear Regression Models (Main Effects) between (Weight for Age) and rural-urban place of residence, controlling for various other covariates; twenty-nine Major States, India, NFHS-4

Predictors	**OLS**	**Model1**	**Model2**	**Model3**	**Model4**
Exp(B)(SE)					
Urban Residence	0.391*** (0.019)		0.396*** (0.018)	0.309*** (0.018)	0.308*** (0.019)
Rural Residence	-0.104*** (0.034)	-	-0.104*** (0.035)	-0.105*** (0.032)	-0.105*** (0.032)
Controls					
Individual Characteristics					
Child age (months)	-0.027 (0.000)	-	-0.045 (0.004)	-0.034 (0.001)	0.059 (0.002)
Sex (base : male) Female	-0.003*** (0.001)	-	-0.013*** (0.002)	-0.019*** (0.003)	-0.018*** (0.002)
Order of birth	-0.001 (0.008)	-	-0.002 (0.009)	-0.001 (0.008)	-0.002 (0.008)
Size at Birth	0.245 (0.022)	-	0.258 (0.023)	0.245 (0.022)	0.225 (0.021)
Suffered (*base: no illness*)recent illness	-0.022** (0.005)	-	-0.020** (0.006)	-0.021** (0.005)	-0.020** (0.006)
Duration of Breastfeeding (*base: less than 6 months*)	-0.014* (0.014)	-	-0.017* (0.013)	-0.018* (0.014)	-0.017* (0.012)
Completed Immunization	0.003* (0.010)	-	0.002* (0.011)	0.002* (0.010)	0.005* (0.011)
Mothers' Characteristics					
Years of Education	0.012 (0.001)	-	-	0.013 (0.001)	0.011 (0.012)
BMI of mother	0.006** (0.003)	-	-	0.005** (0.002)	0.005** (0.001)
Suffers from anemia	0.027 (0.010)	-	-	0.024 (0.008)	0.026 (0.008)
Mother and Child Protection Card	0.002* (0.001)	-	-	0.005* (0.002)	0.006* (0.003)
Institutional delivery	0.045** (0.004)	-	-	0.044** (0.005)	0.041** (0.003)
Decision making Power	0.032** (0.005)	-	-	0.033** (0.002)	0.033** (0.007)
Household Characteristics					
Ethnicity SC ST	-0.066** (0.013)	-	-0.065** (0.014)	-	-0.061*** (0.012)
Water Source(Piped Water)	0.011** (0.002)	-	0.012** (0.002)	-	0.014** (0.001)
Owns a house	0.105** (0.051)	-	0.106** (0.052)	-	0.106** (0.051)

(---------------in continuation of Table 5.3)

Predictors	OLS	Model1	Model2	Model3	Model4
States					
Per capita NSDP	0.101^{***} (0.020)	-	0.107^{***} (0.021)	-0.109^{***} (0.022)	-0.111^{***} (0.021)
Haryana	0.092^{*} (0.015)	-	0.097^{*} (0.012)	-0.099 (0.015)	-0.093 (0.014)
Himachal Pradesh	0.045^{*} (0.091)	-	0.041^{*} (0.091)	0.042^{*} (0.095)	0.043^{*} (0.091)
Punjab	0.117^{**} (0.077)	-	0.117^{*} (0.073)	0.118^{*} (0.072)	0.118^{*} (0.072)
Rajasthan	0.201^{*} (0.034)	-	0.202^{*} (0.034)	0.203 (0.038)	0.203 (0.036)
Uttarakhand	-0.015^{*} (0.092)	-	-0.015 (0.092)	-0.012 (0.093)	-0.013^{*} (0.093)
Chattisgarh	0.001^{*} (0.025)	-	0.002 (0.026)	0.002 (0.026)	0.0033 (0.025)
Madhya Pradesh	-0.029^{*} (0.019)	-	-0.026^{*} (0.016)	-0.026^{*} (0.017)	-0.029^{*} (0.019)
Uttar Pradesh	-0.055^{**} (0.031)	-	-0.054^{**} (0.032)	-0.051^{**} (0.032)	-0.051^{**} (0.032)
Bihar	-0.056^{*} (0.024)	-	-0.055^{*} (0.023)	-0.0529^{*} (0.026)	-0.053^{*} (0.026)
Jharkhand	0.196^{*} (0.083)	-	0.195 (0.083)	0.196 (0.072)	0.195 (0.077)
Odisha	0.175^{*} (0.055)	-	0.178^{*} (0.059)	0.178^{*} (0.054)	0.178^{*} (0.054)
West Bengal	0.099 (0.021)	-	0.095 (0.021)	0.096 (0.021)	0.097 (0.022)
Arunachal Pradesh	0.042 (0.023)	-	0.045 (0.025)	0.046 (0.025)	0.043 (0.026)
Assam	0.055^{*} (0.024)	-	0.054 (0.027)	0.055 (0.027)	0.056 (0.026)
Manipur	0.162^{*} (0.045)	-	0.165 (0.045)	0.166 (0.047)	0.166 (0.047)
Mizoram	0.258^{*} (0.015)	-	0.254 (0.016)	0.254 (0.016)	0.255 (0.015)
Nagaland	0.009^{*} (0.019)	-	0.011 (0.019)	0.013 (0.019)	0.009 (0.015)
Gujrat	-0.152^{*} (0.021)	-	-0.157^{*} (0.022)	-0.157^{*} (0.021)	0.155^{**} (0.020)
Maharashtra	-0.117^{*} (0.025)	-	-0.119^{*} (0.025)	-0.119^{*} (0.025)	-0.119^{*} (0.025)
Andhra Pradesh	0.022^{*} (0.015)	-	0.023^{*} (0.016)	0.22 (0.019)	0.022 (0.019)

(---------------in continuation of Table 5.3)

Predictors	OLS	Model1	Model2	Model3	Model4
States (Household Size)					
Tamil Nadu	0.016^{*} (0.062)	-	0.015 (0.061)	0.015 (0.062)	0.015 (0.063)
Karnataka	-0.022 (0.034)	-	-0.027 (0.035)	-0.027 (0.036)	-0.027 (0.036)
Delhi	-0.007 (0.037)	-	-0.009 (0.039)	-0.009 (0.031)	-0.009 (0.032)
Meghalaya	0.066^{*} (0.051)	-	0.065 (0.052)	0.065 (0.052)	0.066 (0.051)
Sikkim	0.009^{*} (0.021)	-	0.010 (0.025)	0.011 (0.025)	0.011 (0.021)
Tripura	0.026 (0.035)	-	0.027 (0.036)	0.028 (0.039)	0.028 (0.041)
Goa	0.011 (0.047)	-	0.012 (0.049)	0.012 (0.048)	0.015 (0.047)
Constant	-1.112^{***} (0.088)				
N	1,90,156	1,91,200	1,90,952	1,90,952	1,90,921
Log likelihood	R^2 0.152	-41226.2	-35898.5	-38459.1	-38312.3
X^2 Statistics	126.570		3058.6	3177.2	3099.9
P value	0.000		0.002	0.002	0.002

*Significant at ***p<0.001, **p<0.01,*p<0.05*

Source: Calculation by author from NFHS 4 unit data

Table 5.4: Random coefficients, Intra-class correlation and Variance Decomposition estimates (Weight for Age) NFHS 4

Random coefficients, Intra-class correlation and Variance Decomposition estimates				
	Model 1	**Model 2**	**Model 3**	**Model 4**
Random Effects				
σ^2_c Community- PSU	0.127	0.061	0.052	0.033
(S.E)	(0.009)	(0.006)	(0.006)	(0.007)
Proportions of overall (null model) explained by the covariates of the model (in %)		46.323	52.296	53.118
σ^2_h (Household)	0.401	0.475	0.488	0.449
(S.E)	(0.033)	(0.041)	(0.041)	(0.039)
Proportions of overall (null model) explained by the covariates of the model (in %)		-26.225	-20.745	-21.466
$Residual^2$	1.056	1.029	1.025	1.021
(S.E)	(0.025)	(0.019)	(0.021)	(0.024)
Intra-class correlation				
ρ(PSU)	0.065*	0.034*	0.019*	0.020*
ρ(household)	0.196*	0.167*	0.188*	0.184*
Variance Decomposition (in %)				
PSU	29.5	11.9	8.3	11.8
Household	70.5	88.1	91.7	88.2

Source: Calculation by author from NFHS 4 unit data

Table 5.5: Association (βs) from Ordinary Least Squares and Multilevel Linear Regression Models (Main Effects) between (Weight for Height) and rural-urban place of residence, controlling for various other covariates; twenty-nine Major States, India, NFHS-4

Predictors	OLS	Model 1	Model 2	Model 3	Model 4
Exp(B)(SE)					
Urban Residence	0.269*** (0.023)		0.266*** (0.022)	0.269*** (0.021)	0.271*** (0.023)
Rural Residence	-0.095*** (0.031)	-	-0.099*** (0.032)	-0.099*** (0.030)	-0.095*** (0.031)
Controls					
Individual Characteristics					
Child age (months)	-0.055*** (0.002)	-	-0.054*** (0.009)	-0.051*** (0.010)	0.053*** (0.012)
Sex male	-0.019** (0.025)	-	-0.021** (0.025)	-0.022** (0.022)	-0.021** (0.023)
Order of birth	-0.016 (0.007)	-	-0.025 (0.010)	-0.025 (0.011)	-0.025 (0.011)
Size at Birth	0.312 (0.039)	-	0.325 (0.036)	0.311 (0.035)	0.322 (0.034)
Suffered (*base: no illness*)recent illness	-0.109* (0.053)	-	-0.105* (0.052)	-0.102* (0.052)	-0.111* (0.056)
Duration of Breastfeeding	0.061* (0.028)	-	0.062* (0.028)	0.065* (0.029)	0.066* (0.031)
Completed Immunization	0.015* (0.001)	-	0.016* (0.003)	0.017* (0.002)	0.019* (0.002)
Mothers' Characteristics					
Years of Education	0.029** (0.016)	-	-	0.027*** (0.014)	0.022*** (0.014)
BMI of mother	0.011** (0.006)	-	-	0.012** (0.007)	0.012** (0.008)
Suffers from anemia	0.101** (0.051)	-	-	0.102** (0.051)	0.103** (0.052)
Mother and Child Protection Card	0.066* (0.011)	-	-	0.065* (0.012)	0.066* (0.013)
Institutional delivery	0.051** (0.025)	-	-	0.054** (0.026)	0.059** (0.024)
Decision making Power	-0.016 (0.011)	-	-	-0.015 (0.010)	-0.015 (0.010)
Household Characteristics					
Ethnicity SC ST	-0.057** (0.029)	-	-0.058** (0.023)	-	-0.060*** (0.023)
Water Source(Piped Water)	0.055** (0.012)	-	0.052** (0.011)	-	0.054** (0.011)
Owns a house	-0.098 (0.021)	-	-0.096 (0.019)	-	-0.096 (0.018)

(----------in continuation of Table 5.5)

Predictors **States**	**OLS**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
NSDP	0.123*** (0.042)	-	0.122*** (0.043)	0.122*** (0.045)	0.123*** (0.044)
Haryana	-0.039* (0.021)	-	-0.036* (0.017)	-0.039* (0.016)	-0.036* (0.018)
Himachal Pradesh	0.088* (0.074)	-	0.082* (0.072)	0.083* (0.073)	0.086* (0.071)
Punjab	0.129** (0.076)	-	0.127** (0.069)	0.128 (0.065)	0.127 (0.066)
Rajasthan	-0.333** (0.021)	-	-0.332** (0.022)	-0.333** (0.026)	-0.335** (0.029)
Uttarakhand	0.068* (0.029)	-	0.066 (0.025)	0.065 (0.025)	0.065 (0.021)
Chattisgarh	0.025* (0.016)	-	0.022 (0.016)	0.022 (0.015)	0.022 (0.015)
Madhya Pradesh	-0.054** (0.022)	-	-0.059* (0.022)	-0.058* (0.022)	-0.058* (0.022)
Uttar Pradesh	-0.062** (0.021)	-	-0.063** (0.021)	-0.061** (0.025)	-0.063** (0.022)
Bihar	-0.046* (0.031)	-	-0.047* (0.033)	-0.046* (0.032)	-0.045* (0.032)
Jharkhand	- 0.177 (0.078)	-	-0.178 (0.076)	- 0.178 (0.069)	-0.177 (0.069)
Odisha	-0.125 (0.074)	-	-0.124 (0.072)	-0.121 (0.071)	-0.121 (0.073)
West Bengal	-0.132 (0.025)	-	-0.136 (0.022)	-0.133 (0.026)	-0.135 (0.023)
Arunachal Pradesh	-0.109* (0.011)	-	-0.107* (0.012)	-0.104* (0.016)	-0.106* (0.018)
Assam	-0.041* (0.017)	-	-0.044* (0.016)	-0.045* (0.014)	-0.047* (0.015)
Manipur	0.119* (0.033)	-	0.120 (0.034)	0.126 (0.035)	0.127 (0.035)
Mizoram	0.102* (0.021)	-	0.109 (0.024)	0.111 (0.027)	0.112 (0.025)
Nagaland	0.185* (0.093)	-	0.184 (0.096)	0.181 (0.092)	0.187 (0.099)
Gujrat	0.144* (0.035)	-	0.148 (0.036)	0.147 (0.035)	0.147 (0.039)
Maharashtra	-0.095* (0.033)	-	-0.096* (0.034)	-0.099* (0.036)	-0.095* (0.035)
Andhra Pradesh	-0.116* (0.056)	-	-0.121* (0.057)	-0.121* (0.057)	-0.122* (0.051)

(-----------in continuation of Table 5.5)

Predictors States	OLS	Model 1	Model 2	Model 3	Model 4
Tamil Nadu	0.091* (0.027)	-	0.096 (0.026)	0.092 (0.022)	0.096 (0.021)
Karnataka	-0.055* (0.022)	-	-0.061 (0.022)	-0.062 (0.019)	-0.063 (0.022)
Delhi	-0.097 (0.025)	-	-0.098 (0.025)	-0.095 (0.024)	-0.095 (0.029)
Meghalaya	0.061 (0.041)	-	0.059 (0.042)	0.053 (0.043)	0.053 (0.044)
Sikkim	0.121* (0.036)	-	0.122 (0.035)	0.121 (0.035)	0.121 (0.033)
Tripura	0.052 (0.033)	-	0.054 (0.030)	0.050 (0.034)	0.050 (0.031)
Goa	0.165 (0.021)	-	0.159 (0.021)	0.159 (0.019)	0.159 (0.022)
Constant	-1.127*** (0.088)				
N	1,90,156	1,91,200	1,90,952	1,90,952	1,90,921
Log likelihood	R^2 0.419	-40281.20	-39458.55	-38459.19	-38122.17
X^2 Statistics	211.245		2985.6	2944.7	2901.1
P value	0.001		0.001	0.001	0.001

*Significant at ***p<0.001, **p<0.01,*p<0.05*

Source: Calculation by author from NFHS 4 unit data

Table 5.6: Random coefficients, Intra-class correlation and Variance Decomposition estimates (Weight for Height) NFHS 4

Random coefficients, Intra-class correlation and Variance Decomposition estimates				
	Model 1	**Model 2**	**Model 3**	**Model 4**
Random Effects				
σ^2_c Community- PSU	0.145	0.089	0.060	0.041
(S.E)	(0.011)	(0.011)	(0.013)	(0.019)
Proportions of overall (null model) explained by the covariates of the model (in %)		39.385	56.211	58.598
σ^2_h (Household)	0.389	0.452	0.444	0.454
(S.E)	(0.047)	(0.050)	(0.051)	(0.056)
Proportions of overall (null model) explained by the covariates of the model (in %)		-26.225	-20.745	-21.466
Residual^2	1.139	1.144	1.141	1.145
(S.E)	(0.021)	(0.029)	(0.026)	(0.027)
Intra-class correlation				
ρ(PSU)	0.071*	0.042*	0.025*	0.029*
ρ(household)	0.206*	0.212*	0.213*	0.219*
Variance Decomposition (in %)				
PSU	31.7	25.5	15.1	18.8
Household	68.3	74.5	84.9	81.2

Source: Calculation by author from NFHS 4 unit data

Table 5.7: Association (βs) from Ordinary Least Squares and Multilevel Linear Regression Models (Main Effects) between (Height for Age) and rural-urban place of residence, controlling for various other covariates; twenty-nine Major States, India, NFHS-3

Predictors	**OLS**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Exp(B)(SE)					
Urban Residence	0.211*** (0.020)		0.296*** (0.021)	0.202*** (0.021)	0.199*** (0.020)
Rural Residence	-0.109*** (0.017)	-	-0.111*** (0.016)	-0.112*** (0.015)	-0.113*** (0.016)
Controls					
Individual Characteristics					
Child age (months)	-0.061 (0.018)	-	-0.053 (0.019)	-0.066 (0.018)	-0.065 (0.017)
Sex (base : male) female	0.016** (0.009)	-	0.022** (0.006)	0.018** (0.005)	0.019** (0.007)
Order of birth	-0.034 (0.011)	-	-0.035 (0.015)	-0.033 (0.018)	-0.031 (0.014)
Size at Birth	0.189* (0.031)	-	0.193* (0.032)	0.191* (0.036)	0.188* (0.033)
Suffered (*base: no illness*)recent illness	-0.051* (0.019)	-	-0.053* (0.018)	-0.052* (0.016)	-0.051* (0.017)
Duration of Breastfeeding (*base: less than 6 months*)	-0.075* (0.029)	-	-0.078* (0.021)	-0.077* (0.022)	-0.077* (0.026)
Completed Immunization	0.095* (0.017)	-	0.092* (0.017)	0.093* (0.016)	0.094* (0.015)
Mothers' Characteristics					
Years of Education	0.055** (0.016)	-		0.054** (0.014)	0.058** (0.015)
BMI of mother≥ 18.5 (*base= 18.5*)	0.043* (0.011)	-		0.045* (0.012)	0.051* (0.014)
Suffers from anemia	0.185* (0.051)	-		0.181* (0.052)	0.188* (0.056)
Institutional delivery(*base = home delivery)*	0.077*** (0.015)	-		0.078*** (0.014)	0.077*** (0.013)
Decision making Power	0.033* (0.019)	-		0.034* (0.018)	0.035* (0.017)
Household Characteristics					
Ethnicity SC ST	-0.154*** (0.024)	-	-0.156*** (0.025)	-	-0.153*** (0.021)
Water Source(Piped Water)	0.065** (0.011)	-	0.063** (0.012)	-	0.064** (0.013)
Owns a house	0.195* (0.034)	-	0.194* (0.039)	-	0.197* (0.038)

(------------- in continuation of Table 5.7)

Predictors	**OLS**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
States					
Per capita NSDP	0.187** (0.099)	-	0.191** (0.095)	0.192** (0.099)	0.191** (0.096)
Haryana	0.108 (0.064)	-	0.109 (0.061)	0.111 (0.065)	0.111 (0.064)
Himachal Pradesh	0.188* (0.082)	-	0.181* (0.084)	0.181* (0.082)	0.181* (0.085)
Punjab	0.124 (0.061)	-	0.125 (0.064)	0.126 (0.065)	0.124 (0.069)
Rajasthan	-0.109** (0.031)	-	-0.108** (0.040)	-0.111** (0.040)	-0.111** (0.040)
Uttarakhand	-0.187* (0.092)	-	-0.187* (0.093)	-0.186* (0.097)	-0.185* (0.102)
Chattisgarh	0.122 (0.064)	-	0.123* (0.061)	0.121* (0.062)	0.126* (0.063)
Madhya Pradesh	0.025 (0.005)	-	0.027 (0.004)	0.026 (0.005)	0.025 (0.006)
Uttar Pradesh	-0.101* (0.057)	-	-0.103* (0.051)	-0.104* (0.053)	-0.106* (0.054)
Bihar	-0.151* (0.039)	-	-0.156* (0.037)	-0.153* (0.035)	-0.152* (0.034)
Jharkhand	-0.184* (0.033)	-	-0.186* (0.034)	-0.192* (0.038)	-0.192* (0.033)
Odisha	0.144* (0.071)	-	0.146* (0.072)	0.147* (0.071)	0.148* (0.072)
West Bengal	0.141* (0.043)	-	0.145* (0.042)	0.145* (0.045)	0.146* (0.041)
Arunachal Pradesh	0.003 (0.012)	-	0.004 (0.017)	0.009 (0.017)	0.010 (0.017)
Assam	0.027 (0.016)	-	0.027 (0.017)	0.028 (0.016)	0.028 (0.016)
Manipur	0.321 (0.027)	-	0.326 (0.026)	0.325 (0.026)	0.325 (0.029)
Mizoram	0.253 (0.033)	-	0.256 (0.037)	0.255 (0.036)	0.254 (0.035)
Nagaland	0.041 (0.017)	-	0.044 (0.018)	0.043 (0.018)	0.044 (0.017)
Gujrat	-0.205*** (0.046)	-	-0.206*** (0.046)	-0.209*** (0.046)	-0.209*** (0.045)
Maharashtra	-0.153* (0.033)	-	-0.156* (0.035)	-0.157* (0.034)	-0.154* (0.033)
Andhra Pradesh	0.095 (0.056)	-	0.096 (0.055)	0.099 (0.054)	0.098 (0.052)

(------------- in continuation of Table 5.7)

Predictors **States**	**OLS**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Tamil Nadu	0.112* (0.025)	-	0.118* (0.026)	0.119* (0.026)	0.119* (0.028)
Karnataka	-0.011 (0.008)	-	-0.012 (0.007)	-0.016 (0.005)	-0.017 (0.006)
Delhi	-0.084 (0.019)	-	-0.083 (0.017)	-0.081 (0.016)	-0.086 (0.017)
Meghalaya	0.045 (0.021)	-	0.047 (0.022)	0.048 (0.023)	0.049 (0.024)
Sikkim	0.134 (0.051)	-	0.136 (0.052)	0.137 (0.051)	0.133 (0.051)
Tripura	0.055 (0.041)	-	0.056 (0.044)	0.049 (0.045)	0.050 (0.046)
Goa	0.014 (0.035)	-	0.019 (0.033)	0.019 (0.032)	0.019 (0.033)
Jammu &Kashmir	- 0.056 (0.055)	-	-0.057 (0.056)	-0.058 (0.057)	-0.059 (0.054)
Constant	-1.126*** (0.043)	-1.111*** (0.021)	-1.132*** (0.025)	-1.140*** (0.024)	-1.141*** (0.021)
N	40,953	41,006	40,877	40,596	40,945
Log likelihood	R^2 0.149	-33352.36	-39845.26	-38971.31	-39668
X^2 Statistics	158.394		4388.49	4622.3	4411.5
P value	0.000		0.000	0.000	0.000

*Significant at ***p<0.001, **p<0.01,*p<0.05*

Source: Calculation by author from NFHS 3 unit data

Table 5.8: Random coefficients, Intra-class correlation and Variance Decomposition estimates (Height for Age) NFHS 3

Random coefficients, Intra-class correlation and Variance Decomposition estimates				
	Model 1	**Model 2**	**Model 3**	**Model 4**
Random Effects				
σ^2_c Community- PSU	0.209	0.099	0.078	0.044
(S.E)	(0.026)	(0.021)	(0.015)	(0.011)
Proportions of overall (null model) explained by the covariates of the model (in %)		45.965	71.231	66.934
σ^2_h (Household)	0.366	0.412	0.455	0.465
(S.E)	(0.025)	(0.032)	(0.035)	(0.033)
Proportions of overall (null model) explained by the covariates of the model (in %)		-33.688	-25.636	-29.514
Residual^2	1.965	1.632	1.611	1.651
(S.E)	(0.029)	(0.025)	(0.023)	(0.028)
Intra-class correlation				
ρ(PSU)	0.085*	0.050*	0.036*	0.031*
ρ(household)	0.277*	0.254*	0.291*	0.243*
Variance Decomposition (in %)				
PSU	34.9	11.6	8.2	12.2
Household	65.1	88.4	91.8	87.8

Source: Calculation by author from NFHS 3 unit data

Table 5.9: Association (βs) from Ordinary Least Squares and Multilevel Linear Regression Models (Main Effects) between (Weight for Age) and rural-urban place of residence, controlling for various other covariates; twenty-nine Major States, India, NFHS-3

Predictors	**OLS**	**Model1**	**Model2**	**Model3**	**Model4**
Exp(B)(SE)					
Urban Residence	0.325^{***} (0.021)		0.341^{***} (0.022)	0.297^{***} (0.022)	0.298^{***} (0.023)
Rural Residence	-0.101^{***} (0.027)	-	-0.102^{***} (0.028)	-0.102^{***} (0.029)	-0.102^{***} (0.027)
Controls					
Individual Characteristics					
Child age (months)	-0.034^{***} (0.009)	-	-0.049^{***} (0.010)	-0.044^{***} (0.012)	0.048^{***} (0.010)
Sex (base : male) Female	-0.011^{***} (0.009)	-	-0.019^{***} (0.007)	-0.023^{***} (0.005)	-0.020^{***} (0.009)
Order of birth	-0.035 (0.017)	-	-0.033 (0.015)	-0.038 (0.016)	-0.033 (0.017)
Size at Birth	0.281 (0.040)	-	0.285 (0.039)	0.284 (0.038)	0.83 (0.040)
Suffered (*base: no illness*)recent illness	-0.065 (0.022)	-	-0.066 (0.020)	-0.064 (0.021)	-0.066 (0.023)
Duration of Breastfeeding (*base: less than 6 months*)	-0.046^{*} (0.023)	-	-0.049^{*} (0.027)	-0.045^{*} (0.025)	-0.042^{*} (0.025)
Completed Immunization	0.018^{*} (0.008)	-	0.017^{*} (0.009)	0.016^{*} (0.009)	0.019^{*} (0.008)
Mothers' Characteristics					
Years of Education	0.051^{**} (0.018)	-	-	0.052^{**} (0.017)	0.056^{**} (0.018)
BMI of mother	0.022^{**} (0.011)	-	-	0.023^{**} (0.011)	0.024^{**} (0.012)
Suffers from anemia	0.041 (0.015)	-	-	0.043 (0.016)	0.041 (0.016)
Institutional delivery	0.039^{**} (0.012)	-	-	0.038^{**} (0.009)	0.039^{**} (0.009)
Decision making Power	0.049^{**} (0.014)	-	-	0.047^{**} (0.013)	0.047^{**} (0.014)
Household Characteristics					
Ethnicity SC ST	-0.094^{**} (0.050)	-	-0.093^{**} (0.048)	-	-0.096^{***} (0.047)
Water Source(Piped Water)	0.031^{**} (0.011)	-	0.033^{**} (0.012)	-	0.036^{**} (0.011)
Owns a house	0.143^{**} (0.035)	-	0.141^{**} (0.036)	-	0.142^{**} (0.037)

(------------in continuation of Table 5.9)

Predictors	OLS	Model1	Model2	Model3	Model4
States					
NSDP	0.127*** (0.033)	-	0.126*** (0.032)	-0.125*** (0.035)	-0.125*** (0.035)
Haryana	0.086* (0.021)	-	0.085 (0.022)	-0.089 (0.022)	-0.086 (0.022)
Himachal Pradesh	0.064* (0.030)	-	0.065* (0.031)	0.066* (0.031)	0.066* (0.031)
Punjab	0.158* (0.061)	-	0.155* (0.062)	0.154* (0.061)	0.154* (0.061)
Rajasthan	0.239 (0.051)	-	0.234 (0.053)	0.233 (0.054)	0.234 (0.052)
Uttarakhand	-0.022* (0.009)	-	-0.023* (0.010)	-0.023* (0.011)	-0.023* (0.009)
Chattisgarh	0.053* (0.016)	-	0.053* (0.017)	0.053* (0.017)	0.052* (0.017)
Madhya Pradesh	-0.032* (0.021)	-	-0.033* (0.022)	-0.033* (0.022)	-0.032* (0.022)
Uttar Pradesh	-0.076** (0.025)	-	-0.078** (0.026)	-0.078** (0.026)	-0.078** (0.026)
Bihar	-0.019* (0.010)	-	-0.020* (0.010)	-0.020* (0.010)	-0.021* (0.010)
Jharkhand	0.055 (0.016)	-	0.056 (0.017)	0.057 (0.017)	0.057 (0.016)
Odisha	0.044* (0.031)	-	0.047* (0.032)	0.046* (0.032)	0.046* (0.032)
West Bengal	0.065 (0.029)	-	0.066 (0.030)	0.067 (0.032)	0.067 (0.033)
Arunachal Pradesh	-0.087* (0.036)	-	-0.089* (0.035)	-0.088* (0.036)	-0.088* (0.035)
Assam	0.043 (0.022)	-	0.045 (0.023)	0.043 (0.023)	0.044 (0.023)
Manipur	0.115 (0.035)	-	0.117 (0.034)	0.117 (0.037)	0.117 (0.036)
Mizoram	-0.199** (0.023)	-	-0.195** (0.024)	-0.193 (0.025)	-0.194 (0.025)
Nagaland	0.034* (0.021)	-	0.033* (0.022)	0.032* (0.021)	0.033* (0.021)
Gujrat	-0.106* (0.052)	-	-0.105* (0.051)	-0.105* (0.052)	0.106** (0.052)
Maharashtra	0.159 (0.079)	-	-0.156 (0.077)	-0.155 (0.077)	-0.155 (0.077)
Andhra Pradesh	0.051 (0.022)	-	0.055 (0.020)	0.055 (0.020)	0.056 (0.020)

(-----------in continuation of Table 5.9)

Predictors	OLS	Model1	Model2	Model3	Model4
States					
Tamil Nadu	0.039 (0.050)	-	0.038 (0.051)	0.039 (0.051)	0.039 (0.050)
Karnataka	-0.062 (0.025)	-	-0.065 (0.026)	-0.064 (0.027)	-0.064 (0.027)
Delhi	-0.057 (0.035)	-	-0.058 (0.036)	-0.058 (0.035)	-0.059 (0.035)
Meghalaya	0.029 (0.011)	-	0.029 (0.013)	0.028 (0.013)	0.028 (0.013)
Sikkim	0.027 (0.015)	-	0.029 (0.014)	0.029 (0.015)	0.028 (0.015)
Tripura	0.070 (0.028)	-	0.069 (0.029)	0.070 (0.027)	0.070 (0.027)
Goa	0.033 (0.007)	-	0.034 (0.007)	0.035 (0.007)	0.034 (0.007)
Constant	-1.295*** (0.088)		-		
N	40,957	41,153	40,932	40,117	41,062
Log likelihood	R^2 0.166	-36101.20	-39709.23	-38845.64	-39233
X^2 Statistics	155.251		4309.23	4597.8	4463.61
P value	0.001		0.001	0.001	0.001

*Significant at ***p<0.001, **p<0.01,*p<0.05*

Source: Calculation by author from NFHS 3 unit data

Table 5.10: Random coefficients, Intra-class correlation and Variance Decomposition estimates (Weight for Age)

Random coefficients, Intra-class correlation and Variance Decomposition estimates				
	Model 1	**Model 2**	**Model 3**	**Model 4**
Random Effects				
σ^2_c Community- PSU	0.111	0.064	0.048	0.029
(S.E)	(0.016)	(0.009)	(0.010)	(0.008)
Proportions of overall (null model) explained by the covariates of the model (in %)		29.121	41.222	45.459
σ^2_h (Household)	0.435	0.401	0.426	0.389
(S.E)	(0.025)	(0.029)	(0.033)	(0.032)
Proportions of overall (null model) explained by the covariates of the model (in %)		-25.313	-26.361	-21.342
Residual^2	1.128	1.419	1.411	1.599
(S.E)	(0.021)	(0.018)	(0.022)	(0.023)
Intra-class correlation				
ρ(PSU)	0.059*	0.038*	0.022*	0.021*
ρ(household)	0.184*	0.168*	0.176*	0.159*
Variance Decomposition (in %)				
PSU	32.7	20.4	10.6	8.5
Household	67.3	79.6	89.4	91.5

Source: Calculation by author from NFHS 3 unit data

Table 5.11: Association (βs) from Ordinary Least Squares and Multilevel Linear Regression Models (Main Effects) between (Weight for Height) and rural-urban place of residence, controlling for various other covariates; twenty-nine Major States, India, NFHS-3

Predictors	OLS	Model1	Model2	Model3	Model4
Exp(B)(SE)					
Urban Residence	0.275^{***} (0.019)		0.277^{***} (0.020)	0.279^{***} (0.019)	0.268^{***} (0.018)
Rural Residence	-0.021^{***} (0.008)	-	-0.020^{***} (0.009)	-0.019^{***} (0.010)	-0.016^{***} (0.010)
Controls					
Individual Characteristics					
Child age (months)	-0.049 (0.011)	-	-0.054 (0.010)	-0.051 (0.011)	0.053 (0.011)
Sex (base : male) Female	-0.025^{*} (0.015)	-	-0.021^{*} (0.016)	-0.022^{*} (0.017)	-0.021^{*} (0.016)
Order of birth	-0.033 (0.012)	-	-0.037 (0.011)	-0.036 (0.012)	-0.036 (0.012)
Size at Birth	0.253 (0.029)	-	0.255 (0.028)	0.256 (0.028)	0.254 (0.027)
Suffered (*base: no illness*)recent illness	-0.174^{*} (0.050)	-	-0.173^{*} (0.049)	-0.171^{*} (0.048)	-0.172^{*} (0.047)
Duration of Breastfeeding (*base: less than 6 months*)	-0.043^{*} (0.015)	-	-0.045^{*} (0.019)	-0.047^{*} (0.017)	-0.047^{*} (0.015)
Completed Immunization	0.025^{*} (0.007)	-	0.024^{*} (0.009)	0.027^{*} (0.010)	0.028^{*} (0.010)
Mothers' Characteristics					
Years of Education	0.036^{**} (0.011)	-	-	0.035^{***} (0.012)	0.033^{***} (0.011)
BMI of mother	0.055 (0.023)	-	-	0.051^{**} (0.025)	0.054^{**} (0.022)
Suffers from anemia	-0.152^{**} (0.029)	-	-	-0.153^{**} (0.028)	-0.157^{**} (0.027)
Institutional delivery	0.083^{**} (0.019)	-	-	0.081^{**} (0.017)	0.084^{**} (0.020)
Decision making Power	-0.047 (0.030)	-	-	-0.046 (0.031)	-0.043 (0.031)
Household Characteristics					
Ethnicity SC ST	-0.097^{**} (0.014)	-	-0.099^{**} (0.016)	-	-0.098^{***} (0.015)
Water Source(Piped Water)	0.035^{**} (0.008)	-	0.036^{**} (0.007)	-	0.034^{**} (0.008)
Owns a house	-0.117 (0.015)	-	-0.118 (0.013)	-	-0.116 (0.013)

(-----------------in continuation of Table 5.11)

Predictors	OLS	Model1	Model2	Model3	Model4
States					
NSDP	0.141*** (0.055)	-	0.143*** (0.056)	0.143*** (0.054)	0.143*** (0.053)
Haryana	-0.021* (0.006)	-	-0.023* (0.009)	-0.025* (0.010)	-0.027* (0.011)
Himachal Pradesh	0.065 (0.047)	-	0.066 (0.048)	0.066 (0.045)	0.067 (0.047)
Punjab	0.201 (0.013)	-	0.203 (0.017)	0.203 (0.019)	0.203 (0.015)
Rajasthan	-0.254** (0.039)	-	-0.256** (0.042)	-0.254** (0.043)	-0.256** (0.041)
Uttarakhand	0.053 (0.018)	-	0.054 (0.021)	0.057 (0.020)	0.058 (0.019)
Chattisgarh	0.153 (0.020)	-	0.159 (0.023)	0.157 (0.024)	0.158 (0.021)
Madhya Pradesh	-0.041** (0.011)	-	-0.042* (0.016)	-0.045* (0.015)	-0.046* (0.014)
Uttar Pradesh	-0.011** (0.006)	-	-0.012** (0.004)	-0.012** (0.003)	-0.011** (0.005)
Bihar	-0.089* (0.051)	-	-0.085* (0.054)	-0.087* (0.049)	-0.084* (0.050)
Jharkhand	- 0.201* (0.072)	-	-0.202* (0.074)	- 0.203* (0.077)	-0.203* (0.075)
Odisha	0.099* (0.025)	-	0.096* (0.027)	0.092* (0.024)	0.098* (0.024)
West Bengal	-0.189* (0.060)	-	-0.185* (0.059)	-0.187* (0.055)	-0.184* (0.056)
Arunachal Pradesh	-0.156* (0.020)	-	-0.154* (0.026)	-0.155* (0.023)	-0.156 (0.020)
Assam	-0.166* (0.087)	-	-0.162* (0.084)	-0.160* (0.085)	-0.161* (0.086)
Manipur	0.217 (0.051)	-	0.214 (0.052)	0.210 (0.053)	0.219 (0.054)
Mizoram	0.069 (0.019)	-	0.074 (0.020)	0.078 (0.021)	0.075 (0.022)
Nagaland	0.208 (0.088)	-	0.209 (0.085)	0.211 (0.084)	0.209 (0.086)
Gujrat	-0.127* (0.033)	-	-0.136* (0.032)	-0.132* (0.034)	0.139* (0.030)
Maharashtra	-0.052* (0.009)	-	-0.058* (0.006)	-0.062* (0.013)	-0.063* (0.014)
Andhra Pradesh	-0.029* (0.011)	-	-0.030* (0.012)	-0.046* (0.022)	-0.041* (0.019)

(------------------in continuation of Table 5.11)

Predictors	OLS	Model1	Model2	Model3	Model4
States					
Tamil Nadu	0.076 (0.031)	-	0.081 (0.035)	0.073 (0.041)	0.075 (0.039)
Karnataka	-0.025 (0.009)	-	-0.029 (0.016)	-0.45 (0.011)	-0.041 (0.008)
Delhi	-0.052 (0.021)	-	-0.057 (0.019)	-0.049 (0.030)	-0.044 (0.031)
Meghalaya	0.012 (0.032)	-	0.023 (0.031)	0.026 (0.025)	0.017 (0.021)
Sikkim	0.056 (0.025)	-	0.057 (0.022)	0.057 (0.024)	0.061 (0.031)
Tripura	0.035 (0.021)	-	0.036 (0.020)	0.037 (0.021)	0.041 (0.025)
Goa	0.161 (0.011)	-	0.145 (0.019)	0.146 (0.019)	0.110 (0.024)
Constant	-1.184*** (0.059)				
N	1,90,112	1,91,296	1,90,901	1,90,949	1,90,967
Log likelihood	R^2 0.422	-40399.74	-39407.09	-30259.52	-31233.10
X^2 Statistics	199.301		2845.05	2981.1	2814.3
P value	0.002		0.002	0.000	0.002

*Significant at ***p<0.001, **p<0.01,*p<0.05*

Source: Calculation by author from NFHS 3 unit data

Table 5.12: Random coefficients, Intra-class correlation and Variance Decomposition estimates (Weight for Height) NFHS 3

Random coefficients, Intra-class correlation and Variance Decomposition estimates				
	Model 1	**Model 2**	**Model 3**	**Model 4**
Random Effects				
σ^2_c Community- PSU	0.121	0.054	0.041	0.037
(S.E)	(0.014)	(0.012)	(0.010)	(0.018)
Proportions of overall (null model) explained by the covariates of the model (in %)		42.727	42.365	49.163
σ^2_h (Household)	0.431	0.496	0.412	0.453
(S.E)	(0.032)	(0.037)	(0.035)	(0.042)
Proportions of overall (null model) explained by the covariates of the model (in %)		-21.549	-19.711	-18.208
$Residual^2$	1.026	1.101	1.129	1.133
(S.E)	(0.019)	(0.022)	(0.031)	(0.030)
Intra-class correlation				
ρ(PSU)	0.055^*	0.051^*	0.031^*	0.033^*
ρ(household)	0.192^*	0.207^*	0.241^*	0.239^*
Variance Decomposition (in %)				
PSU	28.8	25.9	11.4	15.1
Household	71.2	74.1	88.6	84.9

Source: Calculation by author from NFHS 3 unit data

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Chapter 6

Dietary Pattern and Child Undernutrition in India

6.1 Introduction

Undernutrition is undeniably the biggest public health problem in our country today. The economic condition of a greater number of our populace is quite poor and as a result is unable to afford even the least expensive balanced diet. A number of nutrition and diet surveys carried out among different groups of population and different parts of our country have approved the existence of widespread undernutrition among the poorer sections of our populace. The 2014-15 National family health survey have found that thirty-eight percent of children under age five years are stunted (short for their age); twenty-one percent are wasted (thin for their height); thirty-six percent are underweight (thin for their age); and two percent are overweight (heavy for their height). Children born to mothers with no schooling and children in the lowest wealth quintile are most likely to be undernourished.

For the sake of child's optimal growth, health and development, adequate nutrition from the period in the mother's womb to two years of age is essential. There is a universal consensus on the importance of infant and young child feeding (IYCF) - meaning breastfeeding and complementary feeding as an important determinant of child nutrition. The global public health recommendations suggest that along with disease prevention strategies, complementary feeding interventions are most effective in reducing undernutrition. It states that an infant should be exclusively breast fed for the first six months of life and thereafter timely, adequate and appropriate complementary foods should be introduced to the child's diet while they continue breastfeeding up to two years of age and beyond.

Absence of dietary diversity is a problem and is critical for young children during their complementary feeding period. This is because during this period, children require food containing essential nutrients for normal physical and mental development. Those who eat foods from four or more food groups daily have the minimum recommended dietary diversity as they are assumed to consume at least one animal-source food and at least one fruit or vegetable, in addition to a staple food [World Health Organization: Indicators for assessing infant and young child feeding practices. Conclusions of a consensus meeting held 6–8 November 2007. Washington, DC, USA 2008].

But, for many children from poorer households this minimum is not achieved. There are several studies conducted in developing countries that have identified that poverty, low level of parental education and rural place of residence contributes to the prevalence of undernutrition in children. Along with the socioeconomic factors, dietary diversity is also associated with the nutritional status of young children (Taren & Chen, 1993; Hatloy et al., 2000; Arimond & Ruel, 2002; Onyango et al., 2008). A study by Kakoli Borokoky et al., identified the determinants of nutritional status of children in India with a special focus on dietary diversity at the state level. They used the household-level consumption data from all the three rounds of the Consumption Expenditure Survey of the National Sample Survey Organization (1993–2012). The dietary diversity indices were constructed at the state-level to examine the diversity in the quantity of food consumed and food expenditure. The daily 'per consumer unit' calorie intake at the state level for the three time periods was calculated, i.e., the consumption per head is corrected by age and sex, with the consumption needs of adults not being weighted in the same way as those for a child.For example , in a householdwith two parents and a child, the man counts for 1, the woman for 0.9 (to reflect her lower calorie requirements) and the child for 0.5, which leads to only 2.4 consumer equivalents instead of 3. They obtained the following result (Table: 6.0).

Table 6.0: Daily per consumer unit calorie intake in India by state and place of residence, NSSO, 1993–2012

States	1993-94			2004-05			2011-12		
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban
Rajasthan	3009	3093	2728	2761	2806	2621	2757	2797	2637
Delhi	2872	3049	2851	2595	2504	2602	2533	2585	2529
Haryana	2931	3031	2646	2761	2796	2679	2782	2790	2765
Himachal Pradesh	2922	2919	2949	3034	3046	2957	3240	3241	3236
Jammu & Kashmir	3131	3171	2995	2909	2909	2911	2915	2924	2886
Punjab	2884	2999	2603	2786	2808	2745	2827	2859	2780
Uttaranchal	—	—	—	2814	2808	2832	3006	3054	2875
Bihar	2661	2656	2702	2647	2640	2712	2545	2541	2577
Orissa	2750	2747	2771	2589	2573	2686	2609	2614	2580
West Bengal	2706	2733	2615	2597	2610	2562	2548	2537	2577
Jharkhand	—	—	—	2597	2530	2911	2454	2414	2590
Goa	2388	2333	2463	2363	2371	2347	2578	2476	2674
Gujarat	2498	2490	2515	2546	2534	2568	2461	2340	2605
Maharashtra	2435	2422	2457	2446	2477	2402	2559	2569	2548
Arunachal Pradesh	2597	2537	3046	2743	2771	2576	2424	2383	2574
Assam	2438	2424	2565	2540	2520	2695	2401	2383	2526
Manipur	2636	2665	2557	2687	2685	2694	2414	2415	2411
Meghalaya	2477	2464	2558	2365	2358	2405	2091	2072	2162
Mizoram	2641	2596	2737	2615	2604	2631	2518	2443	2607
Nagaland	2687	2712	2618	2549	2512	2632	2328	2293	2385
Sikkim	2325	2307	2528	2505	2490	2612	2418	2474	2235
Tripura	2388	2370	2505	2342	2294	2608	2633	2619	2700
Madhya Pradesh	2671	2704	2563	2477	2466	2511	2582	2601	2529
Uttar Pradesh	2843	2895	2627	2764	2797	2643	2632	2658	2546
Chhattisgarh	—	—	—	2544	2516	2686	2448	2442	2469
Andhra Pradesh	2543	2565	2480	2609	2629	2552	2725	2760	2654
Karnataka	2575	2599	2516	2456	2416	2538	2515	2543	2470
Kerala	2489	2488	2489	2685	2671	2731	2664	2647	2707
Tamil Nadu	2381	2369	2404	2528	2489	2589	2526	2502	2555
India	2659	2690	2564	2610	2620	2584	2600	2607	2585

Source: Kakoli Borkotoky et al.using NSSO data

It is clear that there is a significant inter-state variation in child under-nutrition parameters and that diversity in dietary intake at the household level may be a significant factor explaining such variations. Dietary diversity may be of various types. It may arise due to the fact that, given the calorific or protein requirements of an able person engaged in a particular type of occupation, the composition of food in the diet may vary, and with changes in the parameters , this composition may also vary between persons classified by age, sex, body weight and type of activity one is engaged in. The importance of dietary diversity for child growth and development is recognized by the World Health Organization. It included ‘diversity in complementary feeding’ as a specific recommendation for breast-fed children aged 6–23 months.

The multi-dimensional child feeding practices undergo rapid change within short-intervals in their first few years of life. Exclusive breastfeeding is considered as a single best indicator of child feeding practices. Other dimensions of child feeding practices are introduction of complementary foods, and optimum quantity and quality of the foods consumed. In 2008, WHO published the document Indicators for assessing infant and young child feeding practices which includes eight core and seven optional indicators. The core list includes early initiation of breastfeeding, exclusive breastfeeding under 6 months, continued breastfeeding at 1 year, introduction of solid, semisolid or soft food, minimum dietary diversity (a proxy for adequate micronutrient-density of foods and liquids other than breast milk), minimum meal frequency (a proxy for adequate energy intake from non-breast milk sources), and minimum acceptable diet among breastfed and non-breastfed children aged 6–23 months.

The upsurge in the recognition of minimum acceptable diet as an important element in healthy nutrition calls for more research in this area. Minimum acceptable diet is anticipated to contribute to good child health of a child. Good health is reflected by good child growth. It is observed in few studies that apart from poor nutrition, inadequate hygiene, living conditions, income and medical care can lead to infection and disease. These infection and diseases could have been prevented if proper medical care and hygienic living condition was ensured. Though stunting, wasting and underweight is observed, the causes of these undernutrition variables are varied and interconnected. Thus, the state of a child's health is often a result of the interactions of factors at the individual and family levels such as access to food, feeding patterns, and factors at the social and physical environmental levels, such as access to health care and to clean water.

Due to varied levels of availability and individual preferences for food, diversity in minimum acceptable diet varies across household. Climatic condition of a locality, local food production practices affect the consumption pattern and availability of foodgrains. Studies have identified food availability and household–level consumption. But the role of agro-climatic region as a possible determinant of minimum acceptable diet has been less explored.

Thus, much remains to be understood about the role of agro-climatic regions in child dietary diversity, and its relationship with stunting, wasting and underweight, and the role played by other individual, household and state level factors. In this chapter, we present an analysis specific to India, using the NFHS data (NFHS 3 and NFHS 4) and under-nutrition parameters.

The present chapter seeks to shed light on two specific objectives:

1) to understand the position of different states of India with respect to its under-nutrition status on the basis of the determinants of Minimum Acceptable Diet, and

2) to explore the relationships of Minimum acceptable diet to childhood under-nutrition parameters for different states in India, when control variables related to maternal, child and household characteristics are accounted for.

6.2 Methodology

6.2.1 Data

The present chapter used a nationally representative dataset from National Family Health Survey- 3 and 4. These are publicly available data. These data set was chosen because they are the most recent data available, and most importantly, they contain the necessary child feeding variables needed for this analysis. The two NFHS surveys have been conducted under the stewardship of the Ministry of Health and Family Welfare (MoHFW), Government of India. NFHS-3 and 4 was designed to provide estimates of important maternal and child health indicators including nutritional status for young children (under five years for NFHS-3 and 4), following standard anthropometric components. The surveys were conducted following stratified two-stage sampling technique. Details on the sampling procedure can be found at IIPS, 2007 and 2014. The 2001 and 2011 census served as the sampling frame for the selection of PSUs.

6.2.2 Study Sample

In this chapter we considered a subset of 73,626 and 27,123 children are taken from NFHS 4 and 3 respectively, aged 6- 23 months from 29 states in India. The data which was missing either anthropometric information or were not included among the 29 states considered for the study, were excluded. As earlier, three indices of nutritional status were calculated for children: height-for-age, weight-for-height and weight-for-age. The first indicator that is, height-for-age look into linear growth retardation and is a signal for chronic under-nutrition. The weight-for-height indicator juxtaposes body mass to body length and indicates acute under-nutrition. The weight-for-age is a composite measure of both chronic and acute under-nutrition. These three indices of nutritional status are expressed in z-scores from the median of international reference population (WHO-NCHS reference population).

6.2.3 Methods Used

We use one analytical method for exploring the relationship between Minimum Acceptable Diet and child under-nutritional parameters controlling for other covariates.

6.2.4 Nutritional Status and Child Feeding Practices

To analyse the objective, the percentages of undernutrion parametes namely, stunting, wasting and underweight are obtained for different states in India from the unit –level data separately for NFHS 3 and NFHS 4. The percentages of the parameters of complementary feeding practices were then obtained for the different states. The parameters includes, percentage of children fed with breastmilk, milk or milk products, percentage of children receiving minimum dietary diversity, percentage of children receiving Minimum Meal frequency and lastly percentage of children fed with Minimum Acceptable Diet. These values calculated for height-for-age, weight-for-height and weight-for-age and the various determinants of complementary feeding practices, helps us to understand the relative position of children of different states of India for NFHS-3 and NFHS-4.

6.2.5 Multi-level Regression

The NFHS data is of stratified nature where the children are nested into mothers, mothers are nested into households, households into Primary Sampling Units (PSUs) and PSUs into states. Hence, a multi-level regression analysis was used to estimate the probability of child under-nutrition.

Here the individual demographic and health attributes (e.g., age, gender, birth order, size at birth, etc.) are the factors, which are independently determined for every child. But, it is anticipated that siblings share certain common characteristics of the mother and the household and children from a particular community or village have in common community level factors. So, the outcome variable may be correlated at the cluster levels. These results to an estimation problem when we employ conventional OLS estimators, which gives efficient estimates only when the community level covariates and the household level covariates are uncorrelated with the child and maternal effects covariates. To estimate models related to nutrition, researchers used fixed effects models and control for unobservable variables at the cluster level. But this leads to the difficulty, that in the process of transforming the variables, apart from the dummy variables, the time-invariant explanatory variables (e.g. caste, gender, parental education, etc) get wiped out from the model. Also differencing leads to removal of long-run effects in the variables are thereby we are left with only the short-run effects in the variables. Again the disturbance term of the fixed effect model suffers from autocorrelation problem. Thus, to understand the impact of minimum acceptable diet on child undernutrition, we adopt an alternative approach of using multilevel model.

Multilevel regression analysis has been performed with individuals and households within the community, and community within the states. Minimum acceptable diet is used as indicators of dietary diversity and its association is examined with nutritional status of children. Here we test the variance component (or random intercept) model. This model has the advantage of correcting the correlated observation in the cluster. This is done by introducuing a random effect at each cluster. That implies that factors within the same cluster will have shared random intercept. Multilevel logistic regression models are evaluated with a log-link function to analyse the factors associated with stunting, wasting and underweight for children aged 6–59 months. Multilevel regression coefficients were estimated using Markov Chain Monte Carlo (MCMC) estimation strategies. Here we examine two clusters, community and household. This is because NFHS gives information on children of one mother chosen from a particular household.

Thus we have,

$Y_i = \alpha + \beta x_{ij} + \delta_i + \mu_{ij}$

$ln[\pi_{ij}/1-\pi_{ij}] = \alpha + \beta x_{ij} + \delta_i + \mu_{ij}$

where $Y_i = \ln[\pi_{ij}/1-\pi_{ij}]$ is the logit in which π_{ij} is the probability of stunting/wasting /underweight for the child(ren) from the jth household in the ith community.

The term x_{ij} are vectors of covariates at child, household and community level. δ_i and μ_{ij} are the unexplained residual terms at community and household level.

Here 'i' is a random community effect denoting the deviation of community i's mean z-score from the grand mean, 'j' is a random household effect that represents deviation of household ij's mean z-score from the ith community mean. The error terms δ_i and μ_{ij} are assumed to be normally distributed with zero mean and variances σ^2_c and σ^2_h respectively. These terms are non-zero and estimated by variance components models.

To assess the appropriateness of the multilevel models, we test whether the variances of the random part are different from zero over households and communities. The estimated vales from the models are used to assess the Intra Class Correlation (ICC). ICC shows the extend of correlation of child undernutrition within household and communities, before and after we have accounted for the observed effects of covariates xij. A notably significantly different ICC from zero suggests appropriateness of random effect models.

In the variance component model a random intercept is initiated at each level or cluster assuming a constant effect of each of the covariates (on the outcome) across the clusters.

The analysis is presented in five models. Model 1 is the null model where the dependent variable is the probability of stunting, wasting and underweight for children aged 6-59 months with no covariates. In the latter models along with the minimum acceptable diet score and agro-climatic zones, other covariates are introduced in a stepwise manner. Model 2 incorporates the agro-climatic zones as covariates. Model 3 incorporates household specific variables. Model 4 introduces mother specific variables. Model 5 takes into account the child specific variables and it is the full model. The state–specific variables are introduced in all the models along with other covariates except model 1. The objective of introducing the covariates in a phased manner is that it is easy to understand the separate role of minimum acceptable diet and agro-climatic zones on the probability of whether the child is stunted, wasted or underweight.

6.3 Variables in the Regression Model

6.3.1 Dependent Variable

We attempt to model the probability of nutritional status for the child(ren) from the jth household in the ith community. This status was defined in accordance with the WHO indices which indicates whether a child was wellnourished or undernourished: underweight (with weight-for-age z-score of -2, or lower); stunted (with a height-for-age z-score of -2, or lower); wasted (with a weight-for-height z-score of -2, or lower).

6.3.2 Independent Variable

6.3.2.1 Complementary Feeding

Following the standard approach, of assessing minimum acceptable diet, the paper uses the criterion given in NFHS 4 and NFHS 3.

The minimum acceptable diet score was calculated for a child aged 6-23 months by taking a summation of the following food groups:

a) The infant should receive two or more feedings of commercial infant formula, fresh tinned and powdered animal milk and yogurt irrespective of whether she is breastfed or not;

b) She should receive minimum dietary diversity which includes (i) milk other than breast milk, cheese or yogurt or other milk products; (ii) food from grains or roots porridge or gruel and fortified baby food; (iii) fruits and vegetables; (iv) other fruits and vegetables rich with vitamin A; (v) eggs; (vi) meat, poultry, fish, shellfish; (vii) beans, peas, lentils or nuts ;(viii) foods prepared from oil, fat ,ghee or butter;

c) Receives minimum meal frequency which comprises – (i) solid or semi-solid food at least twice a day for infants 6-8 months and at least three times a day for 9-23 months children who are breastfed; (ii) and receiving solid or semi-solid food or milk feeds at least four times a day for non-breastfed children.

Minimum Dietary diversity illustrates having adequate micronutrient-quantity of foods. It means feeding the child with the above food groups. The food groups are the better quality diets for both breastfed and non-breast fed children.

The child’s energy requirement is represented by minimum meal frequency. For newborn baby and young children, this index gives an idea on how much is the energy requirement of the child. For non-breast fed child the index gives a better idea about the energy requirements. But for breast-fed child the index tells about how much extra energy the child needs in spite of breast feeding.

The 2015-16 NFHS tells that about 94 percent of Indian children age 6-23 months received breast-milk, milk, or milk products (2+ times) during the day or night before the interview . It reports that 20 percent of breastfed children had an adequately diverse diet. This is because they had been given foods from the appropriate number of food groups, while 31 percent had been fed the minimum number of times appropriate for their age. The feeding practices of only 9 percent of breastfed children age 6-23 months meet the minimum standards for all IYCF feeding practices. Ten percent of all children age 6-23 months were fed the minimum acceptable diet.

The Minimum Acceptable Diet is calculated using the following formula:
Proportion of children 6–23 months of age, who receive a minimum acceptable diet (apart from breast milk).

(*Breastfed children 6–23 months of age who had at least the minimum dietary diversity and the minimum meal frequency during the previous day*) / (*Breastfed children 6–23 months of age*)

and

(*Non-breastfed children 6–23 months of age who received at least 2 milk feedings and had at least the minimum dietary diversity not including milk feeds and the minimum meal frequency during the previous day*) / (*Non-breastfed children 6–23 months of age*)

6.3.2.2 Agro- climatic Regions

The states in India are classified by agro-climatic regions. The classification is done based on climatic conditions of the state. Since district data are available for NFHS 4, hence the agro-climatic zones are considered districtwise as given by the planning commission. It includes the Western Himalayan Region, which includes 39 districts of Himachal Pradesh, Jammu And Kashmir and Uttaranchal states of India. The Eastern Himalayan Region includes 79 districts from Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and 3 districts of West Bengal. The Lower Gangetic Plains comprises of 15 districts of West Bengal. The Middle Gangetic Plains comprises of 60 districts of which 23 districts are from Uttar Pradesh and the rest are from Bihar. The Upper Gangetic Plains consists of 40 districts from the state of Uttar Pradesh. The Trans Gangetic Plains comprises of 48 districts from Delhi, Haryana, Punjab, Chandigarh and 2 districts from Rajasthan. Here we take 47 districts and exclude one district of Chandigarh as it is not considered in this study. The Eastern Plateau & Hills Region comprises of 57 districts from Chattisgarh, Jharkhand, 3 districts of Maharashtra, 15 districts from Orissa and 1 district from West Bengal. The Central Plateau and Hills Region comprises of 57 districts which includes 30 districts from Madhya Pradesh, 20 districts of Rajasthan and 7 districts of Uttar Pradesh. The Western Plateau and Hills Region comprises of 41 districts of which 15 districts are from Madhya Pradesh, 25 districts are from Maharashtra and 1 districts is from Rajasthan. The Southern Plateau & Hills Region comprises of 48 districts which includes 41 districts of Andhra Pradesh, 21 districts of Karnataka and 13 districts are from Tamil Nadu. The East Coast Plains & Hills region consists of 43 districts which comprises of 9 districts of Andhra Pradesh, 15 districts of Orissa, 15 districts of Tamil Nadu and 4 districts of Pondicherry. Here, only 34 districts are considered as 4 districts of Pondicherry are not included since Pondicherry is not a part of the study. The West Coast Plains & Ghats Region is comprised of 30 districts which include all the districts from Goa, Kerala, 6 districts each from Karnataka and Maharashtra and 2 districts from Tamil Nadu. The Gujrat Plains and Hills Region consists of 28 districts from Gujrat, Dadra and Nagar Haveli and Daman and Diu. Again 25 districts are considered here as 2 districts from Daman and Diu and 1 district from Dadra and Nagar Haveli are excluded as these two states are not a part of the study. The Western dry region consists of 9 districts from the state of Rajasthan. The Island Region consists of 3 districts from Andaman and Nicober Islands and Lakshadeep. This climatic zone is not considered as these two states are not a part of the study.

But District identifiers are not available for NFHS-3 data. Hence, for NFHS 3, the classification of the states is done on the basis of that climatic condition that is most applicable for the state. That means, if a state falls under two agro-climatic zones, then that state is classified in that region that covers the major part of the states. The Western Himalayan Region consists of the states of Himachal Pradesh, Jammu And Kashmir and Uttaranchal. The Eastern Himalayan Region includes the states of Arunachal Pradesh, Assam, Manipur, Mizoram and Nagaland. The states of Haryana and Punjab are included in Trans Gangetic Plain Region. The Lower, Middle and Upper Gangetic Plain Region comprised of the states of Uttar Pradesh, Bihar and West Bengal. The states of Chattisgarh, Jharkhand and Orissa are included in Eastern Plateau and Hills Region. Madhya Pradesh and Maharashtra are placed in Central and Western Plateau and Hills Region. The states of Andhra Pradesh, Karnataka and Tamil Nadu fall under the Southern Plateau and Hills Region. The West Coast Plains Region comprises of Kerala. The Gujrat Plains and Hills Region consists of the state of Gujarat. Since a major part of the state of Rajasthan fall under Western Dry Region, it is considered as a separate region even though a few parts of Rajasthan fall under Trans Gangetic Plain Region and Central Plateau and Hills Region.

6.3.2.3 Other Explanatory Variables

The other considerable factors on child undernutrition indicators are chosen on the basis of available literature on the subject and as enumerated in the conceptual framework of the study. Here we consider individual characteristics of the child as covariates of child undernutrition indicators. These covariates are Child Minimum Acceptable Diet (CMAD), child age (in months) (CA), sex of the child (CS), previous birth interval (CP) and whether the child suffered from diarrhea (CD) as incidence of recent illness. The controls for mother-level variables incude: education of the mother in terms of years of education (ME) , place of delivery for the child of interest (MIn), whether the mother has received antenatal care (MA), mother’s status of anemia (MAn) and for NFHS 4, whether the mother received the mother and child protection card (MC). On the household level, except for the regions of residence, controls are included for place of residence (RU), the source of drinking water (HPw), type of the toilet used by the household (HT), sex of the household head (HS) whether the household owns a BPL card (HBPL) and whether the household has a regular income or not (HI), and the number of children in the household

(HC). The state-level variables include Per Capita Net State Domestic Product (PCNSDP).

The equations of the multilevel model are as follows:

Model 1 is the Null Model

Model 2 introduces the agro climatic zones along with per capita NSDP:
$y_i = \alpha + \beta_1$ CMAD + β_2Agro-climatic zones + β_3PCNSDP + $\boldsymbol{\delta_i + \mu_{ij}}$ where $\mu_{ij} \sim N(0, \sigma^2_u)$

Model 3 introduces the household specific variables along with Minimum acceptable diet, agro climatic zones and percapita NSPD:
$y_i = \alpha + \beta_1$ CMAD + β_2Agro-climatic zones + β_3PCNSDP + β_4 Household-level variables + $\delta_i + \mu_{ij}$ where $\mu_{ij} \sim N(0, \sigma^2_u)$

Model 4 introduces the mother specific variables along with household specific variables, Minimum acceptable diet, agro climatic zones and percapita NSPD:
$y_i = \alpha + \beta_1$ CMAD + β_2Agro-climatic zones + β_3PCNSDP + β_4 Household-level variables + β_5Mother- level variables + $\delta_i + \mu_{ij}$ where $\mu_{ij} \sim N(0, \sigma^2_u)$

Model 5 is a full model which includes the child-specific variables along with mother-level variables, household-level variables, Minimum acceptable diet, agro climatic zones and percapita NSPD:
$y_i = \alpha + \beta_1$ CMAD + β_2Agro-climatic zones + β_3PCNSDP + β_4 Household-level variables + β_5Mother- level variables + β_6Child-level variables + $\delta_i + \mu_{ij}$ where $\mu_{ij} \sim N(0, \sigma^2_u)$

6.4 Relative position of different states with respect to nutritional status and child feeding practices

Among the core indicators, as indicated by UNICEF, early initiation of breastfeeding is a hugely discussed topic for health researchers and doctors. It includes the proportion of children who were born in the last 24 months and who were put to the breast within one hour of birth. This indicator is very important as it has the ability to protect the newborn from gaining infection and also helps to reduce the chances of mortality of the newborn baby. It also helps to facilitate emotional attachment between the mother and the baby. When breastfeeding is initiated by the mother within one hour of birth production of breast milk is stimulated. The colostrums or yellow or golden first milk is an essential source of nutrition and boosts the immune system of the newborn.

Exclusive breast feeding is another core indicator of infant and child feeding practices as envisaged by the UNICEF. Keeping in view, these core parameters, percentages of children who started breastfeeding within one hour, and who are exclusively breastfed for the last 6 months, are calculated from the NFHS data, for the various states in India.

The states are then categorized into different groups. Group A states are those whose undernutrition status is more than 50percent. Group B includes those states with undernutrition percentages lying between 40 to 49 percent. Group C states are those with 30 to 39percent of undernutrition parameters and Group D are those states whose undernutrition states are less than 30 percent. The averages of the indicators are then obtained and analyzed.

Table 6.1: Percentage of children born in the five years preceding the survey who started breastfeeding within one hour, and who are exclusively breastfed for the last 6 months, according to state, India, NFHS 3

State	Percentage undernourished			% breastfeed within one hour of birth[1]	% of exclusive breastfeeding under 6 months[2]
	Height-for-weight (stunted)	Weight-for-height (wasted)	Weight-for-age (underweight)		
India	46.7	19.5	41.0	24.3	75.2
Delhi	43.3	15.7	38.2	20.2	72.9
Haryana	34.3	22.4	31.1	20.7	71.6
Himachal Pradesh	34.6	19.9	25.1	43.5	70.7
Jammu & Kashmir	34.7	14.2	23.6	31.7	72.1
Punjab	40.1	10.2	36.8	11.8	72.3
Rajasthan	39.6	22.5	31.7	13.52	70.2
Uttarakhand	52.6	39.6	47.8	30.6	70.7
Chattisgarh	46.5	24.1	57.9	24.7	71.5
Madhya Pradesh	52.4	39.5	41.6	15.3	70.1
Uttar Pradesh	50.1	19.5	54.9	6.9	70.2
Bihar	47.2	32.6	54.6	3.1	70.7
Jharkhand	43.9	35.8	39.5	9.5	70.2
Orissa	41.8	25.7	37.6	52.8	73.2
West Bengal	39	19.2	29.7	21.6	73.1
Arunachal Pradesh	41.1	17.0	35.8	58.9	77.5
Assam	31	16.7	19.5	51.2	72.7
Manipur	34.9	10.8	48.1	57.2	78.5
Meghalaya	35.1	30.1	14.2	57.2	72.6
Mizoram	34.1	9.7	23.7	65.9	75.2
Nagaland	38	15.8	19.1	54.7	72.3
Sikkim	35.1	9.2	38.7	41.6	75.6
Tripura	25.2	24.1	24.6	34.2	74.2
Goa	49.2	14.3	41.1	59.7	77.7
Gujrat	44	19.7	32.7	26.4	72.7
Maharashtra	38.4	17.2	29.8	51.2	75.3
Andhra Pradesh	42.4	14.9	33.3	22.7	73.7
Karnataka	26.5	18.9	21.2	35.2	72.2
Kerala	31.1	15.6	25.9	55.7	78.1
Tamil Nadu	41.7	22.9	25.7	58.2	76.2

Percentage based on unweighted cases:

1) Percentage of children age 6-23 months who receive breast milk within one hour of birth
2) Percentage of children age 6-23months for the who receives exclusive breastmilk for 6 months after birth.

Table 6.1 shows NFHS 3 estimates of the percentages of children under five years of age classified as suffering from undernourishment according to the three measures of nutritional status. The table shows that around 47 percent of children in India are stunted and 20 percent and 41 percent of children are wasted and underweight respectively. This indicates that the pervasiveness of undernutrition is among the highest levels found in any country in the world. Thus undernutrition among children is a paramount problem in every part of India, but is more noted in some states than in others. Table: 6.1 show the state-wise breakdown of three anthropometric measures of nutritional status of children in India.

According to NFHS 3, stunting is more prominent in states of Chattisgarh, Uttar Pradesh, Bihar, Uttanchal and Gujrat. It can be observed that states like Delhi, Haryana, Rajasthan, Madhya Pradesh, Jharkhand, Orissa, West Bengal, Assam, Maharashtra and Karnataka show 40percent to 49 percent of stunting. Again, states like Himachal Pradesh, Jammu & Kashmir, Punjab, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Andhra Pradesh and Tamil Nadu show on an average of 30 percent to 39 percent of stunting. Relatively better position of children is observed for states of Kerala and Goa.

The geographical pattern of wasting is rather different from stunting and underweight. According to NFHS 3, there are significant improvements in the rates of wasting for nearly all the states of India. It can be observed that only Madhya Pradesh and Uttaranchal have rates of wasting between 40 to 49 percent. Wasting is also a problem in the states of Bihar and Jharkhand where more than one out of every three children is too thin. The rest of the 25 states of India have rates of wasting lying below 30 percent.

The pattern of pervasiveness of underweight varies across the states of India. Levels of underweight are very high in Madhya Pradesh, Bihar and Jharkhand where the rate is more than 50 percent. Underweight is also high in the states of Chattisgarh, Uttar Pradesh, Orissa, Meghalaya and Gujrat where the rates are well above the average. States of Haryana, Himachal Pradesh, Rajasthan, Uttaranchal, West Bengal, Assam, Tripura, Maharashtra and Karnataka also has the problem of underweight where the rate varies between 30 to 39 percent. Relatively better position are observed in the states of Delhi, Jammu & Kashmir, Punjab, Arunachal Pradesh, Manipur, Mizoram, Nagaland, Sikkim, Goa, Andhra Pradesh, Kerala and Tamil Nadu.

Undernutrition and its associated disorders among children may be a result of multiple factors, such as insufficient, food intake, severe and recurrent diseases or improper feeding practices. Many mothers in India cannot follow the child feeding practices as advocated by the Government of India and World Health Organization. It is suggested that during the 4 to 6 month of life of a child, the mother should only breastfeed her child and no other food item or not even water should be given. But in NFHS 3, we observe that only around 24 percent of children are breastfed within one hour of birth and 75 percent of children are exclusively breastfed for the first six months of their life.

The last two columns of Table: 6.1 show the breakdown by state in two of the core breastfeeding measures as suggested by WHO. These are percent of children breastfeed within one hour of birth and percent of children who are exclusively breastfed for the first six months of their life for NFHS 3. It can be observed that in general, states with high percentages of stunting, wasting and underweight children also have poor breastfeeding practices.

Table 6.2 shows unweighted average percentages for children breastfed within one hour of birth and those who are exclusively breastfed for the first six months for the children surveyed in NFHS 3. Four groups of states have been categorized. The initiation of breastfeeding within one hour of birth increases from 18 percent for the five states with the highest level of stunting to 58 percent for the two states with lowest level of stunting. The initiation of breastfeeding within one hour of birth is 29 percent for those states in India which has 40 to 49 percent of stunting. The rate increased to 45 percent for the states experiencing 30 to 39 percent of stunting. This series of data affirms that the initiation of breastfeeding within one hour of birth is high for those states of India which has lesser rate of stunting.

In Table 6.2 it can be observed that the initiation of breastfeedng within one hour of birth varies from 39 percent to 15 percent for those children experiencing acute under nutrition. It is 39 percent for those states whose rate of wasting lies below 30 percent. Again it is only 15 percent whose has early initiation of breastfeeding for Madhya Pradesh and Uttaranchal experiencing 40 to 49 percent of wasting. Only 6 percent of wasted children from Bihar and Jharkhand experiences initiation of breastfeeding within one hour of birth.

The average percentage of underweight children who had early initiation of breastfeeding within one hour of birth increases from 9 percent for the three states with highest level of underweight children to 45 percent for the twelve states with the lowest level of underweight children. The rate does not vary much for the states experiencing middle level on undernutrition. It is around 33 percent for those states experiencing 40 to 49 percent and 30 to 39 percent of underweight children.

Similarly, the average percentage of exclusively breastfeeding for children under 6 month rises from 71 percent to 78 percent for the children experiencing low height-for-age. It is 71 percent for those children experiencing very high level of stunting for the five states comprising of Chattisgarh, Uttar Pradesh, Bihar, Uttaranchal and Gujarat. It is 78 percent for the states with better height-for-age nutritional status, namely, Himachal Pradesh, Jammu & Kashmir, Punjab, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Andhra Pradesh, Tamil Nadu. The average percentage of exclusive breastfeeding is 72 percent for the states of Delhi, Haryana, Rajasthan, Madhya Pradesh, Jharkhand, Orissa, West Bengal, Assam, Maharashtra, Karnataka and 74 percent for the states experiencing 30 to 39 percent of stunting, which includes Himachal Pradesh, Jammu & Kashmir, Punjab, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Andhra Pradesh, Tamil Nadu.

For those children undergoing low weight-for-height, the average percentage of exclusively breastfeeding varies within a small range from 70 percent for the states of Madhya Pradesh Uttaranchal Bihar and Jharkhand to 74 percent for the rest of the other 25 states taken in this study for the wasted children surveyed under NFHS 3.

The average percentage of underweight children exclusively breastfed increases from 70 percent for the three states with highest level of underweight children to 75 percent for the twelve states with lowest level of underweight children. The average do not vary significantly for the states of Chattisgarh, Uttar Pradesh, Orissa Meghalaya, and Gujrat experiencing 40 to 49 percent of underweight children to Haryana, Himachal Pradesh, Rajasthan, Uttaranchal, West Bengal, Assam, Tripura, Maharashtra and Karnataka, the average being 72 percent.

Table 6.2: Percentage of children born in the five years preceding the survey who started breastfeeding within one hour, and who are exclusively breastfed for the last 6 months, according to state, India, NFHS 3

States (Percentage stunted, wasted & underweight)	**% breastfeed within one hour of birth**			**% of exclusive breastfeeding under 6 months**		
	Stunting	**Wasting**	**Underweight**	**Stunting**	**Wasting**	**Underweight**
Group A states (50% or more)	18.3	--	9.3	71.2	--	70.3
Group B states (40-49 %)	29.1	15.3	33.6	72.1	70.1	72.0
Group C states (30-39 %)	44.8	6.3	33.5	74.2	70.4	72.3
Group D states (less than 30%)	57.7	38.7	44.8	77.9	73.6	75.2

Source: Calculated from Unit level data

Again, by the age of 6-9 months, children should receive solid or mushy food in addition to breast milk in order to fulfill their requirements of protein, energy and other micronutrients. It can be observed that there is less variation in this respect among the various states of India. Almost all the .states have reported more than 95 percent of feeding with breast milk or milk products during the day or night preceeding the survey.

Again, it can be observed from Table: 3 that the percentage fed with minimum dietary diversity varies to a large extent among the states in India. The states of Jammu and Kashmir, Uttaranchal, Orissa , West Bengal, Manipur Sikkim, Goa, Tripura , Karnataka, Kerala and Tamil Nadu reported to have more than 40 percent of children to be fed with Minimum dietary diversity. Only Maharashtra and Rajasthan reported less than 20 percent of their children to be fed with Minimum Dietary diversity.

Again, for the percentage of children fed with minimum meal frequency varies widely among the different states of India. In this field, Kerala tops the list followed by Sikkim, Manipur and Arunachal Pradesh. The state with poorest meal frequency is the state of Andhra Pradesh.

In terms of percentage of children fed with Minimum Acceptable Diet, it can be observed that there are states, which have fared poorly in this regard. These states have high level of stunting, wasting and underweight compared to other states. Maharashtra has the lowest level of minimum acceptable diet, while the highest is Kerala.

Table 6.3: Percentage of youngest children aged 6-23 months living with the mother who are fed with appropriate feeding practices based upon number of food groups and times they are fed during the day or night preceding the survey, according to state, India, NFHS 3

State	% fed with Breastmilk, Milk or Milk products	% fed with Minimum Dietary Diversity	% fed with Minimum Meal Frequency	% fed with Minimum Acceptable Diet
India	96.7	35.2	40.9	20.5
Delhi	95.6	47.7	52.6	34.4
Haryana	96.2	28.6	31.5	15.9
Himachal Pradesh	97.9	66.1	45.9	39.1
Jammu & Kashmir	98.2	45.7	37.2	25.9
Punjab	98.3	37.2	30.3	19.2
Rajasthan	99.1	19.7	37.1	14.3
Uttarakhand	98.0	47.9	39.0	25.2
Chattisgarh	97.9	33.2	51.2	26.2
Madhya Pradesh	96.5	22.9	44.6	18.7
Uttar Pradesh	97.3	34.2	32.6	17.3
Bihar	96.7	33.5	52.7	22.8
Jharkhand	96.7	26.7	42.8	16.7
Orissa	97.2	43.2	54.6	30.4
West Bengal	98.3	57.7	37.3	28.9
Arunachal Pradesh	96.9	33.7	62.5	26.3
Assam	98.2	31.9	40.2	15.2
Manipur	95.5	53.9	62.6	40.7
Meghalaya	90.0	34.7	41.1	19.2
Mizoram	92.6	34.9	51.4	20.2
Nagaland	89.9	28.7	59.2	22.7
Sikkim	99.5	69.9	62.6	49.2
Tripura	99.2	55.7	41.2	29.8
Goa	98.3	63.6	55.4	43.1
Gujrat	97.2	33.4	41.1	20.7
Maharashtra	94.9	19.6	33.7	11.8
Andhra Pradesh	94.7	26.5	25.0	24.6
Karnataka	95.6	43.2	42.2	23.2
Kerala	98.2	73.3	79.1	61.3
Tamil Nadu	95.1	41.6	52.7	28.2

Source: Calculated from Unit Level data

Table 6.4: Percentage of youngest children aged 6-23 months living with the mother who are fed with appropriate feeding practices based upon number of food groups and times they are fed during the day or night preceding the survey, according to state, India, NFHS 3

States/ (Percentage stunted, wasted & underweight)	% fed with Breastmilk, milk or milk products			% fed with Mminimum Dietary Diversity			% fed with Minimum Meal Frequency			% fed with Minimum Acceptable Diet		
	Stunting	Wasting	Underweight	Stunting	Wasting	Underweight	Stunting	Wasting	Underweight	Stunting	Wasting	Underweight
Group A states (50% or more)	97.4	-	96.6	36.4	-	27.7	43.3	-	46.7	22.4	-	19.4
Group B states (40-49 %)	96.8	96.5	95.9	34.1	22.9	35.7	41.7	44.6	44.1	20.9	18.7	22.7
Group C states (30-39 %)	95.7	96.7	97.4	44.1	30.1	41.1	47.6	47.7	38.6	28.7	19.7	22.6
Group D states (less than 30%)	98.3	96.5	96.0	68.5	42.5	46.3	67.3	46.1	52.55	52.2	27.2	32.9

Sorce: Calculated from Unit level data

Height-for-Age (Stunted)

Group A (50% or more):- Chattisgarh, Uttar Pradesh, Bihar, Uttaranchal and Gujrat

Group B (40%-49%):- Delhi, Haryana, Rajasthan, Madhya Pradesh, Jharkhand, Orissa, West Bengal, Assam, Maharashtra, Karnataka.

Group C (30%-39%):- Himachal Pradesh, Jammu & Kashmir, Punjab, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Andhra Pradesh, Tamil Nadu.

Group D (less than 30%): Kerala, Goa.

Weight-for-Height (Wasted)

Group A (50% or more): No states

Group B (40%-49%):- Madhya Pradesh and Uttanchal

Group C (30%-39%):- Bihar and Jharkhand

Group D (less than 30%):- Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan, Chattisgarh, Uttar Pradesh, Orissa, West Bengal, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Goa, Gujrat, Maharashtra, Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

<u>Weight-for-Age (Underweight)</u>

Group A (50% or more):- Madhya Pradesh, Bihar and Jharkhand.

Group B (40%-49%):- Chattisgarh, Uttar Pradesh, Orissa, Meghalaya and Gujrat.

Group C(30%-39%):- Haryana, Himachal Pradesh, Rajasthan, Uttaranchal, West Bengal, Assam, Tripura, Maharashtra and Karnataka.

Group D (less than 30%):- Delhi, Jammu & Kashmir, Punjab, Arunachal Pradesh, Manipur, Mizoram, Nagaland, Sikkim, Goa, Andhra Pradesh, Kerala and Tamil Nadu.

Table 6.4 illustrates the unweighted average percentages for feeding with breastmilk, milk or milk products, feeding with minimum dietary diversity, feeding with minimum meal frequency and feeding with minimum acceptable diet for four groups of states, grouped according to the percentage of stunting, wasting and underweight. It can be observed that the average percentages for feeding with breastmilk, milk or milk products vary very slightly. It is 96.6 percent for the states experiencing more than 50 percent of stunting while it is 98.3 percent for the states experiencing less than 30 percent of stunting. Surprisingly, those states which have reported more than 50 percent of underweight shows 96.6 percent of children fed with this parameter, while the states enjoying better status of chronic undernutrition gives 96.0 percentage of children to be fed with breastmilk, milk or milk products.

Again, in terms of percentage of children fed with minimum dietary diversity varies from 36.4 percentage for the states with more than 50 percent of stunting to 68.5 percentage for those states experiencing less than 30 percent of stunting. For acute undernutrition the difference is around 20 percent with 22.9 percentage of children suffering from wasting to 42.5 percentage of children enjoying better nutritional status in term of acute undernutrition. For underweight status, it is 27.7 percent of children who are fed with minimum dietary diversity for those states with more than 50 percent of underweight children, to 46.3 percentage for the states with less than 30 percentage of underweight children.

The percentage of children fed with minimum meal frequency varies from 43.3 percent for the states with more than 50percent of children suffering from chronic undernutrition to 67.3 percent for those states with less than 30 percent of stunting. In terms of wasting the percentage of children fed with minimum meal frequency is more in the states with 30 to 39 percent of wasting which is47.7 percent. Again the states with high level of underweight contributes to 46.7 percent of children fed with minimum meal frequency, while the states with better status of underweight children shows 52.5 percent of children fed with minimum meal frequency.

For the percentage of children fed with minimum acceptable diet, it can be observed that 52.2 percent of children enjoys this parameter for those states with relatively lower level of stunting. The rate is 22.5 percent for those states experiencing more than 50 percent of stunting. Again for wasting 27.2 percent of children enjoys minimum acceptable diet for states with less than 30 percent of wasting, compared to 18.7 percent of children in those states which has 40 to 49 percent of wasting. Minimum acceptable diet increases from 19.4 percent for the three states with highest level of underweight children to 33 percent for the twelve states with lowest level of underweight children.

Table 6.5: Percentage of children born in the five years preceding the survey who started breastfeeding within one hour, and who are exclusively breastfed for the last 6 months, according to state, India, NFHS 4

State	Percentage undernourished			% breastfeed within one hour of birth[1]	% of exclusive breastfeeding under 6 months[2]
	Height-for-weight (stunted)	Weight-for-height (wasted)	Weight-for-age (underweight)		
India	38.9	21.2	36.1	40.9	79.9
Delhi	31.2	15.3	26.6	29.2	74.6
Haryana	33.6	20.7	28.9	42.1	73.9
Himachal Pradesh	25.1	13.2	22.1	41.2	72.6
Jammu & Kashmir	27.1	12.4	16.2	47.3	75.8
Punjab	26.1	16.3	20.7	28.2	74.2
Rajasthan	40.2	23.7	37.1	28.6	72.7
Uttarakhand	35.2	20.7	27.2	28.2	73.5
Chattisgarh	37.3	25.1	37.2	47.9	73.8
Madhya Pradesh	43.5	26.1	41.9	33.7	72.4
Uttar Pradesh	47.2	18.2	40.7	24.2	72.9
Bihar	49.1	22.1	44.2	33.6	73.1
Jharkhand	46.7	28.2	47.5	33.2	72.8
Orissa	33.6	19.9	34.7	68.2	76.5
West Bengal	31.3	19.7	31.2	47.1	75.6
Arunachal Pradesh	30	18.1	19.1	60.9	79.2
Assam	37.1	17.2	30.7	64.4	75.7
Manipur	27.9	6.9	13.2	65.7	80.1
Meghalaya	43.3	15.7	28.5	61.6	75.5
Mizoram	28.6	5.2	12.6	72.4	79.7
Nagaland	28.6	11.7	16.2	51.7	75.2
Sikkim	28.9	14.6	14.7	69.3	80.2
Tripura	23.7	16.2	24.8	46.2	79
Goa	19.6	21.7	24.1	75.3	80.2
Gujarat	38.7	26.8	41.1	49.2	73.4
Maharashtra	35.1	26.2	35.2	56.7	77.4
Andhra Pradesh	31.5	17.7	32.1	37.2	74.5
Karnataka	36.7	27	37.2	56.2	75.7
Kerala	20.2	15.2	15.7	62.9	82
Tamil Nadu	27.5	19.1	22.9	54.4	79.1

Source: Calculated from Unit level Data

Percentage based on unweighted cases:

1) Percentage of children age 6-23 months who receive breast milk within one hour of birth
2) Percentage of children age 6-23 months who receive exclusive breastmilk for 6 months after birth.

Table 6.5 shows the state-wise breakdown of the three measures of nutritional status for NFHS 4. The table depicts that the rate of stunting has declined to 39 percent from 47 percent in NFHS 4.But the overall average rate of wasting increased by 1 percent from 20 percent in NFHS 3 to 21 percent in NFHS 4. The rate of underweight children has shown a decline from 41 percent in NFHS 3 to 36 percent in NFHS 4. Hence, it shows that the prevalence of undernutrition is still high in Indian Subcontinent. Here again some states of India have fared better than the others.

In NFHS 4, the prominence of stunting are observed for the states of Rajasthan, Madhya Pradesh, Uttar Pradesh, Bihar, Jharkhand and Meghalaya which recorded an average of 40 to 49 percent of stunting, But it should be noted here that the states of Uttar Pradesh and Bihar had recorded 50 to 59 percent of stunting in NFHS 3, and so it can be concluded that these two states had tried to bring down their rates of stunting. But it should also be observed that the rate of stunting has increased for the state of Meghalaya in NFHS 4 than in NFHS 3.

The states of NFHS 4 which have recorded 30 to 39 percent of stunting are Delhi, Haryana, Uttaranchal, Chhattisgarh, Orissa, West Bengal, Arunachal Pradesh, Assam, Gujarat, Maharashtra, Andhra Pradesh and Karnataka. It can be noted here that the states of Delhi, Haryana, Orissa , West Bengal, Assam, Maharashtra and Karnataka were in the 40 to 49 percent of stunting group in NFHS 3. Hence these states have improved in their status of stunting. The states which have recorded least percentage of stunting are Himachal Pradesh, Jammu & Kashmir, Punjab, Manipur, Mizoram, Nagaland, Sikkim, Tripura, Goa, Kerala and Tamil Nadu. In NFHS 3, It was only Kerala and Goa which had recorded less than 30 percent of stunting. Hence it can be said that the other states in India have improved on their rate of chronic undernutrition.

In NFHS 4 there are no states with more than 30 percent of acute undernutrion, i.e. wasting. All the states have recorded less than 30 percent of wasting.

In terms of underweight, the states which have recorded 40 to 49 percent of underweight children are Madhya Pradesh, Uttar Pradesh, Bihar, Jharkhand and Gujrat. Madhya Pradesh, Bihar and Jharkhand are the states, which have improved on their underweight parameter as because these states recorded more than 50 percent of underweight in NFHS 3. The states, which show 30 to 39 percent of underweight are Rajasthan, Chattisgarh, Orissa, West Bengal, Assam, Maharashtra, Andhra Pradesh and Karnataka. Here too it can be seen that Chattisgarh on an average improved its rate of underweight than it was in NFHS 3. Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Uttaranchal, Arunachal Pradesh, Manipur, Mizoram, Nagaland, Meghalaya, Sikkim, Tripura, Goa Kerala and Tamil Nadu recorded less than 30 percent of underweight. Here too, Haryana, Himachal Pradesh, Uttaranchal and Tripura are the states have improved on their rates compared to their position in NFHS 3.

The last two columns of Table 5 show the breakdown by state in two of the core breastfeeding measures as suggested by WHO which are percent of children breastfeed within one hour of birth and percent of children who are exclusively breastfed for the first six months of their life for NFHS 4. Like NFHS 3, it can be observed that in general, states with high percentages of stunting , wasting and underweight children also have poor breastfeeding practices.

In Table 6.6, we have unweighted average percentages for children breastfed within one hour of birth and those who are exclusively breastfed for the first six months for the children surveyed in NFHS 4. As in NFHS 3, four groups of states have been categorized. The initiation of breastfeeding within one hour of birth increases from 36 percent for the six states whose rate of stunting varies from 40 to 49 percent to 56 percent for the eleven states with lowest level of stunting. The rate is 49 percent for the states experiencing 30 to 39 percent of stunting Hence it can be said that the initiation of breastfeeding within one hour of birth is high for those states of India which has lesser rate of stunting.

For wasting, the data reveals that 49 percent of children are breastfed within one hour for all the states in India. The percentage of breastfeeding within one hour of birth for underweight children showed a marked increase from 35 percent for the states with 40 to 49 percent of underweight to 52 percent for the states recorded with the lowest percentage of underweight.

The Percentage of children under six months of age who are exclusively breastfed varies from 73 percent with 40 to 49 percent of stunting to 78 percent with less than 30 percent of stunting. For Wasting, 76 percent is recorded as exclusively breastfed for all the states of India. For underweight, the rate increases from 73 percent with higher percent of underweight to 77 percent for states with lower rate of underweight children.

Table 6.7 shows the state wise breakdown of the percentage of children fed with breastmilk, milk or milk products, percentage of children fed with minimum dietary diversity, percentage of children fed with minimum meal Frequency and the percentage of children fed with minimum acceptable diet. It can be observed from the table that there is wide variation in percentages of these variables among the states in India. Though the state of Kerala has fared the best in all the respects, in terms of percentage with minimum acceptable diet it is Tamil Nadu, which recorded a better position in this regard.

Table 6.6: Percentage of children born in the five years preceding the survey who started breastfeeding within one hour, and who are exclusively breastfed for the last 6 months, according to state, India, NFHS 4

States/ (Percentage stunted, wasted & underweight)	% breastfeed within one hour of birth			% of Exclusive breastfeeding under 6 months		
	Stunting	Wasting	Underweight	Stunting	Wasting	Underweight
Group A states (50% or more)						
Group B states (40-49 %)	35.8	-	34.7	73.2	-	72.9
Group C states (30-39 %)	48.9	-	50.8	75.4	-	75.2
Group D states (less than 30%)	55.8	48.8	52.3	78.1	75.9	77.2

Source: Calculated from Unit level Data

Table 6.7: Percentage of youngest children aged 6-23 months living with the mother who are fed with appropriate feeding practices based upon number of food groups and times they are fed during the day or night preceding the survey, according to state, India, NFHS 4

State	Percentage undernourished			% fed with breastmilk, milk or milk products	% fed with Minimum dietary diversity	% fed with Minimum Meal Frequency	% fed with Minimum Acceptable Diet
	Height-for-Weight (Stunted)	Weight-for-Height (Wasted)	Weight-for-Age (Underweight)				
India	**38.9**	**21.2**	**36.1**	**93.7**	**22.5**	**35.4**	**9.4**
Delhi	31.2	15.3	26.6	95.6	25.2	37.4	4.9
Haryana	33.6	20.7	28.9	94.8	18.5	32.2	7.1
Himachal Pradesh	25.1	13.2	22.1	93.7	27.2	48.6	10.3
Jammu & Kashmir	27.1	12.4	16.2	94.6	45.2	41.9	22.7
Punjab	26.1	16.3	20.7	94.9	17.3	34.6	5.2
Rajasthan	40.2	23.7	37.1	95.2	9.2	33.4	3.1
Uttarakhand	35.2	20.7	27.2	92.7	21.7	40.6	8.3
Chattisgarh	37.3	25.1	37.2	97.1	18.6	56.1	10.2
Madhya Pradesh	43.5	26.1	41.9	92.6	15.3	35.5	6.1
Uttar Pradesh	47.2	18.2	40.7	95.3	10.6	37.7	5.1
Bihar	49.1	22.1	44.2	94.2	17.9	29.6	7.2
Jharkhand	46.7	28.2	47.5	96.7	14.3	40.9	7.1
Orissa	33.6	19.9	34.7	94.2	21.6	38.4	8.3
West Bengal	31.3	19.7	31.2	96.5	37.1	37.7	19.4
Arunachal Pradesh	30	18.1	19.1	92.1	35.7	29.4	13.6
Assam	37.1	17.2	30.7	95.7	27.2	26.3	8.1
Manipur	27.9	6.9	13.2	93.6	36.5	53.7	18.2
Meghalaya	43.3	15.7	28.5	90.2	47.9	48.2	22.8
Mizoram	28.6	5.2	12.6	91.6	41.3	33.4	14.2
Nagaland	28.6	11.7	16.2	85.1	38.5	48.3	18.4
Sikkim	28.9	14.6	14.7	96.1	48.6	41.7	22.6
Tripura	23.7	16.2	24.8	97.9	16.7	22.1	5.2
Goa	19.6	21.7	24.1	91.7	25.2	32.9	10.1
Gujarat	38.7	26.8	41.1	90.1	15.1	33.2	4.9
Maharashtra	35.1	26.2	35.2	90.7	20.8	28.1	6.2
Andhra Pradesh	31.5	17.7	32.1	91.7	21.7	32.8	7.1
Karnataka	36.7	27	37.2	96.2	22.3	26.8	7.9
Kerala	20.2	15.2	15.7	96.9	37.9	43.3	21
Tamil Nadu	27.5	19.1	22.9	89.9	56.4	51.9	29

Source: Calculated from Unit level Data

Table 6.8: Percentage of youngest children aged 6-23 months living with the mother who are fed with appropriate feeding practices based upon number of food groups and times they are fed during the day or night preceding the survey, according to state, India, NFHS 4

States/ (Percentage stunted, wasted & underweight)	% fed with breastmilk, milk or milk products			% fed with minimum dietary diversity			% fed with minimum meal frequency			% fed with Minimum Acceptable Diet		
	Stunting	Wasting	Underweight	Stunting	Wasting	Underweight	Stunting	Wasting	Underweight	Stunting	Wasting	Underweight
Group A states (50% or more)												
Group B states (40-49 %)	94.1		93.7	19.2		14.6	37.5		35.4	8.6		6.1
Group C states (30-39 %)	93.9		94.6	23.8		22.3	34.9		34.9	8.8		8.8
Group D states (less than 30%)	93.3	93.7	93.2	35.5	27.3	33.7	41.1	37.8	40.0	16.9	11.5	14.6

Source: Calculated from Unit Level data

<u>Height-for-Age (stunted)</u>

Group A (50% or more): Bihar

Group B (40%-49%): Rajasthan, Madhya Pradesh, Uttar Pradesh, Jharkhand, Meghalaya

Group C (30%-39%): Delhi, Haryana, Utthrakhand, Chattisgarh, Orissa, West Bengal, Arunachal Pradesh, Assam, Gujrat, Maharashtra, Andhra Pradesh, Karnataka

Group D (less than 30%): Kerala, Goa, Himachal Pradesh, Jammu & Kashmir, Punjab, Manipur, Mizoram, Nagaland, Sikkim, Tripura, Tamil Nadu.

Weight-for-Height (Wasted)

Group A (50% or more): No states

Group B (40%-49%): No states

Group C (30%-39%): No states

Group D (less than 30%): Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan, Chattisgarh, Uttar Pradesh, Madhya Pradesh, Uttarakhand, Bihar, Jharkhand Orissa, West Bengal, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Goa, Gujrat, Maharashtra, Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.

Weight-for-Age (Underweight)

Group A (50% or more): No states.

Group B (40%-49%): Madhya Pradesh, Uttar Pradesh, Bihar, Jharkhand, Gujrat, Bihar and Jharkhand.

Group C (30%-39%): Rajasthan, Chattisgarh, Orissa, West Bengal, Assam, Maharashtra, Andhra Pradesh, Karnataka

Group D (less than 30%): Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Uttarakhand, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Goa, Kerala, Tamil Nadu.

It can be observed from Table 6.8 that all the categories of states have scored more than 90 percent in terms of percentage of children fed with breastmilk, milk and milk products. It shows that the Indians are well aware of the importance of milk for healthy growth of their children.

The percentage of children fed with minimum dietary diversity varies from 19 percent for the states with 40 to 49 percent of stunting to 34 percent for those states with better height-for-age standards. It is around 27 percent for all the states experiencing less than 30 percent of wasting. Hence it can be concluded that though the level of wasting has improved for the states in India, it has not ensured better feeding practice among the populace. In terms of underweight too, the percentage increases from 15 percent for states with high rate of underweight to 33 percent with states faring better in this respect.

Not much difference is observed among the different groups of states in terms of children with minimum meal frequency. This implies that the populace is conscious of the importance of the number of times per day the baby should be receiving the required food items.

The percentage of children receiving minimum acceptable diet varies from 9 percent for those states recording higher level of stunting to 17 percent for those states which recorded better height-for-age standards. It is only around 12 percent of children who are following the norms for minimum acceptable diet for the children who are suffering from wasting. For underweight the percentage varies from 6 percent for the states grouped within 40 to 49 percent to around 15 percent for those states who have less than 30 percent of underweight. This implies that India lags behind other countries in the world in maintaining the standards of Minimum acceptable diet for children 6-23 months old. This proves that India needs to go a long way to fulfill SDGs of ending all kinds of undernutrition by 2030.

6.5 Results of Multilevel Regression

In order to understand the effect of minimum acceptable diet and other socio-demographic factors on child undernutrition by agro-climatic zones, five multilevel models are used.

The null model (Model 1) of NFHS 4, shows that there is significant variation in child undernutrition at community and household level with a total variance of 0.616 of (community and household). The Intra-class correlation coefficient presented in Table 6.9 differ from zero. That implies that the odds of stunting in children are certainly correlated with households and communities. In NFHS 3, the total variance is 0.553 presented in Table 6.10, and the ICC coefficient differ from zero which suggest the same finding that the odds of child stunting is correlated with household and communities.

In Model 2 of NFHS 4, we find the effect of minimum acceptable diet and agro-climatic regions on the odds of child stunting. Children not receiving the minimum acceptable diet are more prone to stunting compared to children receiving minimum acceptable diet (OR=1.955). In NFHS 4, it can be seen that compared to West Coast Plain and Ghat Region, the children residing in other climatic zones are more likely to be stunted. Children from Upper Gangetic Plain (OR=2.002) and Western Dry Region (OR=2.001) are at higher risk of stunting than children from West Coast Plain and Ghat Region. The reason may be that Upper Gangetic Plain consists the districts of Uttar Pradesh, and Western Dry Region consists districts of Rajasthan and these two states have high rates of stunting as observed earlier. Even, the odds-ratio of all the other agro –climatic zone regions shows significant risks of stunting. The significant values are observed for Lower Gangetic Region (OR=0.986), Middle Gangetic Region (OR=0.914), Trans-Gangetic Region (OR=1.251), Eastern Plateau & Hills Region (OR=1.213), Central Plateau & Hills Region (OR=1.005), Western Himalayan Region (OR=1.004) and Gujarat Plains and hills Region (1.023). When we consider the state-level variables, we can observe that households not having regular income are more vulnerable to stunting as compared to the households having regular income (OR=1.119). Again the intra-class correlation as depicted in Table 6.9 varies from zero, implying that the odds of child stunting are correlated with household and communities. When compared to null model, it can be observed that the measures of variation remained significant across communities and households and the Intra-Class Correlations across households and communities are also significant and differs from zero. The ICC at the household level shows higher correlation than in the case of communities.

In model 3, of NFHS 3 we have included the household level variables. After the inclusion of household level variables, it can be observed that the Southern Plateau and Hills Region (OR=0.412) and East Coast Plain and Hills Region (OR=1.200) shows higher risks of stunting compared to West Coast Plain & Ghat Region. The other climatic Regions loses their significance once the household level variables are introduced. The children not having access to minimum acceptable diet are at a higher risk of being stunted compared to the privileged ones.(OR=0.952). It can be observed that rural place of residence, (OR=1.299), not having access to improved source of drinking water, (OR=1.845) and not having access to flush toilets (OR=0.860) have higher risk are vulnerable to suffer from stunting. Again, families with female head (OR=1.188) and more than two number of children (OR=0.989) significantly contribute to the risk of stunting. Households having regular source of income (OR=1.188) are better off than the ones with irregular income earnings. Since the Intra Class Correlation is significant and differs from zero, it can be easily inferred that that there is correlation across households and communities. If we look at the Intra Class Correlation as depicted in Table 6.9, it can be interpreted that correlation at the household level is higher compared to the communities.

In the model 4 we introduced the mother level variables along with household level covariates. Here again the children not following the norms of Minimum Acceptable Diet has more probability of stunting than the ones with Minimum Acceptable Diet (OR=1.949). Among the agro-climatic region, it is observed that Eastern Himalayan Region (OR=0.056) and Eastern Plateau & Hills Region (OR=2.525), significantly affects the probability of stunting. The children in Eastern Plateau & hills Region has higher probability of stunting than the West Coast & Ghat Region. This region consists of the states of Chattisgarh, Jharkhand, Maharashtra, Orissa and 1 district of West Bengal. It is already shown that Jharkhand has an average of 40 to 49 percent of stunting, whereas the states of Chattisgarh, Maharashtra, Orissa and West Bengal have on an average 30 to 39 percent of stunting. It can also be observed that among the household level covariates, the children from the rural areas (OR=1.286) , the children not having access to improved water facilities (OR=1.841), the children not having access to improved variety of toilet facilities (OR=0.862), when the head of the household is female (OR=1.179) and when the household having more than two children (OR=0.965) have significant higher probability of being stunted. Among the mother –level covariates, it can be seen that the children of mothers with lower level of education (OR=0.094), not having access to better facility of delivery system (OR=0.015), poor antenatal care (OR=0.006), suffering from anemia (OR=0.875) and the children of mothers not having access to Mother and Child Protection Card (OR=0.236) are more vulnerable to suffer from chronic undernutrition. It has been discussed in the literature that the association between maternal education and child under nutrition is complex. While better education increases the ability of the mother to take better care for her child, it may affect the time she can offer to take care of the child.

Among the state level factors, again it shows that families not having access to regular income (OR=0.118) are more prone to stunting and there is a significant association between per capita net state domestic product and chronic undernutrition.

Selected Child-level covariates are included in model 5 which is also the full model. As before, the children not having access to Minimum Acceptable Diet (OR=1.951) are more vulnerable to the risk of being stunted. Again, same as earlier models it is observed that children residing in Southern Plateau & Hills Region and East Coast Plains & Hills Region and Western dry Region are more to stunting compared to children residing in West Coast Plain & Ghat Region. Children residing in rural areas not having access to improved source of water and born to anaemic mothers are found to be significant predictors to stunting. Children from educated mothers and children born at proper health facility are less likely to affect the odds of child stunting. Among the child level covariates, children more than one year of age (OR=1.784(p value less than 0.05)) and those who suffered from recent incidence of diarrhoea (OR=1.333) are likely to be more vulnerable to child stunting. Looking at the state-level covariates it can be said that household with irregular income and Per Capita NSDP significantly affect the odds of child stunting.

Table 6.9: Multi level regression on the association between Minimum Acceptable Diet and other contextual factors on child stunting among children less than 5 years of age in India in 2014-15

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Minimum Acceptable Diet					
Yes (Ref.)					
No		1.955^{***} (1.45,3.99)	1.952^{***} (0.26,3.62)	1.949^{***} (0.23,3.36)	1.951^{***} (0.65,1.86)
West Coast Plain & Ghat Region (Ref.)					
Eastern Himalayan Region		1.025^{**} (0.97,3.65)	1.023^{**} (0.98,3.69)	1.056^{*} (0.32,2.12)	1.002^{*} (0.36,2.15)
Lower Gangetic Plain		1.906^{***} (0.45,1.21)	1.984	1.977	1.965^{*} (0.47,2.54)
Middle Gangetic Plain		1.914^{**} (0.85,3.67)	1.512	0.515	1.002^{*} (0.79,2.85)
Upper Gangetic Plain		2.002^{***} (1.02,2.77)	1.225	2.245	2.065^{*} (1.01,2.03)
Trans Gangetic Plain		1.251^{**} (1.06,4.66)	1.141	1.456	1.009
Eastern Plateau &Hills Region		1.213^{**} (1.06,2.87)	2.209	2.525^{**} (1.53,6.12)	2.056
Central Plateau & Hills Region		1.005^{***} (0.41,6.02)	1.015	1.176	1.035
Western Plateau & Hills Region		0.974^{*} (0.21,3.56)	0.951	1.897	1.022
Southern Plateau & Hills Region		0.459^{**} (0.85,4.91)	0.412^{**} (0.25,1.25)	1.228	1.008^{**} (1.02,2.41)
East Coast Plains & Hills Region		0.602^{**} (0.51,2.41)	1.200^{*} (0.36,5.23)	0.895	1.045^{*} (0.52,3.96)
Western Himalayan Region		1.004^{**} (1.52,4.32)	1.012	1.245	1.099
Gujrat Plains & Hills Region		1.023^{*} (1.20,3.55)	1.034	2.274	1.002
Western Dry Region		2.001^{**} (1.81,4.51)	2.041	1.986	1.083^{*} (0.56.5.31)
Place of residence					
Urban (Ref.)					
Rural			1.299^{**} (0.94,3.99)	1.286^{**} (0.89,3.95)	1.279^{*} (0.01,3.55)

(……in continuation of Table 6.9.)

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Source of drinking water					
Improved (Ref.)					
Not improved			1.845** (0.51,2.41)	1.841** (0.21,2.95)	1.842* (0.06,3.96)
Type of toilet					
Flush(Ref.)					
Other			0.860* (0.53.3.17)	0.862* (0.49,3.12)	0.861
Sex of household head					
Male (Ref.)					
Female			1.188** (0.63,2.11)	1.179** (0.99,3.01)	1.171
Number of children <5					
1 (Ref.)					
≥ 2			0.989* (0.22,3.36)	0.965* (0.39,2.97)	0.962
Education of mother					
None (Ref.)					
Primary				0.686*** (0.19,1.53)	0.641*** (0.21,1.39)
Secondary				0.511*** (0.02,1.96)	0.501*** (0.46,1.83)
Higher				0.094*** (0.17,1.95)	0.095*** (0.18,1.86)
Place of Delivery					
Home				0.015*** (0.03,1.99)	0.022*** (0.03,1.89)
Health Facility (Ref.)					
Antenatal care					
No				1.006** (0.01,1.68)	1.002** (0.01,1.61)
Yes(Ref.)					
Suffers from Anemia					
No				0.875*** (0.55,2.18)	0.868*** (0.65,2.01)
Yes (Ref.)					
Mother and Child Protection Card					
No				0.236** (0.06,3.01)	0.233** (0.05,3.22)
Yes (Ref.)					

(……………in continuation of Table 6.9)

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Age of the child (months)					
6-8 (Ref.)					
9-23					1.485
24-35					1.784
≥ 36					1.655
Child diarrhea					
No					
Yes(Ref.)					1.133*
Previous Birth Interval					
<2 years (Ref.)					
≥ 2years					0.996**
Sex of child					
Male (Ref.)					
Female					1.016
Households with BPL card					
Yes (Ref.)					
No			0.394	0.395	0.395
Household with regular income					
Yes (Ref.)			1.118**	0.118**	0.120**
No			(0.09,3.33)	(0.09,3.33)	(0.09,3.33)
Percapita Net State Domestic Product		0.023* (0.01,4.12)	0.025* (0.03,4.25)	0.021* (0.03,4.16)	0.022* (0.03,4.12)
Random Effects					
Intra-class correlation					
ρ(PSU)	0.064*	0.022*	0.020*	0.021*	0.024*
ρ(household)	0.299*	0.264*	0.241*	0.296*	0.287*
Variance Decomposition in %					
PSU	46.8	40.6	37.1	38.0	37.2
Household	53.2	59.4	62.9	62.0	62.8

**** p< 0.01, ** p< 0.05, *p< 0.10*

Source: Calculated from Unit level Data

In NFHS 3, Model 1 is the null model where no covariates are included. In model 2 the Minimum Acceptable Diet, all the Agro-Climatic Regions and the state fixed variables are included. As in NFHS 4, the children not having access to Minimum Acceptable Diet

(OR=1.715) are more prone to the vulnerability of child chronic undernutrition. It can be observed that all the Regions significantly impact the odds of child stunting. Among the Regions the children residing in Eastern Plateau and Hills Region (OR=2.063) and Western Dry Region (OR=2.001) are prone to chronic undernutrition. Even children from Eastern Himalayan Region (OR=1.004), Trans Gangetic Region (OR=1.011), Central and Western Plateau & Hills Region (OR=1.018), Lower, Middle and Upper Gangetic Plain (OR=1.745), East Coast Plains and Hills Region (OR=1.210), Western Himalayan region (OR=1.019) and Gujarat Plains & Hills Region (OR=1.010) show high probability of stunting. It is seen that the states, which fall in these region show high percentage of children suffering from chronic undernutrition. It can be observed that the odds ratio of both NFHS 3 and 4 that the Western Dry Region consisting of the districts of Rajasthan, are same. That means that inspite of the fact that the rate of stunting in Rajasthan has come down, yet the children of this region are more vulnerable to the risk of stunting. The Eastern Plateau and Hills Region which comprises of the states of the states of Chattisgarh, Jharkhand and Orissa has the highest probability of their children being stunted. Shese are the states which show 40 to 49 percent of stunting and falls behind other Regions to follow the norms of Minimum Acceptable Diet. The Lower, Middle and Upper Gangetic Plain, comprising of the states of Uttar Pradesh, Jharkhand and West Bengal also shows the higher probability of stunting. In NFHS 4, we have seen that the situation of children has not improved in the state of Uttar Pradesh and hence its children has high probability of stunting even after the government taking steps to reduce the rate of undernutrition. As in NFHS 4, the households not having regular income and the per capita net state domestic product significantly affects the the odds of stunting.

In the Model 3, the household level variables are introduced in a phased manner. Here too, the children not following the norms of Minimum Acceptable Diet are more prone to the risk of stunting. Once the household level covariates are introduced few regions loses its significance. Among the regions, it is found that again it is the Eastern Plateau and Hills Region (OR=2.003), which shows a higher probability of stunting. The other climatic regions which significantly affect the odds of stunting are Eastern Himalayan Region, Lower, Middle and Upper Gangetic Plain, Central and Western Plateau and

Hills Region and Western Dry Region. Among the household level variables the Rural Place of Residence (OR=1.299) has more probability to significantly affect the odds of stunting. The household not having access to improved source of drinking water, no proper toilet facilities and the household having female head of the family are also seen to significantly affect the odds of stunting. These results remain the same even in NFHS 4. The state level variables also significantly affect the probably of children being stunted.

After the introduction of mother level variables in model 4, all the agro-climatic region vaiables lose statistical significance. But here too the children deprived from the norms to be followed under Minimum Acceptable Diet (OR=1.849), are more vulnerable to the risk of child stunting. Like model 3, it can be observed that the rural place of residence (OR=1.286) and source of improved drinking water are important predictors to the risk of child stunting. It can be seen that in model 4, all the mother-level variables are found to significantly affect the probability of stunting. Among them, Mothers with higher level of education, mothers accruing the benefit of better healthcare facilities, mothers having access to have proper antenatal care for their children shows lower probability of their children being stunted. Again, households with regular income and Per capita NSDP also show significant association to the risk of stunting. The results did not differ much in NFHS 4.

The full model, introduces the child level covariates along with previous covariates. Here too, the children not accruing benefit of better feeding practices (OR=1.951) has higher probability of being stunted. Again, as in model 4, the agro-climatic regions lose its significance. The rural place of residence and households not having proper source of drinking water facilities shows significant association to child stunting. As in earlier models, mother with higher level of education and enjoying better healthcare facilities and ante-natal care positively and significantly affect the odds of stunting. As in NFHS 4, the children with more than one year of age, and those children who suffered from recent incidence of diarrhea (OR=1.133) are more vulnerable to the odds of child stunting. The households with regular income and at the state level the per capita NSDP affect the probability of child stunting. It can also be observed that in all the models the Child Minimum acceptable diet is significantly associated with child stunting.

Considering all the models of multilevel analysis on wasting, in NFHS 4, it can be observed that children deprived of proper feeding and dietary practices are prone to the risk of child wasting. Among the agro-climatic regions, it can be seen from all the models that the children residing in Gujrat Plains and Hills Region are more vulnerable to acute undernutrition. Place of residence, improved source of drinking water, the type of toilet, mothers education, place of delivery, proper antenatal care, Mother and Child Protection Card are the significant predictors of child wasting. The age of the child, and the children suffering from recent illness due to diarrhea are the factors associated with child wasting. Among the state level factors, the children from households with regular source of income and Percapita NSDP are also found to be significantly influencing the odds of child wasting.

Table 6.10: Multi level regression on the association between Minimum Acceptable Diet and other contextual factors on child stunting among children less than 5 years of age in India in 2004-05

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Minimum Acceptable Diet					
Yes (Ref.)		1.715***	1.742***	1.849***	1.951
No		(0.43,1.98)	(0.32,1.56)	(0.22,1.63)	
West Coast Plain & Ghat Region (Ref.)					
Eastern Himalayan Region		1.004** (0.86,3.55)	1.053** (0.59,3.86)	0.956	0.914
Trans Gangetic Plain		1.011** (0.16,4.13)	1.201	1.456	3.241
Lower, Middle and Upper Gangetic Plain		1.745*** (0.26,1.97)	1.772*** (0.21,1.99)	0.777	0.755
Eastern Plateau &Hills Region		2.063** (1.54,3.10)	2.003** (1.95,3.63)	1.950	1.016
Central and Western Plateau & Hills Region		1.018*** (0.99,1.85)	1.001*** (0.52,1.96)	1.176	1.095
Southern Plateau & Hills Region		0.291** (0.16,2.52)	0.246	1.228	1.129
Western Himalayan Region		1.019** (0.84,1.92)	1.012	1.245	1.234
Gujrat Plains & Hills Region		1.010* (0.26,3.87)	1.001	2.274	1.002
Western Dry Region		2.001** (1.53,3.53)	1.995** (0.98,2.88)	1.986	1.083
Place of residence					
Urban (Ref.)					
Rural			1.299* (0.65,4.85)	1.286* (0.59,4.81)	1.279* (0.59,4.87)
Source of drinking water					
Improved (Ref.)			0.845*	0.941*	0.842*
Not improved			(0.061,2.96)	(0.046.2.85)	(0.051,4.12)
Type of toilet					
Flush(Ref.)					
Other			0.860* (0.024.3.01)	0.862* (0.054, 3.06)	0.861
Sex of household head					
Male (Ref.)			0.188*	1.179	1.171
Female			(0.021.2.99)		

(……….in continuation with table 6.10)

Variables	**Model l 1**	**Model 2 CI**	**Model 3 CI**	**Model 4 CI**	**Model 5 CI**
Number of children					
<5					
1 (Ref.)			0.989	0.965	0.962
≥ 2					
Education of mother				0.519***	0.511***
None (Ref.)				(0.23,1.28)	(0.05,1.29)
Primary				0.482***	0.412***
Secondary				(0.21,1.65)	(0.08,1.96)
Higher				0.222***	0.202***
				(0.37,1.54)	(0.18,1.65)
Place of Delivery					
Home				0.055***	0.612***
Health Facility(Ref.)				(0.01,0.99)	(0.24,1.34)
Antenatal care					
No				0.046***	0.535***
Yes(Ref.)				(0.21, 1.02)	(0.12,1.61)
Suffers from Anemia					
No				0.921***	0.815***
Yes(Ref.)				(0.25,1.86)	(0.21.1.33)
Age of the child					1.485***
(months)					(0.15,1.84)
6-8 (Ref.)					1.784***
9-23					(0.14,1.96)
24-35					1.655***
≥ 36					(0.25,1.99)
Child diarrhea					1.133*
No (Ref.)					(0.24,1.58)
Yes					
Previous Birth					
Interval					
<2 years (Ref.)					0.824
≥ 2years					
Sex of child					
Male (Ref.)					
Female					0.154

(……in continuation with table 6.10)

Variables	Model l 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Households with BPL card					
No			0.292	0.291	0.292
Yes(Ref.)					
Household with regular income			0.127^{**}	0.127^{**}	0.127^{**}
No			(0.88,1.94)	(0.84,1.99)	(0.87,1.95)
Yes(Ref.)					
Percapita Net State Domestic Product		0.031^{*} (0.03,4.25)	0.037^{*} (0.03,4.16)	0.035^{*} (0.03,4.12)	0.032^{*} (0.02,4.06)
Random Effect					
Intra-class correlation					
ρ(PSU)	0.071^{*}	0.022^{*}	0.020^{*}	0.062^{*}	0.021^{*}
ρ(household)	0.125^{*}	0.264^{*}	0.219^{*}	0.248^{*}	0.296^{*}
Variance Decomposition in %					
PSU	40.1	37.4	32.4	33.8	32.1
Household	59.9	62.6	67.6	66.2	67.9
**** p< 0.01, ** p< 0.05, *p< 0.10*					

Source: Calculated from Unit level data

Table 6.11: Multi level regression on the association between Minimum Acceptable Diet and other contextual factors on child wasting among children less than 5 years of age in India in 2014-15

Variables	**Model 1**	**Model 2 CI**	**Model 3 CI**	**Model 4 CI**	**Model 5 CI**
Minimum Acceptable Diet					
Yes (Ref.)		1.015***	1.021***	1.020***	1.021***
No		(1.54,3.19)	(1.29,3.22)	(1.26,3.19	(1.24,3.09)
Western Himalayan Region (Ref.)					
Eastern Himalayan Region		0.016	0.015	0.019	0.015
Lower Gangetic Plain		0.095	0.096	0.096	0.096
Middle Gangetic Plain		0.011	0.011	0.012	0.012
Upper Gangetic Plain		1.035	1.032	1.033	1.033
Trans Gangetic Plain		1.022	1.023	1.026	1.026
Eastern Plateau &Hills Region		0.124	0.127	0.127	0.124
Central Plateau & Hills Region		0.85	0.85	0.86	0.87
Western Plateau & Hills Region		0.019	0.019	0.018	0.018
Southern Plateau & Hills Region		0.246	0.245	0.245	0.247
East Coast Plains & Hills Region		1.52	1.53	1.53	1.56
West Coast Plain & Ghat Region		0.056	0.054	0.052	0.062
Gujarat Plains & Hills Region		1.45* (1.20,3.55)	1.46* (1.21,3.88)	1.47	1.47
Western Dry Region		1.099* (1.01,4.25)	1.098* (1.01,4.31)	1.094	1.095
Place of residence					
Urban(Ref.)			1.002*	1.003*	1.004*
Rural			(0.94,3.99)	(0.89,3.95)	(0.81,3.95)

(…………….in continuation of Table 6.11)

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Source of drinking water					
Improved (Ref.)					
Not improved			1.055*	1.051**	1.052*
			(0.51,2.41)	(0.48,2.45)	(0.45,2.56)
Type of toilet					
Flush(Ref.)			0.074*	0.073*	0.071*
Other			(0.53.3.17)	(0.49,3.12)	(0.45,3.15)
Sex of household head					
Male (Ref.)					
Female			1.148	1.149	1.151
Number of children <5					
1 (Ref.)					
≥ 2			0.840	0.841	0.838
Education of mother				0.285**	0.277***
None				(0.21,2.96)	(0.20,1.41)
Primary				0.452**	0.245***
Secondary				(0.12,3.43)	(0.19,1.66)
Higher(Ref.)				0.124**	0.196***
				(0.09,2.39)	(0.17,1.89)
Place of Delivery					
Home (Ref.)				0.019***	0.019***
Health Facility				(0.01,1.54)	(0.01,1.96)
Antenatal care					
No				0.546***	0.512***
Yes(Ref.)				(0.42,1.46)	(0.43,1.53)
Suffers from Anemia					
No (Ref.)				1.563*	1.599***
Yes				(0.22,1.16)	(0.34,1.01)
Mother and Child Protection Card					
No				0.211**	0.219**
Yes(Ref.)				(0.06,2.25)	(0.14,3.06)
Age of the child					1.213***
(months)					(0.52,2.65)
6-8 (Ref.)					1.249***
9-23					(0.41,2.32)
24-35					1.301***
≥ 36					(0.59,2.86)
Child diarrhea					
No (Ref.)					1.153*
Yes					(0.89,2.54)
Previous Birth Interval					
<2 years (Ref.)					0.456**
≥ 2years					(0.54,2.57)

(……………in continuation of Table 6.11)

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Sex of child Male (Ref.) Female					1.016
Child Minimum Acceptable Diet		0.020***	0.019***	0.019***	0.018***
Households with BPL card No (Ref.) Yes		0.395	0.355	0.355	0.394
Household with regular income No Yes(Ref.)			0.110** (0.92,1.84)	0.107** (0.94,1.89)	0.110** (0.97,1.95)
Per capita Net State Domestic Product			0.007* (0.03,4.16)	0.005* (0.03,4.12)	0.001* (0.02,4.06)
Random Effect					
Intra-class correlation					
ρ(PSU)	0.053*	0.041*	0.019*	0.027*	0.021*
ρ(household)	0.091*	0.277*	0.254*	0.265*	0.274*
Variance Decomposition in %					
PSU	45.2	39.9	34.7	35.1	34.9
Household	54.8	60.1	65.3	64.9	65.1
**** p< 0.01, ** p< 0.05, *p< 0.10*					

Source: Calculated from Unit Level Data

When we look into all the models of wasting in NFHS 3, it can be seen that that proper feeding practices are an essential determinant to acute undernutrition among children. The odds ratios confirm that children deficient in diet are likely to suffer from this short-term undernutrition. It can be observed that after the incorporation of all the variables only Eastern Himalayan Region is significantly associated with the odds of child wasting. Thus the agro-climatic regions do not show much significance in predicting acute undernutrition among children. As before, the rural place of residence, not having access to improved source of water, mothers with lower level of education, mothers not having access to antenatal care, mothers who suffered from anemia, a child suffering from illness of diarrhea affect the risk of wasting in children. The average income of the household is an important predictor for the odds of child wasting, as is the per capita NSDP.

Table 6.12: Multi level regression on the association between Minimum Acceptable Diet and other contextual factors on child wasting among children less than 5 years of age in India in 2004-2005

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Minimum Acceptable Diet					
No (Ref.)		1.611^{***}	1.619^{***}	1.615^{***}	1.615^{***}
Yes		(0.21,1.91)	(0.24,1.92)	(0.19,1.93)	(0.21,1.99)
West Coast Plain & Ghat Region (Ref.)					
Eastern Himalayan Region		0.954^{*} (0.23,3.96)	0.941^{**} (0.51,3.51)	0.912^{**} (0.39,3.52)	0.914^{**} (0.42,3.53)
Trans Gangetic Plain		0.674	0.667^{***}	0.677	0.664
Lower, Middle and Upper Gangetic Plain		0.457	0.449	0.418	0.419
Eastern Plateau &Hills Region		2.042	2.056	2.245	2.187
Central and Western Plateau & Hills Region		3.011^{**} (2.16,4.1)	2.201)	1.456^{*}	1.103
Southern Plateau & Hills Region		2.063	2.003	2.525	1.016
Western Himalayan Region		1.018	1.001	1.176	1.095
Gujarat Plains & Hills Region		0.765^{*} (0.06,4.21)	0.694^{*} (0.09,4.56)	1.897	0.156
Western Dry Region		0.291^{**} (0.16,2.52)	0.246	1.228	1.129
Place of residence					
Rural (Ref.)			1.299^{*}	1.286^{*}	1.279^{*}
Urban			(0.65,4.85)	(0.59,4.81)	(0.59,4.87)
Source of drinking water					
Improved (Ref.)			0.845^{*}	0.841^{*}	0.842^{*}
Not improved			(0.21,4.55)	(0.27,4.43)	(0.23,4.10)
Type of toilet					
Flush(Ref.)					
Other			0.860	0.862	0.861
Sex of household head					
Male (Ref.) Female			1.188	1.179	1.171

(………in continuation of Table 6.12)

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Number of children <5					
1 (Ref.)					
≥ 2			0.989	0.965	0.962
Education of mother				0.519*	0.511*
None (Ref.)				(0.05,3.98)	(0.06,3.88)
Primary				0.482*	0.412*
Secondary				(0.06,3.56)	(0.04,3.55)
Higher				0.222*	0.202*
				(0.04,3.63)	(0.36,5.12)
Place of Delivery					
Home (Ref.)					
Health Facility				0.655	0.612
Antenatal care					
No (Ref.)				1.546***	1.535***
Yes				(0.94,2.05)	(0.95,2.01)
Suffers from Anemia					
No (Ref.)				1.521***	1.515***
Yes				(0.88,2.15)	(0.86,2.18)
Age of the child (months)					
6-8 (Ref.)					
9-23					1.485
24-35					1.784
≥ 36					1.655
Child diarrhea					
No (Ref.)					1.133*
Yes					(0.21,3.65)
Previous Birth Interval					
<2 years (Ref.)					0.824*
≥ 2years					(0.12,3.99)
Sex of child					
Male (Ref.)					
Female					0.154
Child Minimum Acceptable Diet		0.013***	0.017***	0.014***	0.014***
Households with BPL card					
No (Ref.)					
Yes			0.119	0.121	0.121
Household with regular income					
No (Ref.)			0.106**	0.107**	0.107**
Yes			(0.81,1.90)	(0.74,1.83)	(0.72,1.81)

(…….in continuation of Table 6.12)

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Per capita Net State Domestic product		0.026^{*} (0.09,4.07)	0.024^{*} (0.14,4.05)	0.025^{*} (0.12,4.01)	0.026^{*} (0.06,4.09)
Random Effects Intra-class correlation					
ρ(PSU)	0.071^{*}	0.022^{*}	0.020^{*}	0.062^{*}	0.021^{*}
ρ(household)	0.125^{*}	0.264^{*}	0.219^{*}	0.248^{*}	0.296^{*}
Variance Decomposition in %					
PSU	47.0	41.2	36.8	40.4	39.9
Household	53.0	58.8	63.2	59.6	60.1
**** p< 0.01, ** p< 0.05, *p< 0.10*					

Source: Calculated from Unit Level Data

In NFHS 4, it can be observed from Model 1 (Null Model) that there is significant variation in child underweight at the community and household level. The Intra-class correlations (ICCs) can be observed at the community and household level for child underweight. Model 2 shows the effect of agro-climatic region on the odds of child underweight. It can be observed that compared to Western Coastal Region, Children of other agro-climatic zones were more likely to be underweight.

But after the inclusion of other covariates in successive models, it can be observed that the agro-climatic zones lose its significance. Here too, the rural place of residence, source of drinking water and other household level variables are important predictors of the risk of child underweight. Education of the mother, delivery t the health facility, proper antenatal check-up and other mother level variables are also important indicators to the vulnerability of child underweight. Household without regular income and per capita NSDP also significantly associate with the risk of child under weight.

Here also it can also be observed that in all the models, the Minimum acceptable diet is significantly associated with child wasting.

Table 6.13: Multi level regression on the association between Minimum Acceptable Diet and other contextual factors on child underweight among children less than 5 years of age in India in 2014-2015

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Minimum Acceptable Diet					
Yes (Ref.)					
No		0.912** (0.55,2.11)	0.913** (0.53,2.03)	0.911** (0.54,2.01)	0.909** (0.55,1.86)
West Coast Plain & Ghat Region (Ref.)					
Eastern Himalayan Region		0.855** (1.97,3.65)	0.856	0.899	0.896
Lower Gangetic Plain		0.233* (0.12,3.53)	0.231	0.266	0.245
Middle Gangetic Plain		0.344* (0.16,3.96)	0.396	0.412	0.411
Upper Gangetic Plain		0.745* (0.32,3.63)	0.711	0.755	0.736
Trans Gangetic Plain		1.025* (0.21, 3.69)	1.075	1.084	1.087
Eastern Plateau &Hills Region		1.002* (0.36,3.99)	0.956	0.911	0.963
Central Plateau & Hills Region		0.974* (0.32,3.96)	0.912	0.942	0.962
Western Plateau & Hills Region		0.841* (0.52,3.02)	0.745	0.755	0.675
Southern Plateau & Hills Region		0.774* (0.42,3.41)	0.454	0.421	0.411
East Coast Plains & Hills Region		0.213* (0.33,3.45)	0.312	0.324	0.356
Western Himalayan Region		1.006* (0.61,3.95)	1.023	1.045	1.043
Gujrat Plains & Hills Region		1.052* (0.63,3.01)	1.022* (0.76, 4.53)	1.051* (0.87,4.41)	1.045
Western Dry Region		1.087* (0.51,3.77)	1.073* (0.54,4.01)	1.022* (0.71,3.95)	0.955
Place of residence					
Urban (Ref.)					
Rural			1.024* (0.87,4.02)	1.054* (0.42,3.15)	1.024* (0.45,3.85)
Source of drinking water					
Improved (Ref.)					
Not improved			1.012* (0.46,3.44)	1.092* (0.44,3.21)	1.012* (0.46,3.44)
Type of toilet					
Flush(Ref.)					
Other			0.023	0.031	0.033

(………… in continuation of Table 6.13)

Variables	**Model 1**	**Model 2 CI**	**Model 3 CI**	**Model 4 CI**	**Model 5 CI**
Sex of household head					
Male (Ref.)			1.024*	1.024*	1.024*
Female			(0.87,4.02)	(0.87,4.02)	(0.87,4.02)
Number of children <5					
1 (Ref.)			1.012*	1.012*	1.012*
≥ 2			(0.46,3.44)	(0.46,3.44)	(0.46,3.44)
Education of mother				0.524*	0.524*
None (Ref.)				(0.23,5.63)	(0.23,5.63)
Primary				0.621*	0.621*
Secondary				(0.66,5.96)	(0.66,5.96)
Higher				0.023*	0.023*
				(0.55,5.99)	(0.55,5.99)
Place of Delivery					
Home (Ref.)				0.011*	0.012*
Health Facility				(0.22,6.21)	(0.23,6.01)
Antenatal care					
No (Ref.)				0.091*	0.086*
Yes				(0.025,6.32)	(0.021,6.55)
Suffers from Anemia					
No (Ref.)				0.986*	0.944*
Yes				(0.03,6.02)	(0.08, 5.99)
Mother and Child Protection Card					
No (Ref.)				0.301**	0.309**
Yes				(0.66,2.25)	(0.62,3.06)
Age of the child					1.213***
(months)					(0.52,2.65)
6-8 (Ref.)					1.249***
9-23					(0.41,2.32)
24-35					1.301***
≥ 36					(0.59,2.86)
Child diarrhea					
No (Ref.)					1.149*
Yes					(0.99,2.70)
Previous Birth Interval					
<2 years (Ref.)					
≥ 2years			0.513	0.514	0.514
Sex of child					
Male (Ref.)					
Female			0.955	0.941	0.942
Child Minimum Acceptable Diet		0.022***	0.021***	0.017***	0.018***
Households with BPL card					
Yes (Ref.)					
No			0.523	0.521	0.522

(………. in continuation of Table 6.13)

Variables	Model 1	Model 2 CI	Model 3 CI	Model 4 CI	Model 5 CI
Household with regular income					
Yes (Ref.)			1.259**	1.259**	1.256**
No			(0.03,3.06)	(1.06,3.02)	(1.02,3.01)
Per capita Net State Domestic Product		0.011* (0.05,4.08)	0.016* (0.084.09)	0.016* (0.06,4.05)	0.016* (0.09,4.04)
Random Effects					
Intra-class correlation					
ρ(PSU)	0.064*	0.022*	0.020*	0.021*	0.024*
ρ(household)	0.099*	0.264*	0.241*	0.296*	0.287*
Variance Decomposition in %					
PSU	46.1	39.5	35.3	34.8	41.2
Household	53.9	60.5	64.7	65.2	58.8

**** p< 0.01, ** p< 0.05, *p< 0.10*

Source: Calculated from Unit Level Data

The results for child underweight do not differ much in NFHS 3. The Child Minimum acceptable diet is significantly associated with child Underweight in all the models.

6.6 Discussion and Conclusions

Most of the existing studies have estimated the association of food consumption pattern and child undernutrition. The present study differs from earlier studies as it takes into consideration the association between Minimum acceptable diet and child underuntrition controlling for other covariates at different levels. It was found that the Minimum acceptable Diet is influenced by many factors such as agro-climatic conditions, and other possible socio-demographic factors. Selected socio-demographic indicators are included in the analysis. Different models were applied to maintain the hierarchy to examine the association of factors with three child nutritional indicators namely stunting, wasting and underweight.

Compared with the West Coast Plain, other agro-climatic regions had higher risk of child stunting and underweight. It was found that Upper Gangetic Plain and Western Dry Region showed more prevalence of undernutrition. This is because the state of Uttar Pradesh and Rajasthan are the states where there is more concentration of people living below the poverty line. The economic condition of the household may be a crucial factor for determining Minimum Acceptable Diet. This is because high-income households may have followed all the nutrient requirements for Minimum Acceptable Diet while the poor spending mostly on basic requirements. Madise et al. (1999) in a study suggested that regional economic development is an important source of variation in child undernutrition.

But in majority of the models no significant association was observed for wasting. It was found that after the introduction of household level factors the agro–climatic regions lost their significance.

The multi level analysis found that Minimum Acceptable diet significantly affects the child undernutrition status. It was also observed that people living in rural areas have a higher prevalence of undernutrition as compared to their urban counterpart. This highlights the fact that as children in rural areas belong to lower socio-economic classes, they are more nutritionally deprived. Borkotoky et al (2017) observed that total calorie intake of urban areas has increased.

This study also suggests that that households with regular income has significantly positively associated with reducing child undernutrition parameters. Again per capita Net State Domestic Product (NSDP) is also a significant factor associated with child undernutrition. Hadad et al. (2002) suggested that greater income at the state level leads to higher quality health care and improved water and sanitation systems. There are other studies too where it is observed that there is a positive association of GDP with reduction in child undernutrition (Subramanyam et al., 2011; Harttgen et al., 2013). However, Vollmer et al. (2014), on the other hand, reported a null or very small association of increase in per capita GDP with reduction in child undernutrition. The study revealed that the education of mother make an important contribution to the the betterment of nutritional status of children. Communities where mothers have high average years of education tend to have better anthropometric indicators among children. Additionally, mothers receiving antenatal care significantly reduce the risk of children being underweight, stunted or wasted. Therefore, care during pregnancy has a long-term impact on the health of the children.

It can thus be concluded that diversity in complementary feeding has a significant association with the three indicators of child nutritional status. It is also seen that breastfeeding practices are satisfactory in all the states of our country overtime. But better feeding practices in terms of MAD is yet to be ensured among the children under five years of age for all the states in the country. This study focused mainly on Minimum Acceptable Diet and the importance of agro-climatic zones in influencing the nutritional status of children in India. The study observed that if children were fed according to WHO guidelines then there is less likely for the child to remain undernourished. So following WHO guidelines for Minimum Acceptable Diet, provision of antenatal care and better sanitation and drinking water facility is likely to bring down the percentage of undernourished children in our country.

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Chapter 7

Economic Growth and Child Undernutrition in India

7.1 Introduction

Improvement in child health is considered by the United Nations as an important indicator for progress towards Sustainable Development Goals. Undernutrion among children puts them towards greater risk of disease vulnerability. It also adversely affects their physical, cognitive and mental development. Globally, India's performance in terms of child undernutrition is quite poor. Although recent NFHS gives data on slight improvement in the rate of child undernutrition, there are still unacceptably large number of Indian children who are still nutritionally compromised.

Available literature on child undernutrition (both by individual authors as well as by international agencies) tend to suggest that the poorer countries in the world are hosts to majority of undernourished children across the globe. This is true irrespective whether the measurement of child undernutrition follows an 'input based' methodology or an 'output- based' one. Since nations with low per capita incomes are considered as 'poor', the obvious corollary of that position is the presence of negative association between the indicators of child under-nutrition and per capita income levels of regions and countries. Such propositions are essentially macroeconomic in nature and therefore require proper verifications. Same argument also translates to the domain of economic growth: e.g. does there exist a relation between high economic growth and low child undernutrition among the Indian states? This is because economic growth improves the income, especially the poor and increases their access to and consumption of health-promoting goods and services, which in turn helps in improved nutritional status of children. That means when economic growth stimulates the average income of the population, then it is quite natural to assume that people may spend a larger portion of their income on the consumption of health and nutrition relevant goods and services. There are also certain studies which states that healthier population leads to increased economic growth, and improved standard of living. Increased GDP may also boost the necessity of provision of nutrition – relevant services and social and health infrastructures as government may plan on higher public spending towards improvement in nutrition of the population. But if economic growth is associated with rising income inequality, then the poorest may not be able to capture the benefits of increased national income. The persistence of child undernutrition in India is a serious public health concern even though the country had experienced a 9% or greater growth rate after 2005, which, however, has slumped in the pandemic period.

The previous three chapters of the present dissertation have been based on individual child level data to find the relationship between the indices of Under 5 child undernutrition and several micro-level socio-demographic factors. These studies have revealed a number of individual-level factors influencing the nutritional status of children. Such factors are indeed important, but they do not necessarily conform to a macro pattern of causality between economic factors and child undernutrition. In this chapter, we have tried to examine the relationship between child undernutrition and economic growth with other selected macro-level variable. The aim of this chapter is, therefore, to study the inter-relationship between the indicators of child undernutrition in our country at the state level with the macroeconomic aggregates likes the per capita SDP or the rate of growth the states' SDP over time, controlling for important social factors like mothers' anaemia or their levels of education as measured by the mothers' literacy. Since policy interventions usually and mostly take place in the form of macro-aggregates, it is important to verify the realistic foundations underlying macro propositions. For example, one of the policy suggestions to alleviate the incidence of poverty in a region or country has been to accelerate the growth rate of the economy and regions, and many empirical studies at various levels by experts [both national experts as well as international agencies] have demonstrated that growth effect dominates the distribution effect in the reduction of the incidence of poverty between periods. Yet, there are also cases, where the faster growing states have not necessarily experienced sharper reduction in the incidence of poverty. Similarly , while searching for appropriate policy packages for attaining the sustainable development goals, which include reductions in the incidences of child undernutrition, an important concern is macroeconomic- viz, should the country adopt growth promoting strategies in the states and release investment on sectors which has the highest and quickest growth potential. Also, it is important to check whether the levels of per capita income, say at the state levels, influence the incidence of child undernutrition along with social factors like mothers'education and mothers' health conditions. The present chapter precisely wants to check the importance of such factors at the macro-economic level using statewise data.

In this study panel data regression is used to examine whether improvement in economic growth and other relevant state level variables like per capita NSDP(economic growth), female literacy and mother's anaemia have any impact on state-level child undernutrition of few selected states in India. We have used per capita net state domestic product, as a measure of a state's economic development. These data are obtained from Reserve Bank of India, for the years 1998, 2005 and 2014 and measured in 2005 base prices. The per capita state domestic product is a measure of economic performance of a state , with higher values indicating higher levels of economic development. It is the value of all goods and services produced within the boundaries of a state for that year, minus the cost of capital used in the production, per capita . Even the Government of India uses this measure to allocate central resources among various states. We, have also considered mother's anaemia, characterized by low hemoglobin in the blood, is one of the major health hazards affecting people in both developed and developing countries. Anaemia may occur at all stages of life, but women in the childbearing age are the most vulnerable. In women, anaemia adversely affects their capacity to work and may lead to poor pregnancy outcomes. We have also considered the state female literacy to measure the level of education of the mothers of the state. It has been found in various literature, that low level of maternal education is associated with poor feeding practices, leading to a greater risk of giving birth to undernourished babies.

We have also calculated percentage change in per capita state domestic product to measure economic growth as $((x_t - x_{t-1}) / x_{t-1}) * 100$. That means we considered per capita NSDP in a particular year minus the per capita NSDP in the previous year divided by per capita income of the previous year, expressed as a percentage. For this we considered 1998-99 and 1999-2000 for NFHS-2, 2004-2005 and 2005-2006 for NFHS-3 and 2013-2014 and 2014-2015 for NFHS-4. The data for state female literacy is obtained from Census 2001 and 2011. The date for mother's anaemia for the states in India is taken from NFHS-3 and NFHS-4 reports.

Panel data, also known as longitudinal data or cross- sectional time series data, refers to data containing time series observations of a number of cross sections.

The data for this study are taken from NFHS conducted in India in 1998-99, 2005-2006 and 2014-15. To ensure comparability of data across various rounds, we took data for only those states which are common to all the rounds. It is a short panel data as the number of cross-sectional units (N) is greater than the number of time points (T).One may be suspicious about the robustness of the estimates because the data size is small, but use of Panel Data econometrics is quite novel in the context of studying child undernutrition in India .

7.2 Method of Panel Data Exercise

Any panel data set can be represented in terms of algebraic model. In this paper , we consider the following regression equation

$\text{Undernutrion}_{it} = \alpha + \beta_1(\text{Economic Growth}) + \beta_2 (\text{Female Literacy}) + \beta_3(\text{Mother's Anaemia})+ \varepsilon_{it}$

Where $i = 1,2,\ldots\ldots,17$

$t = 1,2,3$

In this model, all the variables have the intercept as *it*. i and t are respectively the cross-sectional and time series aspects of the data. Here cross-sectional units (N) is 17 and number of years (T) is 3, so there are 51 observations on each variable (NT= 51). The disturbance term ε_{it} is assumed to be independently and identically distributed. For the purpose of hypothesis testing, we also assume that ε_{it} is normally distributed. Again, all the explanatory variables are also assumed to be non-stochastic and none of these is correlated with the disturbance term of the model.

In order to capture the heterogeneity feature of the cross-sectional units, the Fixed Effect Model is considered initially. This model considers the intercept as the variable so to account for differences among individuals with regard to the value of the intercept. But in Fixed-effect Model, though the intercept is allowed to vary across cross-sectional units, but for each cross-sectional unit, the intercept is assumed to remain constant over time, that is, the intercept across each cross-sectional unit is time-invariant.

The Fixed Effect Models is estimated through the Ordinary Least Squares (OLS) method. Here, we apply the usual t-test to examine whether an individual intercept is zero. Further, we find the Resticted F-test to test the appropriateness of the fixed effect model. Initially, we used the Fixed Effect Model that considers only the cross section effect. We used the data presented in Table: 1

The data are collected from the reports of National Family Health survey for the states of our country for three time periods NFHS-2 (1998-1999), NFHS-3 (2004-2005) and NFHS-4 (2014-2015 Three indices of nutritional status were calculated for children: height-for-age, weight-for-height and weight-for-age and Composite Index of Anthropomertric failure. The data for state level female literacy is obtained from Census report.

7.3 Results

Table 7.1 is arranged with data on stunting and other macro-economic variables like Economic Growth using per NSDP on the selected states of India, state-level female literacy and state-level mother's anaemia rates. The results of fixed effect model on state-level stunting and economic growth are presented in Table: 7.2.

From the Table 7.2 it is clear that there is a negative relationship between economic growth and stunting. The same negative relationship holds between female literacy and stunting. However, there is a positive relationship between mother's anaemia and stunting. Further, the estimated coefficients of all the variables are statistically significant. Economic growth is statistically significant at 1% level as the p-value of the computed t-statistic less than 0.01. The other variables are statistically significant at 5% level, as the p-value for computed t-statistics are greater than 0.01, but less than 0.05.Thus, from the above, it can be concluded that as the rate of economic growth rises and female literacy rises and mother's anemia level falls the incidence of stunting among the children will fall.

Here 'C' is the common intercept, which is the average of all the intercepts, which means it is the average of estimated intercepts of all the 17 cross-sectional units or cross-sectional states. The EViews presents individual or fixed effects as deviations of individual intercepts from the common intercept.

The cross-section fixed effects as deviations from common intercept in the context of our model are given in Table 7.3. Since all the cross-section fixed effects are non-zero, the presence of fixed effects is confirmed.

It can be seen from Table 7.2 that the computed Durbin-Watson statistic in fixed effect model is 3.015689, which indicates presence of positive autocorrelation. In order to check the appropriateness of the Fixed Effect Model we examined the Random Effects Model. Thus, we estimated the Random Effects Model by invoking the cross-section effect and generated the series for cross-section effects and thereby conducted the Hausman test.

The Random Effects Model does not use the dummy variables as Fixed Effect model, to capture the presence of individual effect. It rather assumes that the individual effect is a random variable with a specific mean value. Here, we have a composite random error that considers two components : (i) individual-specific random error component, and (ii) a combined time series and cross-section random error component, sometimes called idiosyncratic random error term because it varies over cross-sectional units/states as well as over time. Since this model considers individual effect as a random variable, hence it is referred to as Random Effects Model.

In this model, it is considered that the composite error term is not correlated with any of the explanatory variables included in the model. But since the composite error term includes the individual-specific random error component, hence the composite error term may be correlated with the explanatory variables included in the Random Effect Model. In such a situation, Random Effects model will result in inconsistent estimation of regression coefficients, and hence the result is checked through Hausman Test.

The observations that can be derived from the above tables is that , both in fixed and random effect model, economic growth and state female literacy shows a negative relationship with the rate of stunting, implying that as economic growth and state female literacy increases, the state rate of child stunting will reduce. On the other hand, it can be observed that there is a positive relationship between the slope coefficient of mother's anemia level and rate of child stunting, which implies that as the rate of mother's anemia increases, the rate of stunting will also increase. All the results of the slope coefficients are statistically significant. The tables of Fixed effect and Random effect model (Tables7.3 and 7.5) also confirm that there is a presence of cross-effects as the cross-effects random effects values are non-zero. The problem of auto correlation is absent in the Random Effect Model as the computed value of Durbin-Watson statistic is 2.086345, which is greater than theoretical Durwin-Watson values (both lower and upper). It is also observed from the Hausman test (Table 7.6), that the Random Effect Model is more appropriate in this case as the computed Chi-square is statistically insignificant.

From Table 7.8 it can be observed that the slope coefficients for economic growth and female literacy are negative and the estimated coefficients of both the variables are statistically significant at 5% level of significance. From this, it can be concluded that as the percentage of economic growth and female literacy increases, the incidence of wasting among children is reduced. The slope coefficient for mother's anemia has been found to be statistically insignificant. Here too 'C', the common intercept is the average of the estimated intercepts of 17 cross-sectional states. The cross-section fixed effects, as deviations from common intercept are non-zero. This implies that there is a presence fixed effect in the model. This is evident from Table: 7.9.

Here too, we have estimated the Random Effects Model to check the appropriateness of the Fixed Effect Model. This is because we need to confirm the absence of autocorrelation in the context of Fixed Effect Model. Thus, we estimated the Random Effects Model by invoking the cross-section effect and thereby generated the series for cross-section random effects, and performed the Hausman test. The results are given in Tables: 7.10, 7.11, 7.12.

The following observations can be made here: Similar to Fixed Effect Model, it can be seen that the slope coefficients of Random Effect Model have negative signs for both Economic Growth and State female literacy and they are statistically significant too. However, the state level anemia for mothers is found to be statistically insignificant. The presence of cross-section effect is also confirmed on the basis of non-zero values of cross-section random effects. The problem of autocorrelation is absent in the Random Effect Model as the computed Durbin-Watson statistic is 2.512212, which is greater than theoretical Durbin- Watson values. The presence of Random effect is confirmed on the basis of Hausman Effect as the computed chi-square is found to be statistically insignificant.

Underweight is considered as the third parameter for child undernutrition. Therefore we need to estimate the relationship between Underweight and Economic Growth. We considered the Table: 7.13 to find the relationship between the two.

As in the previous two cases, we initially considered the Fixed Effect Model, by considering the intercept as a variable and thereby use dummy variables to account for differences among the individuals with regard to the value of the intercept. Since the

Fixed effect Model is simply a regression model, we apply the usual *t*-test to examine whether the individual intercept is zero. Then we test the appropriateness of the Fixed Effect Model by applying the Restricted *F*-Test. This is evident from the following Table 7.14.

As in the case with wasting, it can be observed here that there is a negative relationship between Economic growth and state child underweight. Negative relationship is also observed with state Female Literacy and state of child undernutrition. This implies that with higher Economic Growth, the incidence of state child underweight falls and as state Female literacy increases, the incidence of state Child underweight falls. This explains the fact that Economic Growth and increase in Female literacy are likely to improve the state child undernutrition rate. It is also observed that the estimated coefficients of both the variables are statistically significant.

On the other hand, the state level of anemia among mothers has no impact on state child underweight, as the estimated coefficient is found to be statistically insignificant. Here, too the 'C' is called the common intercept. The EViews presents the individual or fixed effects as deviations of individual intercepts from the common intercept. The cross-section fixed effects as deviations from common intercept in the context of our model are given in Table: 7. 15. Since all the cross-section fixed effects are non-zero, therefore the presence of fixed effects is confirmed.

However, it is also essential to check the appropriateness of Fixed Effects Model as against Random Effects Model. This is because we have not been able to confirm the absence of autocorrelation in the context of the Fixed Effects Model. Accordingly, we estimated the Random Effects Model by invoking the cross-section effect, and thereby generated the series for cross-section random effects, and thereafter performed the Hausman Test. The results are shown in Tables: 7.16, 7.17, 7.18.

It can be observed from the Tables: 7.16, that both Economic Growth and State Female Literacy have a negative association with state child underweight and the slope coefficients are statistically significant too. As in the case of Fixed Effect Model, here too in the Random Effect Mode, it can be seen that the state level anemia among mothers does not have any impact on child underweight parameter as the coefficient is found to be statistically insignificant.

The presence of cross-section effects is also confirmed from Table: 7 17, on the basis of non-zero values of the cross-section random effects. The problem of autocorrelation is absent in Random Effect Model as the computed value of Durbin-Watson statistic is 2.023014, which is greater than theoretical DurbinWatson values. Here too, the Random Effect Model gets accepted on the basis of Hausman test (Table:7.18) as the computed Chi-square value is found to be statistically insignificant.

Now we consider the CIAF as one of the child undernutrition parameter and examine the relationship between economic growth and other macroeconomic variables with CIAF. We have performed similar set of tests as have been done in the previous three cases.

Here, again we initially performed the Fixed Effect Model by considering the intercept as the variable and using dummy variables to account for differences among individuals with regard to the value of the intercept. Thereafter we conducted the Random Effect Model followed by Hausman Test to check the appropriateness of Fixed Effect Model as against the Random Effect Model.

It can be observed from both the Fixed Effect (Table: 7.20) and Random Model(Table:7.22), that economic Growth and Female literacy have a negative relationship with CIAF. On the other hand, mother anemia level is positively related to the incidence of child CIAF. This implies that an increase in both economic growth and state female literacy, the incidence of child CIAF will reduce. Again, as mother's anemia level reduces the incidence of CIAF will reduce. It can be seen that all the slope coefficients are statistically significant too. Here too, the Random Effect model gets accepted on the basis of Hausman test (Table: 7.24) as the compared chi-square value is seen to be statistically insignificant.

In the above four cases we have considered Economic growth as one of the macro economic variables. Let us now consider the per capita NSDP as one of the macro economic variables along with state Female Literacy and State Mother's anemia, to find a relationship with the three undernutrition parameters as well as CIAF.

The Table: 7.25 helps to understand the relationship between stunting and other macroeconomic variables including per capita NSDP. Table:7.25 is arranged with data on stunting and other macro-economic variables like per capita NSDP on the selected states of India, state-level female literacy and state-level mother's anaemia rates, for three different time periods, 1997-98, 2004-05 and 2014-15. The results of fixed effect model on state-level stunting and economic growth are presented in the Table: 7.26.

Table: 7.26 considered the data presented in Table:7.25 to estimate the Fixed Effect Model. The Fixed Effect Model considers only the cross-section effect. The results as presented in Table:7. 26 show that there is a negative relationship between stunting and Per Capita NSDP and stunting. Negative relationship is also observed between stunting and state-level female literacy . Further, the estimated coefficients of these variables are statistically significant at 5% level as the p-value of the computed t-statistics is greater than 0.01 but less than 0.05. A positive relationship can be observed between mother's anaemia and stunting, but it is not statistically significant as the computed as the p-value of the computed t-statistics is greater than 0.05.Thus, it can be concluded that as the percentage of Per capita NSDP and state level female literacy increases the incidence of state level stunting rate falls.

In the output Table:7.26, 'C' is called the common which is the average of all the individual intercepts, that is, intercept the average of estimated intercepts of 17 cross sectional states. The EViews presents individual or fixed effects as deviations of individual intercepts from the common intercept. The cross section effects as deviations from the common intercept is being presented in Table: 7.27. It can be seen that all the cross-section fixed effects are non-zero, which confirms the presence of fixed effects.

To check the appropriateness of Fixed Effect Model, we performed the Random Effects model. Further, the Fixed Effects could not confirm the absence of autocorrelation. So we estimated the Random Effects model by incorporating the cross-section effect. We generated a series of cross section random effects and also performed the Hausman test. The results are presented in Tables: 7.28, 7.29 and 7.30 respectively.

It can be observed in Table7.28 that the slope coefficients of Random Effects Model have negative signs. But only Per capita NSDP and state female literacy rate is statistically significant as the p-value of the computed t-statistics are greater than 0.01 but less than 0.05.The cross section effects is confirmed as the values of cross-section random effects are all non-zero. The problem of auto correlation is absent in the Random Effects Model as computed Durbin- Watson statistic is 2.018919 which is greater than the theoretical Durbin-Watson values (both upper and lower). Here too, the Random Effects Model gets accepted on the basis of Hausman test as the computed Chi-square value is statistically insignificant.

Table:7.31 helps to understand the relationship between wasting and other macroeconomic variables including per capita NSDP. The table is arranged with data on wasting and other macro-economic variables like per capita NSDP on the selected states of India, state-level female literacy and state-level mother's anaemia rates. For three different time periods, 1997-98, 2004-05 and 2014-15. The results of fixed effect model on state-level wasting and economic growth are presented in the Table: 7.32.

Table: 7.32 considered the data presented in Table: 7. 30 to estimate the Fixed Effect Model. The Fixed Effect Model considers only the cross-section effect. The results as presented in Table:7.32 show that there is a negative relationship between wasting and Per Capita NSDP. But it is statistically insignificant as the p-value of the t-statistic is greater than 0.05. Negative relationship is observed between wasting and state-level Female literacy. The estimated coefficients of these variables are statistically significant at 5% level as the p-value of the computed t-statistics is greater than 0.01 but less than 0.05. A negative and statistically insignificant relationship can be observed between mother's anaemia and wasting. Hence, it can be concluded that as the percentage of state level female literacy increases the incidence of state level wasting rate falls.

In the output Table:7.32, 'C' is called the common which is the average of all the individual intercepts, that is, intercept the average of estimated intercepts of 17 cross sectional states. The EViews presents individual or fixed effects as deviations of individual intercepts from the common intercept. The cross section effects as deviations from the common intercept is being presented in Table:7.33. It can be seen that all the cross-section fixed effects are non-zero, which confirms the presence of fixed effects.

Next we performed the Random Effects model to check the appropriateness of Fixed Effect Model. This is because the Fixed Effects could not confirm the absence of autocorrelation. So we estimated the Random Effects model by incorporating the cross-section effect. We generated a series of cross section random effects and also performed the Hausman test. The results are presented in Tables:7.34, 7.35 and 7.36 respectively.

It can be observed in Table: 7.34 that the slope coefficients of Random Effects Model have negative signs. But only Per capita NSDP and state female literacy rate is statistically significant as the p-value of the computed t-statistics are greater than 0.01 but less than 0.05.The cross section effects is confirmed as the values of cross-section random effects are all non-zero. The problem of auto correlation is absent in the Random Effects Model as computed Durbin- Watson statistic is 2.041251 which is greater than the theoretical Durbin-Watson values (both upper and lower). Here too, the Random Effects Model gets accepted on the basis of Hausman test as the computed Chi-square value is statistically insignificant.

Table: 7.37 helps to understand the relationship between underweight and other macroeconomic variables including per capita NSDP. The Table: 7.37 is arranged with data on underweight and other macro-economic variables like per capita NSDP on the selected states of India, state-level female literacy and state-level mother's anaemia rates. The data are collected from NFHS reports, Census reports on three different time periods, 1997-98, 2004-05 and 2014-15. The results of fixed effect model on state-level stunting and economic growth are presented in the Table: 7.38.

Table: 7.38 considered the data presented in Table: 7.37 to estimate the Fixed Effect Model between child underweight and per capita NSDP. The Fixed Effect Model considers only the cross-section effect. The results as presented in Table: 7.38 show that there is a negative relationship between per capia NSDP, female literacy and mother's anemia with child underweight. But since only per capita NSDP is seen to be statistically significant, hence it can be inferred that a high per capita NSDP can ensure low child underweight for the state. Table 39 shows the cross-section effects.

It can be observed in table 40 that the slope coefficients of per Capita NSDP and State Female literacy Random Effects Model have negative signs while state anaemia has a positive sign. But only the per capita NSDP is found to be statistically significant as the p-value of the computed t-statistics are greater than 0.01 but less than 0.05. Since the p-values for state female literacy and state level, mother anaemia is found to be statistically insignificant, hence these variables do not impact the state undernutrition for children below 5 years of age. The cross section effects are confirmed as the values of cross-section random effects are all non-zero. The problem of auto correlation is absent in the Random Effects Model as computed Durbin- Watson statistic is 2.022894 which is greater than the theoretical Durbin-Watson values (both upper and lower). Here too, the Random Effects Model gets accepted on the basis of Hausman test as the computed Chi-square value is statistically insignificant.

The Table: 7.43 helps to understand the relationship between CIAF and other macroeconomic variables including per capita NSDP. The Table:7.43 is arranged with data on CIAF and other macro-economic variables like per capita NSDP on the selected states of India, state-level female literacy and state-level mother's anaemia rates. For three different time periods, 1997-98, 2004-05 and 2014-15. The results of fixed effect model on state-level wasting and economic growth are presented in the Table: 7.44.

Table: 7.44 considered the data presented in Table: 7.43 to estimate the Fixed Effect Model. The Fixed Effect Model considers only the cross-section effect. The results as presented in Table:7.44 show that there is a negative relationship between CIAF and Per Capita NSDP. It is statistically insignificant as the p-value of the t-statistic is between 0.01and 0.05. Negative relationship is observed between CIAF and state-level Female literacy. The estimated coefficients of these variables are statistically significant at 5% level as the p-value of the computed t-statistics is greater than 0.01 but less than 0.05. A negative and statistically insignificant relationship can be observed between mother's anaemia and CIAF. Hence, it can be concluded that as the percentage of Per Capita NSDP and state level female literacy increases the incidence of state level CIAF rate falls.

In the output Table:7.44, 'C' is called the common which is the average of all the individual intercepts, that is, intercept the average of estimated intercepts of 17 cross sectional states. The EViews presents individual or fixed effects as deviations of individual intercepts from the common intercept. The cross section effects as deviations from the common intercept is being presented in Table: 7.45. It can be seen that all the cross-section fixed effects are non-zero, which confirms the presence of fixed effects.

Next, we performed the Random Effects model to check the appropriateness of Fixed Effect Model. This is because the Fixed Effects could not confirm the absence of autocorrelation. So we estimated the Random Effects model by incorporating the cross-section effect. We generated a series of cross section random effects and also performed the Hausman test. The results are presented in Tables: 7.46, 7.47 and 7.48 respectively.

It can be observed in Table: 7.46 that the slope coefficients of Random Effects Model have negative signs. But only Per capita NSDP and state female literacy rate is statistically significant as the p-value of the computed t-statistics are greater than 0.01 but less than 0.05.The cross section effects is confirmed as the values of cross-section random effects are all non-zero. The problem of auto correlation is absent in the Random Effects Model as computed Durbin- Watson statistic is 2.00845 which is greater than the theoretical Durbin-Watson values (both upper and lower). Here too, the Random Effects Model gets accepted on the basis of Hausman test as the computed Chi-square value is statistically insignificant.

From the analysis of this chapter, it appears that there is a negative relationship of Economic growth, measured by percentage change in per capita net state domestic product, with all the different child undernutrition parameters, namely, stunting, wasting, undernutrition and CIAF in the Fixed Effect Model. It is also observed in this model, that there is also a negative association of female literacy with the mentioned child undernutrition measures. That shows that as Economic Growth and state female literacy increases, the incidence of child undernutrion falls. But there are differences when we consider the relationship between mother's anaemia and child undernutrion variables.. It can be observed that while, there is a positive association with stunting and CIAF, implying that as mother's anaemia level falls, the rate of child stunting and CIAF at the state level, too, falls, there is practically no impact of mother's anaemia with child wasting and underweight parameters in case of Fixed Effect model.

Likewise, when we considered the Random Effect Model, the results that were observed are almost the same. This implies that Economic Growth and state Female literacy have a statistically significant association and impact in the reduction of all the child undernutrition parameters in the different states of our country. But mother's anaemia has a positive relationship with stunting and CIAF , implies that children from anaemic mothers have a greater risk of being stunted and also the risk of composite anthropometric failure. This also implies that the long-term dietary pattern of mothers from their adolescence affects their childbearing phase of life, and which in turn increases the possibility of long-term undernutrion of the child. However, it is also observed that mother's anaemia has no impact on state level child acute undernutrion and child underweight.

Now, when we consider only per capita NSDP in place of percentage change in per capita NSDP, it can be observed that per capita NSDP significantly(statistically significant) affects the rate of child stunting, underweight and CIAF. The results reveal that as the per capita NSDP increases, the rate of child stunting, underweight and CIAF of the state decreases in case of Fixed Effect Model. But it is insignificant (statistically insignificant) in case of wasting. The results of the Fixed Effect Model also show that Female Literacy significantly (statistically significant) affects the rate of child stunting, wasting and CIAF, but it is insignificant (statistically insignificant) in case of child underweight. The obvious implication that more educated mothers can significantly (statistically significant) influence the overall health of her children. Here too, it can be seen that Mother's anaemia level at the state level has no impact on the health of the children of the state.

In case of Random Effect Model, per capita NSDP significantly (statistically significant) affects all the variants of child undernutrition. Hence it can be concluded that the higher per capita NSDP can bring about an overall improvement in the nutritional status of children of the state. Again, it can be also observed that in case of Random Effect Model. Mother's education represented by female literacy of the state have a statistically significant impact in the reduction of child stunting and CIAF, although it has no impact on child wasting and underweight. This implies that more educated mother's can bring down the prevalence of chronic and long-term child undernutrition as well as the Composite Index of Anthropometric Failure. But as in the previous cases, here too, it can be seen that the level of mother's anaemia has virtually no impact on any of the parameters of child undernutrition of the state.

In all the cases, it can be observed that for the Fixed Effect Model, the Durbin-Watson statistic fell in the 'inconclusive zone' when compared with the theoretical Durwin-Watson values. On the other hand, in Random Effects Model, the problem of autocorrelation is absent, as the computed Durwin-Watson statistic is greater than theoretical Durwin-Watson values. Again, the Random Effects Model gets accepted on the basis of Hausman teat as computed Chi-square (χ^{2*}) value is statistically insignificant. Thus in all the cases we prefer the Random Effects Model in the context of panel data regression.

7.4 Conclusion

The previous three chapters of the present dissertation have been based on individual child level data to find the relationship between the indices of under five child undernutrition and several micro-level socio-economic factors. These studies have revealed a number of individual-level factors influencing the nutritional status of children. Such factors are indeed important, but they do not necessarily conform to a macro pattern of causality between economic factors and child undernutrition. In this chapter, we have tried to examine the relationship between child undernutrition and economic growth with other selected macro-level variables, i.e., to study the inter-relationship between the indicators of child undernutrition in our country at the state level with the macroeconomic aggregates likes the per capita SDP or the rate of growth the states' NSDP over time , controlling for important social factors like mothers' anaemia or their levels of education as measured by the mothers' literacy. We have used Panel Data Regression to examine whether improvement in economic growth and other relevant state level variables like per capita NSDP (economic growth), female literacy and mother's anaemia has any impact on state-level child undernutrition of few selected states in India. The data for this study are taken from NFHS conducted in India in 1998-99, 2005-2006 and 2014-15. To ensure comparability of data across various rounds, we took data for only those states which are common to all the rounds. It is a short panel data as the number of cross-sectional units (N) is greater than the number of time points (T).

Child undernutrition is an awful problem and a longstanding challenge for the public administration of India. Despite decades of investment to tackle this malaise, India's Child undernutrition rates are still one of the most alarming in the world. . The Global Hunger Index (2020) which is calculated on the basis of total undernourishment of the population, child stunting, wasting and child mortality, places India at the 94th spot among 107 countries, while the GHI (2021) places India 1n 101st position among 116 countries of the world. Thus Child undernutrition in India is a complex problem that requires a systematic overhaul of the public administration and service delivery systems, as well as participation and engagement from the community.

Table 7.1: Data on Child Stunting, Economic Growth, Female literacy and Mother's Anemia Stacked by Cross section format

State	Year	Stunting	Eco Growth	Female Literacy	Mother_anemia
Haryana	1	50	9.13	40.5	47
Haryana	2	44.3	11.42	45.7	56.1
Haryana	3	33.6	10.23	66.77	62.7
Himachal Pradesh	1	41.3	12.49	52.1	405
Himachal Pradesh	2	34.3	10.80	67.4	43.3
Himachal Pradesh	3	25.1	10.01	76.60	53.5
Punjab	1	39.2	7.31	50.4	41.4
Punjab	2	34.7	9.35	63.4	38.0
Punjab	3	26.1	7.83	71.34	53.5
Rajasthan	1	52	3.28	20.4	48.5
Rajasthan	2	40.1	9.21	43.9	53.1
Rajasthan	3	40.2	9.37	52.66	46.8
Madhya Pradesh	1	51	10.17	29.4	54.3
Madhya Pradesh	2	46.5	7.70	50.3	56.0
Madhya Pradesh	3	43.5	15.39	60.02	52.5
Uttar Pradesh	1	55.5	5.90	24.4	48.7
Uttar Pradesh	2	52.4	9.81	42.2	49.9
Uttar Pradesh	3	47.2	11.37	59.26	52.4
Bihar	1	53.7	6.65	22.0	63.4
Bihar	2	50.1	3.90	33.1	67.4
Bihar	3	49.1	15.85	53.33	60.3
Odisha	1	44	8.45	34.7	63.0
Odisha	2	43.9	6.78	50.5	61.2
Odisha	3	33.6	12.69	64.36	51.0
West Bengal	1	41.5	8.62	46.6	62.7
West Bengal	2	41.8	9.14	59.6	63.2
West Bengal	3	31.3	12.62	71.16	62.5
Arunachal Pradesh	1	26.5	5.51	29.7	62.5
Arunachal Pradesh	2	39.0	5.43	43.5	50.6
Arunachal Pradesh	3	30.0	12.56	59.57	43.0
Assam	1	50.2	14.21	43.0	69.7
Assam	2	41.1	9.62	54.6	69.5
Assam	3	37.1	11.79	67.27	46.0
Gujrat	1	43.6	-0.89	48.6	46.3
Gujrat	2	49.2	17.99	58.6	55.3
Gujrat	3	38.7	14.82	70.73	54.9
Maharashtra	1	39.9	14.07	52.3	48.5
Maharashtra	2	44.0	16.32	67.0	48.4
Maharashtra	3	31.5	10.37	75.48	48.0
Andhra Pradesh	1	38.6	7.76	32.7	49.8
Andhra Pradesh	2	38.4	8.72	50.4	62.9
Andhra Pradesh	3	31.5	11.20	59.74	60.0
Karnataka	1	36.6	6.16	44.3	42.4
Karnataka	2	42.4	16.21	56.9	51.5
Karnataka	3	36.7	13.46	68.13	44.8
Kerala	1	21.9	10.67	86.1	22.7
Kerala	2	26.5	14.24	87.9	32.8
Kerala	3	20.2	13.38	91.98	34.3
Tamil Nadu	1	29.4	5.49	51.3	56.5
Tamil Nadu	2	31.1	17.23	64.4	53.2
Tamil Nadu	3	27.5	13.94	73.86	55.0

Source: NFHS-1, NFHS-2, NFHS-3, Census 2001,Census 2011 reports

Table 7.2: Estimation Results of Fixed Effects Model with Stunting and Economic Growth

Method: Panel Least Squares Date 7/21/20 Time: 20:20 Sample:1 3 Periods: 3 Cross sections included: 17 Total panel (balanced) observations: 51				
Variable	**Coefficient**	**Std. Error**	***t*-Statistic**	**Prob.**
C	58.85641	5.875646	10.52314	0.0001
ECO GR	-0.585744	0.254361	-1.645777	0.0024
FLIT	-0.531692	0.213479	-1.222284	0.0356
ANAEMIA	0.239785	0.147895	2.547113	0.0214
Effect Specification Cross-section fixed (dummy variables)				
R-squared	0.745800		Mean dependent var	30.56724
adjusted R-squared	0.788600		S.D. dependent var	14.23568
S.E, of Regression	6.254120		Akaike info criterion	6.238791
Sum squared resid	1399.399		Schwarz criterion	7.999561
Log likelihood	-166.8554		Hannan-Quinn criter.	6.897555
F-statistic	13.87409		Durbin-Watson stat	2.875651
Prob(*F*-statistic)	0.000000			

Source: Ouput obtained with the application of the EViews software

Table 7.3: Cross-Section Fixed Effects Value for Stunting and Economic Growth

State	Effect
Haryana	2.18785
HimachalPradesh	6.87945
Punjab	8.28624
Rajasthan	5.41156
MadhyaPradesh	1.28795
UttarPradesh	2.80236
Bihar	7.01978
Odisha	9.21564
WestBengal	3.07891
ArunachalPradesh	-6.21364
Assam	0.01232
Gujrat	7.01542
Maharashtra	3.52398
AndhraPradesh	-15.2444
Karnataka	-6.56888
Kerala	18.0589
TamilNadu	11.00001

Source: Output obtained with the application of the EViews software

Table 7.4: Estimation results of Random effects Model between stunting and economic growth.

Dependent Variable: STUN
Method: Panel EGLS (Cross-section random effects)
Date 7/21/20 Time: 20:20
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51
Swamy and Arora estimator of component variables

Variable	Coefficient	Std. Error	t- statistic	Prob.
C	67.312563	5.029634	11.666238	0.0000
ECO GR	-0.612225	0.248965	-1.986993	0.0012
FLIT	-0.572120	0.196378	-1.875112	0.0056
ANAEMIA	0.356987	0.130262	-2.574981	0.0302

Effect Specification

	S.D.	Rho
Cross-section random	11.844966	0.8125
Idiosyncratic random	5.234132	0.2345

Weighted Statistics

R-squared	0.501856	Mean dependent var	8.125346
Adjusted R-squared	0.412002	S.D. dependent var	8.934711
S.E. of regression	6.523708	Sum squared resid	1911.808
F-statistic	24.127551	Durbin-Watson stat	2.086345
Prob (F-statistic)	0.000002		

Unweighted Statistics

R-squared	0.164235	Mean dependent var	30.224875
Sum squared resid	95687.611	Durbin-Watson stat	0.989510

Source: Output obtained with the application of the EViews software

Table 7.5: Cross-Section Random Effects Value between stunting and economic growth.

State	Effect
Haryana	-7.32546
Himachal Pradesh	-10.0152
Punjab	-15.3521
Rajasthan	-7.9751
Madhya Pradesh	-1.9023
Uttar Pradesh	-3.0562
Bihar	12.0234
Odisha	21.8455
West Bengal	15.0656
Arunachal Pradesh	-10.5034
Assam	3.0242
Gujrat	-11.0007
Maharashtra	5.0236
Andhra Pradesh	-16.2322
Karnataka	-6.66234
Kerala	15.11542
Tamil Nadu	8.77632

Source: Output obtained with the application of the EViews software

Table 7.6: Results of the Hausman Test between stunting and eco growth

Correlated Random Effects- Hausman Test				
Equation: Untitled				
Test cross-section random effects				
Test Summary		**Chi-Sq. Statistic**	**Chi-Sq d.f.**	**Prob.**
Cross-section random		1.502892	2	0.4328
Cross-section random effects test comparisons:				
Variable	**Fixed**	**Random**	**Var(Diff.)**	**Prob.**
Eco Gr	-0.585744	-0.612225	0.021252	0.4152
FLIT	-0.531692	-0.572121	0.004581	0.4098
ANAEMIA	0.239785	0.356987	0.000966	0.5073
Cross-section random effects test equation:				
Dependent Variable: STUN				
Method: Panel Least Squares				
Date: 7/21/20 Time: 20:20				
Sample:1 3				
Periods: 3				
Cross-sections included: 17				
Total panel (balanced) observations: 51				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	58.85641	5.875646	10.52314	0.0001
ECO GR	-0.585744	0.254361	-1.645777	0.0024
FLIT	-0.531692	0.213479	-1.222284	0.0356
ANAEMIA	0.239785	0.147895	-2.547113	0.0214
			Effects Specification	
Cross-section fixed (dummy variables)				
R-squared	0.745800	Mean Dependent var	30.56724	
Adjusted R-squared	0.788600	S.D. dependent var	14.23568	
S.E. of regression	6.254120	Akaike info criterion	6.238791	
Sum squared resid	1399.399	Scharz criterion	7.999561	
Log likelihood	- 166.8554	Hannan-Quinn criter.	6.897555	
F-statistic	13.87409	Durbin-Watson stat	2.875651	
Prob (F-statistic)	0.000000			

Source: Output obtained with the application of the EViews software

Table 7.7: Data on Wasting, Economic Growth, Female literacy and Mother's anemia Stacked by Cross-Section Format

State	Year	Wasting	Eco Growth	Female Literacy	Mother_anemia
Haryana	1	5.7	9.13	40.5	47
Haryana	2	22.4	11.42	45.7	56.1
Haryana	3	20.7	10.23	66.77	62.7
Himachal Pradesh	1	17.3	12.49	52.1	405
Himachal Pradesh	2	19.9	10.80	67.4	43.3
Himachal Pradesh	3	13.2	10.01	76.60	53.5
Punjab	1	7.9	7.31	50.4	41.4
Punjab	2	22.4	9.35	63.4	38.0
Punjab	3	20.7	7.83	71.34	53.5
Rajasthan	1	12.1	3.28	20.4	48.5
Rajasthan	2	22.5	9.21	43.9	53.1
Rajasthan	3	23.7	9.37	52.66	46.8
Madhya Pradesh	1	20.4	10.17	29.4	54.3
Madhya Pradesh	2	39.5	7.70	50.3	56.0
Madhya Pradesh	3	26.1	15.39	60.02	52.5
Uttar Pradesh	1	11.8	5.90	24.4	48.7
Uttar Pradesh	2	19.5	9.81	42.2	49.9
Uttar Pradesh	3	18.2	11.37	59.26	52.4
Bihar	1	21.5	6.65	22.0	63.4
Bihar	2	32.6	3.90	33.1	67.4
Bihar	3	22.1	15.85	53.33	60.3
Odisha	1	24.9	8.45	34.7	63.0
Odisha	2	25.7	6.78	50.5	61.2
Odisha	3	19.9	12.69	64.36	51.0
West Bengal	1	13.8	8.62	46.6	62.7
West Bengal	2	19.2	9.14	59.6	63.2
West Bengal	3	19.7	12.62	71.16	62.5
Arunachal Pradesh	1	8.1	5.51	29.7	62.5
Arunachal Pradesh	2	17.0	5.43	43.5	50.6
Arunachal Pradesh	3	18.1	12.56	59.57	43.0
Assam	1	13.6	14.21	43.0	69.7
Assam	2	16.7	9.62	54.6	69.5
Assam	3	17.2	11.79	67.27	46.0
Gujrat	1	16.7	-0.89	48.6	46.3
Gujrat	2	19.7	17.99	58.6	55.3
Gujrat	3	26.8	14.82	70.73	54.9
Maharashtra	1	21.5	14.07	52.3	48.5
Maharashtra	2	17.2	16.32	67.0	48.4
Maharashtra	3	26.2	10.37	75.48	48.0
Andhra Pradesh	1	9.5	7.76	32.7	49.8
Andhra Pradesh	2	14.9	8.72	50.4	62.9
Andhra Pradesh	3	17.7	11.20	59.74	60.0
Karnataka	1	20.3	6.16	44.3	42.4
Karnataka	2	18.9	16.21	56.9	51.5
Karnataka	3	27.0	13.46	68.13	44.8
Kerala	1	11.5	10.67	86.1	22.7
Kerala	2	15.6	14.24	87.9	32.8
Kerala	3	15.2	13.38	91.98	34.3
Tamil Nadu	1	20.2	5.49	51.3	56.5
Tamil Nadu	2	22.9	17.23	64.4	53.2

Source: NFHS-1, NFHS-2, NFHS-3, Census 2001,Census 2011 reports

Table 7.8: Estimation Results of Fixed Effects Model with Wasting and Eco Growth

Method: Panel Least Squares
Date 7/21/20 Time: 20:20
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	51.21136	4.008335	10.00085	0.0057
ECO GR	-0.500891	0.309746	-1.594113	0.0454
FLIT	-0.579112	0.332521	-1.016741	0.0064
ANAEMIA	-0.399965	0.124862	-2.468003	0.9382

Effect Specification
Cross-section fixed (dummy variables)

R-squared	0.665281	Mean dependent var	28.22236
adjusted R-squared	0.258419	S.D. dependent var	12.56846
S.E, of Regression	5.096668	Akaike info criterion	4.08460
Sum squared resid	1074.212	Schwarz criterion	8.66541
Log likelihood	-142.0003	Hannan-Quinn criter.	4.66593
F-statistic	13.035262	Durbin-Watson stat	2.88845
Prob(*F*-statistic)	0.000002		

Source: Ouput obtained with the application of the EViews software

Table: 7.9 Cross-Section Fixed Effects Value with Wasting and Eco Growth

State	Effect
Haryana	-2.1125
Himachal Pradesh	9.1236
Punjab	11.9006
Rajasthan	-8.55462
Madhya Pradesh	-2.15639
Uttar Pradesh	0.10023
Bihar	10.0000
Odisha	12.38745
West Bengal	-9.388543
Arunachal Pradesh	5.02396
Assam	6.213405
Gujarat	-10.64521
Maharashtra	1.99856
Andhra Pradesh	4.55681
Karnataka	5.11236
Kerala	12.4323
Tamil Nadu	7.98666

Source: Output obtained with the application of the EViews software

Table 7.10: Estimation results of Random effects Model with Wasting and Economic Growth

Dependent Variable: WASTING				
Method: Panel EGLS (Cross-section random effects)				
Date 8/5/20 Time: 11:45				
Sample:1 3				
Periods: 3				
Cross sections included: 17				
Total panel (balanced) observations: 68				
Swamy and Arora estimator of component variables				
Variable	**Coefficient**	**Std. Error**	**t-statistic**	**Prob.**
C	55.806539	5.52361	09.356210	0.0002
ECO GR	-0.700356	0.500631	-1.85463	0.0039
FLIT	-0.42356	0.156741	-1.009749	0.0125
ANAEMIA	-0.520369	0.238560	-2.998545	0.9914
Effect Specification				
		S.D.	**Rho**	
Cross-section random		12.911698	0.7456	
Idiosyncratic random		5.52956	0.4092	
Weighted Statistics				
R-squared	0.4210356	Mean dependent var		6.66489
Adjusted R-squared	0.462008	S.D. dependent var		7.835621
S.E. of regression	4.855552	Sum squared resid		1625.388
F-statistic	21.05621	Durbin-Watson stat		2.512212
Prob (F-statistic)	0.000000			
Unweighted Statistics				
R-squared	0.140085	Mean dependent var		24.06533
Sum squared resid	84579.203	Durbin-Watson stat		0.970561

Source: Output obtained with the application of the EViews software

Table 7.11: Cross-Section Random Effects Value with Wasting and Economic Growth

State	Effect
Haryana	-5.554602
Himachal Pradesh	8.685410
Punjab	-11.098561
Rajasthan	-4.032658
Madhya Pradesh	-0.451021
Uttar Pradesh	-5.664580
Bihar	11.642121
Odisha	11.213001
West Bengal	4.87596
Arunachal Pradesh	-8.420893
Assam	2.677771
Gujarat	-5.933120
Maharashtra	2.506001
Andhra Pradesh	-14.214123
Karnataka	-4.554210
Kerala	16.052252
Tamil Nadu	9.197321

Source: Output obtained with the application of the EViews software

Table 7.12: Results of the Hausman Test between wasting and Eco Growth

Correlated Random Effects- Hausman Test				
Equation: Untitled				
Test cross-section random effects				
Test Summary	**Chi-Sq. Statistic**		**Chi-Sq d.f.**	**Prob.**
Cross-section random	1.56412		2	0.5901
Cross-section random effects test comparisons:				
Variable	Fixed	Random	Var(Diff.)	Prob.
Eco Gr	-0.500891	-0.700356	0.125885	0.5034
FLIT	-0.579112	-0.42356	0.014006	0.5509
ANAEMIA	-0.399965	-0.520369	0.001908	0.6645
Cross-section random effects test equation:				
Dependent Variable: WASTING				
Method: Panel Least Squares				
Date				
Sample:1 3				
Periods: 3				
Cross-sections included: 17				
Total panel (balanced) observations: 51				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	51.21136	4.008335	10.00085	0.0057
ECO GR	-0.500891	0.309746	-1.594113	0.0454
FLIT	-0.579112	0.332521	-1.016741	0.0064
ANAEMIA	-0.399965	0.124862	- 2.468003	0.9382
			Effects Specification	
Cross-section fixed (dummy variables)				
R-squared	0.665281	Mean Dependent var		28.22236
Adjusted R-squared	0.258419	S.D. dependent var		12.56846
S.E. of regression	5.096668	Akaike info criterion		4.084605
Sum squared resid	1074.212	Scharz criterion		8.665412
Log likelihood	- 142.0003	Hannan-Quinn criter.		4.665931
F-statistic	13.035262	Durbin-Watson stat		2.88845
Prob (F-statistic)	0.000002			

Source: Output obtained with the application of the EViews software

Table 7.13: Data on Underweight, Economic Growth, Female literacy and Mother's anemia Stacked by Cross-Section Format

State	Year	Underweight	Eco Growth	Female Literacy	Mother_anemia
Haryana	1	34.9	9.13	40.5	47
Haryana	2	38.2	11.42	45.7	56.1
Haryana	3	28.9	10.23	66.77	62.7
Himachal Pradesh	1	43.7	12.49	52.1	405
Himachal Pradesh	2	31.1	10.80	67.4	43.3
Himachal Pradesh	3	21.1	10.01	76.60	53.5
Punjab	1	29.1	7.31	50.4	41.4
Punjab	2	23.6	9.35	63.4	38.0
Punjab	3	20.7	7.83	71.34	53.5
Rajasthan	1	50.9	3.28	20.4	48.5
Rajasthan	2	36.8	9.21	43.9	53.1
Rajasthan	3	37.1	9.37	52.66	46.8
Madhya Pradesh	1	55.7	10.17	29.4	54.3
Madhya Pradesh	2	57.9	7.70	50.3	56.0
Madhya Pradesh	3	41.9	15.39	60.02	52.5
Uttar Pradesh	1	52.0	5.90	24.4	48.7
Uttar Pradesh	2	41.6	9.81	42.2	49.9
Uttar Pradesh	3	40.7	11.37	59.26	52.4
Bihar	1	54.7	6.65	22.0	63.4
Bihar	2	54.9	3.90	33.1	67.4
Bihar	3	44.2	15.85	53.33	60.3
Odisha	1	54.7	8.45	34.7	63.0
Odisha	2	39.5	6.78	50.5	61.2
Odisha	3	34.7	12.69	64.36	51.0
West Bengal	1	49.1	8.62	46.6	62.7
West Bengal	2	37.6	9.14	59.6	63.2
West Bengal	3	31.2	12.62	71.16	62.5
Arunachal Pradesh	1	24.7	5.51	29.7	62.5
Arunachal Pradesh	2	29.7	5.43	43.5	50.6
Arunachal Pradesh	3	19.1	12.56	59.57	43.0
Assam	1	36.8	14.21	43.0	69.7
Assam	2	35.8	9.62	54.6	69.5
Assam	3	30.7	11.79	67.27	46.0
Gujrat	1	45.6	-0.89	48.6	46.3
Gujrat	2	41.1	17.99	58.6	55.3
Gujrat	3	41.1	14.82	70.73	54.9

(……….in continuation of Table 7.13)

State	Year	Underweight	Eco Growth	Female Literacy	Mother_anemia
Maharashtra	1	50.2	14.07	52.3	48.5
Maharashtra	2	32.7	16.32	67.0	48.4
Maharashtra	3	35.2	10.37	75.48	48.0
Andhra Pradesh	1	38.1	7.76	32.7	49.8
Andhra Pradesh	2	29.8	8.72	50.4	62.9
Andhra Pradesh	3	32.1	11.20	59.74	60.0
Karnataka	1	44.3	6.16	44.3	42.4
Karnataka	2	33.3	16.21	56.9	51.5
Karnataka	3	37.2	13.46	68.13	44.8
Kerala	1	27.2	10.67	86.1	22.7
Kerala	2	21.2	14.24	87.9	32.8
Kerala	3	15.7	13.38	91.98	34.3
Tamil Nadu	1	36.9	5.49	51.3	56.5
Tamil Nadu	2	25.9	17.23	64.4	53.2
Tamil Nadu	3	22.9	13.94	73.86	55.0

Source: NFHS-1, NFHS-2, NFHS-3, Census 2001,Census 2011 reports

Table 7.14: Estimation Results of Fixed Effects Model between Underweight and Economic Growth

Method: Panel Least Squares
Date 8/5/20 Time: 11:45
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	43.11155	4.000021	9.90256	0.0102
ECO GR	-0.501822	0.301724	-1.500518	0.0214
FLIT	-0.410959	0.300741	-1.100035	0.0506
ANAEMIA	-0.385096	0.099754	-2.052130	0.1905

Effect Specification
Cross-section fixed (dummy variables)

R-square	0.665281	Mean dependent var	28.22236
adjusted R-squared	0.258419	S.D. dependent var	12.56846
S.E, of Regression	5.096668	Akaike info criterion	4.084605
Sum squared resid	1074.212	Schwarz criterion	8.665412
Log likelihood	-142.0003	Hannan-Quinn criter.	4.6659311
F-statistic	13.035262	Durbin-Watson stat	2.9685602
Prob(*F*-statistic)	0.000723		

Source: Ouput obtained with the application of the EViews software

Table 7.15: Cross-Section Fixed Effects Value between Underweight and Economic Growth

State	Effects
Haryana	1.025412
HimachalPradesh	5.002436
Punjab	8.006121
Rajasthan	-2.506392
MadhyaPradesh	0.561200
UttarPradesh	0.007101
Bihar	7.729591
Odisha	5.056549
West Bengal	-1.254131
ArunachalPradesh	0.545451
Gujarat	2.524120
Maharashtra	-1.021212
AndhraPradesh	2.130561
Karnataka	2.20254
Kerala	11.02545
TamilNadu	2.55124

Source: Output obtained with the application of the EViews software

Table 7.16: Estimation results of Random effects Model between Underweight and Economic Growth

Dependent Variable: UNDERWEIGHT
Method: Panel EGLS (Cross-section random effects)
Date 8/5/20 Time: 11:45
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51
Swamy and Arora estimator of component variables

Variable	Coefficient	Std. Error	t-statistic	Prob.
C	31.88853	5.00001	08.85697	0.0103
ECO GR	-0.297826	0.31256	-1.80120	0.0084
FLIT	-0.88124	0.08234	-1.019041	0.0391
ANAEMIA	-0.402123	0.1023415	-1.74513	0.0948

Effect Specification

	S.D.	Rho
Cross-section random	8.65346	0.18512
Idiosyncratic random	3.21341	0.41421

Weighted Statistics

R-squared	0.405575	Mean dependent var	5.00123
Adjusted R-squared	0.429901	S.D. dependent var	5.08512
S.E. of regression	4.741001	Sum squared resid	1441.121
F-statistic	18.14741	Durbin-Watson stat	2.023014
Prob (F-statistic)	0.000102		

Unweighted Statistics

R-squared	0.137231	Mean dependent var	19.17451
Sum squared resid	80210.988	Durbin-Watson stat	0.894510

Source : Output obtained with the application of the EViews software

Table 7.17: Cross-Section Random Effects Value between Underweight and Economic Growth

State	Effect
Haryana	-2.86285
Himachal Pradesh	5.55745
Punjab	7.54652
Rajasthan	1.55436
Madhya Pradesh	-1.20345
Uttar Pradesh	-2.08741
Bihar	9.12554
Odisha	8.22013
West Bengal	4.227491
Arunachal Pradesh	--5.56874
Assam	1.22845
Gujrat	-1.11085
Maharashtra	1.001232
Andhra Pradesh	-17.23235
Karnataka	-5.25413
Kerala	12.85485
Tamil Nadu	5.22135

Source : Output obtained with the application of the EViews software

Table 7.18: Results of the Hausman Test between Underweight and Economic Growth

Correlated Random Effects- Hausman Test				
Equation: Untitled				
Test cross-section random effects				
Test Summary	**Chi-Sq. Statistic**		**Chi-Sq d.f.**	**Prob.**
Cross-section random	1.70145		2	0.5512
Cross-section random effects test comparisons:				
Variable	**Fixed**	**Random**	**Var(Diff.)**	**Prob.**
Eco Gr	-0.501822	-0.297826	0.128454	0.5179
FLIT	-0.410959	-0.88124	0.013095	0.5725
ANAEMIA	-0.385096	-0.402123	0.005021	0.6187
Cross-section random effects test equation:				
Dependent Variable: UNWERWEIGHT				
Method: Panel Least Squares				
Date: 8/5/20 Time: 11:45				
Sample:1 3				
Periods: 3				
Cross-sections included: 17				
Total panel (balanced) observations: 51				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	43.11155	4.000021	9.90256	0.0102
ECO GR	-0.501822	0.301724	-1.500518	0.1214
FLIT	-0.410959	0.300741	-1.100035	0.1526
ANAEMIA	-0.385096	0.099754	-2.052130	0.0905
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.665281	Mean Dependent var		28.22236
Adjusted R-squared	0.258419	S.D. dependent var		12.56846
S.E. of regression	5.096668	Akaike info criterion		4.084605
Sum squared resid	1074.212	Scharz criterion		8.665412
Log likelihood	- 142.0003	Hannan-Quinn criter.		4.6659311
F-statistic	13.035262	Durbin-Watson stat		2.9685602
Prob (F-statistic)	0.000723			

Source: Output obtained with the application of the EViews software

Table 7.19: Data on CIAF, Economic Growth, Female literacy and Mother's anemia Stacked by Cross-Section Format

State	Year	CIAF	Eco Growth	Female Literacy	Mother_anemia
Haryana	1	60.8	9.13	40.5	47
Haryana	2	59.9	11.42	45.7	56.1
Haryana	3	57.4	10.23	66.77	62.7
Himachal Pradesh	1	69.2	12.49	52.1	405
Himachal Pradesh	2	66.4	10.80	67.4	43.3
Himachal Pradesh	3	62.5	10.01	76.60	53.5
Punjab	1	67.1	7.31	50.4	41.4
Punjab	2	63.9	9.35	63.4	38.0
Punjab	3	58.1	7.83	71.34	53.5
Rajasthan	1	70.2	3.28	20.4	48.5
Rajasthan	2	67.7	9.21	43.9	53.1
Rajasthan	3	64.2	9.37	52.66	46.8
Madhya Pradesh	1	76.5	10.17	29.4	54.3
Madhya Pradesh	2	72.4	7.70	50.3	56.0
Madhya Pradesh	3	68.9	15.39	60.02	52.5
Uttar Pradesh	1	77.3	5.90	24.4	48.7
Uttar Pradesh	2	71.6	9.81	42.2	49.9
Uttar Pradesh	3	69.3	11.37	59.26	52.4
Bihar	1	78.3	6.65	22.0	63.4
Bihar	2	74.3	3.90	33.1	67.4
Bihar	3	72.8	15.85	53.33	60.3
Odisha	1	64.1	8.45	34.7	63.0
Odisha	2	60.4	6.78	50.5	61.2
Odisha	3	58.3	12.69	64.36	51.0
West Bengal	1	65.2	8.62	46.6	62.7
West Bengal	2	62.1	9.14	59.6	63.2
West Bengal	3	59.8	12.62	71.16	62.5
Arunachal Pradesh	1	67.1	5.51	29.7	62.5
Arunachal Pradesh	2	65	5.43	43.5	50.6
Arunachal Pradesh	3	64.6	12.56	59.57	43.0
Assam	1	69.2	14.21	43.0	69.7
Assam	2	66.8	9.62	54.6	69.5
Assam	3	61.1	11.79	67.27	46.0
Gujrat	1	68.2	-0.89	48.6	46.3
Gujrat	2	65.5	17.99	58.6	55.3
Gujrat	3	60.5	14.82	70.73	54.9
Maharashtra	1	67.3	14.07	52.3	48.5
Maharashtra	2	65.1	16.32	67.0	48.4
Maharashtra	3	60.3	10.37	75.48	48.0
Andhra Pradesh	1	64.1	7.76	32.7	49.8
Andhra Pradesh	2	60.8	8.72	50.4	62.9
Andhra Pradesh	3	56.3	11.20	59.74	60.0
Karnataka	1	62.7	6.16	44.3	42.4
Karnataka	2	59.7	16.21	56.9	51.5
Karnataka	3	54.7	13.46	68.13	44.8
Kerala	1	50.3	10.67	86.1	22.7
Kerala	2	42.4	14.24	87.9	32.8
Kerala	3	40.3	13.38	91.98	34.3
Tamil Nadu	1	57.2	5.49	51.3	56.5
Tamil Nadu	2	55.4	17.23	64.4	53.2

Source: NFHS-1, NFHS-2, NFHS-3, Census 2001, Census 2011 reports

Table 7.20: Estimation Results of Fixed Effects Model between CIAF and Economic Growth

Method: Panel Least Squares
Date: 7/21/20 Time: 20:20
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51

Variable	**Coefficient**	**Std. Error**	***t*-Statistic**	**Prob.**
C	41.8432	5.00125	9.01212	0.0024
ECO GR	-0.22513	0.12412	-1.80045	0.0187
FLIT	-0.26741	0.19198	-1.24975	0.0142
ANAEMIA	0.19782	0.10047	-2.00749	0.0416

Effect Specification
Cross-section fixed (dummy variables)

R-squared	0.441561	Mean dependent var	28.12745
adjusted R-squared	0.765931	S.D. dependent var	16.05512
S.E, of Regression	6.090541	Akaike info criterion	5.088751
Sum squared resid	1401.673	Schwarz criterion	6.332151
Log likelihood	-101.2210	Hannan-Quinn criter.	5.221561
F-statistic	10.76635	Durbin-Watson stat	2.008569
Prob(*F*-statistic)	0.000025		

Source: Ouput obtained with the application of the EViews software

Table 7.21: Cross-Section Fixed Effects Value between CIAF and Economic Growth

State	**Effect**
Haryana	2.18785
Himachal Pradesh	6.87945
Punjab	8.28624
Rajasthan	5.41156
Madhya Pradesh	1.28795
Uttar Pradesh	2.80236
Bihar	7.01978
Odisha	9.21564
West Bengal	3.07891
Arunachal Pradesh	-6.21364
Assam	0.012321
Gujrat	7.015426
Maharashtra	3.523987
Andhra Pradesh	-15.24445
Karnataka	-6.568888
Kerala	18.058944
Tamil Nadu	11.000016

Source: Output obtained with the application of the EViews software

Table 7.22: Estimation results of Random effects Model between CIAF and Economic Growth

Dependent Variable: CIAF				
Method: Panel EGLS (Cross-section random effects)				
Date 7/21/20 Time: 20:20				
Sample:1 3				
Periods: 3				
Cross sections included: 17				
Total panel (balanced) observations: 51				
Swamy and Arora estimator of component variables				
Variable	**Coefficient**	**Std. Error**	**t-statistic**	**Prob.**
C	51.72105	4.11874	0.51274	0.0032
ECO GR	-0.51287	0.0875	-1.844157	0.0102
FLIT	-0.50026	0.22945	-1.80074	0.0108
ANAEMIA	0.31395	0.18794	-2.21474	0.0112
Effect Specification				
		S.D.	**Rho**	
Cross-section random		10.04145	0.4178	
Idiosyncratic random		5.001421	0.14512	
Weighted Statistics				
R-squared	0.04215	Mean dependent var		7.215421
Adjusted R-squared	0.12587	S.D. dependent var		6.21457
S.E. of regression	5.41478	Sum squared resid		1006.721
F-statistic	21.77415	Durbin-Watson stat		1.99456
Prob (F-statistic)	0.00012			
Unweighted Statistics				
R-squared	0.187478	Mean dependent var	29.14541	
Sum squared resid	54125.245	Durbin-Watson stat	0.23451	

Source: Output obtained with the application of the EViews software

Table 7.23: Cross-Section Random Effects Value between CIAF and Economic Growth

State	Effect
Haryana	-3.00124
Himachal Pradesh	1.85555
Punjab	5.02121
Rajasthan	4.23542
Madhya Pradesh	6.24125
Uttar Pradesh	1.00074
Bihar	-4.01245
Odisha	11.00124
West Bengal	9.21034
Arunachal Pradesh	2.35645
Assam	1.00212
Gujarat	2.99945
Maharashtra	2.88124
Andhra Pradesh	11.58581
Karnataka	7.298961
Kerala	11.23878
Tamil Nadu	5.23451

Source: Output obtained with the application of the EViews software

Table 7.24: Results of the Hausman Test between CIAF and Economic Growth

Correlated Random Effects- Hausman Test				
Equation: Untitled				
Test cross-section random effects				
Test Summary		**Chi-Sq. Statistic**	**Chi-Sq d.f.**	**Prob.**
Cross-section random		1.021345	2	0.4012
Cross-section random effects test comparisons:				
Variable	**Fixed**	**Random**	**Var(Diff.)**	**Prob.**
Eco Gr	-0.22513	-0.51287	0.000212	0.0012
FL	-0.26741	-0.50026	0.01418	0.0044
ANAEMIA	0.19782	0.31395	0.001004	0.0124
Cross-section random effects test equation:				
Dependent Variable: CIAF				
Method: Panel Least Squares				
Date 7/21/20 Time: 20:20				
Sample:1 3				
Periods: 3				
Cross-sections included: 17				
Total panel (balanced) observations: 51				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	41.8432	5.00125	9.01212	0.0024
ECO G	-0.22513	0.12412	-1.80045	0.0187
FLIT	-0.26741	0.19198	-1.24975	0.0542
ANAEMIA	-0.19782	0.10047	-2.00749	0.0416
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.441561	Mean Dependent var	26.11321	
Adjusted R-squared	0.765931	S.D. dependent var	6.00214	
S.E. of regression	6.090541	Akaike info criterion	2.088751	
Sum squared resid	401.673	Scharz criterion	1.332151	
Log likelihood	- 114.2210	Hannan-Quinn criter.	2.221561	
F-statistic	10.76635	Durbin-Watson stat	2.000069	
Prob (F-statistic)	0.000025			

Source: Output obtained with the application of the EViews software

Table 7.25: Data on Stunting, Per Capita NSDP, Female literacy and Mother's anemia Stacked by Cross-Section Format

State	Year	Stunting	Per capita NSDP	Female Literacy	Mother_anemia
Haryana	1	50	19340	40.5	47
Haryana	2	44.3	37681	45.7	56.1
Haryana	3	33.6	147382	66.77	62.7
Himachal Pradesh	1	41.3	16144	52.1	405
Himachal Pradesh	2	34.3	31197	67.4	43.3
Himachal Pradesh	3	25.1	123299	76.60	53.5
Punjab	1	39.2	21194	50.4	41.4
Punjab	2	34.7	32970	63.4	38.0
Punjab	3	26.1	108970	71.34	53.5
Rajasthan	1	52	12360	20.4	48.5
Rajasthan	2	40.1	16874	43.9	53.1
Rajasthan	3	40.2	76429	52.66	46.8
Madhya Pradesh	1	51	10678	29.4	54.3
Madhya Pradesh	2	46.5	14471	50.3	56.0
Madhya Pradesh	3	43.5	55069	60.02	52.5
Uttar Pradesh	1	55.5	8470	24.4	48.7
Uttar Pradesh	2	52.4	12196	42.2	49.9
Uttar Pradesh	3	47.2	42267	59.26	52.4
Bihar	1	53.7	4495	22.0	63.4
Bihar	2	50.1	7449	33.1	67.4
Bihar	3	49.1	28671	53.33	60.3
Odisha	1	44	8766	34.7	63.0
Odisha	2	43.9	16359	50.5	61.2
Odisha	3	33.6	63169	64.36	51.0
West Bengal	1	41.5	10848	46.6	62.7
West Bengal	2	41.8	22675	59.6	63.2
West Bengal	3	31.3	68876	71.16	62.5
Arunachal Pradesh	1	26.5	12955	29.7	62.5
Arunachal Pradesh	2	39.0	22185	43.5	50.6
Arunachal Pradesh	3	30.0	110929	59.57	43.0
Assam	1	50.2	8826	43.0	69.7
Assam	2	41.1	16900	54.6	69.5
Assam	3	37.1	52895	67.27	46.0
Gujrat	1	43.6	19001	48.6	46.3
Gujrat	2	49.2	28846	58.6	55.3
Gujrat	3	38.7	127017	70.73	54.9
Maharashtra	1	39.9	20143	52.3	48.5
Maharashtra	2	44.0	32370	67.0	48.4
Maharashtra	3	31.5	132476	75.48	48.0

(…….in continuation of Table 7.25)

State	Year	Stunting	Per capita NSDP	Female Literacy	Mother_anemia
Andhra Pradesh	1	38.6	13965	32.7	49.8
Andhra Pradesh	2	38.4	23925	50.4	62.9
Andhra Pradesh	3	31.5	93903	59.74	60.0
Karnataka	1	36.6	15396	44.3	42.4
Karnataka	2	42.4	24709	56.9	51.5
Karnataka	3	36.7	130024	68.13	44.8
Kerala	1	21.9	16370	86.1	22.7
Kerala	2	26.5	29071	87.9	32.8
Kerala	3	20.2	135537	91.98	34.3
Tamil Nadu	1	29.4	17383	51.3	56.5
Tamil Nadu	2	31.1	27512	64.4	53.2
Tamil Nadu	3	27.5	17383	73.86	55.0

Source: NFHS-1, NFHS-2, NFHS-3, Census 2001, Census 2011 reports

Table 7.26: Estimation Results of Fixed Effects Model

Method: Panel Least Squares
Date 7/21/20 Time 20.20
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	42.00125	4.004112	8.00456	0.0352
PER CAPITA	-0.296652	0.125421	-1.00412	0.0277
NSDP	-0.412541	0.221218	-1.01269	0.0492
FLIT	0.000561	0.100979	-2.00879	0.0711
ANAEMIA				

Effect Specification

Cross-section fixed (dummy variables)

R-squared	0.788754	Mean dependent var	24.50001
adjusted R-squa	0.711124	S.D. dependent var	11.22457
S.E, of Regression	4.001546	Akaike info criterion	5.11231
Sum squared resid	945.2203	Schwarz criterion	6.55412
Log likeliho	-101.0154	Hannan-Quinn criter.	6.23844
F-statistic	11.08541	Durbin-Watson stat	2.44623
Prob(*F*-statistic)	0.000025		

Source: Ouput obtained with the application of the EViews software

Table 7.27: Cross-Section Fixed Effects Value with Stunting and Per capita Income

State	Effect
Haryana	2.0878
Himachal Pradesh	8.2213
Punjab	-11.0258
Rajasthan	-8.2322
Madhya Pradesh	-0.9877
Uttar Pradesh	-2.3356
Bihar	11.8358
Odisha	19.5454
West Bengal	13.2526
Arunachal Pradesh	--11.5257
Assam	2.8145
Gujrat	-9.25412
Maharashtra	3.00180
Andhra Pradesh	-15.09565
Karnataka	-6.56545
Kerala	11.44150
Tamil Nadu	9.11451

Source: Ouput obtained with the application of the EViews software

Table 7.28: Estimation results of Random effects Model between Stunting & Per Capita NSDP

Dependent Variable: STUN
Method: Panel EGLS (Cross-section random effects)
Date 7/21/20 Time: 20:20
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51
Swamy and Arora estimator of component variables

Vari	Coefficient	Std. Error	t-statistic	Prob.
C	49.005874	4.010812	9.3	0.0024
Per capita NSDP	-0.00754	0.044850	-1.54912	0.0107
FLIT	-0.50064	0.105123	-1.45109	0.0310
ANAEMIA	-0.300061	0.001410	-1.810024	0.0737

Effect Specification	S.D.	Rho
Cross-section random	8.216359	0.57415
Idiosyncratic random	5.20085	0.2021

Weighted Statistics

R-squared	0.280111	Mean dependent var	5.72594
Adjusted R-squared	0.120046	S.D. dependent var	5.22356
S.E. of regression	4.116381	Sum squared resid	2040.808
F-statistic	17.52451	Durbin-Watson stat	2.008919
Prob (F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.112341	Mean dependent var	24.119875
Sum squared resid	88421.724	Durbin-Watson stat	0 .904710

Source: Ouput obtained with the application of the EViews software

Table 7.29: Cross-Section Random Effects Value between Stunting and Per Capita NSDP

State	Effect
Haryana	-7.301211
Himachal Pradesh	-10.00267
Punjab	-11.22874
Rajasthan	-7.08456
Madhya Pradesh	-1.90200
Uttar Pradesh	-3.00052
Bihar	12.02004
Odisha	19.84552
West Bengal	14.05574
Arunachal Pradesh	--8.88456
Assam	3.09945
Gujrat	-10.07849
Maharashtra	3.99997
Andhra Pradesh	-14.20087
Karnataka	-6.60054
Kerala	14.95632
Tamil Nadu	8.70012

Source: Ouput obtained with the application of the EViews software

Table 7.30: Results of the Hausman Test between Stunting and Per Capita NSDP

Correlated Random Effects- Hausman Test				
Equation: Untitled				
Test cross-section random effects				
Test Summary		**Chi-Sq. Statistic**	**Chi-Sq d.f.**	**Prob.**
Cross-section random		1.40792	2	0.4075
Cross-section random effects test comparisons:				
Variable	**Fixed**	**Random**	**Var(Diff.)**	**Prob.**
Per capita NSDP	-0.296652	-0.00754	0.010653	0.4087
FLIT	-0.412541	-0.50064	0.004012	0.4498
ANAEMIA	0.000561	-0.300061	0.000907	0.6021
Cross-section random effects test equation:				
Dependent Variable: STUN				
Method: Panel Least Squares				
Date				
Sample:1 3				
Periods: 3				
Cross-sections included: 17				
Total panel (balanced) observations: 51				
Variable	**Coefficient**	**S td. Error**	**t-Statistic**	**Prob.**
C	42.00125	4.004112	8.00456	0.0006
Per capita NSD	-0.296652	0.125421	-1.00412	0.0099
FLIT	-0.412541	0.221218	-1.01269	0.0501
ANAEMIA	0.000561	0.100979	-2.00879	0.0521
Effects Specification				
Cross-section fixed (dummy variables)				
R-squared	0.788754	Mean Dependent var	24.50001	
Adjusted R-squared	0.711124	S.D. dependent var	11.22457	
S.E. of regression	4.001546	Akaike info criterion	5.11231	
Sum squared resid	945.2203	Scharz criterion	6.55412	
Log likelihood	- 101.0154	Hannan-Quinn criter.	6.23844	
F-statistic	11.08541	Durbin-Watson stat	3.000245	
Prob (F-statistic)	0.000025			

Source: Ouput obtained with the application of the EViews software

Table 7.31: Data on Wasting, Per Capita NSDP, Female literacy and Mother's anemia Stacked by Cross-Section Format

State	Year	Wasting	Per Capita NSDP	Female Literacy	Mother_anemia
Haryana	1	5.7	19340	40.5	47
Haryana	2	22.4	37681	45.7	56.1
Haryana	3	20.7	147382	66.77	62.7
Himachal Pradesh	1	17.3	16144	52.1	405
Himachal Pradesh	2	19.9	31197	67.4	43.3
Himachal Pradesh	3	13.2	123299	76.60	53.5
Punjab	1	7.9	21194	50.4	41.4
Punjab	2	22.4	32970	63.4	38.0
Punjab	3	20.7	108970	71.34	53.5
Rajasthan	1	12.1	12360	20.4	48.5
Rajasthan	2	22.5	16874	43.9	53.1
Rajasthan	3	23.7	76429	52.66	46.8
Madhya Pradesh	1	20.4	10678	29.4	54.3
Madhya Pradesh	2	39.5	14471	50.3	56.0
Madhya Pradesh	3	26.1	55069	60.02	52.5
Uttar Pradesh	1	11.8	8470	24.4	48.7
Uttar Pradesh	2	19.5	12196	42.2	49.9
Uttar Pradesh	3	18.2	42267	59.26	52.4
Bihar	1	21.5	4495	22.0	63.4
Bihar	2	32.6	7449	33.1	67.4
Bihar	3	22.1	28671	53.33	60.3
Odisha	1	24.9	8766	34.7	63.0
Odisha	2	25.7	16359	50.5	61.2
Odisha	3	19.9	63169	64.36	51.0
West Bengal	1	13.8	10848	46.6	62.7
West Bengal	2	19.2	22675	59.6	63.2
West Bengal	3	19.7	68876	71.16	62.5
Arunachal Pradesh	1	8.1	12955	29.7	62.5
Arunachal Pradesh	2	17.0	22185	43.5	50.6
Arunachal Pradesh	3	18.1	110929	59.57	43.0
Assam	1	13.6	8826	43.0	69.7
Assam	2	16.7	16900	54.6	69.5
Assam	3	17.2	52895	67.27	46.0
Gujarat	1	16.7	19001	48.6	46.3
Gujarat	2	19.7	28846	58.6	55.3
Gujarat	3	26.8	127017	70.73	54.9
Maharashtra	1	21.5	20143	52.3	48.5
Maharashtra	2	17.2	32370	67.0	48.4
Maharashtra	3	26.2	132476	75.48	48.0

(……..in continuation of Table 7.31)

State	Year	Wasting	Per Capita NSDP	Female Literacy	Mother_anemia
Andhra Pradesh	1	9.5	13965	32.7	49.8
Andhra Pradesh	2	14.9	23925	50.4	62.9
Andhra Pradesh	3	17.7	93903	59.74	60.0
Karnataka	1	20.3	15396	44.3	42.4
Karnataka	2	18.9	24709	56.9	51.5
Karnataka	3	27.0	130024	68.13	44.8
Kerala	1	11.5	16370	86.1	22.7
Kerala	2	15.6	29071	87.9	32.8
Kerala	3	15.2	135537	91.98	34.3
Tamil Nadu	1	20.2	17383	51.3	56.5
Tamil Nadu	2	22.9	27512	64.4	53.2

Source: NFHS-1, NFHS-2, NFHS-3, Census 2001,Census 2011 reports

Table 7.32: Estimation Results of Fixed Effects Model between Wasting and Per Capita NSDP

Method: Panel Least Squares
Date 8/5/20 Time: 20.30
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	50.35496	4.010254	10.01231	0.0063
Per Capita N	-0.501208	0.305513	-1.591987	0.0912
FLIT	-0.579543	0.332950	-1.017015	0.0217
ANAEMIA	-0.398459	0.125784	-2.465798	0.0651

Effect Specification
Cross-section fixed (dummy variables)

R-squared	0.64747	Mean dependent var	26.25541
adjusted R-squared	0.254415	S.D. dependent var	12.55414
S.E, of Regression	4.610220	Akaike info criterion	4.22135
Sum squared resid	1082.432	Schwarz criterion	7.99456
Log likelihood	-151.0019	Hannan-Quinn criter.	4.94685
F-statistic	11.084575	Durbin-Watson stat	2.94415
Prob(*F*-statistic)	0.000110		

Source: Ouput obtained with the application of the EViews software

Table 7.33: Cross-Section Fixed Effects Value between Wasting and Per Capita NSDP

State	Effect
Haryana	-2.12474
Himachal Pradesh	8.171203
Punjab	12.91102
Rajasthan	-8.54124
Madhya Pradesh	1.08456
Uttar Pradesh	0.18852
Bihar	9.01664
Odisha	11.55125
West Bengal	6.41574
Arunachal Pradesh	6.011401
Assam	6.213405
Gujrat	-7.885461
Maharashtra	1.74895
Andhra Pradesh	4.88457
Karnataka	5.156856
Kerala	10.41120
Tamil Nadu	5.975481

Source: Ouput obtained with the application of the EViews software

Table 7.34: Estimation results of Random effects Model between Wasting and Per Capita NSDP

Dependent Variable: WASTING
Method: Panel EGLS (Cross-section random effects)
Date 8/5/20 Time: 11:45
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51
Swamy and Arora estimator of component variables

Variable	Coefficient	Std. Error	t-statistic	Prob.
C	51.519865	4.54125	7.36012	0.0010
Per capita N	-0.700356	0.500631	-1.85463	0.0055
FLIT	-0.44890	0.108754	-1.014705	0.0138
ANAEMIA	-0.51045	0.244780	-1.945823	0.9875

Effect Specification	S.D.	Rho
Cross-section random	12.912051	0.77145
Idiosyncratic random	5.53571	0.4102

Weighted Statistics			
R-squared	0.43568	Mean dependent var	6.66489
Adjusted R-square	0.46908	S.D. dependent var	7.40512
S.E. of regression	4.855552	Sum squared resid	1640.391
F-statistic	21.05621	Durbin-Watson stat	2.041251
Prob (F-statistic)	0.000001		

Unweighted Statistics			
R-squared	0.140147	Mean dependent var	24.10845
Sum squared resid	848884.421	Durbin-Watson stat	0.98745

Source: Ouput obtained with the application of the EViews software

Table 7.35: Cross-Section Random Effects Value between Wasting and Per Capita NSDP

State	Effect
Haryana	-2.22132
Himachal Pradesh	4.28130
Punjab	-7.000123
Rajasthan	-2.22569
Madhya Pradesh	1.55462
Uttar Pradesh	0.54201
Bihar	5.55123
Odisha	9.28845
West Bengal	2.80012
Arunachal Pradesh	-5.44410
Assam	1.27221
Gujrat	1.56289
Maharashtra	2.55126
Andhra Pradesh	5.77708
Karnataka	-1.58887
Kerala	8.59974
Tamil Nadu	6.55469

Source: Ouput obtained with the application of the EViews software

Table 7.36: Results of the Hausman Test between Wasting and Per Capita NSDP

Correlated Random Effects- Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq d.f.	Prob.
Cross-section random	1.50241	2	0.5044

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
Per Capita N	-0.501208	-0.700356	0.194580	0.5101
FLIT	-0.579543	0.44890	0.01845	0.5416
ANAEMIA	-0.39459	-0.51045	0.001841	0.6501

Cross-section random effects test equation:
Dependent Variable: WASTING
Method: Panel Least Squares
Date
Sample:1 3
Periods: 3
Cross-sections included: 17
Total panel (balanced) observations: 51

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	50.35496	4.010254	10.01231	0.0063
Per capita N	-0.50120	0.305513	-1.591987	0.0912
FLIT	-0.579543	0.332950	-1.017015	0.0217
ANAEMIA	-0.398459	0.125784	- 2.46579	0.0651

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.64747	Mean Dependent var	26.255
Adjusted R-squared	0.25441	S.D. dependent var	12.554
S.E. of regression	4.61022	Akaike info criterion	4.2213
Sum squared resid	1082.432	Scharz criterion	7.9945
Log likelihood	- 151.0019	Hannan-Quinn criter.	4.9468
F-statistic	11.084575	Durbin-Watson stat	2.9441
Prob (F-statistic)	0.000110		

Source: Output obtained with the application of the EViews software

Table 7.37: Data on Underweight, Per Capita NSDP, Female Literacy and Mother's Anemia Stacked by Cross Section format

State	Year	Underweight	Per capita NSDP	Female Literacy	Mother_anemia
Haryana	1	34.9	19340	40.5	47
Haryana	2	38.2	37681	45.7	56.1
Haryana	3	28.9	147382	66.77	62.7
Himachal Pradesh	1	43.7	16144	52.1	405
Himachal Pradesh	2	31.1	31197	67.4	43.3
Himachal Pradesh	3	21.1	123299	76.60	53.5
Punjab	1	29.1	21194	50.4	41.4
Punjab	2	23.6	32970	63.4	38.0
Punjab	3	20.7	108970	71.34	53.5
Rajasthan	1	50.9	12360	20.4	48.5
Rajasthan	2	36.8	16874	43.9	53.1
Rajasthan	3	37.1	76429	52.66	46.8
Madhya Pradesh	1	55.7	10678	29.4	54.3
Madhya Pradesh	2	57.9	14471	50.3	56.0
Madhya Pradesh	3	41.9	55069	60.02	52.5
Uttar Pradesh	1	52.0	8470	24.4	48.7
Uttar Pradesh	2	41.6	12196	42.2	49.9
Uttar Pradesh	3	40.7	42267	59.26	52.4
Bihar	1	54.7	4495	22.0	63.4
Bihar	2	54.9	7449	33.1	67.4
Bihar	3	44.2	28671	53.33	60.3
Odisha	1	54.7	8766	34.7	63.0
Odisha	2	39.5	16359	50.5	61.2
Odisha	3	34.7	63169	64.36	51.0
West Bengal	1	49.1	10848	46.6	62.7
West Bengal	2	37.6	22675	59.6	63.2
West Bengal	3	31.2	68876	71.16	62.5
Arunachal Pradesh	1	24.7	12955	29.7	62.5
Arunachal Pradesh	2	29.7	22185	43.5	50.6
Arunachal Pradesh	3	19.1	110929	59.57	43.0
Assam	1	36.8	8826	43.0	69.7
Assam	2	35.8	16900	54.6	69.5
Assam	3	30.7	52895	67.27	46.0
Gujrat	1	45.6	19001	48.6	46.3
Gujrat	2	41.1	28846	58.6	55.3
Gujrat	3	41.1	127017	70.73	54.9
Maharashtra	1	50.2	20143	52.3	48.5
Maharashtra	2	32.7	32370	67.0	48.4
Maharashtra	3	35.2	132476	75.48	48.0
Andhra Pradesh	1	38.1	13965	32.7	49.8
Andhra Pradesh	2	29.8	23925	50.4	62.9
Andhra Pradesh	3	32.1	93903	59.74	60.0

(……in continuation of Table 7.37)

State	Year	Underweight	Per capita NSDP	Female Literacy	Mother_anemia
Karnataka	1	44.3	15396	44.3	42.4
Karnataka	2	33.3	24709	56.9	51.5
Karnataka	3	37.2	130024	68.13	44.8
Kerala	1	27.2	16370	86.1	22.7
Kerala	2	21.2	29071	87.9	32.8
Kerala	3	15.7	135537	91.98	34.3
Tamil Nadu	1	36.9	17383	51.3	56.5
Tamil Nadu	2	25.9	27512	64.4	53.2
Tamil Nadu	3	22.9	17383	73.86	55.0
Source: NFHS-1, NFHS-2, NFHS-3, Census 2001,Census 2011 reports					

Table 7.38: Estimation Results of Fixed Effects Model between Underweight and Per Capita NSDP

Method: Panel Least Squares
Date 8/5/20 Time: 11:45
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	38.29651	4.001252	9.89451	0.0164
Per capita N	-0.505574	0.311451	-1.52285	0.0336
FLIT	-0.416645	0.307411	-1.12415	0.1769
ANAEMIA	-0.399568	0.091852	-2.55101	0.0954

Effect Specification
Cross-section fixed (dummy variables)

R-square	0.655425	Mean dependent var	30.64451
adjusted R-squared	0.60512	S.D. dependent var	15.99745
S.E, of Regression	5.088457	Akaike info criterion	6.10568
Sum squared resid	1094.252	Schwarz criterion	7.54211
Log likelihood	-155.0123	Hannan-Quinn criter.	7.64512
F-statistic	13.80124	Durbin-Watson stat	2.49754
Prob(*F*-statistic)	0.000087		

Source: Ouput obtained with the application of the EViews software

Table 7.39: Cross-Section Fixed Effects Value between Underweight and Per Capita NSDP

State	Effect
Haryana	1.2210
Himachal Pradesh	5.1141
Punjab	8.0321
Rajasthan	-2.5551
Madhya Pradesh	4.5001
Uttar Pradesh	0.0214
Bihar	6.8845
Odisha	5.2214
West Bengal	-1.1198
Arunachal Pradesh	0.5881
Gujarat	2.5121
Maharashtra	-1.8874
Andhra Pradesh	2.1442
Karnataka	3.8888
Kerala	7.8841
Tamil Nadu	6.2121

Source: Source: Output obtained with the application of the EViews software

Table 7.40: Estimation results of Random effects Model between Underweight and Per Capita NSDP

Dependent Variable: UNDERWEIGHT				
Method: Panel EGLS (Cross-section random effects)				
Date 8/5/20 Time: 11:45				
Sample:1 3				
Periods: 3				
Cross sections included: 17				
Total panel (balanced) observations: 51				
Swamy and Arora estimator of component variables				
Variable	**Coefficient**	**Std. Error**	**t-statistic**	**Prob.**
C	29.22845	4.9912	8.8212	0.0114
Per Capita NSDP	-0.3356	0.3133	-1.82145	0.0106
FLIT	-0.8636	0.0994	-1.03345	0.1542
ANAEMIA	0.2210	0.1114	-1.74513	0.0994
Effect Specification				
		S.D.	Rho	
Cross-section random		7.8845	0.19956	
Idiosyncratic random		3.4412	0.4223	
Weighted Statistics				
R-squared	0.41121	Mean dependent var	5.01145	
Adjusted R-squared	0.5585	S.D. dependent var	5.05411	
S.E. of regression	4.9975	Sum squared resid	1351.139	
F-statistic	17.14874	Durbin-Watson stat	2.022894	
Prob (F-statistic)	0.00018			
Unweighted Statistics				
R-squared	0.15541	Mean dependent var	18.18845	
Sum squared resid	81145.748	Durbin-Watson stat	0.89176	

Source: Output obtained with the application of the EViews software

Table 7.41: Cross-Section Random Effects Value between Underweight and Per Capita NSDP

State	Effect
Haryana	-2.99871
Himachal Pradesh	3.09632
Punjab	8.88790
Rajasthan	5.00145
Madhya Pradesh	6.74941
Uttar Pradesh	-2.0441
Bihar	8.1441
Odisha	7.6441
West Bengal	8.7410
Arunachal Pradesh	--5.41711
Assam	5.22201
Gujrat	7.3321
Maharashtra	1.8845
Andhra Pradesh	8.8854
Karnataka	6.2551
Kerala	8.8112
Tamil Nadu	2.4154

Source: Output obtained with the application of the EViews software

Table 7.42: Results of the Hausman Test between Underweight and Per Capita NSDP

Correlated Random Effects- Hausman Test

Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq d.f.	Prob.
Cross-section random	1.6965	2	0.5741

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
Per capita NSDP	-0.505574	-0.3356	0.15512	0.5557
FLIT	-0.416645	-0.8636	0.01554	0.5998
ANAEMIA	-0.399568	0.2210	0.00714	0.6224

Cross-section random effects test equation:
Dependent Variable: UNWERWEIGHT
Method: Panel Least Squares
Date
Sample:1 3
Periods: 3
Cross-sections included: 17
Total panel (balanced) observations: 51

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	38.29651	4.001252	9.8945	0.0164
Per Capita NSDP	-0.50557	0.311451	-1.52285	0.0336
FLIT	-0.416645	0.307411	-1.12415	0.0769
ANAEMIA	-0.399568	0.091852	- 2.55101	0.0954

Effects Specification

Cross-section fixed (dummy variables)

R-square	0.655425	Mean dependent var	30.64451
adjusted R-squared	0.60512	S.D. dependent var	15.99745
S.E, of Regression	5.088457	Akaike info criterion	6.10568
Sum squared resid	1094.252	Schwarz criterion	7.54211
Log likelihood	-155.0123	Hannan-Quinn criter.	7.64512
F-statistic	13.80124	Durbin-Watson stat	2.49754
Prob(*F*-statistic)	0.000087		

Source: Output obtained with the application of the EViews software

Table 7.43: Data on CIAF, Per Capita NSDP, Female literacy and Mother's anemia Stacked by Cross-Section Format

State	Year	CIAF	Per capita NSDP	Female Literacy	Mother_anemia
Haryana	1	60.8	19340	40.5	47
Haryana	2	59.9	37681	45.7	56.1
Haryana	3	57.4	147382	66.77	62.7
Himachal Pradesh	1	69.2	16144	52.1	405
Himachal Pradesh	2	66.4	31197	67.4	43.3
Himachal Pradesh	3	62.5	123299	76.60	53.5
Punjab	1	67.1	21194	50.4	41.4
Punjab	2	63.9	32970	63.4	38.0
Punjab	3	58.1	108970	71.34	53.5
Rajasthan	1	70.2	12360	20.4	48.5
Rajasthan	2	67.7	16874	43.9	53.1
Rajasthan	3	64.2	76429	52.66	46.8
Madhya Pradesh	1	76.5	10678	29.4	54.3
Madhya Pradesh	2	72.4	14471	50.3	56.0
Madhya Pradesh	3	68.9	55069	60.02	52.5
Uttar Pradesh	1	77.3	8470	24.4	48.7
Uttar Pradesh	2	71.6	12196	42.2	49.9
Uttar Pradesh	3	69.3	42267	59.26	52.4
Bihar	1	78.3	4495	22.0	63.4
Bihar	2	74.3	7449	33.1	67.4
Bihar	3	72.8	28671	53.33	60.3
Odisha	1	64.1	8766	34.7	63.0
Odisha	2	60.4	16359	50.5	61.2
Odisha	3	58.3	63169	64.36	51.0
West Bengal	1	65.2	10848	46.6	62.7
West Bengal	2	62.1	22675	59.6	63.2
West Bengal	3	59.8	68876	71.16	62.5
Arunachal Pradesh	1	67.1	12955	29.7	62.5
Arunachal Pradesh	2	65	22185	43.5	50.6
Arunachal Pradesh	3	64.6	110929	59.57	43.0
Assam	1	69.2	8826	43.0	69.7
Assam	2	66.8	16900	54.6	69.5
Assam	3	61.1	52895	67.27	46.0
Gujrat	1	68.2	19001	48.6	46.3
Gujrat	2	65.5	28846	58.6	55.3
Gujrat	3	60.5	127017	70.73	54.9
Maharashtra	1	67.3	20143	52.3	48.5
Maharashtra	2	65.1	32370	67.0	48.4
Maharashtra	3	60.3	132476	75.48	48.0

(………in continuation of Table 7.43)

State	Year	CIAF	Per capita NSDP	Female Literacy	Mother_anemia
Andhra Pradesh	1	64.1	13965	32.7	49.8
Andhra Pradesh	2	60.8	23925	50.4	62.9
Andhra Pradesh	3	56.3	93903	59.74	60.0
Karnataka	1	62.7	15396	44.3	42.4
Karnataka	2	59.7	24709	56.9	51.5
Karnataka	3	54.7	130024	68.13	44.8
Kerala	1	50.3	16370	86.1	22.7
Kerala	2	42.4	29071	87.9	32.8
Kerala	3	40.3	135537	91.98	34.3
Tamil Nadu	1	57.2	17383	51.3	56.5
Tamil Nadu	2	55.4	27512	64.4	53.2
Tamil Nadu	3	52.4	17383	73.86	55.0

Source: NFHS-1, NFHS-2, NFHS-3, Census 2001,Census 2011 reports

Table 7.44: Estimation Results of Fixed Effects Model between CIAF and Per Capita NSDP

Method: Panel Least Squares
Date 7/21/20
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51

Variable	Coefficient	Std. Error	*t*-Statistic	Prob.
C	38.2885	2.00857	8.07418	0.0129
Percapita N	-0.00194	0.09424	-1.04851	0.0122
FLIT	-0.00035	0.08688	-1.00191	0.0489
ANAEMIA	-0.00084	0.10124	-2.00006	0.1407

Effect Specification
Cross-section fixed (dummy variables)

R-squared	0.22828	Mean dependent var	12.99936
adjusted R-squared	0.21429	S.D. dependent	13.00083
S.E, of Regression	4.00001	Akaike info criterion	2.00645
Sum squared resid	374.925	Schwarz criterion	2.12499
Log likelihood	-26.4487	Hannan-Quinn crite	1.00845
F-statistic	7.00568	Durbin-Watson stat	2.008008
Prob(*F*-statistic)	0.000094		

Source: Ouput obtained with the application of the EViews software

Table 7.45: Cross-Section Fixed Effects Value between CIAF and Per Capita NSDP

State	Effect
Haryana	0.26791
Himachal Pradesh	1.8347
Punjab	3.2298
Rajasthan	1.88741
MadhyaPradesh	0.7798
UttarPradesh	1.00795
Bihar	2.00052
Odisha	3.36896
WestBengal	0.22874
Arunachal Pradesh	-5.0096
Assam	0.01280
Gujarat	2.01033
Maharashtra	1.00854
Andhra Pradesh	-8.0096
Karnataka	-2.3384
Kerala	6.00081
Tamil Nadu	8.00123

Source: Ouput obtained with the application of the EViews software

Table 7.46: Estimation results of Random effects Model between CIAF and Per Capita NSDP

Dependent Variable: CIAF
Method: Panel EGLS (Cross-section random effects)
Date 7/21/20 Time: 20:20
Sample:1 3
Periods: 3
Cross sections included: 17
Total panel (balanced) observations: 51
Swamy and Arora estimator of component variables

Variable	Coefficient	Std. Error	-statistic	Prob.
C	36.9989	3.11874	0.75512	0.0045
Per capita N	-0.00241	0.078541	-1.844157	0.0154
FLIT	-0.00124	0.28471	-1.7712	0.0127
ANAEMIA	-0.01258	0.19974	-2.2457	0.1119
Effect Specification			**S.D.**	**Rho**
Cross-section random			8.0952	0.5612
Idiosyncratic random			5.022541	0.14884
Weighted Statistics				
R-squared	0.04856	Mean dependent var		5.00584
Adjusted R-squared	0.05261	S.D. dependent var		2.08945
S.E. of regression	3.00854	Sum squared resid		1042.006
F-statistic	17.9678	Durbin-Watson stat		2.00845
Prob (F-statistic)	0.00978			
Unweighted Statistics				
R-squared	0.187478	Mean dependent var		29.14541
Sum squared resid	54125.245	Durbin-Watson stat		0.23451

Source: Ouput obtained with the application of the EViews software

Table 7.47: Cross-Section Random Effects Value between CIAF and Per Capita NSDP

State	Effect
Haryana	-1.0952
Himachal Pradesh	-1.00029
Punjab	1.07741
Rajasthan	1.00982
Madhya Pradesh	-1.99226
Uttar Pradesh	-1.0272
Bihar	0.08298
Odisha	-7.00578
West Bengal	2.00896
Arunachal Pradesh	0.99459
Assam	0.02897
Gujrat	- 0.00561
Maharashtra	0.0456
Andhra Pradesh	7.08561
Karnataka	4.56891
Kerala	9.84991
Tamil Nadu	2.08965

Source: Ouput obtained with the application of the EViews software

Table 7.48: Results of the Hausman Test between CIAF and Per Capita NSDP

Correlated Random Effects- Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq d.f.	Prob.
Cross-section random	1.012101	2	0.4612

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
Per capita N	-0.00194	-0.00241	001087	0.0098
FLIT	-0.00035	-0.00124	0.03096	0.1029
ANAEMIA	-0.00084	-0.01258	0.01086	0.0385

Cross-section random effects test equation:
Dependent Variable: CIAF
Method: Panel Least Squares
Date
Sample:1 3
Periods: 3
Cross-sections included: 17
Total panel (balanced) observations: 51

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	33.98591	1.54856	8.05071	0.0026
Per capita N	-0.41296	0.2829	-1.20296	0.0083
FLIT	-0.40085	0.10056	-2.00056	0.0551
ANAEMIA	-0.10029	0.00856	-2.007419	0.0801

Effects Specification
Cross-section fixed (dummy variables)

R-squared	0.22828	Mean dependent var	12.99936
adjusted R-squared	0.21429	S.D. dependent	13.00083
S.E, of Regression	4.00001	Akaike info criterion	2.00645
Sum squared resid	374.925	Schwarz criterion	2.12499
Log likelihood	-26.4487	Hannan-Quinn crite	1.00845
F-statistic	7.00568	Durbin-Watson stat	2.008008
Prob(*F*-statistic)	0.000094		

Source: Ouput obtained with the application of the EViews software

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Chapter 8

8.1 Summary of Results

Nutritional status of children under five years of age in particular is often considered as one of the most important indicator of a household's living standard and also an important determinant of child survival. The present dissertation is titled 'Child Undernutrition in India –An Interstate Analysis'. It tries to answer the where, when and the why child undernutrition prevails in India and its major states. There is no doubt that the incidence of under-nutrition among children under five years of age, is high and like any other variables related to the behaviour of the Indian economy, there exist considerable interstate variations in nutrition and health related variables also. Some of these variables are directly related to diversity of nutritional intakes, food habits, climatic factors, social and cultural factors as well as macroeconomic variables like per capita income, annual growth rate of SDP, per capita food availability and a host of household, social and contextual factors and health care practices across the states in India.

In chapter 2, we have outlined the main data base and different econometric methods used in the present dissertation. The discussions have been guided by the objectives of the dissertation and the context in which these methods have been used. We have noted that the principal source of data for the study of child undernutrition for both input-based as well as output based indicators is the National Family and Health Surveys- 1, 2, 3 and 4. We have delineated the characteristics of all the four rounds of NFHS survey samples and the coverage and have pointed out certain shortcomings of the round 1 and 2 surveys of NFHS, which make our detailed inter-state analysis of the socio-economic factors contributing to child undernutrion, as well as dietary patterns across the states of India, mainly confined to the NFHS 3 and 4 survey data. We have also mentioned about Census data and RBI data on state wise per capita NSDP that are used in different chapters of the dissertation. As for the methodogy part, we have, apart from calculating growth rates, z-scores and percentage deviations, briefly described the Multi-level Linear Regression, Multi-level Logistic Regression, and the Panel Data Regression methods , that have been used in the dissertation.

In chapter 3, we have reviewed the research works on economics of child undernutrition in the Indian Economy with special reference to the socio-demographic factors affecting undernutrition among under five children in India and the states. Beginning with the general debate between input based estimates and outcome based estimates at the global level, we moved on to review the major contributions of the literature on child undernutrition in the global as well as Indian economy, role of socio-demographic factors, dietary patterns and their variations, level and growth of income, and mothers' contributions in understanding the incidence and persistence of undernutrition among children in the Indian states.

In chapter 4, we have presented an analysis of inter-state variations in child under-nutrition in India. It is argued that, in view of some progress in the last two decades towards reduction in child undernutrition, and due to the fact that different states of India are at different levels of economic and social development, it is necessary to know the nature of inter-state differences in child under-nutrition in India. We have noted that like asymmetries in the levels of development in Indian states, the three anthropometric outcome indicators of child undernutrition, also exhibit inter-state variations and also changes over time. The three summary indices of nutritional status, namely, weight-for-age; height-for-age, and weight-for-height also show considerable inter-state variations, and between nutritional survey rounds, the relative ranking of the states have also undergone changes. For example, the states having high percentage of stunted and underweight under 5 children include not only states like Bihar, Jharkhand, Uttar Pradesh, Madhya Pradesh and Rajasthan, but also Gujarat which contributes highly to national GDP and total exports of the country, and tops the list after Jharkhand for having children wasted less than five years of age.

First, we have portrayed the nutritional status of children under five years of age in Indian states as are revealed through NFHS 1 and NFHS 2 Surveys, with ranking of the states. With respect to the first indicator that is used to reflect stunting, states like Kerala, Nagaland ,Goa, Manipur, Mizoram , Punjab , Rajasthan and Delhi exhibit better performance compared to worse performing states like Bihar, Uttar Pradesh, Assam, Arunachal and even Maharashtra during the NFHS –1 survey period , i.e., 1992-93. During the NFHS-2 survey period of 1998-99, states which improved their ranking in terms of the indicator for height-for-age (Stunting) –some dramatically, and some moderately- , included Arunachal, Goa, Tripura & Sikkim, but those states whose ranking worsened dramatically included Bihar, Uttar Pradesh , Rajasthan, Assam , Punjab and Haryana. Secondly, with respect to the second indicator of weight-for-height (Wasting), between the first two NFHS Survey rounds, the diversity across states were also visible , and the states that could improve their standing with respect to wasting included Punjab, Tripura, U.P., and Rajasthan, whereas Karnataka, Maharashtra, Gujarat, Goa, Assam, Orissa, Bihar worsened their relative positions. In both these indicators, the data on West Bengal were not recorded for the NFHS-1, so we could not report their inter-temporal changes in rankings with respect to these two indicators of child under nutrition. With respect to the third indicator, namely, weight-for-age (Underweight), the states which worsened their relative positions between the two rounds were Delhi, Haryana, Himachal Pradesh, Rajasthan, Madhya Pradesh, Orissa, Gujarat and Maharashtra, with Bihar, U.P. Tamil Nadu remaining more or less stable. Improvements in some other states also were moderate in order.

When we have focused on NFHS-3 and NFHS-4 for the purpose of comparing all the states in India on the basis of unit-level information on child under nutrition collected in these two rounds, we have first used the three anthropometric indicators of child under-nutrition as mentioned earlier. We have calculated the z-score of all the three indicators of undernutrition, namely, stunting, wasting and underweight, and then have calculated UN, defined as the percentage of children under five years of age who are stunted, wasted and underweight in NFHS-3 and NFHS 4. The relative measure is calculated using the formula $RUN_{STATE} = 100 * (UN_{STATE} / UN_{NATION})$. The state relatives RUN are the degree of undernourishment among children in the state compared to the national average between the two rounds of NFHS Surveys.

When we rank the changes in z-scores for child stunting, it is observed that Meghalaya is able to make maximum changes, followed by Gujarat, Madhya Pradesh, Chattisgarh, Haryana, Arunachal Pradesh and Mizoram. Though Kerala registered lowest level of stunting, it ranks in the 9^{th} position among the other states in terms of improvement in the z-scores of height-for-age child undernutrition parameter. States of West Bengal, Tamil Nadu and Sikkim fared lowest in terms improvement in stunting from NFHS 3 to NFHS 4. It is striking to observe that though the position of Gujarat is at a lower end in both the NFHSs, but in terms of improvement in the z-scores for stunting, the state is at second position among the other states of our country. On the contrary, Goa and Kerala are the states which recorded better anthropometric score in both the NFHSs, but the position in terms of improvement of the score is quite low. The position of Punjab and Nagaland are on a better end for both the NFHS. However, in terms of improvement in stunting rates, both the states have fared very low.

In terms of child wasting, it was seen that maximum and remarkable improvement is observed for the state of Goa. Equally good performance in terms of improvement is observed in Meghalaya, Uttaranchal, followed by Mizoram, Manipur, Nagaland, Madhya Pradesh, Tripura and Tamil Nadu. Hence is can be said that other than the north-eastern states, the states which are considered less developed in terms of child under-nutrition like Uttarakhand, Madhya Pradesh, Uttar Pradesh, Bihar , Jharkhand and Orissa had made great strides in reducing the percentage of child acute under-nutrition. Not much improvement is observed for West Bengal and Assam, while the industrially developed states like Maharashtra, Gujarat and Karnataka have failed miserably to improve on their score with regard to child wasting.

When we consider the relative percentage improvement in child underweight it was noticed that maximum improvement has taken place in the state of Tripura, followed by Meghalaya, Jammu & Kashmir and Arunachal Pradesh. The other states which have recorded certain percentage of improvements are Manipur, Himachal Pradesh, Madhya

Pradesh, and Nagaland. There is not much improvement for the state of Kerala. The worst improvement percentage is by Karnataka, followed by Andhra Pradesh , Maharashtra, Delhi , Meghalaya and Gujarat. Equally poor performance can be observed for the states of Goa, Assam, Sikkim, Jharkhand, Bihar, Orissa, Mizoram, Tamil Nadu, Uttar Pradesh, Rajasthan, Punjab and Uttaranchal.

Thus, a comparison between the two NFHS report brings out a myriad picture of the position of different states of our country. It can be seen that the z-scores have improved for all the states of our country from NFHS 3 to NFHS 4. When we compare the positions of the states in the two NFHS it can be seen that some states have improved their position considerably from NFHS 3 to NFHS 4. In terms of change in z-scores over a period of ten years from NFHS 3 to NFHS 4, it can be observed that while some states have taken strides to improve their position, others have been lagging behind. When we use the compatible data from NFHS 3 and NFHS 4 for children of less than five years of age to estimate the z-scores of CIAF- a combined measure suggested by Svedberg(2000)- for the 29 states of India to gauge the pattern of inter-state variations in under five child undernutrition data, we find that overall the incidence of child undernutrion is higher through CIAF compared to three separate indicators in both NFHS 3 and NFHS 4. After checking for CIAF indicator for 29 states of India the two NFHS rounds and their ranking, we have also reranked the states in terms of changes in the CIAF Z-scores between the two rounds per the changes (+/-) for these 29 states.

It was noted that in terms of CIAF, Kerala ranks first among all the other states of our country. It has taken the lead not only in NFHS-3 and NFHS-4, but also in terms of changes in the z-scores. It shows that the state has even taken initiatives to improve child undernutrion. The state of Sikkim and Goa were also found to be in better positions. But the scores of the other north –eastern states like Mizoram, Nagaland, Assam and Arunachal Pradesh are at the lower end of ranking. Apart from Kerala, the other south-Indian states of Tamil Nadu and Karnataka also ranked better than the other states. The western states of Gujarat and Maharshtra have fared poorly in terms of z-score of child CIAF. But these two states had taken efforts to improve this child undernutrition parameter and thus in terms of change in rank. The worse performing states as is evident from the above table are Bihar, Uttar Pradesh, Madhya Pradesh, Uttarankhand , Rajasthan and Himachal Pradesh. The position of West Bengal showed the state has not taken much initiative to improve the nutrition of the children of the state. The state of child CIAF in Orissa and Chattisgarh is better than that of West Bengal.

In order to have an insight as to which state requires a greater push in health intervations towards improving the status of child undernutrion, we did a comparative analysis among the states in India. Here, we tried to pick out those states, which have progressed topmost and those which discharged an awful performance within and across all the four rounds of NFHSs. Then we calculated the range between these states and also tried to understand whether there had been any decline in the range as well as national average across the various rounds of NFHSs for all the three conventional parameters of child undernutrition.

We found, across all the four rounds of NFHSs, that the undivided state of Bihar is the most vulnerable state with regard all the different conventional parameters of undernutrition. Again the state of Madhya Pradesh and Uttar Pradesh and to some extent Orissa is not far behind. The state of Gujarat, which is considered as one the most economically advanced state, performed miserably in NFHS 4 towards child wasting. These are the states, which contributes maximum population burden of the country. While it can also be seen that there are few states, especially Kerala, Mizoram, Goa and Tripura have performed relatively prudently in almost all the rounds, yet, these states could not contribute efficiently towards bringing down the average rates of undernutrition in the country.

Again, considering the range of different parameters of child undernutrion between the states in each individual round, it can be observed, that overall child stunting and underweight rates of the country is high, though there is a gradual decline in the rates across the various rounds of NFHSs. The rate of child wasting of the country as a whole with that range in each round is more or less same, implying that the country has failed to cure short-term child undernutrition problem of the country.

Hence, it can be deduced that mostly the middle and upper gangetic plains are the areas which is posing enormous challenge to the country towards reducing the burden of child undernutrition in the country. Hence better and effective nutritional programmes specific to these areas needs to be executed. This exercise in Chapter 4, was required to find out the states where extra progress is required to solve the over-arching problem of child undernutrition in the country.

In chapter 5, we find that child undernutrition in India is widely varied across the rural-urban areas of the states in India. From the variance component models we find that there is clustering of observations at the community and at the household level. That means in the 29 states of India, children in the households who shared similar communities showcase similar nutritional status. The result is true for all the measures of undernutrition namely, stunting, wasting and underweight. Intra-household correlation is more prominent as compared to intra-community correlation.

In this chapter, we have considered rural- urban place of residence (RU) as an explanatory variable in the study. The other explanatory variables are child's age in months (CA), sex of the child (CS), birth order (CB), size of the child at birth (CSz), complete doses of immunization (CI), child suffereing from recent illness (CII) and recommended feeding practice denoted by exclusive breastfeeding for infants below six months of age (CBf). Apart from the child level covariates, we have also considered the mother level controls. These includes : education of mothers in terms of number of years of education (ME), mother's body mass index(MBmi) (BMI base = 18.5), mother's status of anemia (MAn), mother's availing Mother and Child Protection Card (MC), place of birth of the child (MIn), mother's decision making power in terms of autonomy for taking medical help (MAu).

The household level factors that are considered, except for rural-urban differences (RU), controls are included for ethnicity of the household (HEn), i.e., whether they belong to scheduled casters and scheduled tribe households, either the household has the piped water facility (HPw), and whether the household owns a house of its own(HOh). The last two factors are used as an indicator of the nature of asset the household has. Since the community characteristic is regarded a distant covariate of child undernutrition in the model, hence the percapita NSDP and different states are considered in each of the models as controls or as fixed effects of the multilevel model. Initially, the z-score is calculated and then we have considered the regression equation,

$\mathbf{z_{ij} = \beta^{/}\, x_{ij} + \delta_i + \mu_{ij}}$ **, w**here $\mathbf{z_{ij}}$ is the height-for-age, weight-for-height and weight-for-age for the child(ren) from the j^{th} household in the i^{th} community.

The vector of the regression coefficients is represented by β corresponding to the effects of fixed covariates x_{ij} . x_{ij} are the observed characteristics of the child, the household and the community. The random community effect 'i' denoted the deviation of community i's mean z-score from the grand mean. Likewise, 'j' is a random household effect that denotes the deviation ij household's mean z-score from the ith community mean. The error terms are $\mathbf{\delta_i}$ and $\mathbf{\mu_{ij}}$**.** It is assumed that the error terms are normally distributed with zero mean and variances σ^2_c and σ^2_h of community and household respectively. These terms are nonzero and are estimated by the variance component models. In order to affirm the appropriateness of the multi-level model we have tested whether the variances of the random part of the model are different from zero over the households and communities. For that we assessed the Intra-Class correlation (ICC), which shows the extent of correlation between child undernutrition and household and communities.

It is important to note that the household level observations are not always independent, as children belonging to a particular household often share common characteristics in the process of their growth. It is also seen that children from the households in the rural areas of all the states in our country have higher prevalence of worst nutritional status. That suggests that children belonging to households in the urban areas show better nutritional status. These findings are supportive of the earlier studies based on NFHS data. Such association is consistent across the different variance component models applied in this study. This reaffirms the fact that better nutritional status is enjoyed by the children living in urban parts of the country having favorable socio-demographic background. This is true in all the models where there are controls at the individual, maternal and community characteristics. This also emphasizes that the differences in the availability of resources to the families in urban and rural parts of the country act as an important determinant to child undernutrition. Hence, we can infer that the prevailing socio-demographic status is an important determinant of the level of nutritional achievement among children of our country. If we look forward to the betterment of such socio-demographic condition, then it is expected to improve nutritional growth of the children through better nutritional intake and reduced morbidity.

State specific fixed effects are found to be significant except for a few states.The results of OLS are also more or less consistent with the results of the other models where the covariates are introduced in phased manner.

The uniqueness chapter 5 is the consideration of huge set of individual level data set for both NFHS 3 and NFHS 4. This chapter observed certain distinctive results not observed by most of the studies in literature. Here, we have seen that percapita NSDP significantly influences all the conventional undernutrition parameters both for NFHS 3 and for NFHS 4. Also, the result that intra-household correlation is more prominent to intra-community correlation, is also quite discrete from studies conducted on earlier.

Most of the existing studies have estimated the association of food consumption pattern and child undernutrition. The present study in Chapter 6 differs from earlier studies as it takes into consideration the association between Minimum acceptable diet and child underuntrition controlling for other covariates at different levels.

In this chapter, we have calculated, percentage of children fed with breastmilk, milk or milk products, percentage of children receiving minimum dietary diversity, percentage of children receiving Minimum Meal frequency and lastly percentage of children fed with

Minimum Acceptable Diet. These values are calculated for height-for-age, weight-for-height and weight-for-age and the various determinants of complementary feeding practices, for NFHS-3 and NFHS-4. We have also calculated the agro-climatic regions separately for NFHS-3 and NFHS-4 respectively. We have used multilevel logistic regression model.

It was found that the Minimum acceptable Diet is influenced by many factors such as agro-climatic conditions, and other possible socio-demographic factors. Selected socio-demographic indicators are included in the analysis. Different models were applied to maintain the hierarchy to examine the association of factors with three child nutritional indicators namely stunting, wasting and underweight.

Compared with the West Coast Plain, other agro-climatic regions had higher risk of child stunting and underweight. It was found that Upper Gangetic Plain and Western Dry Region showed more prevalence of undernutrition. This is because the state of Uttar Pradesh and Rajasthan are the states where there is more concentration of people living below the poverty line. The economic condition of the household may be a crucial factor for determining Minimum Acceptable Diet. This is because high-income households may have followed all the nutrient requirements for Minimum Acceptable Diet while the poor spending mostly on basic requirements. It was found that after the introduction of household level factors the agro–climatic regions lost their significance.

The multi level analysis found that Minimum Acceptable diet significantly affects the child undernutrition status. It was also observed that people living in rural areas have a higher prevalence of undernutrition as compared to their urban counterpart. This highlights the fact that as children in rural areas belong to lower socio-economic classes, they are more nutritionally deprived. Our study also suggests that that households with regular income have significantly associations with the reduction of child undernutrition parameters. Per capita Net State Domestic Product (NSDP) is also significantly associated with the reduction of the incidence of child undernutrition. This chapter revealed that the education of mother make an important contribution to the the betterment of nutritional status of children. Communities where mothers have high average years of education tend to have better anthropometric indicators among children. Additionally, mothers receiving antenatal care significantly reduce the risk of children being underweight, stunted or wasted. Therefore, care during pregnancy has a long-term impact on the health of the children.

Chapter 6 concludes that diversity in complementary feeding has a significant association with the three indicators of child nutritional status. It is also seen that breastfeeding practices are satisfactory in all the states of our country overtime. But better feeding practices in terms of MAD is yet to be ensured among the children under five years of age for all the states in the country. This study focused mainly on Minimum Acceptable Diet and the importance of agro-climatic zones in influencing the nutritional status of children in India. The study observed that if children were fed according to WHO guidelines then there is less likely for the child to remain undernourished. So following WHO guidelines for Minimum Acceptable Diet, provision of antenatal care and better sanitation and drinking water facility is likely to bring down the percentage of undernourished children in our country.

In chapter 7, we have tried to examine the relationship between child undernutrition and economic growth with other selected macro-level variable. The aim of this chapter has been to study the inter-relationship between the indicators of child undernutrition in our country at the state level with the macroeconomic aggregates likes the per capita NSDP or the rate of growth the states' NSDP over time, controlling for important social factors like mothers' anaemia or their levels of education as measured by the mothers' literacy. We have used per capita net state domestic product, as a measure of a state's economic development. These data are obtained from Reserve Bank of India, for the years 1998, 2005 and 2014 and measured in 2005 base prices. For this we considered 1998-99 and 1999-2000 for NFHS-2, 2004-2005 and 2005-2006 for NFHS-3 and 2013-2014 and 2014-2015 for NFHS-4, and have used Panel Data regression analysis in this chapter.

The analysis of this chapter makes it clear that there is a negative relationship of Economic growth, measured by percentage change in per capita net state domestic product, with all the different child undernutrition parameters, namely, stunting, wasting, undernutrition and CIAF in the Fixed Effect Model. It is also observed in this model, that there is also a negative association of female literacy with the mentioned child undernutrition measures. That shows that as Economic Growth and state female literacy increases, the incidence of child undernutrion falls. But there are differences when we consider the relationship between mother's anaemia and child undernutrion variables.. It can be observed that while, there is a positive association with stunting and CIAF, implying that as mother's anaemia level falls, the rate of child stunting and CIAF at the state level, too, falls, there is practically no impact of mather's anaemia with child wasting and undernutrion parameters in case of Fixed Effect model.

Likewise, when we considered the Random Effect Model, the results that were observed are almost the same. This implies that Economic Growth and state Female literacy have a significant association and impact in the reduction of all the child undernutrition parameters in the different states of our country. But mother's anaemia has a positive relationship with stunting and CIAF , implies that children from anaemic mothers have a greater risk of being stunted and also the risk of composite anthropometric failure. This also implies that the long-term dietary pattern of mothers from their adolescence affects their childbearing phase of life, and which in turn increases the possibility of long term undernutrion of the child. However, it is also observed that mother's anaemia has no impact on state level child acute undernutrion and child underweight.

Now, when we consider only per capita NSDP in place of percentage change in per capita NSDP, it can be observed that per capita NSDP significantly affects the rate of child stunting, underweight and CIAF. The results reveal that as the per capita NSDP increases, the rate of child stunting, underweight and CIAF of the state decreases in case of Fixed Effect Model. But it is insignificant in case of wasting. The results of the Fixed Effect Model also show that Female Literacy significantly affects the rate of child stunting, wasting and CIAF, but it is insignificant in case of child underweight. The obvious implication that more educated mothers can significantly influence the overall health of her children. Here too, it can be seen that Mother's anaemia level at the state level has no impact on the health of the children of the state.

In case of Random Effect Model, per capita NSDP significantly affects all the variants of child undernutrition. Hence it can be concluded that the higher per capita NSDP can bring about an overall improvement in the nutritional status of children of the state. Agaiin it can be also observed that in case of Random Effect Model. Mother's education represented by female literacy of the state have a significant impact in the reduction of child stunting and CIAF, although it has no impact on child wasting and underweight. This implies that more educated mother's can bring down the prevalence of chronic and long-term child undernutrition as well as the Composite Index of Anthropometric Failure. But as in the previous cases, here too, it can be seen that the level of mother's anaemia has virtually no impact on any of the parameters of child undernutrition of the state.

In all the cases, it can be observed that for the Fixed Effect Model, the Durbin-Watson statistic fell in the 'inconclusive zone' when compared with the theoretical Durwin-Watson values. On the other hand, in Random Effects Model, the problem of autocorrelation is absent, as the computed Durwin-Watson statistic is greater than theoretical Durwin-Watson values. Again, the Random Effects Model gets accepted on the basis of Hausman test as computed Chi-square (χ^{2*}) value is statistically insignificant. Thus in all the cases we prefer the Random Effects Model in the context of panel data regression.

The dissertation made a reasonable attempt to understand the inter-state variations in child undernutrition in India. Several observations emerge from the findings of the dissertation. The states which have fared better overtime from NFHS-3 to NFHS-4, are the states of Kerala. Tamil Nadu, Himachal Pradesh and Haryana. UttarPradesh, Bihar, Madhya Pradesh, Rajasthan, Jharkhand showed maximum percentage of stunted children in the country. The percentage of stunted children in Gujarat , Maharashtra and Assam is also high in both the NFHSs. There has been an increase in the prevalence of child wasting from NFHS 3 to NFHS 4 in the states of Maharashtra, Gujarat, Uttar Pradesh, Andhra Pradesh and Delhi. Jharkhand, Karnataka and Chattisgarh also shows a huge percentage of wasted children.

Improvement in child wasting is observed in all the north-eastern states except Arunachal Pradesh. Slight improvement is registered in Uttarkhand and Orissa while the position of West Bengal is more or less stagnant. Maharashtra and Goa have recorded an increase in child underweight from NFHS 3 to NFHS 4. Apart from these states, the other states, which have registered high level of child underweight, are Uttar Pradesh, Madhya Pradesh, Bihar, Gujarat, Andhra Pradesh and Karnataka. A look into the first phase report of fifth round of NFHS (2019-2021) from the 22 states surveyed so far, revealed that the percentage of stunted, wasted or underweight children either increased or remained stagnant in most of the states. The states of Telangana, Gujarat, Kerala, Maharashtra, and West Bengal — all saw increased levels of child stunting. When it comes to the proportion of underweight children, several big states, Gujarat, Maharashtra, West Bengal, Telangana, Assam and Kerala, have seen an increase.

India has always had a high level of child wasting, when compared to other developing countries of the world, but instead of reducing it, several states such as Telangana, Kerala, Bihar, and Assam as well as the UT of J&K have witnessed an increase.Others like Maharashtra and West Bengal have been stagnant on this.

In 2015, India committed to achieve the Sustainable Development Goal (SDG) of zero hunger. As a step towards meeting the targets by 2030, the Government of India launched the Prime Minister's Overarching Scheme for Holistic Nutrition (POSHAN) Abhiyan in 2017. Targets were set to reduce stunting, under-nutrition and low birth weight by two per cent each and anaemia by three per cent by 2022. However, the situation worsened due to the onset of the corona pandemic.

It is challenging for the governments to support with adequate food to the under-nourished children, particularly in states with low per capita income. With the disruption of Anganwadi services and Mid-Day Meal (MDM) during the pandemic , a large number of children no longer have access to regular, nutritious meals. Given the enormity of the problem , it is difficult to comprehend how and when India would achieve the target of SDG within the stipulated time in the near future.

Child malnutrition is an awful problem and a longstanding challenge for the public administration of India. Despite decades of investment to tackle this malaise, India's Child undernutrition rates are still one of the most alarming in the world. . The Global Hunger Index (2020) —which is calculated on the basis of total undernourishment of the population, child stunting, wasting and child mortality, places India at the 94th spot among 107 countries. According to the data from the fifth round of NFHS (2019-2021) from the 22 states surveyed so far, only nine showed a decline in the number of stunted children, 10 in wasted children and six in underweight children. But the percentage of undernutrition parameters of children under the age of five remained unchanged in the remaining states.

The status of Child undernutrition and its consequences can be partly attributed to the inadequate political focus on budgetary allocation made to tackle this issue. But the shortfall in budgetary allocations cannot alone be blamed for India's child undernutrition crisis. Evidence points to numerous shortcomings in implementation as well. The CAS portal has been defunct since September 2020. This has severely compromised the administration's ability to track the status of undernourished children who have been pushed further at risk due to the (COVID-19) pandemic.

To highlight the major departures of the present dissertation from the earlier studies, it is important to note, firstly, that the present dissertation attempts to place the problem of child undernutrition in the context of development of the Indian economy and explain inter-state diversity in the pattern of child undernutrion in the Indian states.

Secondly, the present dissertation recognises the fact that need for appropriate combinations of socio-demographic factors with health care practices, maternal resources for childcare and household resources, supported by community and government, the potential risks associated with high under-nutritional outcomes of children and mothers, in analysing the factors underlying child undernutrition among the Indian states.

Thirdly, the present dissertation is an attempt to use large unit level comparable data from NFHS 3 and NFHS 4 in identification of determinants of child undernutrition in Indian states, role of dietary diversity and mothers' health conditions and many of the behaviorial results estimated would constitute an advancement from the existing literature and so on.

Finally, the dissertation attempts to link the state level macroeconomic indicators like economic growth or GDP with the nutritional deprivation of children using panel data econometrics and this constitute a departure from the literature on existing studies.

8.2 Policy Recommendations

Since, it has been observed that there are large inter-state variations in child undernutrition status, hence, the existing ICDS scheme may be reformed. Apart from following uniform ICDS scheme throughout the country, special and specific intervention is required depending upon the needs of a particular state and particular agro-climatic zone. It is also observed that the rural-urban disparity in the states is quite widespread in India. Hence, an appropriate guideline that focuses more on the children belonging to the rural areas should be given importance. It is also observed that communities belonging to SC and ST and non-availability of piped water are more probable from suffering from child wasting. Hence special focus needs to be given to improve the nutrition status of these marginalized groups.

Provision for proper drinking water and sanitation facility should be given serious importance as availability of clean water in the household would help to prevent the transmission of various water borne diseases which might help in the reduction of the incidence of child wasting in the states of our country.

Mother's education affects the child's health not only at the household level, but also at the state level. Therefore, there is a need to focus on the implementation of education programme to target women education. It is also seen that women with greater autonomy towards taking medical help for self also positively impacts the nutritional status of children. Hence, improving the quality of primary education and subsequently higher education will enrich the decision making power among women.

Efforts should also be given towards easy accessibility for essential maternal and child health services, including skilled birth attendance, essential newborn health, early initiation of breastfeeding, and maintaining the parameters of Minimum acceptable diet.

8.3 Scope for further research

The dissertation revealed the child undernutrition performance of the states in India by considering data mainly from NFHS 3 and NFHS 4. But, in NFHS 4, data related to several districts within a state and Union Territory is also available. So further research can be done by taking into consideration the undernutrition status of various districts within each state and UT of the country. Similarly, including nutrition data at the state levels at more frequent intervals would enable researchers to test for the robustness of macroeconomic propositions that would guide effective formulation of the policy.

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