ASSESSING TRANSITION IN DETERMINANTS OF MATERNAL MALNUTRITION IN INDIA OVER A PERIOD OF TWO DECADES: SECONDARY ANALYSIS USING NATIONAL FAMILY HEALTH SURVEY

JUNE 2021

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B.Sc. FOODS AND NUTRITION

(Public Health Nutrition)

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTERS OF SCIENCE

(Faculty of Family and Community Sciences)

(PUBLIC HEALTH NUTRITION)

BY

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CERTIFICATE

This is to certify that the research work presented in this thesis has been carried out independently by

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ABBREVIATIONS

AARR	: Annual Average Rate of Reduction
ANC	: Ante-Natal Care
AR	: HIV test results
ARI	: Acute Respiratory Infection
BF	: Breastfeeding
BMI	: Body Mass Index
BR	: Birth Recode
CAB	: Clinical, Anthropometric, and Biochemical
CED	: Chronic Energy Deficiency
CI	: Confidence Interval
CMRA	: Child Marriage Restraint Act
CR	: Couple's Recode
CSDH	: Commission on Social Determinants of Health
DHS	: Demographic Health Surveys
EBF	: Exclusive Breastfeeding
EDHS	: Ethiopian Demographic and Health Survey
ENSIN	: Encuesta Nacional de la Situación Nutricional in Colombia
Hb	: Hemoglobin
HIV	: Human Immune Virus
HR	: Household Recode
IR	: Individual Recode
IRDP	: Integrated Rural Development Programme
IUGR	: Intra Uterine Growth Restrictions
KR	: Kids/Children's Recode
LAZ	: Length for age Z-score
LBW	: Low Birth Weight
MCDB	: maternal and child double burden
MDGs	: Millennium Development Goals
MMR	: Maternal Mortality Ratio
MoHFW	: Ministry of Health and Family Welfare
MR	: Male Recode

MUAC	: Mid-Upper-Arm Circumference
NCDs	: Non-Communicable Diseases
NDHS	: Nigeria Demographic and Health Survey
NFHS	: National Family Health Survey
NOS	: Newcastle-Ottawa Scale
NRHM	: National Rural Health Mission
ORS	: Oral Rehydration Therapy
PAFs	: Population Attributable Fractions
PCMA	: Prohibition of Child Marriage Act
PLW	: Pregnant and lactating women
PR	: Person Recode
PRCs	: Population Research Centers
RMNCH+A	: Reproductive, Maternal, Newborn Child, plus Adolescent Health
SDGs	: Sustainable Development Goals
SES	: Socio-Economic Status
TSF	: Targeted supplementary feeding
UN	: United Nations
USAID	: United States Agency for International Development
VHND	: Village Health and Nutrition Day
VHSND	: Village Health, Sanitation and Nutrition Day
WHA	: World Health Assembly
WHO	: World Health Organization
WLZ	: Weight for length Z-score
WRA	: Women of Reproductive Age

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Abstract

ABSTRACT

Consequences of malnutrition on maternal and child health are very alarming. It affects the overall maternal and child health, survival, individual economic productivity, and a child's healthy development and growth.

The present study was conducted to assess transition in determinants of maternal malnutrition in India over a period of two decades by secondary data analysis using data from National Family and Health Surveys (1998-2016).

Secondary data for India was obtained through the DHS website post permission. Applying the exclusion criteria, the data was cleaned and then used for further analysis. Based on the exclusion criteria, an analytical sample of 69625, 74547 & 73708 mothers from NFHS-2, 3 & 4 respectively was obtained. Body Mass Index (BMI) lower than 18.5 kg/m², was used as the dependent variable. Binary logistic regression was used to ascertain the effects of selected characteristics on the dependent variable.

In NFHS 3 and 4, the proportion of mothers in all the wealth quintiles were almost similar, where the proportion of mothers living in the poorest quintile was the lowest at 18.3% and proportion of mothers living in the richest quintile was the highest at 20.9%. The proportion of mothers with no education was found to have decreased from 53.1% in NFHS-2 to 33.4% in NFHS-4, while the proportion of mothers with secondary education almost doubled from 21.8% in NFHS-2 to 42.5% in NFHS-4. In NFHS-2, partners of majority (40%) of the women were employed in agricultural work which then decreased to 33.3% in NFHS-3 and 32.9% in NFHS-4 still being the major profession, since India is an agricultural country. It was evident from the data that the proportion of working women has continuously decreased from 39.3% mothers who were employed in NFHS-2 through 38% in NFHS-3 to 25.6% in NFHS-4.

Prevalence of thinness (BMI < 18.5 kg/m²) among mothers had reduced from around 36.4% in NFHS-2 to around 17.6% in NFHS-4. While the prevalence of overweight & obesity was observed to have increased over the years from 8.1% & 11.1% in NFHS-2 to 14.4% & 27.1% in NFHS-4. Prevalence of anemia was found to have reduced from around 56% in NFHS-3 to 53.8% in NFHS-4.

Interrelationship between BMI and variables of interest obtained through cross tabulation showed that across the years, maternal thinness (BMI<18.5kg/m²) was found to be more prevalent among mothers residing in rural areas, mothers belonging to poor households, mothers with no education, mothers whose partners had no education, mothers whose partner/husband were employed in agriculture, mothers with more number of children, mothers who gave birth to their first child at a smaller age of 15-19 years, and the mothers who were anemic.

An analysis of interrelationship between anemia and variables of interest, showed that across the years, moderate and severe anemia was more prevalent among mothers residing in rural areas, mothers from poor and middle socioeconomic quintiles, mothers having no education, mothers who had given birth to their first child between the age of 15-24 years, mothers whose partners were working in agriculture or did skilled and unskilled manual work.

In binary logistic regression analysis, using BMI, different variables were found significantly associated with thinness. These determining variables varied across the surveys. The major determinants identified in NFHS-2 were: Place of residence, parity, partner's occupation. The major determinants identified in NFHS-3 were: Place of residence, parity, partner's education. The major determinants identified in NFHS-4 were: socioeconomic status (wealth index), mother's age and anemia levels.

A strong holistic approach is required rather than singular approaches to improve nutrition, education, and sanitation as well as wealth status of individuals in order to reduce the prevalence of co-existing thinness and anemia.

Introduction

INTRODUCTION

Malnutrition is a condition resulting from imperfect and inexact nutrition. It consists of two types: over-nutrition and undernutrition (Khalid, N., et al. 2017). Undernutrition manifests as wasting or low weight for height (acute malnutrition), stunting or low height for age (chronic malnutrition), thin or low weight for age, and mineral and vitamin deficiencies or excessiveness. Over nutrition includes overweight, obesity and diet-related non-communicable diseases (NCDs) such as diabetes mellitus, heart disease, some forms of cancer and stroke (1).

Consequences of malnutrition on maternal and child health are very alarming. It affects the overall maternal and child health, survival, individual economic productivity, and a child's healthy development and growth. (Khalid, N., et al. 2017)

Malnutrition is an unacceptable social condition for both sexes and across ages and sexes (González-Cossío, T., & Delgado, H. 1991). In the developing world, maternal and child malnutrition are major public health issues that cripple society from being functionally active (2). The nutritional status of the mother is thought to be a significant factor in the successful completion of pregnancy. Maternal nutrition plays a critical role in improving pregnancy outcome and unlike other factors, such as heredity or pre-existing conditions; the nutritional status is amenable to change (Sonko, A. 2016).

Maternal malnutrition, including both undernutrition and overweight, has been a long standing global problem with serious consequences for survival, healthy development and the economic productivity of individuals and societies (Black, R. E., et al. 2013). In most countries, maternal undernutrition (defined as a body mass index of less than 18.5 kg/m^2) ranges from 10% to 19%, while it's a serious concern in most South-eastern Asian countries, where more than 20% of women have a body mass index of less than 18.5 kg/m^2. With a prevalence of low body-mass index around 22.9% in women, the situation can be considered critical in India. (Black, R. E., et al. 2008; IIPS,I. 2017). This clearly shows that maternal nutrition must be prioritized, and existing programs must be implemented more effectively (Nguyen, P. H., et al. 2019).

Maternal health is a major concern and is central to sustainable growth and a key to future generations (Graham, W., et al. 2016).The most nutritionally-vulnerable stages

of the life cycle are women of childbearing age (especially pregnant and lactating women as pregnancy and lactation places an additional nutritional demand), infants and young children (Lartey, A. 2008).

Low pregnancy weight gain and elevated child and maternal morbidity and mortality reflect the effects of poor maternal nutritional status (Lartey, A. 2008).

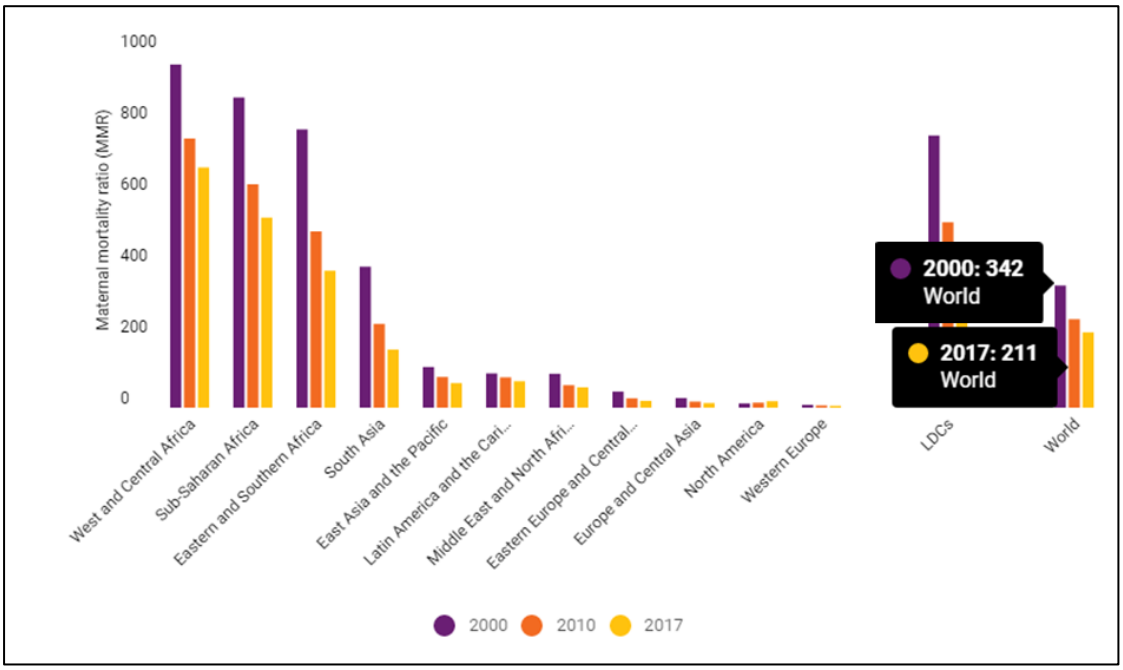
Maternal Mortality refers to deaths which occur due to complications from pregnancy or childbirth. There has been significant progress since 2000. The Global Maternal Mortality Ratio (MMR) declined by 38 per cent from 342 deaths in 2000 to 211 deaths per 100,000 live births in 2017, as shown in figure 1.1, according to UN inter-Agency estimates (3).

In the year 2000, the United Nations (UN) Member States pledged to work towards a series of Millennium Development Goals (MDGs), including the target of a three-quarters reduction in the 1990 maternal mortality ratio (MMR; maternal deaths per 100 000 live births), to be achieved by 2015. This target (MDG 5A) along with that of achieving universal access to reproductive health (MDG 5B) together formed the two targets for MDG 5: Improve maternal health (Figure 1.2) (WHO. 2015b).

Building on the momentum generated by MDG 5, the Sustainable Development Goals (SDGs) established a transformative new agenda for maternal health towards ending preventable maternal mortality; target 3.1 (Figure 1.4) of SDG 3 (Figure 1.3) was to reduce the global MMR to less than 70 per 1,00,000 live births by 2030 (Khalid, N., et al. 2017).

SDG3 goes beyond mortality and also consider morbidity, disability, and functionality; it goes beyond physical health to include social and mental well-being and even goes to a life-course viewpoint and inter-generational or intra-household impacts beyond individual episodes (Graham, W., et al. 2016). Approaches to life courses have emerged as unifying structures (Azenha, G. S., et al. 2013), putting together major temporal aspects for women and their offspring (Graham, W., et al. 2016).

Figure 1.1: Maternal mortality ratio (MMR) trends by region



Source: https://data.unicef.org/topic/maternal-health/maternal-mortality/

Figure 1.2: Millenium Development Goal 5 – Improve maternal Health

Image source: [https://www.un.org/milleniumgoals/poverty.shtml]

Figure 1.3: Sustainable Development Goal 3 – Good Health and Well Being

Image source: [https://www.un.org/sustainabledevelopment/sdg-plamming-calender/]

Figure 1.4: Sustainable Development Goal 3 Target 3.1 - Reduce Maternal Mortality

Image source: [https://opendevelopmentmekong.net/topics/sdg-3-good-health-and-well-being/]

Because maternal malnutrition has intergenerational consequences, women's nutrition must be dealt with quite early in life (Huffman, S. L., et al. 2001). The unmistakable negative consequence of poor prenatal health and nutrition, as well as inadequate care during pregnancy and childbirth is reflected in the high prevalence of maternal mortality in developing countries (Mora, J. O., & Nestel, P. S. 2000).

Although poor prenatal nutrition contributes to high mortality rate both directly and indirectly, the extent of its contribution has not been measured because the main recorded causes of maternal mortality (hemorrhage, obstructed birth, eclampsia, sepsis, and unsafe abortion) greatly overshadow the role of nutrition (Mora, J. O., & Nestel, P. S. 2000). And though reducing preventable maternal mortality (WHO. 2015a) should remain a priority, it is also important to consider death as the tip of the iceberg below which lies the true diversity of the burden or consequences of pregnancy-related health issues, i.e. poor maternal health (Graham, W., et al. 2016).

The level of malnutrition of all segments of the population can be calculated with greater reliability using the knowledge of child and maternal anthropometry. But what is most important today is how, with the resources available, one can reduce the levels of malnutrition. This requires that the determinants of malnutrition amongst pregnant women are identified. (2)

The Commission on Social Determinants of Health (CSDH) set up by the World Health Organization (WHO) tasked with synthesizing the evidence on how the structure of societies affects population health through a variety of social interactions, norms, and institutions, and what governments and public health may do about it. To assist the Commission in its monumental task, the WHO Secretariat undertook a review and summary of alternative frameworks for understanding the socioeconomic determinants of health. This review was summarized and synthesized into a unified conceptual framework for action on social determinants of health (Figure 1.5), which was submitted to and widely approved by the CSDH for orienting their work. (Solar O, Irwin A. 2010)

The CSDH framework demonstrates how social, economic, and political mechanisms produce a set of socioeconomic positions in which populations are stratified by income, education, occupation, gender, race/ethnicity, and other factors; these

socioeconomic positions then shape specific determinants of health status (intermediary determinants) that reflect people's position within social hierarchies.

Hamal, M., et al. (2020), adapted the CSDH framework to maternal health (Figure 1.6) by integrating two widely used frameworks on factors of maternal health, namely the 1994 Thaddeus and Maine's "three-delay model" (initially published in 1990) and the 1992 McCarthy and Maine's framework on distant and immediate determinants of maternal death.

The researchers identified maternal health as a social phenomenon whose outcomes are influenced by contextual factors in this integrated framework. Maternal health inequities are caused by contextual factors that generate social hierarchies or stratifications in communities.

They also identified governance, policies and laws (national), cultural and social values, and international laws, policies, treaties, and conventions, as the socioeconomic and political contexts that create socioeconomic hierarchies in societies in terms of social class, ethnicity/racism, gender, education, occupation, and income. To produce differences in maternal health outcomes, this socioeconomic position operates through a set of intermediate factors that can be broadly categorized into individual-level factors (biological, health status, behavioral, and psychosocial), environmental factors (community, family, and peer influences), and health system factors.

Figure 1.5: Conceptual framework for actions on social determinants of health (CSDH)

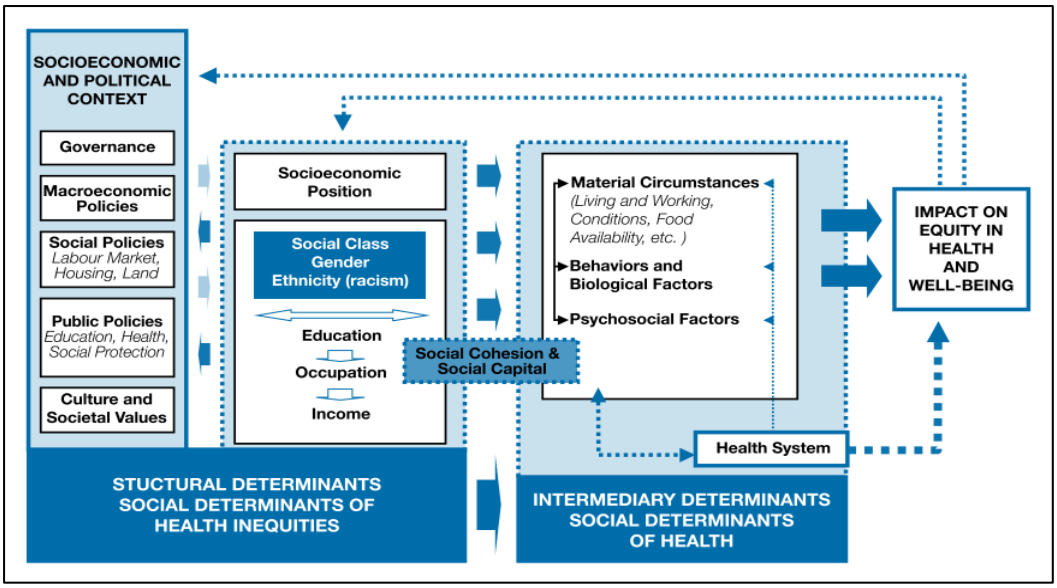
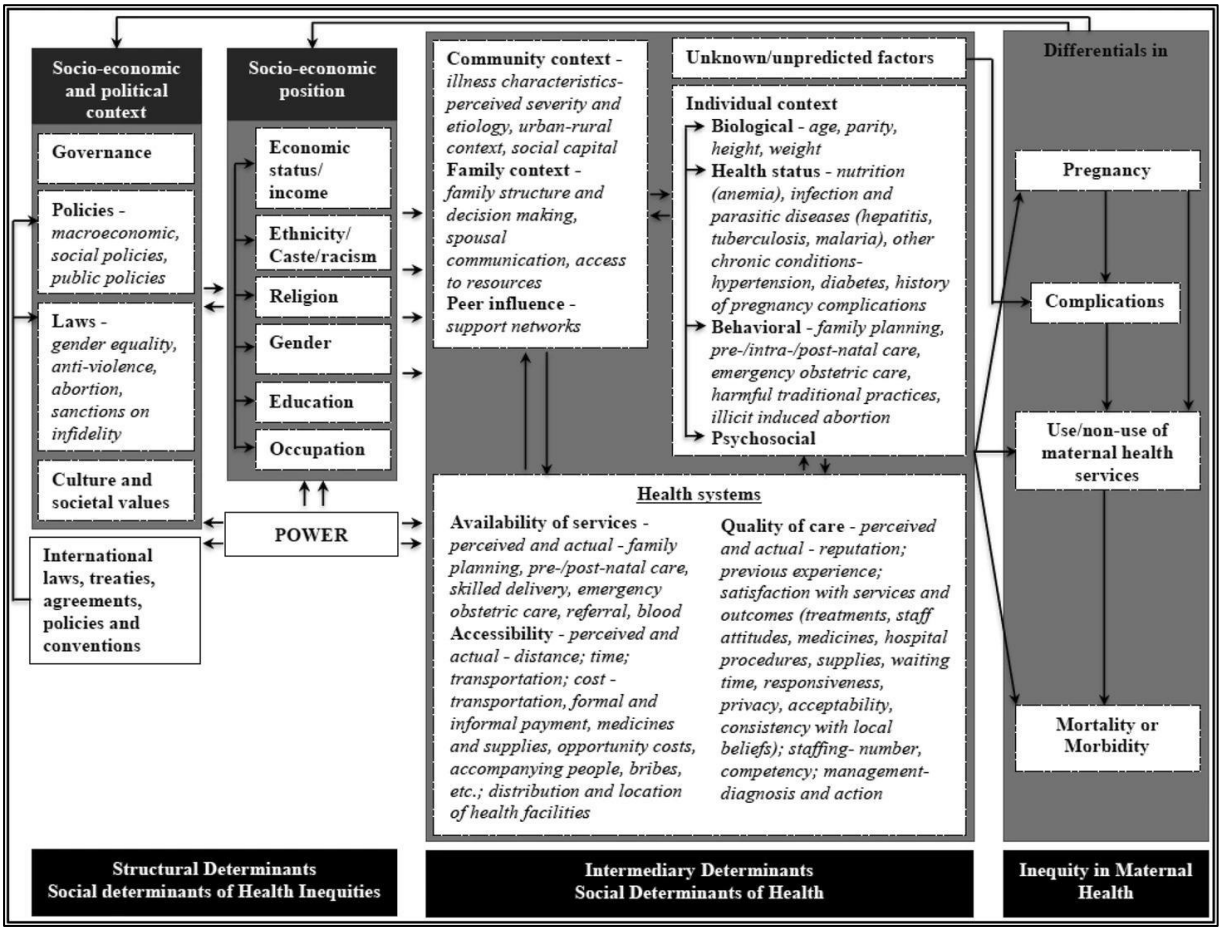


Figure 1.6: Conceptual framework of social determinants of maternal health



There are very limited studies on determinants of maternal malnutrition, which have used comprehensive approach to study the determinants of malnutrition (2). Thus, creating a need to study the determinants of maternal malnutrition comprehensively.

JUSTIFICATION OF THE STUDY

Various studies have shown multiple determinants of maternal malnutrition in different parts of the world. However, these determinants are different in different settings. Most of the studies have studied the determinants at a particular point of time.

Thus, there is a strong need to understand how these determinants have transitioned with the passing years and also which are the major determinants to be focused upon now.

An in-depth understanding of the transition in the determinants, if any will help in understanding the prospective changes in future. In order to support the on-going programmes for healthcare and nutrition, an understanding of the determinants will help in coming up with recommendations for reducing adverse outcomes.

Also, large secondary datasets are available for health policy research. Health policy research in a country like India requires large sample sizes, cutting across geographic, demographic, and other relevant population categories. Obtaining such data directly from the field proves time-consuming and expensive for individual researchers (Iqbal F. 2013). In comparison, available secondary data constitute a low-cost alternative for policy studies (Best, A. E. 1999).

OBJECTIVES

Broad Objective – To assess the transition in the determinants of maternal malnutrition in India over a period of two decades by conducting secondary analysis of data obtained from National Family and Health Surveys

Specific Objectives

- To identify the common indicators of maternal malnutrition using the datasets.
- To assess the determinants of maternal malnutrition in individual datasets.
- To evaluate the transition in the determinants of maternal malnutrition and arrive at predictive factors.

Review of Literature

REVIEW OF LITERATURE

Nutrition plays a crucial role in human wellbeing. It is both a necessary component of and a crucial insight into other aspects of well-being (Sunny, J., & K, N. 2008.). Undernutrition (wasting, stunting, and thin), insufficient vitamins and nutrients, overweight, obesity, and the associated diet-related non-communicable diseases are all examples of malnutrition (4).

Malnutrition affects every nation on the planet in one way or another. Combating malnutrition in all of its forms is one of the world's most pressing public health challenges (4). Undernutrition is passed down from generation to generation, perpetuating the vicious cycle (Ahmed, T., et al. 2012).

Malnutrition is most prevalent in pregnant and lactating mothers, as well as small children under the age of three (5). Approximately half of the world's population is affected by maternal and child undernutrition and micronutrient deficiencies (Ahmed, T., et al. 2012).

Women's nutritional status is an important factor in a stable pregnancy. Poor foetal development, foetus morbidity, foetus mortality, and a low body mass index are caused by maternal malnutrition or undernutrition in women (Khalid, N., 2017.). Women that are malnourished at the time of conception are unlikely to boost their nutritional status during pregnancy, as the developing foetus puts additional demands on them (Ahmed, T., et al. 2012).

Pregnancy and childbearing are especially dangerous for women who are malnourished, especially if they have anaemia. High blood pressure, high cholesterol, tobacco use, obesity, and abuse are all risk factors, which are becoming increasingly important (WHO. 2009). According to NFHS-4 (2015-16), almost half of pregnant women (50.4 %) aged 15 to 49 years were anaemic and around a quarter women (22.9 %) had Body Mass Index (BMI) below normal (BMI < 18.5 kg/m^2).

The effects of women's malnutrition on human development are numerous and cumulative. Maternal malnutrition, for instance, raises the risk of maternal mortality (Sunny, J., & K, N. 2008.). Pregnancy and childbearing have been significant causes of morbidity and mortality in women throughout history (WHO. 2009). Maternal mortality (defined as a woman's death during pregnancy, childbirth, or the postpartum

period) is an important indicator of a woman's health and well-being. Although it takes two to make a baby, women alone are subjected to the health risks associated with pregnancy and childbirth, which accounts for 14% of all deaths in this age group globally (WHO. 2009).

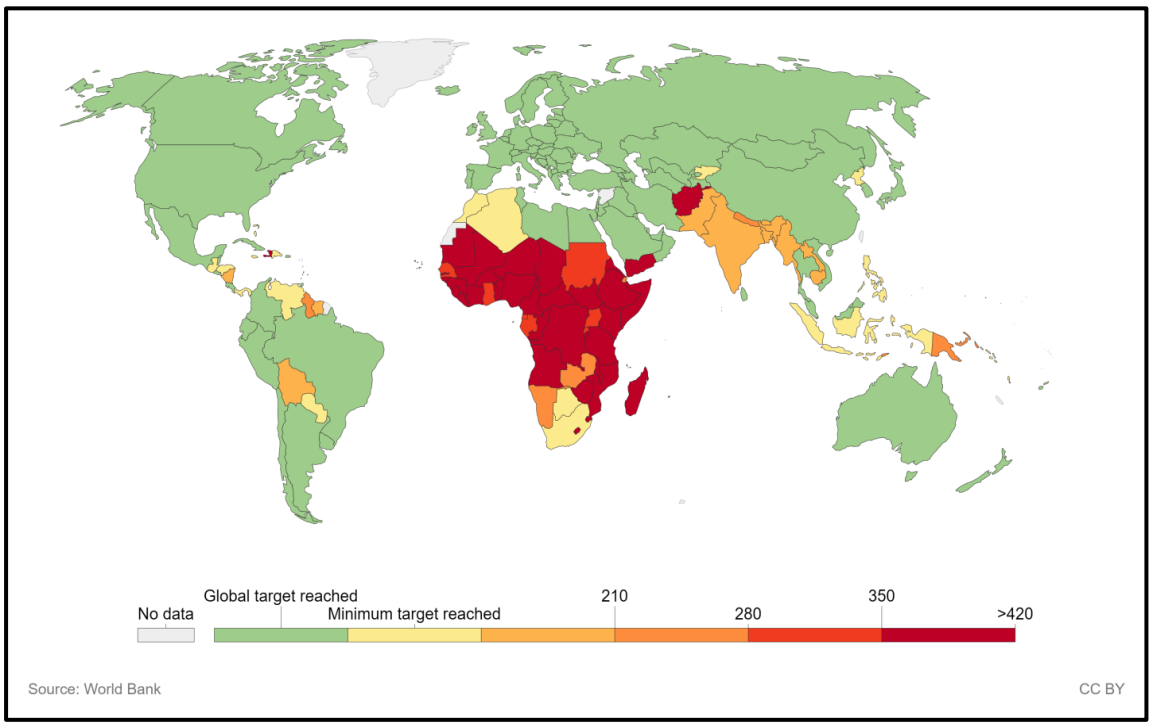
The maternal mortality ratio (MMR) is a key indicator of maternal health globally (Khan Y.P., 2009). The global status of MMR as of the year 2015 can be seen in the figure 2.1. Figure 2.2 shows the trends of MMR India over the years, it is evident that India has made a significant progress in reducing the MMR from 254 maternal deaths per 100,000 live births in year 2004-06 to 113 maternal deaths per 100,000 live births in year 2016-18 and is on track to achieve a MMR of less than 70 by 2030.

In the developing countries, maternal mortality remains a major public health concern. While infant mortality and total fertility rates have seen significant improvements over the last two decades, maternal mortality however has not so much. When compared to other developing and developed countries throughout the world, India lies at the bottom in terms of health results. It's due to a lack of public spending on determinants of health outcomes, as well as flaws in the current health system.

Kachhwaha, K. P., & Jain, M. (2019) conducted a retrospective observational study in the Ahmedabad (a tertiary care institute) with an aim to review existing maternal mortality ratio and the causes of maternal deaths at a tertiary care centre so that corrective actions can be taken. They found that largest number of deaths (83.1%) occurred in the age group of 20-34 years owing to the fact that this is when women are most likely to give birth; hence actions aimed at this age range would most effectively lower the number of deaths. Poverty influenced a woman’s general health by way of malnutrition and influenced her utilization of health services. Indirect medical causes like hepatitis, cardiac diseases, anemia and communicable diseases accounted of almost 50% of the maternal deaths in this study. Despite the high prevalence of anemia, only 3.3 percent of people died in this study. The fact that anemia rarely causes death on its own explains this. Anemia was a contributory cause in 22 deaths, accounting for 23.9 % of all deaths. The authors concludes that Proper implication of NRHM programmes, improvement in primary healthcare in rural areas and up gradation of hospitals in rural areas, availability of safe drinking water, proper

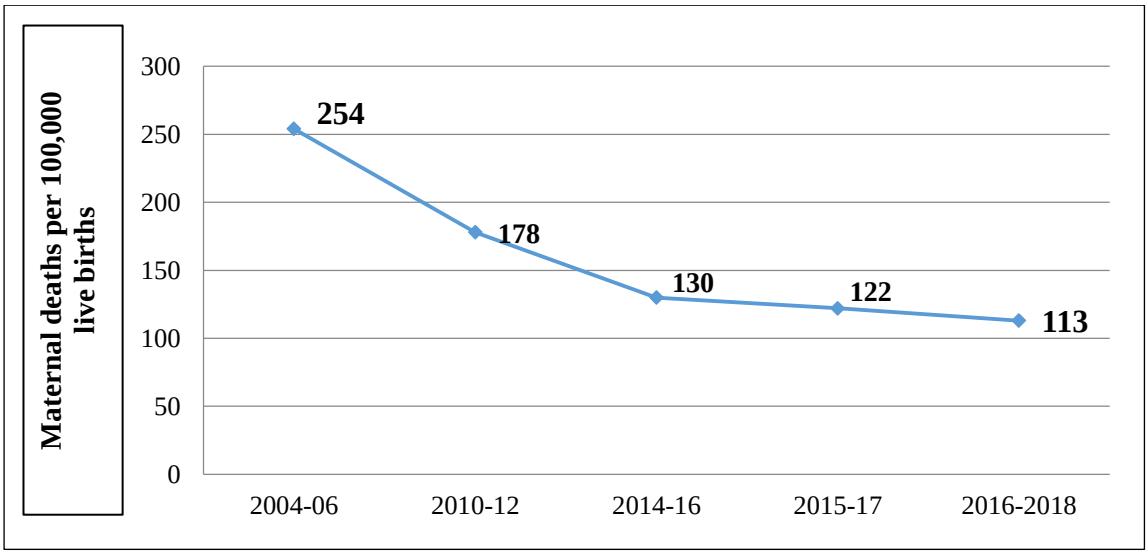
sanitation measures and hygienic living conditions can help in bringing down the maternal deaths.

Figure 2.1: Maternal mortality ratio (Global status)



Source: https://ourworldindata.org/grapher/maternal-mortality-ratio-sdgs?country=~IND

Figure 2.2: Maternal Mortality Ratio trends in India



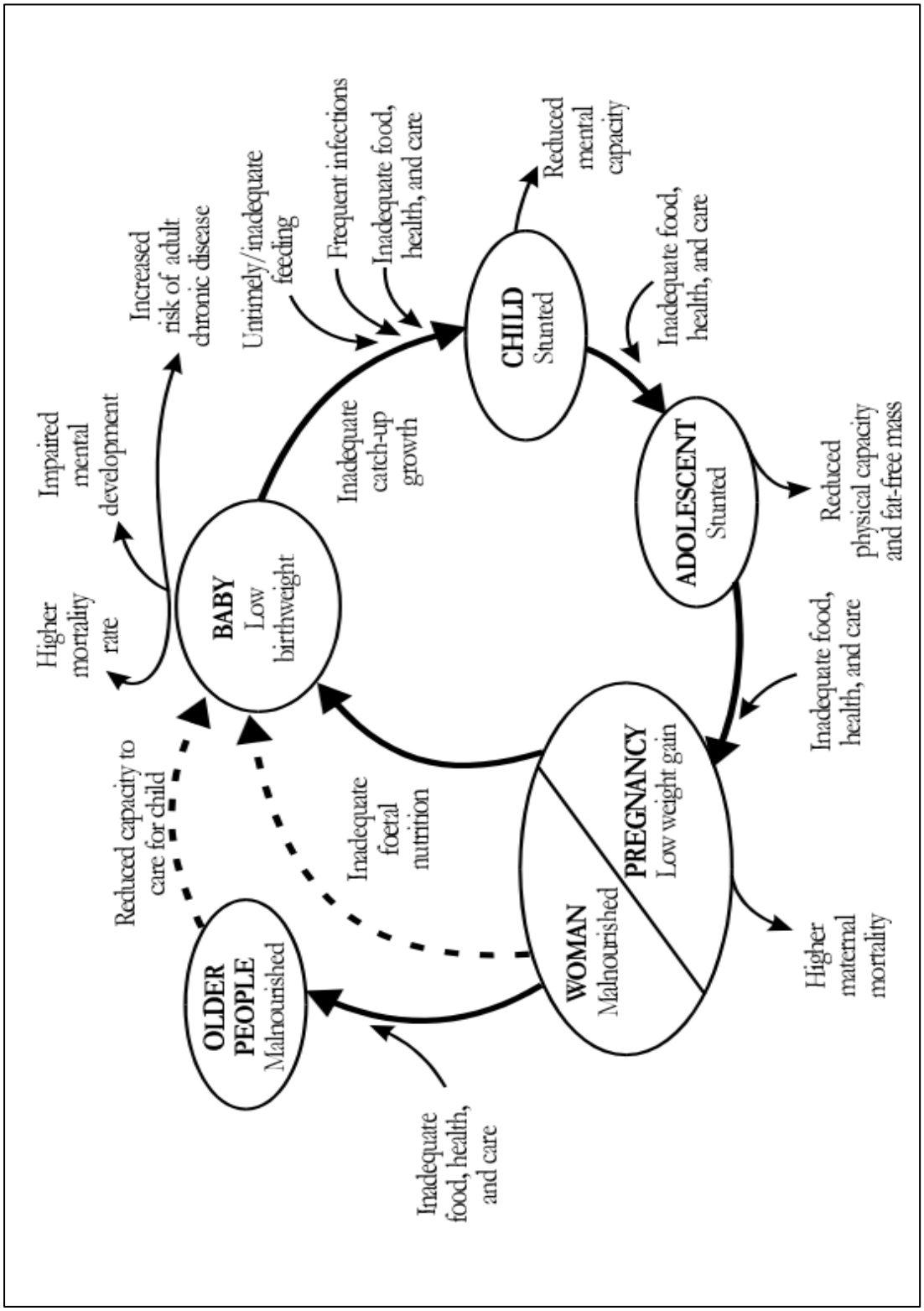
Source:https://niti.gov.in/content/maternal-mortality-ratio-mmr-100000-live-births, https://sdgindiaindex.niti.gov.in/#/ranking, Special bulletin on maternal mortality in India (2016-18). Sample registration system office of the registrar general, india

Sunny Jose and K Navneetham (2018) on analysing data from NFHS 2 and 3 in relation to women's malnutrition showed that not only do women's levels of malnutrition continue to be very high in India, but levels among women from deprived social and economic groups are much higher. Poor women were found to be at the receiving end of rising malnutrition from almost all social groups. Over the period of consideration, the incidence of chronic energy deficiency (CED) among ever-married women came down, though marginally but still showed a sign of progress. On the contrary, the incidence of iron deficiency anaemia increased over the same period. Analysis revealed and concluded that women's malnutrition should be treated as an important issue of human development and doing so should involve both urgent steps to combat malnutrition and the firm positioning of women's well-being on the development agenda.

Lartey, A. (2008) studied the nutritional issues affecting women and children in Sub-Saharan Africa in order to highlight effective strategies to tackle these challenges. Issues of maternal nutrition, and young children, Infant feeding practices and suggested interventions to improve maternal and child health were studied. The study concluded that interventions needed to tackle the problem of high morbidity and mortality rates in sub-Saharan Africa and issues related to maternal and child health although were known, yet there was a need to scale up these interventions to levels that would make an impact. It was suggested that interventions like improving maternal nutritional status, sustaining exclusive breast-feeding and improving complementary feeding practices should be utilized.

An undernourished mother inevitably gives birth to an undernourished baby, perpetuating an intergenerational cycle of undernutrition (Figure 2.3) (6).

Figure 2.3: Nutrition throughout life cycle



Source: ACC/SCN (2000) Fourth Report on the World Nutrition Situation. Geneva: ACC/SCN in collaboration with IFPRI.

Prevalence studies (Malnutrition)

Malnutrition among reproductive-age rural Bangladeshi women is still very high. This elevated prevalence is attributed to a variety of adverse health effects on women and their offspring. **Milton, A. H., et al. (2010)** conducted a cross-sectional study with the objective to determine the prevalence of malnutrition among rural Bangladeshi women of reproductive age (WRA) and examine the possible risk factors associated with malnutrition. Results revealed that 34% of the women suffered from malnutrition. The univariate analysis showed that the correlation between malnutrition and income category, oral contraceptive history, current pregnancy, breastfeeding history and years of education was marginally significant. When income was implemented as a continuous variable in the multiple logistic model, a statistically significant inverse correlation was found between monthly income and malnutrition implying that increased total monthly household's income decreases the risk of malnutrition. The research concludes that among rural Bangladeshi women of reproductive age, poverty remains the single most significant risk factor for malnutrition and suggests that as a priority, the National Nutrition Policy should focus on women of reproductive age.

Prevalence studies (Anemia)

Anaemia is a worldwide public health problem that has a major effect on pregnant women. **Melku, M., et al. (2014)** conducted a cross-sectional study with the aim to assess the prevalence and predictors of maternal anemia on pregnant mothers attending ante-natal care (ANC) at Gondar University Teaching Hospital, Northwest Ethiopia. The mean Hb (hemoglobin concentration) level of pregnant women was found to be 11.96 ± 1.37 g/dl (range: 5.85– 17.05 g/dl) and the overall prevalence of maternal anemia was 16.6%. The results showed that of the anemic women, 6%, 30%, and 64% were severely, moderately, and mildly anemic, respectively. The study shows that low family income, high family size, hookworm infection, and living with HIV/AIDS were the main predictors of maternal anemia in the study population. According to the results, mothers with a low monthly family income are three times more likely to be anaemic than mothers with a high monthly family income. According to the findings of the research, pregnant mothers who grew up in a family with more than four members were more likely to be anaemic than those who grew up

in a family with only two members. It was found that hookworm raised the risk of anaemia.

A cohort study in eastern rural Maharashtra, India was conducted by **Patel, A., et al. (2018)** to study the trend in the prevalence of anaemia and low BMI among pregnant women from Eastern Maharashtra and evaluate if low BMI and anemia affect pregnancy outcomes. It was found that more than 90% of the pregnant women were anemic, 35% were thin (BMI<18.5) and nearly a third had both conditions. While mild anemia recorded before 20 weeks of gestational age did not increase the risk of stillbirths, neonatal deaths or LBW, but it increased the risk of stillbirths and neonatal deaths when recorded later in the pregnancy (>20 weeks). Moderate/ severe anemia recorded anytime during pregnancy increased the risk of neonatal deaths and LBW. It also increased the risk of stillbirths when recorded later in pregnancy. This study showed that a subtle public health action of early and aggressive management of anemia could lower the risk of adverse neonatal outcomes and thus concluded that a combination of anemia and thinness in pregnancy increased the risk of stillbirths, neonatal deaths and delivering LBW babies.

In May 2012 the 65th World Health Assembly (WHA) endorsed a Comprehensive Implementation Plan on Maternal, Infant, and Young Child Nutrition, which included six global targets: reducing stunting and wasting in children under the age of five, halting the obesity epidemic, reducing anaemia in women of reproductive age, reducing low birth weight, and increasing exclusive breastfeeding rates (Figure 2.4) (7).

The WHA targets were considered in the development of the 2030 development agenda, and are referred in Sustainable Development Goal 2.2, which aims to “end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons” (7).

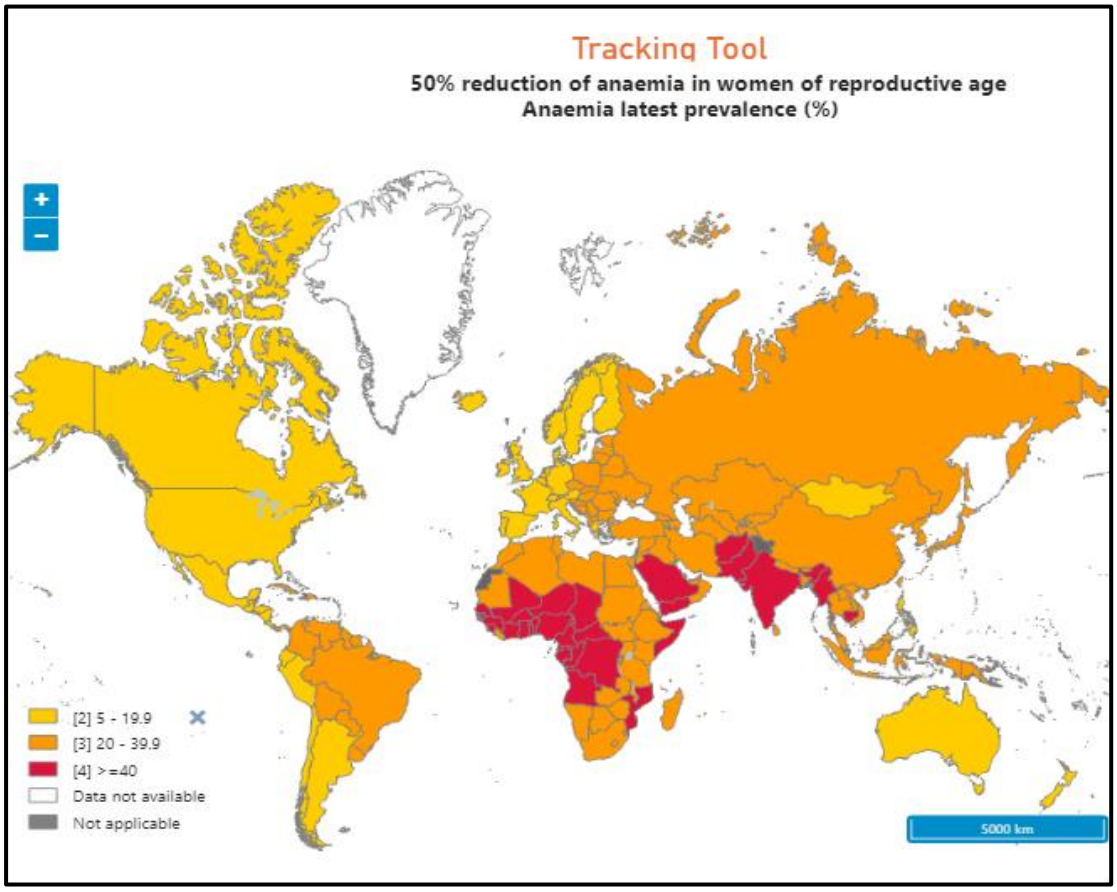
The aim of 2025 target is to reduce the prevalence of anaemia in WRA by 50 % by 2025. With a global baseline prevalence of 30.3 % in 2012 (8), the target in 2025 will be to reach a global prevalence of 15.2%. Between 2012 and 2025, to achieve the target, this change should be equivalent to a 5.2 AARR (annual average rate of

reduction) (7). The figure 2.5 shows the global status of anemia among WRA as of year 2016. The figure 2.6 shows the anemia profile for India, according to which, with the baseline prevalence of 51.3% in 2012, the target for 2025 is to reduce the prevalence of anemia among WRA to 25.6%. The required AARR for India to achieve the target is 5.2.

Figure 2.4: Global nutrition targets 2025

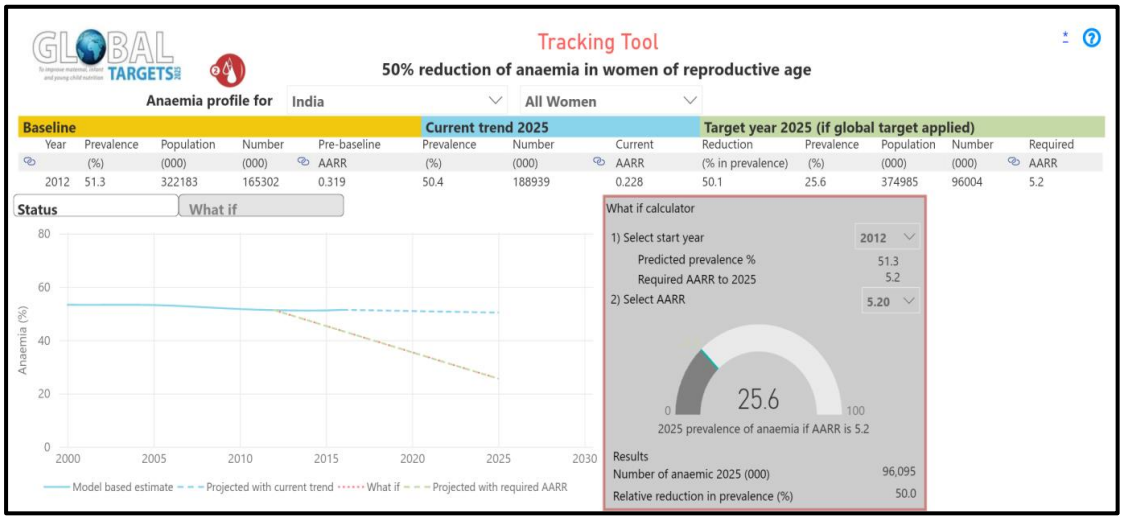
Source: https://www.who.int/nutrition/topics/English_Poster_B_Global_Target_2025.pdf?ua=1

Figure 2.5: Indicator mapping: Anaemia (world)



Source: https://extranet.who.int/nhdtargets/en/AnaemiaMap

Figure 2.6: Anaemia profile of India



Source: https://extranet.who.int/nhdtargets/en/AnaemiaMap

The figure 2.7 shows the trends in anemia among pregnant women in India during the period of around 18 years. It can be seen that though the progress have been made from NFHS-3 to NFHS-4 but the problem is still significantly persistent. It is evident from the data that around half of the women still suffer from any form of anemia despite all the actions being taken to prevent it. It was observed that though there has not been much improvement, but over the years, the proportion of severe anemia among pregnant women has reduced almost by half from 2.5% to 1.3%.

The figure 2.8 shows the trends in anemia among WRA in India over period from NFHS-2 to NFHS-4. Trends of anemia among WRA are somewhat similar to the trend observed among pregnant women, although the progress has been made, it is not up to the desirable rate. It was observed that prevalence of mild anemia among WRA has increased from 35% to 39.6% over the years.

The figure 2.9 shows the most recent available data on anemia in India, which shows that as of 2016, the prevalence of anemia was 51.4% among women of reproductive age.

Factors associated with Maternal Malnutrition

Despite international agreements and national laws to the contrary, the practice of marrying girls below the age of 18 is prevalent in many parts of the world and affects the lives of millions of young girls. A study by **Mathur S, Greene M, Malhotra A. (2003)** focusing thoroughly on the topic of early marriage of young girls and its consequences found a strong association between early age of mother and poor health status of infant and child. It was also observed that early marriage had negative developmental consequences in the areas of health, welfare, and economics that affect not only girls and their children, but also entire communities. As an example of Mali, where the maternal mortality ratio (MMR) for women aged 15–19 is 178 per 100,000 live births, compared to an MMR of only 32 for women aged 20–34 it was justified that childbearing in the adolescent years is truly harmful to both mother and child (Family Care International 1998; Centers for Disease Control and Prevention 2002).

Figure 2.7: Trends in anemia among pregnant women (India)

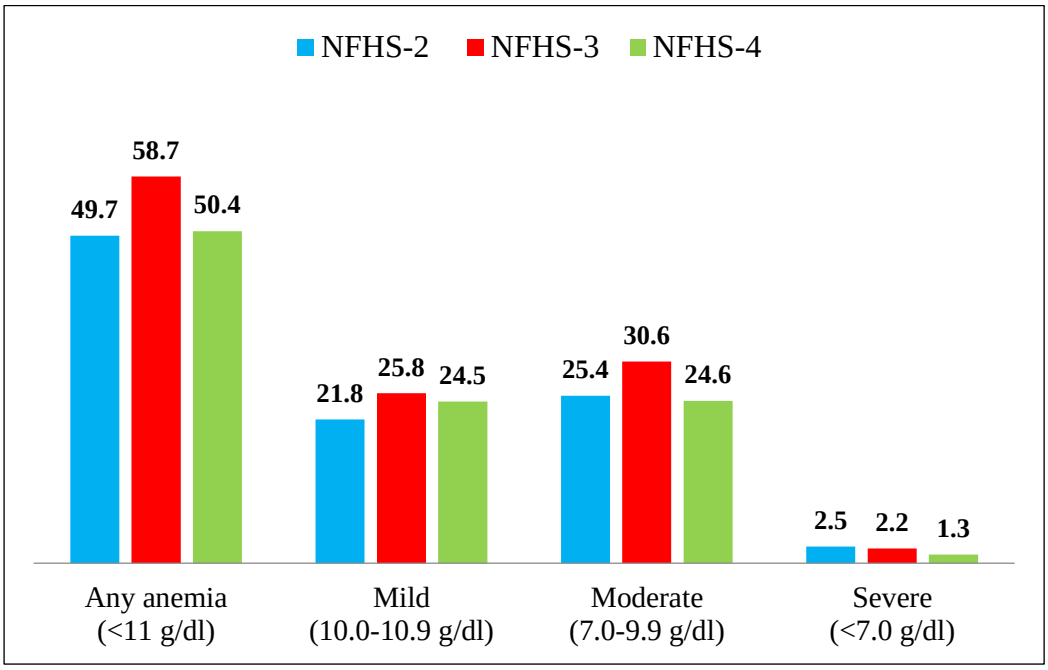


Figure 2.8: Trends in anemia among women of reproductive age (India)

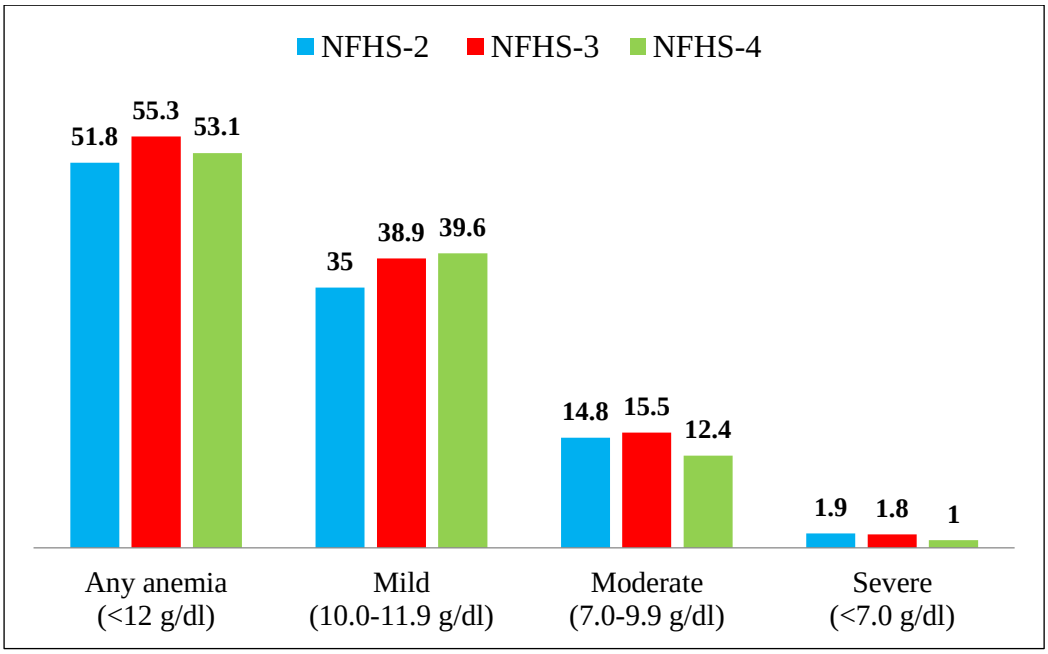
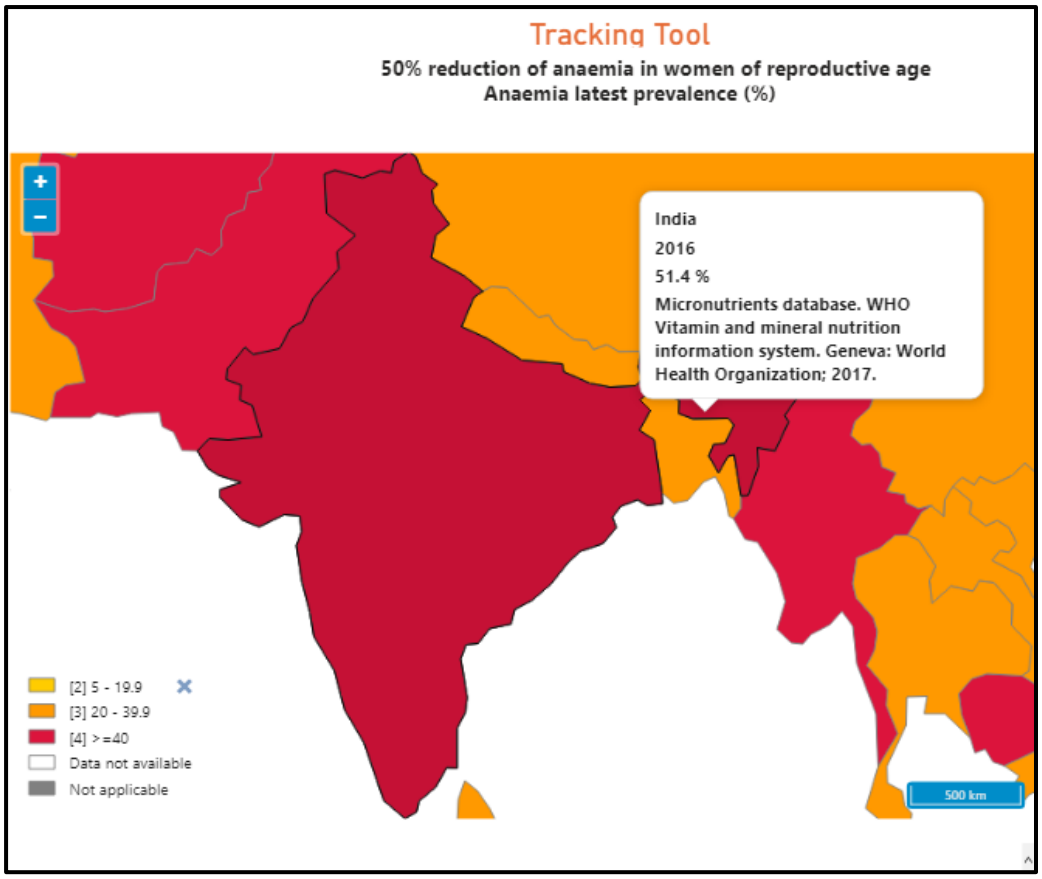


Figure 2.9: Indicator mapping: Anaemia (India)



Source: https://extranet.who.int/nhdtargets/en/AnaemiaMap

Most women living in developing countries experience various biological and social stresses that increase the risk of malnutrition in mother and child. **Ahmed T, Hossain M, Sanin K I (2012)** suggested that scaling up direct nutrition interventions, as well as addressing female illiteracy, lack of livelihoods, and women's empowerment, is critical to controlling the problem. Human development is not possible without taking care and controlling of undernutrition and micronutrient deficiencies. Factors which are responsible for the high levels of maternal and child undernutrition in developing countries are poverty, food insecurity, ignorance, lack of appropriate infant and young child feeding practices, heavy burden of infectious illnesses and poor hygiene and sanitation. The authors concluded that National governments, international organisations, and development partners should work together to combat IUGR, undernutrition, food insecurity, and micronutrient deficiencies, as a large portion of the world's population suffers from malnutrition. Only then would humanity be able to progress.

Silveira, K. B. R, et al. (2010) conducted a cross-sectional study in Maceió, Brazil with the aim to investigate the association of malnutrition in children with maternal nutritional status and environmental factors residing in substandard settlements. Through a household survey, socioeconomic, demographic, anthropometric, maternal and child health data were collected. An association between child malnutrition and maternal height was found but was not observed for body mass index. It was found that, as opposed to the socioeconomic variables, maternal education level had the greatest association with malnutrition. In both mothers with poor weight gain and those who were overweight, short height was associated with infant malnutrition, indicating that short maternal height is independent of the current nutritional status as a risk factor for stunting of infants. It is also clear that short maternal height is a powerful indicator of child malnutrition, as it is significantly linked to poverty and adverse environmental conditions.

Women of reproductive age (WRA) and children in particular, are vulnerable to malnutrition due to insufficient dietary intake, inequitable distribution of food within the household, improper storage and preparation of food, dietary taboos, infectious diseases, serious and recurrent infections, and limited health care. The physiological costs of pregnancy and lactation also greatly contribute to women's low nutritional status. **Regassa, N., &Stoecker, B. J. (2012)** conducted a study to estimate the

magnitude of maternal malnutrition in one of the most populated areas of southern Ethiopia, the Sidama region, and to analyse the associated contextual risk factors. Researchers used both body mass index (BMI) and mid-upper-arm circumference (MUAC) to estimate the nutritional status of mothers. The results showed that 28.1 % of women were malnourished (BMI <18.5), 67.5 % were in the normal category (BMI 18.5 to <25) and a small proportion (4.5%) were found to be overweight (BMI 25 to <30) or obese (0.8 %), based on BMI measurements. While assessment of maternal malnutrition by MUAC gave slightly different results: that is, the percentage of undernourished women increased to 31.4 %. A multivariable analysis in a form of logistic regression employed to identify the risk factors of chronic energy deficiency in women revealed that three individual-level variables were important predictors of maternal malnutrition: woman's age, duration of breast-feeding, literacy status. Three additional household variables were also found to be significantly associated: marital form, land size and priority access to food in the household.

Despite encouraging progress in a number of maternal health indicators, maternal malnutrition (particularly undernutrition) remains one of Ethiopia's most pressing development challenges. Thus, **Geda, N. R. (2021)** very recently conducted a study with the aim to examine disparities in maternal malnutrition and estimate the population level impacts of key risk factors using the most recent nationally representative data. This study was based on a nationally representative cross-sectional data from the Ethiopian Demographic and Health Survey/EDHS, conducted in 2016. The current research used weighted samples of 9949 mothers between the ages of 15 and 49 who were not pregnant at the time. The main outcome variables were maternal undernutrition and overweight and/or obesity defined by Body Mass Index (BMI). Information on parental education, wealth index, age (15–24, 25–34 and 34 + years), type of residency (rural vs. urban), religion (Orthodox Christian vs. others), type of family structure (monogamous vs. polygamous), work status (working vs. not working), household size (small, large and medium), and household headship (male vs. female) were included. Prevalence of undernutrition among mothers was found to be 22%. To find factors linked to malnutrition among women of reproductive age in the study population, researcher used multivariable logistic regression analyses. Age of the women, residence, maternal education, and non-monetary income all tended to have a significant relationship with both undernutrition and overweight/

obesity. The combined population-level impacts of the three socioeconomic variables, as well as other variables, on maternal undernutrition were verified by further study of the risk factors using the Population Attributable Fractions (PAFs). Rural residence, non-educated mothers, non-educated husbands, being young (age 15–24 years), religion (Orthodox Christian), being in the lowest income group, and living in a polygamous family system were all found to play a role in the occurrence of maternal undernutrition. This study emphasized on the importance of addressing both demand side (such as providing economic support to poor rural women, education and health promotion initiatives, and improving access to a balanced diet) and supply side (such as enhancing policies and services that can simultaneously minimise the risk or burden of both undernutrition and overweight/obesity in the) interventions.

Aldana-parra, F., Vega, G. O., & Fewtrell, M. (2020) carried out a secondary study using data from a national survey conducted in Colombia in 2010: the Encuesta Nacional de la Situación Nutricional in Colombia (ENSIN) for the purpose of estimating the effect on the anthropometric status of children under the age of 2 in Colombia of the maternal body mass index (BMI) and infant feeding mode, in particular breastfeeding (BF) practices. ENSIN was a survey of nationally covered households with urban and rural representation that provided socio-demographic features of households, anthropometric data of mothers and children, and information on breastfeeding and early feeding. The study used Infant anthropometry indicators like Weight for length Z-score (WLZ) and length for age Z-score (LAZ) as outcome variables. Maternal anthropometric status, breastfeeding practices and infant feeding mode variables were taken as the predictors of infant anthropometry. Some socio demographic variables were also included such as such as place of residence (urban/rural), wealth index, maternal age, ethnicity (mestizo/minorities), education attainment in years, living with the partner, currently working, alcohol and cigarettes consumption during pregnancy and delivery by caesarean section. In this secondary analysis, a strong correlation between higher maternal BMI and infant overweight was observed, but no association with EBF, BF and liquid, semi-solid and solid food initiation age was identified. Adjustable factors related to maternal nutritional status, such as maternal BMI and maternal weight, were therefore found relevant and feasible targets for the development of population-level public policies that promote balanced growth in the infant population. The study concluded that efforts to promote

healthy maternal weight in primary care health, beginning from pre-conception and continuing during pregnancy can decrease the risk of childhood overweight and obesity and have long-term health benefits.

Many developing countries now face the double burden of malnutrition. **Oddo, V. M., et al. (2012)** conducted a study to estimate the prevalence of the double burden of malnutrition and to identify associated maternal, child, and household characteristics in rural Indonesia and Bangladesh. The analysis included 247,126 rural households from the Indonesia Nutrition Surveillance System (2000–2003) and 168,317 rural households from the Bangladesh Nutritional Surveillance Project (2003–2006). Separate analyses were conducted for rural Indonesia and Bangladesh. Logistic regression models were used to determine the maternal and child double burden (MCDB) and its association with individual and household characteristics. Maternal characteristics such as age, height, and education level were strongly associated with the risk of MCDB in both Indonesia and Bangladesh. In both countries, maternal short stature was linked to increased risk of MCDB. Higher levels of maternal education were protective against MCDB in the Indonesian study, while on the other hand, it was linked to an increased risk of MCDB in rural Bangladesh. Household characteristics, such as family size and socioeconomic status, were also examined in this study. Higher SES, as measured by weekly household expenditure, was found to be significantly linked to MCDB. The current research stresses the importance of using a broad concept of malnutrition. These results indicate that MCDB is not limited to urban areas, and suggests potential policies and interventions should focus on malnutrition in both rural and urban settings.

With property and land passing from mother to daughter, the Minangkabau people of West Sumatra in Indonesia are renowned for their matrilineal culture. Despite a comparatively equitable social position for women in the society, the effect of health inequality is unequal. Therefore, **Bhanbhro, et al. (2020)** carried out an exploratory study to investigate the relationship between social, cultural and economic backgrounds, from the perspectives of mothers, fathers and care providers, in such a distinctive group with maternal nutrition and pregnancy-related health results, with an aim to identify opportunities in the commonly known matrilineal culture of Indonesia to develop culturally relevant approaches to enhance maternal health and nutrition. Qualitative, semi-structured interviews (n=19) with women, men, midwives and

health workers in the community were used to undertake the study. ‘Minangkabau matrilineality and the role of women’; ‘culture and supportive attitude towards pregnant women’; ‘dietary patterns, attitude and access to food’; and ‘poor access to food and nutrition information’ were the key themes that emerged from the results. Participants expressed that Minang matrilineality empowered and enabled women to make nutrition and household resource management decisions during pregnancy; however, significant factors such as low income, no government support, limited access to nutritional information, and food-related cultural beliefs had a negative impact on their pregnancy. To interpret the data, the inductive or 'bottom-up' method of thematic analysis was used manually. Using the model of social determinants, it was determined from the data that the major factor in women's nutritional well-being is household income. Although the matrilineal culture of Minang empowered them to make decisions, family income and poverty hindered them from getting sufficient access to the right nutrition. The study showed that the Minang matrilineal culture promoted women's empowerment and provided an empowering atmosphere and an opportunity to co-operate and assess initiatives that were locally responsive and sustainable to enhance maternal health and nutrition.

Nguyen, P. H., et al.(2016) with an aim to examine associations between adolescent pregnancy and child undernutrition in India used data from the fourth round of India’s National Family Health Survey (NFHS-4) 2015-16 which is representative at both the state and district levels, gathered data from 601 509 households. To understand the degree to which adolescent pregnancy and the possible social, biological, and programmatic mechanisms related to nutritional status of offspring, multivariable regression and structural equation model were used. The findings of the study showed that children born to adolescent mothers were at risk of being undernourished which was associated with poor maternal nutritional status of adolescent mothers. Stunting and thin were 11 percentage points more prevalent in children born to adolescent mothers compared to children born to adult mothers. It was also found that adolescent pregnancy was negatively associated with maternal nutritional status. The study suggested that interventions should be made to increase age at first marriage, age at first birth, and education for girls which can be a successful strategy to enhance maternal and child nutrition.

Determinants of Maternal malnutrition

Malnutrition in pregnancy remains unacceptably high in all regions of Africa, despite encouraging global change. Primary research may not be appropriate to paint a full picture of malnutrition during pregnancy and its main risk factors. As a response, **Desyibelew, H. D., &Dadi, A. F. (2019)** conducted a systematic review and meta-analysis of observational studies published from January 1/2008 to January 31/2018 to look at the impact of malnutrition during pregnancy in Africa, specifically protein energy malnutrition, and to see how widespread it was and what factors influenced it and also to generate comprehensive data for experts and decision-makers in order to support policy implementation progress. Studies that assessed malnutrition during pregnancy using the measurement of body mass index (BMI) and Mid Upper Arm Circumference (MUAC) were included. Studies conducted in high or low risk pregnant population such as those living in refugee camps, Human Immune Virus (HIV) patients, or if the study has been conducted in any other restricted populations like adolescent pregnant population as prevalence studies conducted in such restricted population might not represent the general population were excluded. Articles quality was assessed using the Newcastle-Ottawa Scale (NOS) and studies with fair to good quality were included. A total of127 records were identified through database searching and 104 retrieved studies were omitted through step-by-step process for various reasons. 23 articles when assessed by the NOS criteria were found to be of fair to good quality and were included for the final review. It was found that the odds of malnutrition were higher in pregnant mothers living in rural areas and they had a 2.6 times higher chance of being malnourished as compared to their urban counterparts. The partner's low educational status was also found to have a direct effect on maternal nutrition. Pregnant women who came from households with better economic status had a 53 % lower chance of being malnourished. The findings also showed that women who had two or more pregnancies had a 2.15 times greater risk of malnutrition than women who had only one pregnancy. Authors suggested that efforts should be renewed to ensure that proper and widespread implementation systems are put in place in order to substantially reduce the burden on African countries.

Malnutrition is a major public health problem that affects a huge portion of reproductive-age women around the world. In most African settings, the prevalence of

malnutrition among reproductive-age females is unacceptably high. **Bestman, P. L., Kaminga, A. C., &Luo, J. (2020)** conducted a systematic review with the objective to investigate the prevalence and determinants of maternal malnutrition in Africa. To identify published research-based articles reporting on maternal malnutrition, a selective systematic search was conducted in a number of related databases. The primary aim of the search was to locate cross-sectional studies that recorded on outcomes related to the study and were published between January 1st, 2000 and December 31st, 2019. Through electronic database scanning, a total of 2,483 documents were found, and 2,467 studies were omitted through a systematic process. Finally, this systematic study covered 16 studies involving 81,185 reproductive-age females. The New Castle-Ottawa Scale for cross sectional studies was used to determine the quality of the 16 studies included. The prevalence rate of maternal malnutrition (specifically, undernutrition) among reproductive-age women in Africa assessed in this study was estimated to be 20.2 percent. Maternal age, bad marital condition, frequent coffee drinking, household food insecurity, low decision making autonomy at household level, husband's poor educational status were the variables found to be significantly associated with maternal under nutrition. The interrelationship between a mother's nutritional status and that of her child emphasizes the importance of improving maternal nutritional status because it can benefit both maternal and child health outcomes. The authors concluded that in order to ensure optimal cognitive growth and development for women of reproductive age in Africa, it is essential to resolve the challenges of maternal malnutrition. As a result, policymakers, health-care agencies, civil society groups, and programme implementers must do more to fight this deadly disease.

A study conducted in Ethiopia by **Girma W, Genebo T. (2002)** on Determinants of the Nutritional Status of Mothers and Children was based on data from the 2000 Demographic and Health Survey. This study used Women's BMI (Body mass index) as an indicator to assess chronic energy deficiency (CED) malnutrition in women. Both bivariate and multivariate analyses were employed to identify the determinants of chronic energy deficiency in women. The logistic regression analysis identified the most important explanatory variables of nutritional status in urban women. In this model, region of residence, household economic status, employment status and marital status of women were found to be determinants of women nutritional status.

Household economic status, women's employment status, woman's decision making autonomy over her own cash earnings were some of the most important determinants of nutritional status in Ethiopian women.

Women's malnutrition, especially undernutrition, in Ethiopia remains a major public health challenge. Although the levels and determinants of women's nutritional status were explored in different studies, the impact of living close to the international border on women's nutrition was not investigated. Therefore, **Delbiso, T. D., et al. (2016)** conducted this research with an aim to examine the effect of living close to borders on the nutritional status of women in Ethiopia, while also taking into account other relevant covariates. The third comprehensive Ethiopian Demographic and Health Surveys (EDHS) 2011 dataset was the basis for the study. The outcome variable was the nutritional status of women as measured by BMI. The research exposure variable was the residency status (border resident or not), measured in kilometers (km) from the borders by the nearest distance. Research showed that about 25 % women (non-pregnant, non-lactating) were thin in Ethiopia, while 8 % were overweight. The results also showed that women in lowland areas were more likely to be thin. The findings also stated that the odds of being overweight increased with age, education, family wealth, having access to improved toilet facilities, and living in urban settings or lowlands. The research concluded that improved access to sanitation and initiatives to boost household resources and livelihood support are recommended as targeted measures to improve nutritional status in border zones.

Malnutrition remains a major public health issue in Ethiopia, despite important advances and improvement in past years. Among the most vulnerable population groups during emergencies and droughts are pregnant and lactating women (PLW), along with young children. The screening and management of PLW with malnutrition, especially in the humanitarian context, is not often thoroughly investigated. Therefore, **Gebre, et al. (2018)** carried out a community-based cross-sectional study with the objective to help bridge the gap in evidence on the magnitude and determinants of maternal nutrition in humanitarian settings in general and, in particular, in the Ethiopian context. In this analysis, the dependent variable was acute malnutrition or wasting, described as MUAC < 21 cm. Age, educational status, marital status and occupation of mothers, annual household income, attendance at antenatal care (ANC), type of assistance obtained by household members in the

preceding 3 months and receipt of TSF (targeted supplementary feeding) food rations or safety net food rations by any member of the family in the preceding 6 months were variables considered to construct the regression model. Even with on-going interventions, malnutrition rates among pregnant and lactating women remain high in emergency setting. Factors correlated with maternal nutritional status in this study were receiving antenatal treatment, maternal occupational status and belonging to families that received TSF. This suggested the need for sustainable ways to deal with the high prevalence of PLW malnutrition. Interventions targeting health system responses were recommended, such as extensive nutritional education and support through prenatal care and empowerment for women.

A cross-sectional study by **Kedir H. Berhane Y, Worku A. (2016)** in eastern Ethiopia to determine the magnitude and determinants of malnutrition among pregnant women found that the risk of malnutrition was positively and significantly associated with lower levels of maternal autonomy in household decision-making. It was also found that those women who received prenatal dietary information were at lower risk of malnutrition and the risk of malnutrition was higher among women in households not possessing livestock.
Furthermore, women whose husbands had some education had better access to information regarding nutrition during pregnancy through their husbands. Hence, such women got better health and nutrition support than their counterparts.

A paper on Quantitative Analysis of determinants of Child and Maternal Malnutrition in Nigeria by **Ajieroh V. (2009)** focusing on the impact of socioeconomic and demographic factors on child and maternal nutritional status used data from the 2003 Nigeria Demographic and Health Survey (NDHS). For the women's model, the Body Mass Index (BMI) was used to reflect the nutritional status of mothers. The effect of maternal work, household economic status, having primary and secondary education, maternal age, woman having the final say on her health was found to be significant on maternal nutrition (BMI). The determinant with the greatest potential to reduce child malnutrition appeared to be maternal education.

High levels of food insecurity and infection with the human immunodeficiency virus (HIV) place most breastfeeding mothers at high risk of malnutrition in Kenya. **Gewa, C. A., Oguttu, M., &Yandell, N. S. (2012)** examined the role of selected socio-

economic, demographic and health factors as determinants of nutritional status among HIV-infected and HIV-uninfected mothers in rural Kenya in a research, and the interrelationship between maternal nutrition and child nutrition within this population was further investigated. Mean maternal anthropometric measurements did not vary from maternal HIV status, suggesting that there are other overarching factors besides HIV status that affect maternal nutrition status. In the majority of the maternal anthropometric measures used in this analysis, having several children under the age of two and breastfeeding at the time of study were correlated with significantly lower values. Compared with food insecure households, food-safe households were associated with significantly higher levels of maternal BMI, MUAC and body fat mass. Low household SES is also associated with restricted access to services such as food and health care that are known to affect nutritional status. The existence of a significant positive association between maternal anthropometric status and child nutrition status independent of maternal HIV status and age, household SES, and age and sex of children was demonstrated in this study.

Najafizada, S. A. M., Bourgeault, I. L., & Labonté, R. (2017) conducted a literature review with an aim to examine the impact of various social determiants of health on maternal health in Afghanistan, thereby filling a significant gap in the existing literature, and to identify the social determinants that influence maternal health in order to inform policy and programmes aimed at improving maternal health in Afghanistan. This review followed Arksey and O'Malley's framework, which included (1) defining the question, (2) searching the literature, (3) evaluating the studies, (4) synthesising selected evidence in context, and (5) summarising potential programmatic implication of the context. For this study, a total of 125 citations were examined. Following a procedure of identifying and filtering citations, 38 articles/reports were found to meet the inclusion criteria and were included in the study. Health care, education, sociocultural practices, employment, income, food, and sanitation were all revealed to be important determinants of maternal health in Afghanistan, according to the literature. In the literature, it was well established that social determinants have an impact on maternal health. According to the studies included in this review, health determinants in Afghanistan have either a direct impact on maternal health or mediated by other determinants. The reviewers believed that, Individual determinants, cannot explain the complexity of maternal health; thus, a

web of correlations between determinants has a bigger impact than the sum of all determinants. As a result, they suggested that interventions aimed at improving maternal health should be comprehensive.

A cross sectional study by **Ravaoarisoa, L et al. (2018)** with an aim to identify the socioeconomic determinants of malnutrition among mothers was carried out in Amoron'i Mania region of Madagascar conducted during the post-harvest period among 670 mothers using a two-stage cluster sampling. Mother's nutritional status was assessed using anthropometric measurements such as weight, height and Mid Upper Arm Circumference (MUAC). Information about dietary, socioeconomic, health and reproductive characteristics were also collected. BMI was calculated as a variable for the nutritional status, Dietary Diversity Score was calculated as a variable for Dietary diversity. The study affirmed that the problem of undernutrition affects mothers with significant frequency in the region of Amoron'i Mania. Bivariate analysis showed that for BMI model, household size equal to or greater than 6, use of unsafe water source and for MUAC model, use of unsafe water source, low movable property score, breastfeeding status of mothers and education level were found to be significantly associated with maternal undernutrition. Similar results were also observed in the multivariate analysis where, in BMI model, again household size and water source and for MUAC model, water source and number of children under five were found to be the significant factors for maternal undernurition. Combating maternal malnutrition requires measures to improve access to clean drinking water and to facilitate family planning. The study suggested the necessity to analyze the adequacy between the solutions adopted and the real causes in order to re-adjust the interventions which would help in resolving the problem of malnutrition in the region.

Shariff A, Singh G. (2002) from the cross-sectional rural household survey conducted by the National Council of Applied Economic Research in 1994 performed analysis using the data on 7000 odd women in the reproductive age group who delivered a child in the year before the survey and revealed that the utilization of reproductive health care services in India is significantly affected by the mother's education and family composition. Further, Husband's education was also found to be significantly correlated with health care utilization. Authors concluded that new strategies should be evolved to ensure that millions of pregnant and lactating mothers

receive the benefits of modern technology that will reduce both maternal and infant and child mortality which was being missed by many mothers and the access to locally available health services significantly increases maternity care use.

A scoping review by **Hamal, M., et al. (2020)** on Social determinants of maternal health was conducted using peer-reviewed journal articles in two databases (PubMed and Science Direct) on quantitative and qualitative studies conducted in India after 2000. Forty-one studies that met the study objectives were included: 25 identified through databases and search engines and 16 through reference check focusing on structural and intermediary factors in the framework that influenced maternal health outcomes in terms of "maternal mortality" and "maternal health service use". Poverty or economic status, caste/ethnicity, maternal education, husband's education, gender, and religion were the most frequently associated structural factors of maternal health service use in India. Community-related factors that were found to influence maternal health service use in India were place of residence; higher concentration of wealth and education at the community level and of large family and caste, particularly SC/ST; factors influencing accessibility of health service, namely, distance to health facilities, village connected by all-weather road, and availability of transportation; and migration status or duration of residency. Women's age at marriage, maternal age at childbirth, and parity were found to influence maternal health service use in India.

Secondary data analysis to determine the levels and trends of different forms of malnutrition among urban poor women in India by **Sethi et al. (2020)** was done using data from two rounds of DHS conducted during 2005–2006 (DHS-3) and 2015–2016 (DHS-4). This study indicated that mothers in urban India suffered from various forms of malnutrition (short stature, thinness, anaemia, and obesity). The major findings of the study were that, first, the prevalence of short stature, thinness, and anaemia among urban poor mothers was significantly higher than among mothers in the immediate next wealth quartile and remaining two higher quartiles. Second, prevalence of thinness and obesity was comparable among urban poor mothers. Third, decadal gains were significant for thinness reduction but there was little to no change in prevalence of short stature and anaemia (any form), whereas obesity increased by over 2.5 times. Fourth, belonging to tribal household increased odds of thinness among urban poor women. Fifth, daily intake of milk/milk products, pulses/beans/ egg/meats, and dark green leafy vegetables emerged as a key influencer for reducing

short stature and thinness among urban poor mothers, along with secondary or higher education.

Goli, S., Rammohan, A., & Singh, D. (2015) conducted a study aimed to analyze the association between early marriage and early childbearing on nutritional status of Indian women, with an emphasis on Bihar and Andhra Pradesh, the two states accounting for the highest proportion of women marrying and giving first birth before 18 years of age. The researchers used data from the third round of India's National Family Health Survey (NFHS), which was conducted in 2005–2006. Nutritional status of women measured using the Body Mass Index (BMI) and anemia level measured as the amount (grams) of hemoglobin level in deciliter blood were the dependent variables of the study. BMI is commonly used to classify thin, normal and obese. Three levels of severity of anemia were distinguished in non-pregnant women: Mild anemia (10.0–11.9 g/dl), Moderate anemia (7.0–9.9 g/dl), and Severe anemia (<7.0 g/dl). The key independent variables used in this study were early age at marriage and early childbearing. A number of other socioeconomic factors such as age, Children Ever Born (CEB), place of resident, caste, educational status of respondent and her partner, religion, economic status were also used in the study as control factors. In the statistical analysis, firstly to estimate differential in nutritional status of women by age at marriage and age at first births bivariate analysis was carried out followed by multinomial regression to estimate coefficients of three categories (Thin, Normal and Obese) of BMI of women by age at marriage and age at first birth after controlling for relevant socioeconomic factors. All analyses of this study were carried out using STATA 13 (Stata crop LP, College Station, Texas, USA). The findings showed that 60 % of currently married women aged 15-49 years in India were married before they became 18 years old and around 34% of women gave first birth before the age of 18 years. Early marriage and pregnancy were found to be more common in rural areas and among socially disadvantaged groups such as SCs, STs and OBCs than in the upper class. The results revealed a considerably larger percentage of women married before the age of 18 were in the 'thin' category than women married at older ages that in India (35 %, $p<0.001$) and the selected states of Andhra Pradesh (31 %, $p<0.001$) and Bihar (43 %, $p<0.001$). Similar results were also observed with regards to women who had their first birth before 18 years of age. The finding also shows that the prevalence of anemia decreased steadily with the increasing age at marriage in

Andhra Pradesh, Bihar and India. The researchers suggest that India's multi-sectoral initiative to combat maternal malnutrition needs to be strengthened.

A study by **Sethuraman, K., Lansdown, R., & Sullivan, K. (2006)** which explored the relationship between women's empowerment, maternal nutritional status, and the nutritional status of their children aged 6 to 24 months in rural and tribal communities of South India was undertaken in the Mysore region of Karnataka, India using both qualitative and quantitative methods of data collection. Structured interviews with mothers were performed and anthropometric measurements were obtained for 820 mother–child pairs. The data were analyzed by multivariate and logistic regression. They observed that women's empowerment variables were significantly associated with child's weight-for-age and maternal nutritional status. The findings of this study suggested that the combination of empowerment with knowledge and resources can further reduce malnutrition significantly, more than any one of these inputs alone.

The above discussed literature shows that multiple determinants of maternal malnutrition have been identified in different parts of the world at different points of time. The majority of studies have looked at the determinants at a specific point in time or over a short time interval.

Thus, there is a strong need to understand how these determinants have transitioned with the passing years and also which are the major determinants to be focused upon now.

An in-depth understanding of the transition in the determinants, if any will help in understanding the prospective changes in future. In order to support the ongoing programmes for healthcare and nutrition, an understanding of the determinants will help in coming up with recommendations for reducing adverse outcomes.

Also, large secondary datasets are available for health policy research. Health policy research in a country like India requires large sample sizes, cutting across geographic, demographic, and other relevant population categories. Obtaining such data directly from the field proves time-consuming and expensive for individual researchers (Iqbal F. 2013). In comparison, available secondary data constitute a low-cost alternative for policy studies (Best, A. E. 1999).

Many studies reviewed above were primary studies and various studies used available secondary data, showing that there is a vast area that can be explored with available secondary data.

Methods and Materials

METHODS AND MATERIALS

The present study was conducted to assess transition in determinants of maternal malnutrition in India over a period of two decades by conducting a secondary data analysis using data from National Family and Health Surveys (1998-2016).

National Family Health Surveys (NFHS)

The Government of India's Ministry of Health and Family Welfare (MoHFW) funded the establishment of 18 Population Research Centers (PRCs) in universities and institutes of national repute across the country. With funding from the United States Agency for International Development (USAID), the MoHFW launched the project to strengthen the survey research capabilities of the PRCs (PRC Project) in 1991. One of the most significant aspects of the PCR Project was the National Family Health Survey (NFHS) (IIPS. 1995).

The National Family Health Survey (NFHS) is a multi-round, large-scale survey carried out in a representative sample of Indian households. The survey gathers data on fertility, infant and child mortality, family planning use, maternal and child health, reproductive health, nutrition, anaemia, and the use and quality of health and family planning services in India (9). This data was intended to help policymakers, administrators, and researchers evaluate and assess population and family welfare programmes and strategies (IIPS. 1995).

Since the first survey in 1992-93, there have been five rounds of the survey. Factsheets of key indicators on population, reproductive and child health, family welfare, nutrition and others for 22 States/UTs of the first Phase of the most recent 2019-20 National Family Health Survey (NFHS-5) was recently released, and the key indicators for the second phase are not yet released due to delays caused by the pandemic but will be available shortly.

Each successive round of the NFHS has had two specific goals:

a) “To provide essential data on health and family welfare needed by the Ministry of Health and Family Welfare and other agencies for policy and programme purposes,” and

b) “To provide information on important emerging health and family welfare issues.”

National Family Health Survey 1 (NFHS-1)

The first National Family Health Survey (NFHS-1) was conducted in 1992-93, designed to explore the demographic and socioeconomic determinants of fertility, family planning and maternal and child health. The NFHS covered the population from 24 states and the National Capital Territory of Delhi, containing 99 percent of the population of India. A total of 88,562 households were surveyed, with rural households accounting for two-thirds of the total. The NFHS is a household survey that included 89,777 ever married women between the ages of 13 and 49. The data collection under NFHS-1 was carried out in three phases from April 1992 to September 1993. (IIPS. 1995)

National Family Health Survey 2 (NFHS-2)

After the conducting India's first National Family Health Survey (NFHS-1) in 1992-93, MoHFW designated the International Institute for Population Sciences (IIPS) in Mumbai as the nodal agency for a second survey (NFHS-2), which took place in 1998–99. One of the main goals of NFHS-2 was to provide information on fertility, family planning, infant and child mortality, reproductive health, child health, women's and children's nutrition, and the quality of health and family welfare services at the state and national levels. Examining this data in the light of relevant socioeconomic and cultural influences was another important goal. The NFHS-2 sample covered more than 99 percent of India's population living in all 26 states excluding the Union Territories. The overall target sample size included was of approximately 90,000 ever-married women between the ages of 15 and 49 years. Information from 91,196 households was collected along with information on 32,393 children born in the three years preceding the survey. (IIPS., & ORC Macro. 2000)

Figure 3.1: NFHS-1 survey methodology

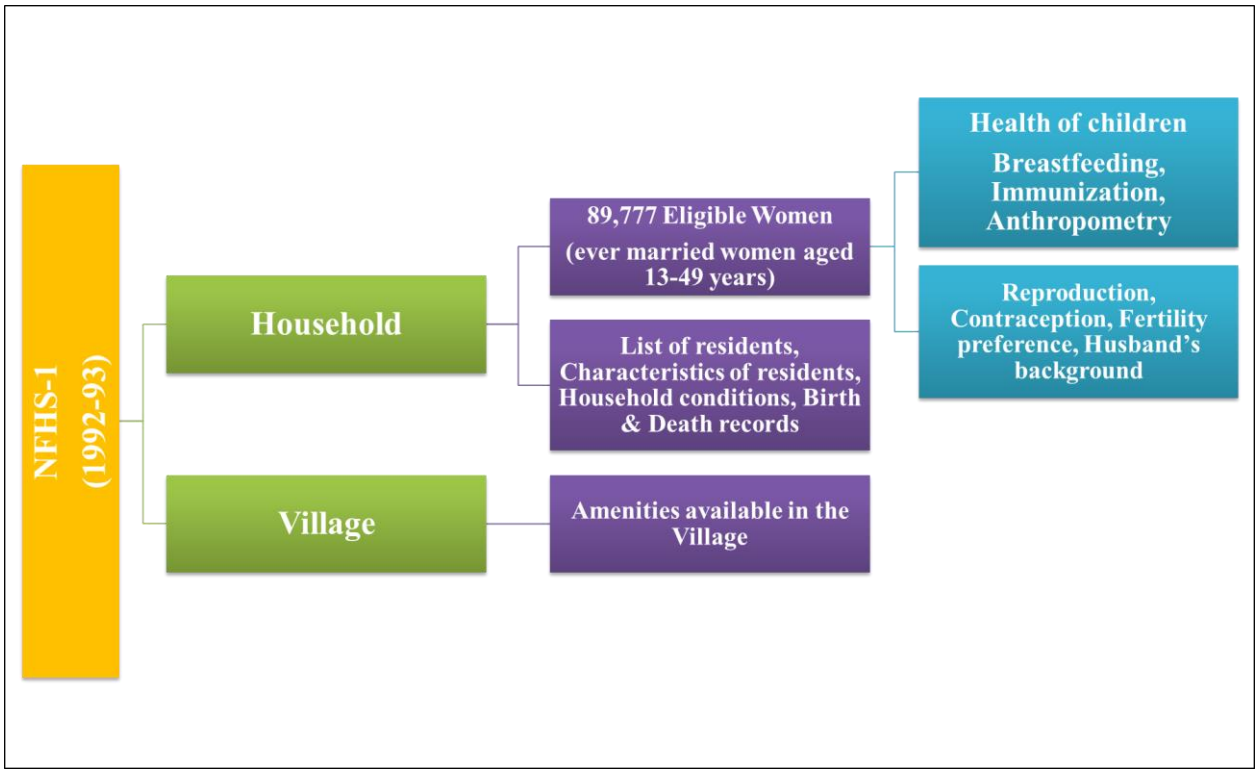
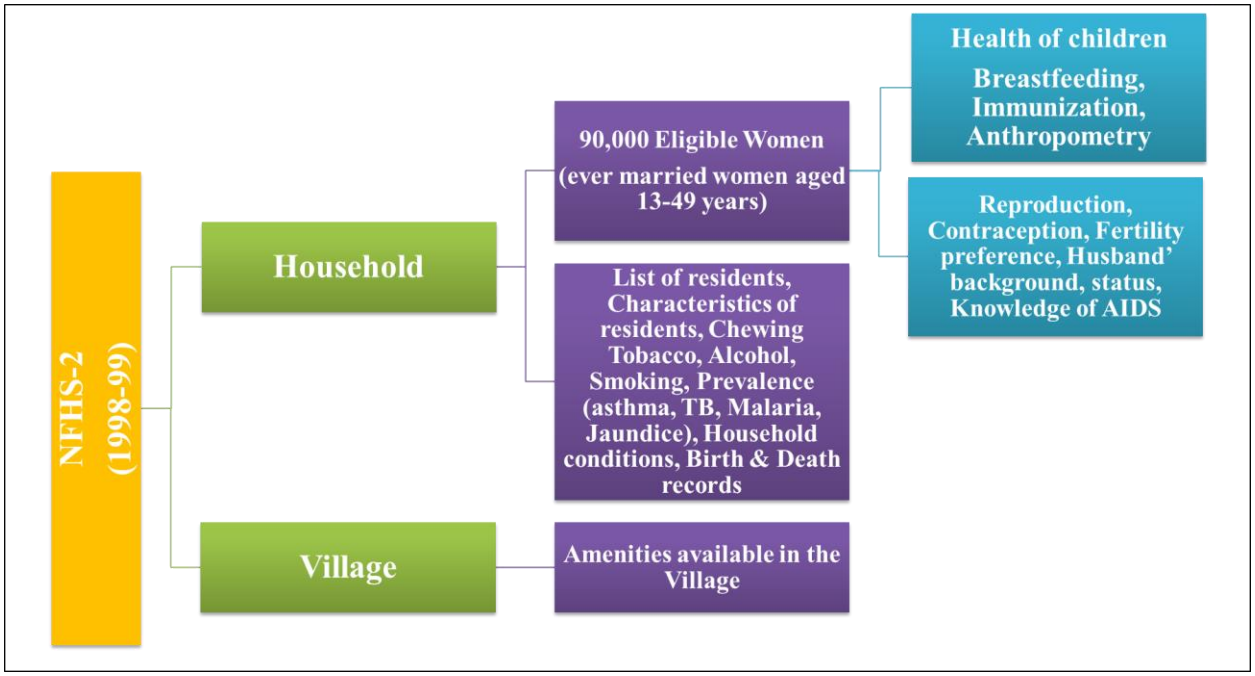


Figure 3.2: NFHS-2 survey methodology



National Family Health Survey 3 (NFHS-3)

The third National Family Health Survey (NFHS-3) was conducted in 2005-06 under the auspices of the Government of India and coordinated by the International Institute for Population Sciences (IIPS). NFHS-3, like its predecessors NFHS-1 (1992-93) and NFHS-2 (1998-99), offered data on fertility, mortality, family planning, HIV-related knowledge, and essential aspects of nutrition, health, and health care. NFHS-3, unlike previous surveys, interviewed men aged 15 to 54 and never married women aged 15 to 49, as well as ever-married women, and asked about perinatal mortality, male participation in maternal health care, adolescent reproductive health, higher-risk sexual conduct, family life education, healthy injections, and tuberculosis awareness. In addition, for the first time in India, NFHS-3 conducted HIV blood testing to provide population-based data on HIV prevalence.NFHS-3 gathered data from 109,041 households across the country, including 124,385 women aged 15 to 49 and 74,369 men aged 15 to 54. The NFHS-3 nationally representative sample included 99 percent of India's population, distributed across all 29 states. (IIPS., & Macro international. 2007)

National Family Health Survey 4 (NFHS-4)

The fourth in the NFHS series, the 2015-16 National Family Health Survey (NFHS-4), provided data on India's population, health, and nutrition for each state and union territory. The 2015-16 National Family Health Survey's prime objective was to collect vital information on health and family welfare, as well as information on emerging issues in these fields. Via a series of biomarker tests and measurements, the clinical, anthropometric, and biochemical (CAB) part of NFHS-4 was designed to provide crucial estimates of the prevalence of malnutrition, anaemia, hypertension, HIV, and high blood glucose levels. In NFHS-4, 601,509 households, 699,686 eligible women age 15-49 and 112,122 eligible men age 15-54 were interviewed for a response rate of 98 percent, 97 percent and 92 percent respectively. The data gathered through NFHS-4 was intended to help policymakers and programme managers set benchmarks and track improvement in India's health sector over time, as well as recognize the need for new programs in specific health areas. (IIPS., & ICF. 2017)

Figure 3.3: NFHS-3 survey methodology

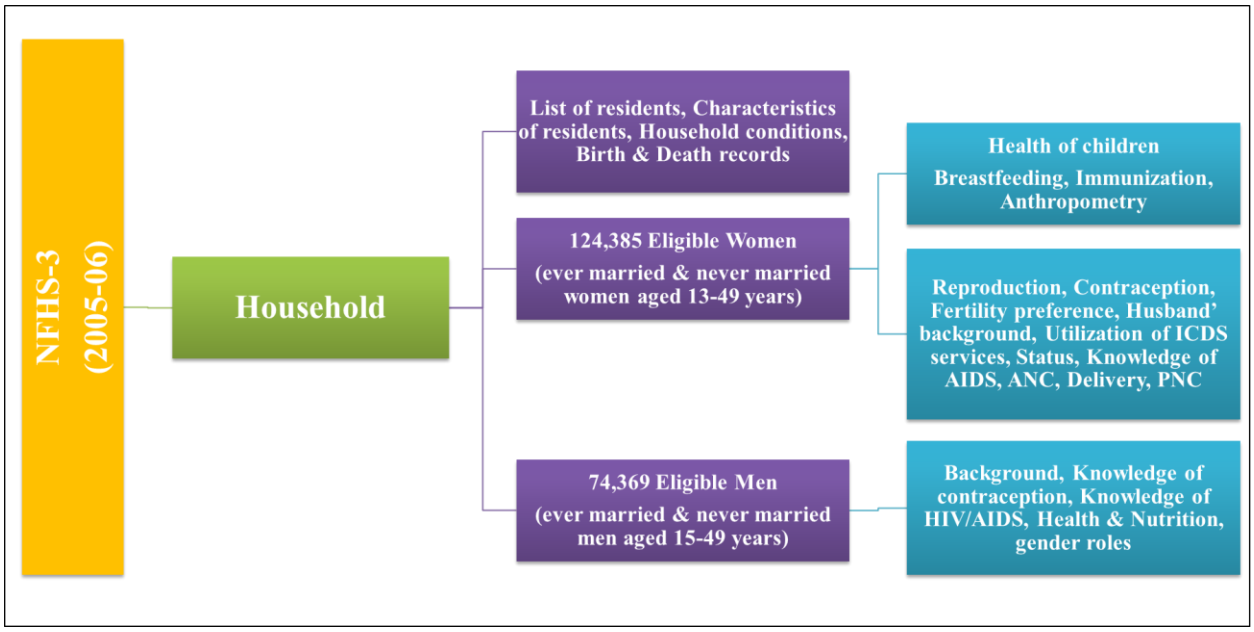
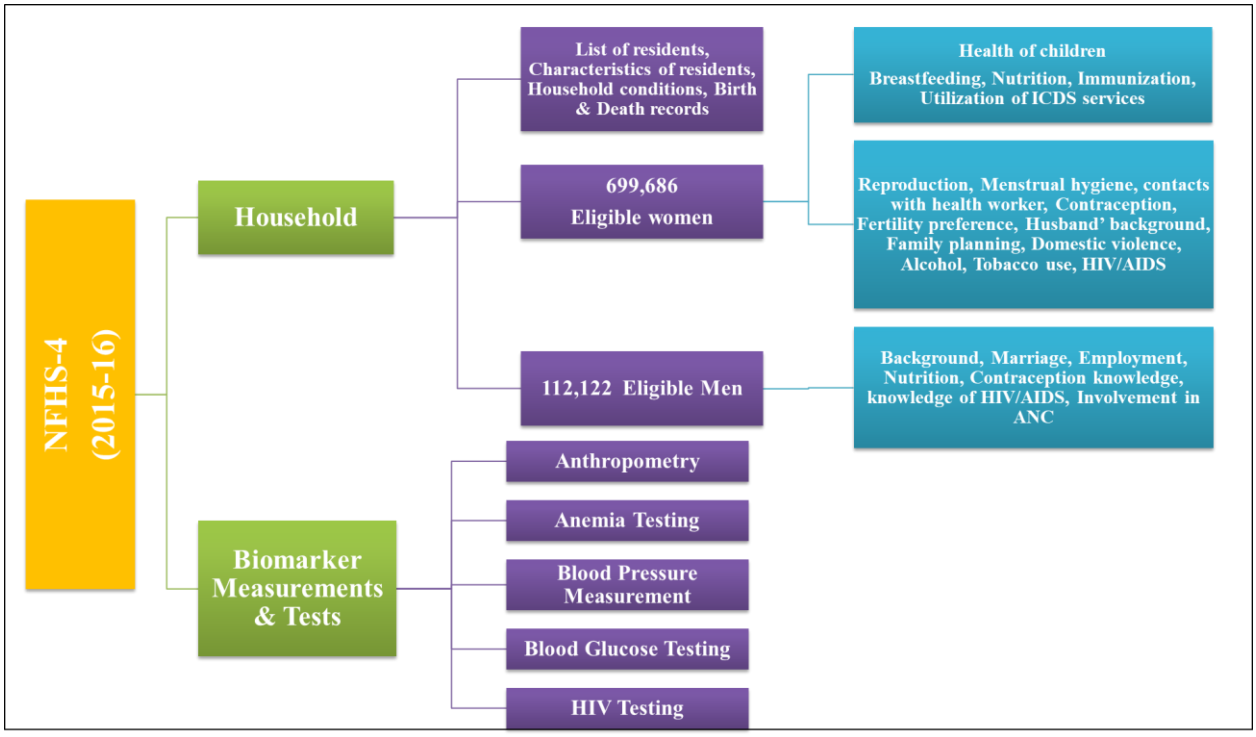


Figure 3.4: NFHS-4 survey methodology



Questionnaires used in NHFS

Over the years, changes have been made in the types of Questionnaires being used in National Family Health Surveys. NFHS mainly used the following types of questionnaires: the Household Questionnaire, the Woman's Questionnaire, the Man's Questionnaire, the Village Questionnaire and the Biomarker Questionnaire. The questionnaires used were mainly bilingual, consisting of questions in both the state language and English. The questionnaire were first translated to local language and then translated back to English once the information was obtained.

In NFHS-1 and NFHS-2, three types of Questionnaires were used: the Household Questionnaire, the Woman's Questionnaire, and the Village Questionnaire. NFHS-3 used the Household Questionnaire, the Woman's Questionnaire, and the Man's Questionnaire. In NFHS-4 along with the Household Questionnaire, the Woman's Questionnaire, and the Man's Questionnaire, the Biomarker Questionnaire was also used.

Household Questionnaire

Household Questionnaire listed all the residents of the household and also all the visitors who stayed there during night. The basic demographic information of the listed persons such as,

- sex,
- age,
- education,
- marital status,
- occupation,
- schooling, and
- relationship to the head of the household was also collected.

It also covered information on the

- type of toilet facilities,
- type of cooking fuel,
- source of drinking water,
- construction,
- lighting,
- agriculture and

- live-stock.

Religion, caste, place and records of birth and death, within last two years, were also recorded. Information on prevalence of diseases like asthma, tuberculosis, malaria, and jaundice was also obtained using the questionnaire. The main objective of the household questionnaire was to find the women who are eligible to answer to the Women's Questionnaire, including both ever married and never married women, age 13 – 49 years.

Women's Questionnaire

The Women's Questionnaire used by NFHS highlighted the information collected from all eligible women, usual residents as well as visitors, age 13-49 years. The questionnaire contained questions on large variety of topics, including the following:

Background characteristics: Information on age, marital status, age at marriage and education of the eligible women as well as visitors (if any) own household information is covered.

Reproduction and Reproductive behavior: Total number of children that a woman has given birth to, stillbirths and abortions, birth and death history of children, current pregnancy and menstruation status.

Contraception/ Family Planning: Use of and attitudes toward various family planning methods.

Maternal and child health, breastfeeding, and nutrition: antenatal care; delivery care; postnatal care; postpartum amenorrhoea; breastfeeding and child feeding practices; vaccination coverage; prevalence and treatment of diarrhoea: symptoms of acute respiratory infection (ARI), and fever; use of oral rehydration therapy (ORT); utilization of ICDS services.

Fertility Preferences: Desire for additional children, sex composition of children, desire for more children, ideal number of children, gender preferences for children, intention to use family planning, birth intervals and husbands attitude toward family size.

Husband's background and Women's work: Age, education and work status of the woman and her husband.

HIV/AIDS: knowledge of HIV and AIDS, methods of HIV transmission, sources of HIV information, ways to avoid HIV, previous HIV testing, HIV stigma, other sexually-transmitted infections

Status of women and spousal violence: women's autonomy, gender relations, men's involvement in health care for women, and various forms of physical and sexual violence experienced by women.

Men's Questionnaire

Men's Questionnaire was designed to interview men aged 15-54 who were usual residents of the sample household or visitors who stayed in the sample household the night before the survey. It contained a subset of questions that were covered in the Women's Questionnaire, plus some additional questions only administered to men such as reproductive behavior and intentions, knowledge and use of contraception, male involvement in health care, attitude toward gender roles, sexual life, HIV/AIDS, tobacco and alcohol use, knowledge of tuberculosis, current morbidity (diabetes, asthma, goiter, heart disease, cancer), and household decision making.

Village Questionnaire

The Village Questionnaire was another important questionnaire used by the NFHS to collect information on various amenities in the villages covered under the NFHS such as water, transport, health and educational facilities. Village Questionnaire respondents were also questioned about the village's development and welfare programmes. The Village Questionnaire was managed only in the rural areas.

Biomarker Questionnaire

It covered measurements of height, weight, and haemoglobin for children, and measurements of height, weight, haemoglobin, blood pressure, and random blood glucose for women age 15-49 and (in the state module subsample of households only) men age 15-54. In addition, eligible women and men were requested to provide a few drops of blood from a finger prick for laboratory testing for HIV.

Demographic Health Survey (DHS)

Demographic Health Surveys (DHS) was the original survey tool developed by The DHS Program in 1984. More than 400 DHS surveys have been conducted over 90 countries. It improves the collection, analysis, dissemination of data which includes information about the population, health and nutrition. The data collected is important for policy and decision making, planning as well as program management.

Data Procurement

The DHS Program assists countries around the world in collecting and analyzing data for population, health, and nutrition programs. Data for country India was obtained through the DHS website https://dhsprogram.com/. Applications were made to the DHS Program for procurement of data. Post permission from the agency, data was downloaded in the required SPSS format. Data was extracted and the variables related to child undernutrition and the determinants responsible were selected from all the National Family and Health Surveys. Data analysis was carried out using SPSS version 20 and above.

The DHS program provides datasets or data files in formats of STATA, SPSS or SAS. For DHS data there are different data files for different unit of analysis. The "unit of analysis" is "who or what is being studied". The different units of analysis (Figure 3.5) are Households, Women (15-49 years), Men (15-54 years) and children. Each unit of analysis has a separate data file (Figure 3.6).

- **Household Recode (HR file**) - data on all the households that were interviewed in the survey.
- **Person Recode (PR file) -** data of all usual household members and also the visitors who stayed the night before survey.
- **Individual Recode (IR file) -** data for all the eligible women interviewed i.e., usually all women aged 15- 49 years with completed interviews.
- **Kids/Children's Recode (KR file) -** data for children under 5 years of age of interviewed women.
- **Birth Recode (BR file) -** data for every child ever born to interviewed women up to 20 births.
- **Male Recode (MR file) -** data for all the eligible men with completed interviews.

- **Couple's Recode (CR file) -** data for men and women with completed interviews who both declared to be married to each other or living together.
- **HIV test results (AR file) -** contains HIV tests results of the people who got tested in the survey.

OBJECTIVES

Broad Objective – To assess the transition in the determinants of maternal malnutrition in India over a period of two decades by conducting secondary analysis of data obtained from National Family and Health Surveys

Specific Objectives

- To identify the common indicators of maternal malnutrition using the datasets.
- To assess the determinants of maternal malnutrition in individual datasets.
- To evaluate the transition in the determinants of maternal malnutrition and arrive at predictive factors.

Figure 3.5: Unit of analysis

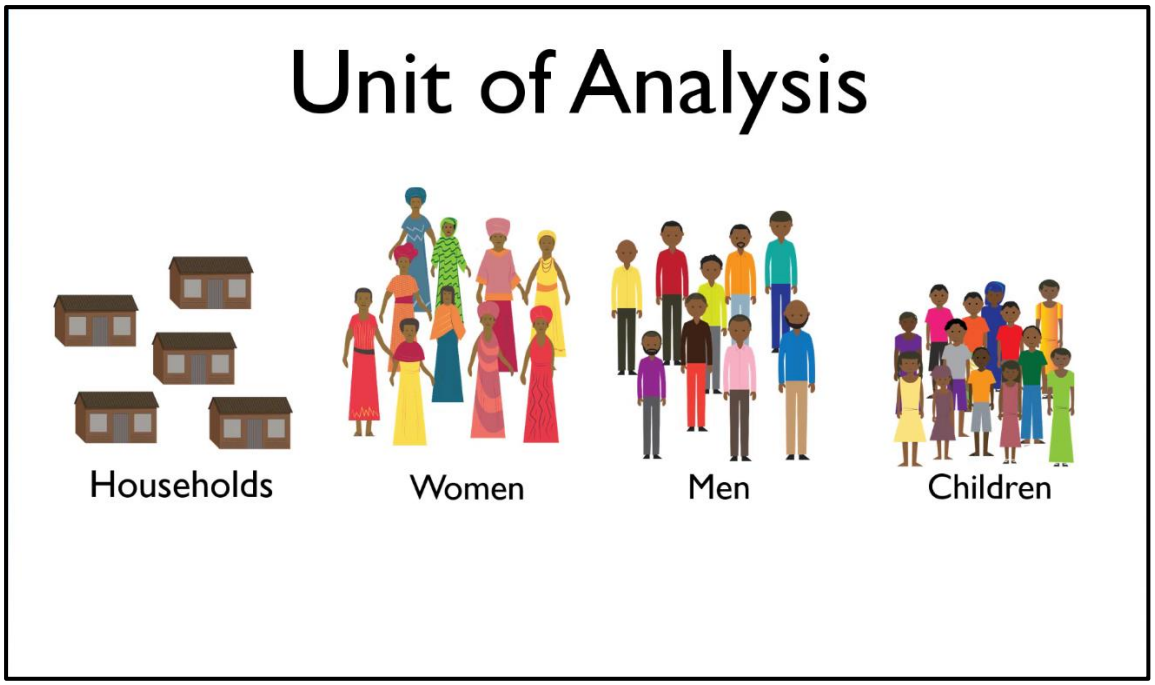


Image source: https://www.youtube.com/watch?v=fzLNQkkvDeI&list=PL2br2Ozsggh6fEzAYhrjqZzZsvc88O-py&index=1

Figure 3.6: Types of data files

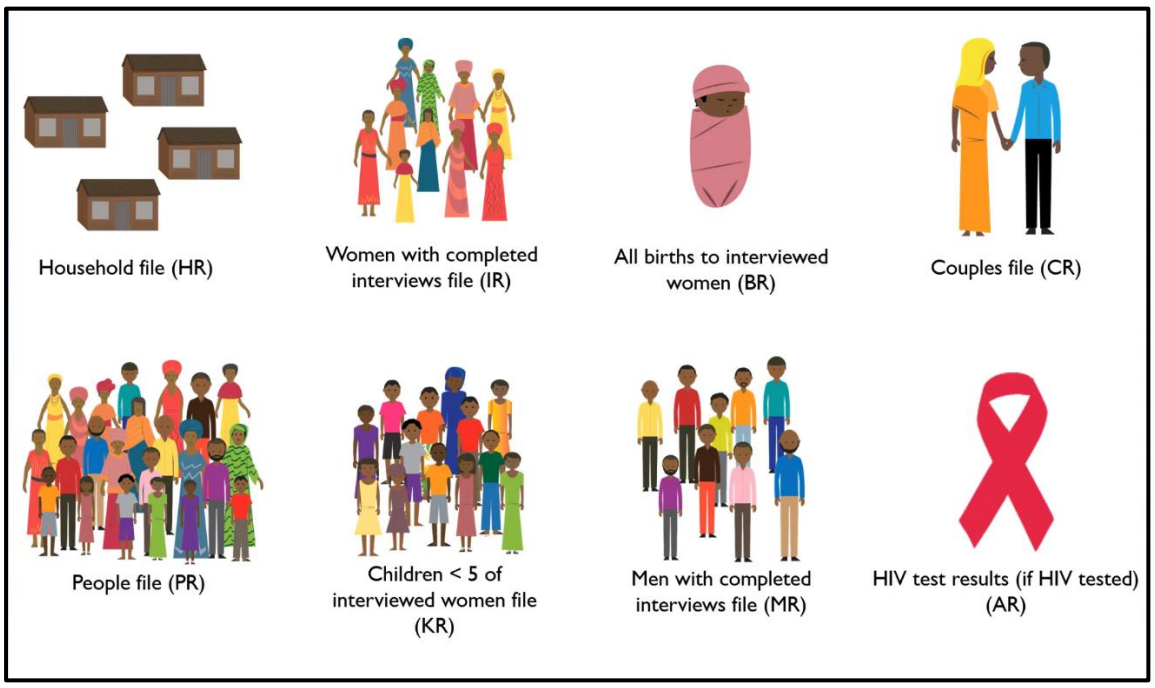


Image source: https://www.youtube.com/watch?v=JGRJZCGiCJw&list=PL2br2Ozsggh6fEzAYhrjqZzZsvc88O-py&index=3

The present study was divided into two phases:

Phase I A – Selection of survey for analysis i.e., NFHS 2, 3, and 4

- Questionnaires were reviewed
- Registered for accessing data
- Downloading the datasets from The DHS program
- Identification of indicators of maternal health and Nutrition

Phase I B – Conducting descriptive Statistical analysis for identifying determinants in individual datasets

Phase II- Identify Transition in determinants over a period of two decades comparing the 3 datasets

Data Analysis

Country wise data was obtained for India from the DHS program site for analysis. As per the objective of this research, data from **IR file** was used and variables of interest were also selected from the same.

The dependent variable for the present study was considered as maternal BMI. The independent variables that were included for analysis were:

- region of residence (rural, urban),
- drinking water facility ,
- toilet facility,
- wealth index (poorest, poorer, middle, richer, richest),
- mother's education (illiterate, primary, secondary, higher),
- parity of the mother,
- mother's age at first child's birth,
- sex of the household head,
- partner's education,
- partner's occupation,
- mother's working status

Exclusion Criteria:

Applying the exclusion criteria, the data was cleaned. The exclusion included currently pregnant women (as BMI standards for normal adults cannot be used for

pregnant women), missing data for any of the selected variables and outliers. Exclusion flowchart for NFHS- 2, 3 & 4 are shown in figure 3.7, 3.8 and 3.9 respectively. The cases with missing data in any of the following variables were excluded from the study:

- Current age of the mother in 5 years group (V013)
- Type of place of residence (V025)
- Mother's highest education level attended (V106)
- Main source of drinking water (V113)
- Type of toilet facility (V116)
- Wealth index (V190)
- Total number of children ever born (V201)
- Age of the respondent at first birth (V212)
- Weight of the respondent in kilograms (V437)
- Height of the respondent in centimeters (V438)
- Body mass index (BMI) (V445)
- Hemoglobin level (V453)
- Anemia level (V457)
- Husband or partner's highest level of education attended (V701)
- Standardized partner's occupation groups (V705)
- Whether the respondent is currently working (V714)
- Making large household purchases (V743B)

The data was analysed using SPSS version 20 or above.

- Percentages were calculated for all parameters that could be expressed in a rank order fashion.
- Means and standard errors were calculated for all parameters that were expressed numerically.
- Crosstabs were computed between indicators of nutritional status and other parameters of interest.
- Binary logistic regression analysis was performed to establish the determinants.

Figure 3.7: Sampling flowchart (NFHS-2)

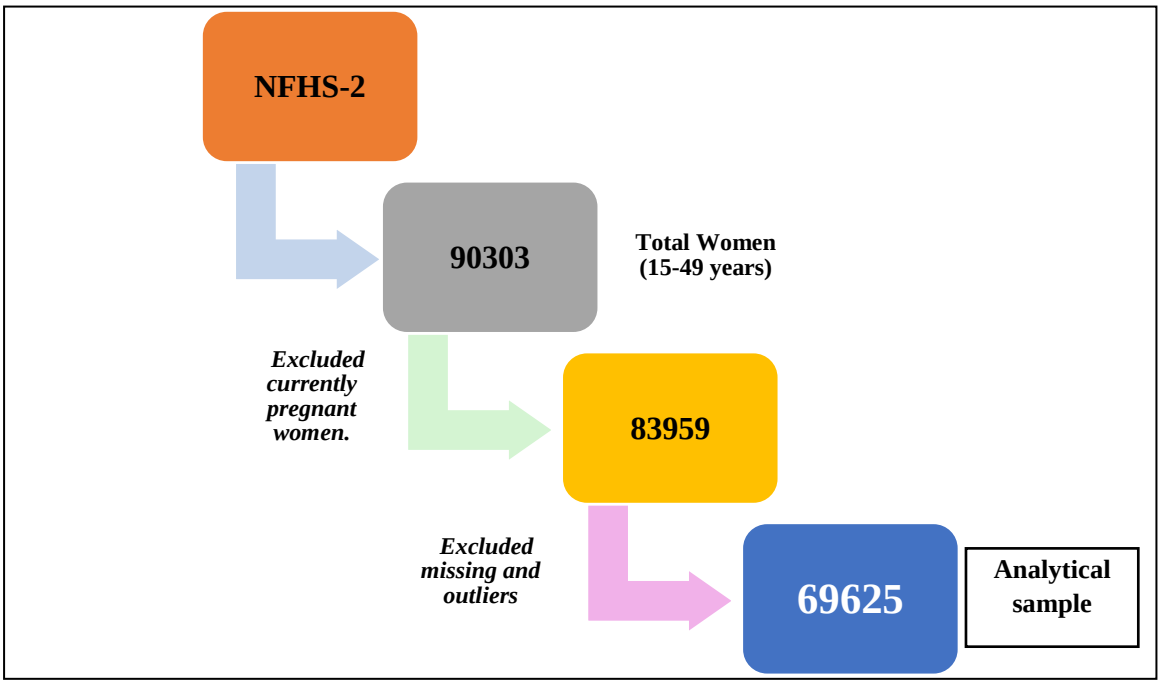


Figure 3.8: Sampling flowchart (NFHS-3)

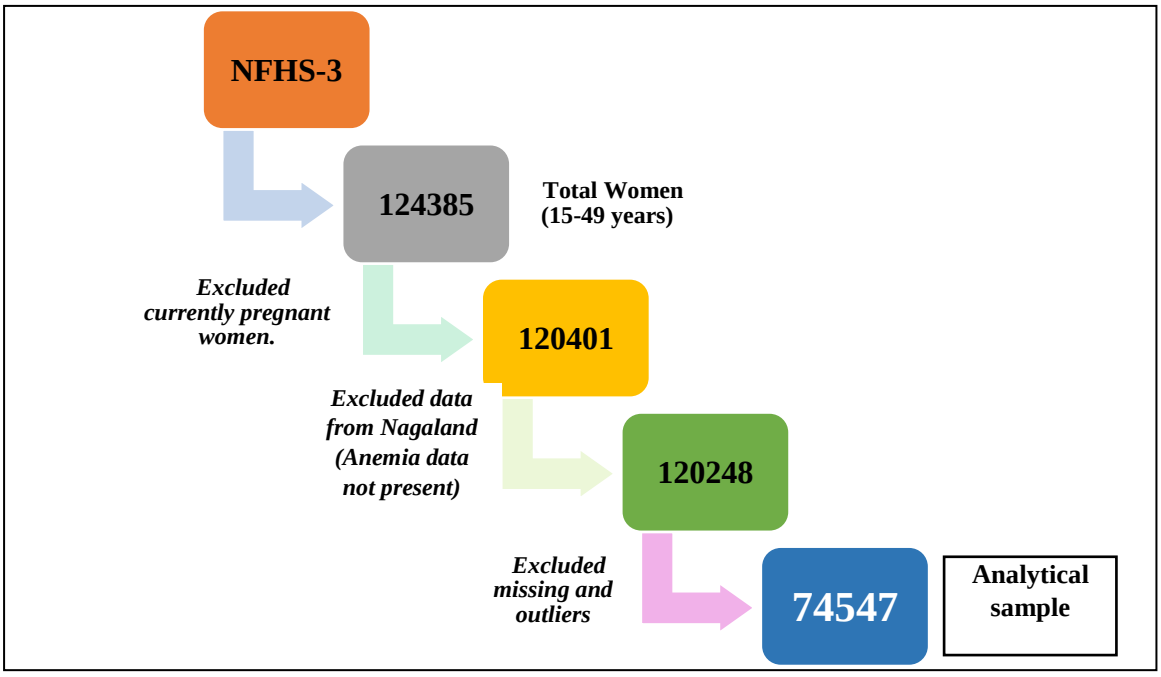
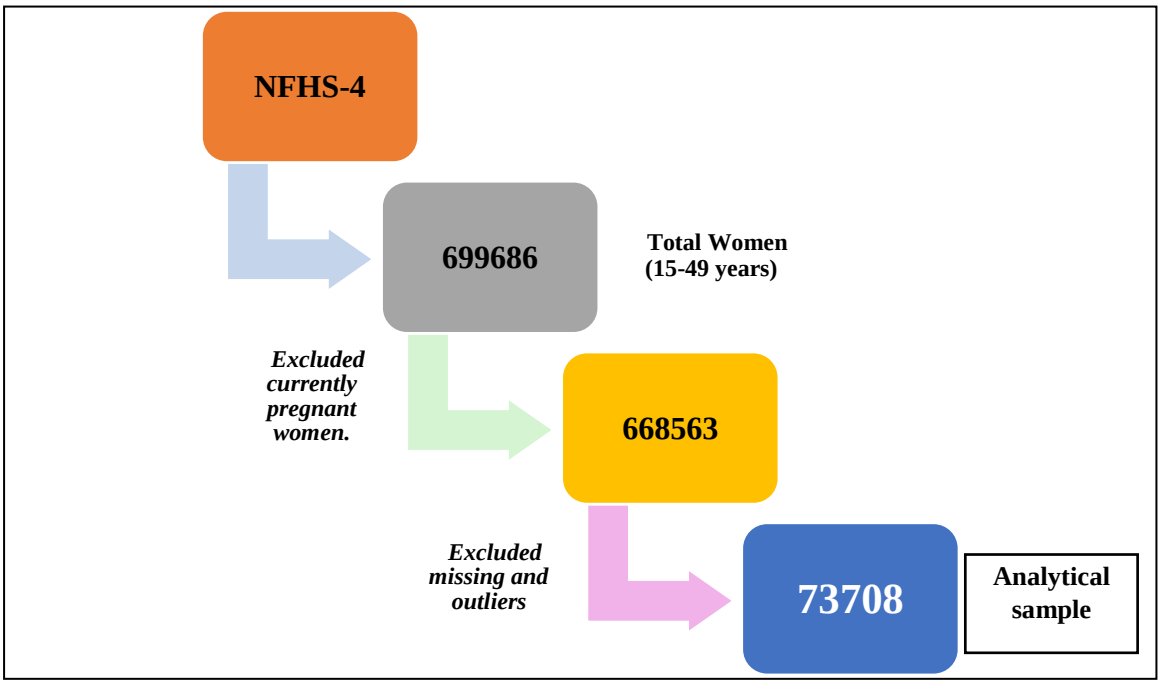


Figure 3.9: Sampling flowchart (NFHS-4)



Results and Discussion

RESULTS AND DISCUSSION

The present study involved secondary data analysis to assess the transition in the determinants of maternal malnutrition over a period of 2 decades. Secondary data obtained from National Family Health Surveys II, III and IV covering a period of 22 years between 1998- 2021 was utilized for the study. Final sample for statistical analysis was obtained after data cleaning and exclusions as per the objectives of the study.

This chapter presents the findings of secondary data analysis conducted on NFHS datasets obtained from the Demographic Health Surveys program, post permissions and ethical clearance by Department and Faculty level technical and ethical committees.

The present study was divided into 2 phases:

Phase I A – Selection of survey for analysis i.e., NFHS 2, 3, 4 and understanding the variables and the recodes.

Phase I B – Conducting descriptive statistical analysis for identifying determinants in individual datasets.

Phase II- Identify transition in determinants over the period of two decades comparing the datasets.

Findings of the study are presented in this chapter as follows:

1. Socio demographic profile of the study population
2. Maternal characteristics
3. Prevalence of malnutrition
4. Interrelationship between the variables
5. Assessment of the determinants of thinness
6. Identification of the transition in the determinants of thinness over the years

4.1 Socio demographic profile of the study population

During NFHS-2, majorities (73.1%) of the mothers were residents of the rural areas, and around 26.9% mothers resided in urban areas. In NFHS-3, majority of the mothers (69.8 %) were residing in rural areas, and around 30.2 % were living in the

urban areas. In NFHS-4, around 65.9 mothers were the residents of rural areas, and around 34.1 % were living in urban areas (Figure 4.1).

The economic status of a household is an indicator of access to adequate food supplies, use of health services, availability of improved water sources, and sanitation facilities, which are prime determinants of child and maternal nutritional status (UNICEF, 1990). The data for wealth index was only available for NFHS-3 & NFHS-4. During NFHS-3, the proportion of mothers in all the wealth quintiles were almost similar, where the proportion of mothers living in the poorest quintile was the lowest at 18.3% and proportion of mothers living in the richest quintile was the highest at 20.9%. While during NFHS-4, though the proportion of mothers living in the poorest quintile comparatively decreased to 16.5%, the proportion of mothers living in the richest quintile increased to 21.8% simultaneously (Figure 4.2).

The source of drinking water is considered safe if it comes from 'piped into residence or yard/plot', 'public tap/ stand pipe', 'tube well/ bore well', 'protected well' and unsafe if it comes from 'unprotected/ unimproved wells', 'rivers' (Ravaoarisoa, L et al. 2018). During NFHS-2, more than half (58.5%) of the households, drew water from well of which 17.3% drew water from open well which is considered to be unsafe source, followed by piped facility (38.4%). The situation didn't improve much in NFHS-3, during which again more than half (53.8%) households used well for the source of their drinking water of which 9.3% used water from unprotected well which again is an unsafe source and around 38.2 % used piped water. In NFHS-4, around 44.6% households used piped water for drinking purpose which is considered to be a safe source, while almost same amount %) of households used water from well, of which, 4% accounted of unprotected well (unsafe source) (Table 4.1).

During NFHS-2, the proportion of no toilet facility or defecation in bush/field was dangerously high at 63.4%, which then gradually decreased to 52.6% in NFHS-3 and then 36.2% in NFHS-4, which is still very high as per the SDG target 6.2 which aims achieve access to adequate and equitable sanitation and hygiene for all and to end open defecation (Table 4.1).

The data show that, around 28.6% of partners/husbands of the mothers had no education, which then decreased to 26.8% in NHFS-2 and then further decreased to

19.2 in NFHS-4. A similar kind of improvement was also observed with secondary level of education where the proportion of mothers increased from around 21.8% during NFHS-2 through 30.7% in NFHS-3 to 42.5% in NFHS-4 which is almost twice the amount observed during NFHS-2. Similarly, proportion of secondary level of education in fathers/partners increased from 34.3% through 44.7% to 51.7% during NFHS-2, 3 & 4 respectively (Table 4.1).

During NFHS-2, partners of majority (40%) of the mothers were employed in agricultural work which then decreased to 33.3% in NFHS-3 and 32.9% in NFHS-4 but still being the major profession, since India is an agricultural country (Table 4.1).

4.2 Maternal characteristics

The analysis of the socio-economic characteristics of the respondents showed that during the period of NFHS-2, the mean (± SD) age of mothers was 32.46 ± 8.404 (table 4.3.2) and around 4.4% of mothers were in the youngest age group of 15-19 years, while around 10.5% of mothers were in the oldest age group of 45-49 years. In NFHS-3, the mean (± SD) age of the mothers included in the analysis was 32.77 ± 8.17 (table 4.3.2). Very few women (3.2 %) were in the 15-19 year age group (youngest age group) and 10.4 % were in the 45-49 year age group (oldest age group). In NFHS-4, the mean (± SD) age of the mothers included in the analysis was 34.10 ± 8.082 (table 4.3.2). Around 1.3% mothers were in the youngest age group (15-19 year age group) and 14.4 % were in the oldest age group (45-49 year age group) (Table 4.2).

Women who receive even a minimal education are generally more aware than those who have no education of how to utilize available resources for the improvement of their own nutritional status and that of their families (Girma, W., & Genebo, T. 2002). From descriptive analysis of data, an improvement can be seen where the proportion of mothers with no education significantly decreased from 53.1% in NFHS-2, through 48.3% in NFHS-3 to 33.4% in NFHS-4 (Table 4.2).

It was observed that, during NFHS-2, majority (47.8) of the mothers had given birth to 3 to 5 children, and the proportion of mothers in this category gradually decreased to 45.5% and then to 38.7% in the succeeding surveys of NFHS-3 and NFHS-4 respectively. Also proportion of mothers with 2 or less children increased from 38.7%

in NFHS-2, to more than half (56.1%) of the total in NFHS-4 along with the gradual decrease in proportion of mothers with 6 or more children from 13.6% in NFHS-2 to only 5.3% in NFHS-4 (Table 4.2).

More than half (57.1%) of the mothers during NFHS-2 were in the age group of 15-19 years when they first gave birth, that means they were still in adolescence. Some extreme cases were also observed in which around 7.1% mothers were in even smaller age group of 10-14 years when they first gave birth and 1 mother was below 10 years when she first gave birth. During NFHS-3 also there were extreme cases in which around 5.7% mothers were between 10-14 years at the time of their first birth and around 3 mothers were under 10 years when they first gave birth; while more than half (53.6%) mothers were still adolescents (15-19 years) when they first gave birth. All the mothers who gave birth under 19 years of age shows that, they were married off even younger, which is shocking since legal marriage age for women has been set at 18 years since 1978 as per Indian constitution (Table 4.2).

Women's employment status is also another important socioeconomic variable explaining nutritional status. Women's paid employment could provide an additional income source that can improve food security of the household and raise the status of women by allowing them to have more control over resources (Girma, W., & Genebo, T. 2002). It's evident from the data that proportion of working women has continuously decreased from 39.3% mothers who were employed in NFHS-2 through 38% in NFHS-3 to 25.6% in NFHS-4 (Table 4.2).

Figure 4.1: Distribution of study population by place of residence

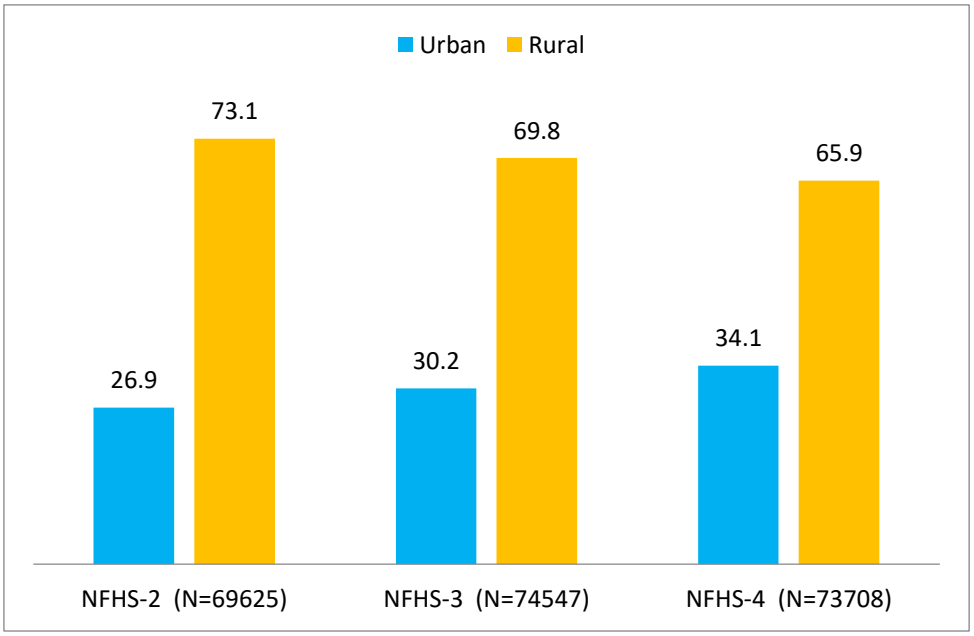


Figure 4.2: Distribution of study population by wealth index

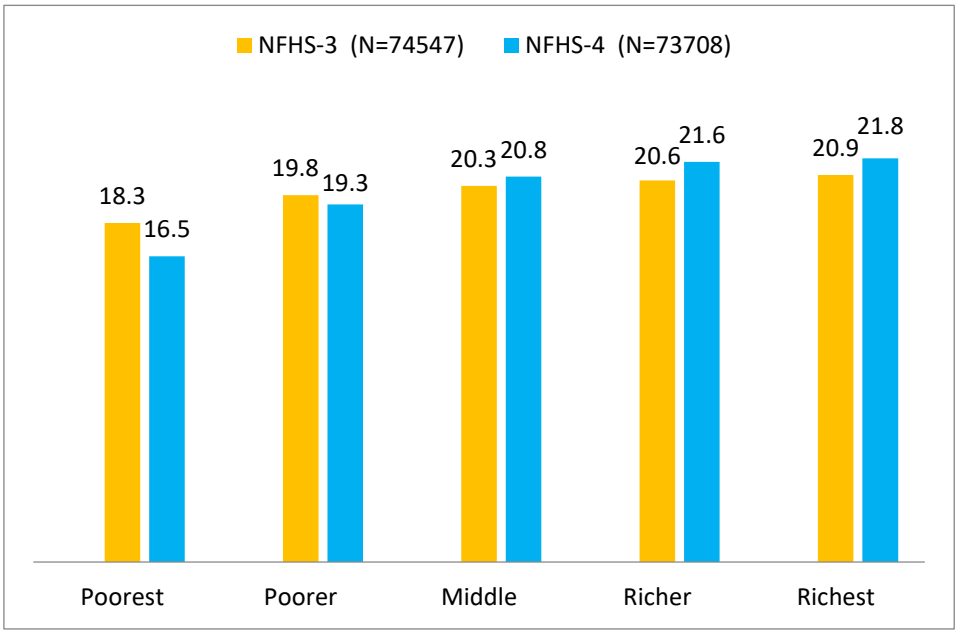


Table 4.1: Socio demographic profiles of the population

	NFHS-2 n (%) (N= 69625)	**NFHS-3 n (%) (N= 74547)**	**NFHS-4 n (%) (N= 73708)**
Source of drinking water			
Piped water	38.4 (26720)	38.2 (28475)	44.6 (32856)
Well water	58.5 (40742)	53.8 (40140)	45.5 (33507)
Surface water	2.5 (1651)	2.1 (1559)	1.5 (1128)
Rainwater	0.0 (31)	0.1 (96)	0.1 (109)
Tanker water / Cart with small tank	0.2 (125)	0.5 (374)	1.2 (888)
Bottled water	-	0.3 (216)	3 (2218)
Community RO plant	-		0.5 (392)
Other	0.5 (365)	0.1 (101)	0.1 (86)
Not de jure resident	-	4.8 (3585)	3.4 (2523)
Type of Toilet facility			
Flush toilet	24.2 (16879)	37.2 (27764)	52.6 (38756)
Pit toilet Latrine	12.3 (8559)	4.6 (3439)	6.9 (5096)
No facility/bush/field	63.4 (44109)	52.6 (39246)	36.2 (26685)
Composting toilet	-	0.1 (39)	0.2 (126)
Dry toilet	-	0.5 (249)	0.5 (385)
Other	0.1 (77)	0.2 (126)	0.2 (138)
Not a de jure resident	-	4.8 (3585)	3.4 (2523)
Husband/partner's education level			
No education	28.6 (19910)	26.8 (20003)	19.2 (14136)
Primary	19.7 (13691)	16.6 (12392)	15.6 (11520)
Secondary	34.3 (23900)	44.7 (33286)	51.7 (38128)
Higher	17.4 (12123)	11.3 (8388)	13.3 (9782)
Don't know		0.6 (478)	0.2 (141)
Husband/partner's occupation			
Not working/no occupation	2.6 (1781)	1.8 (1333)	4 (2924)
Professional/technical/managerial	7.4 (5158)	6.9 (5157)	8.1 (5949)
Clerical	3.9 (2700)	4.4 (3278)	2.9 (2148)
Sales	10.2 (7128)	12.3 (9162)	11.5 (8499)
Agricultural	40 (27830)	33.3 (24816)	32.9 (24277)
Household & domestic	0.2 (145)		
Services	4.1 (2877)	5.5 (4069)	9.8 (7259)
Skilled and unskilled manual	21.3 (14817)	35.8 (26691)	29.7 (21917)
Don't know	0.9 (594)	0.1 (41)	1 (736)

Table 4.2: Maternal characteristics

	NFHS-2 n (%) (N= 69625)	**NFHS-3 n (%) (N= 74547)**	**NFHS-4 n (%) (N= 73708)**
Age in 5-year groups			
15-19	4.4 (3038)	3.2 (2413)	1.3 (942)
20-24	15.5 (10813)	14.9 (11079)	11.8 (8683)
25-29	20.7 (14382)	20.2 (15045)	19.5 (14379)
30-34	18.7 (13052)	19.4 (14474)	19.6 (14415)
35-39	16.6 (11567)	17.7 (13195)	18 (13272)
40-44	13.6 (9443)	14.2 (10569)	15.5 (11429)
45-49	10.5 (7329)	10.4 (7773)	14.4 (10589)
Mother's Highest Level of Education			
No education	53.1 (36979)	48.3 (36037)	33.4 (24595)
Primary	17.5 (12186)	15.6 (11660)	14.7 (10820)
Secondary	21.8 (15174)	30.7 (22864)	42.5 (31291)
Higher	7.6 (5285)	5.3 (3985)	9.5 (7003)
Total children ever born			
2 or less	38.7 (26916)	43 (32036)	56.1 (41316)
3 to 5	47.8 (33265)	45.5 (33998)	38.7 (28513)
6 or more	13.6 (9943)	11.5 (8512)	5.3 (3879)
Age of respondent at 1st birth			
Lowest to 10 years	0.0 (1)	0.0 (3)	3.4 (2511)
10 to 14 years	7.1 (4936)	5.7 (4212)	
15 to 19 years	57.1 (39732)	53.6 (39940)	39.9 (29414)
20 to 24 years	29.6 (20597)	33 (24625)	43.2 (31858)
25 to 29 years	5.4 (3726)	6.6 (4894)	11.4 (8415)
30 to 34 years	0.8 (547)	1 (757)	1.7 (1258)
35 to 39 years	0.1 (79)	0.1 (101)	0.3 (231)
40 to 44 years	0 (8)	0.0 (10)	0.0 (20)
45 to 49 years	0 (0)	0.0 (3)	0.0 (1)
Respondent currently working			
No	60.7 (42256)	62 (46247)	74.4 (54876)
Yes	39.3 (27369)	38 (28299)	25.6 (18833)

4.3 Prevalence of malnutrition

Data showed that, over the years though the proportion of thinness among mothers has decreased but the proportion of overweight & obesity has gradually increased. The proportion of mothers being thin (BMI 16-18.5 kg/m²) and severely thin (BMI < 16 kg/m²) went from 29.5% and 6.9% in NFHS-2 to 14.7% and 2.9% in NFHS-4 respectively. The proportion of overweight among mothers increased gradually from 8.1% to 9.6% & 14.4% in NFHS-2, 3 & 4 respectively. The proportion of obesity has more than doubled from 11.1% during NFHS-2 to 27.1% during NFHS-4. This indicates the increase in double burden of maternal malnutrition (Table 4.3.1).

In NFHS-2, data on anemia was not available. During NFHS-3, more than half of the mothers (around 56%) had anemia, of whom the majority (39.9%) were mildly anemic, followed by 14.4% being moderately anemic and 1.6% being severely anemic. During NFHS-4, the situation improved by a bit but still alarming, where around 53.8% mothers were anemic and around 39.7%, 12.9% & 1.2% were mild, moderate and severe anemic (Table 4.3.1).

Descriptive statistics of maternal anthropometric and biochemical parameters is showed in table 4.3.2.

Table 4.3.1: Prevalence of malnutrition amongst mothers

	NFHS-2 n (%) (N= 69625)	**NFHS-3 n (%) (N= 74547)**	**NFHS-4 n (%) (N= 73708)**
Body Mass Index			
Lowest to 15.9	6.9 (4827)	6.1 (4569)	2.9 (2145)
16 – 18.5	29.5 (20506)	27 (20145)	14.7 (10869)
18.51 – 22.9	44.4 (30912)	42 (31316)	40.9 (30131)
23 – 24.9	8.1(5655)	9.6 (7151)	14.4 (10596)
>25	11.1(7724)	15.2 (11365)	27.1 (19967)
Anemia level (adjusted for pregnancy)			
Severe	-	1.6 (1217)	1.2 (888)
Moderate	-	14.4 (10740)	12.9 (9482)
Mild	-	39.9 (29756)	39.7 (29278)
Not anemic	-	44 (32834)	46.2 (34060)

Table 4.3.2: Descriptive statistics of maternal anthropometric and biochemical parameters

	NFHS-2 mean ± S.D (N= 69625)	**NFHS-3 mean ± S.D (N= 74547)**	**NFHS-4 mean ± S.D (N= 73708)**
Respondent's current age	32.46 ± 8.404	32.77±8.175	34.1 ±8.082
Woman's weight in kg (1 decimal)	465.24± 94.927	481.26±104.810	525.63±116.108
Woman's height in cm (1 decimal)	1512± 57.512	1518.25± 58.450	1519.95±60.784
Body Mass Index (2 decimals)	2029±379.024	2087.89±453.264	2277.09±519.294
Hemoglobin test result (g/dl) (1 decimal)	--------	115.58 ± 17.454	116.47 ± 16.917

4.4 Interrelationship between Body Mass Index and the variables of interest

National Family Health Survey 2 (1998-99)

Crosstabs were used to establish relationships between different variables. Trends of malnutrition differed with the type of residence i.e. urban & rural. Of total mothers residing in rural areas, majority (33.7%) of the mothers had normal BMI, very closely followed by thin mothers (30.4%) and 9.9% were overweight & obese, while in urban areas, the prevalence of normal BMI and Overnutrition was almost similar with 10.7% mothers falling in normal BMI range and 10.2 mothers were overweight and obese. It clearly showed that mothers residing in urban areas were more prone to overweight and obesity than the mothers from rural areas. While the prevalence of thinness was higher among mothers from rural areas than amongst mothers from urban areas (Table 4.4.1).

The table 4.4.1 shows, that of all the mothers with BMI < 18.5 kg/m², majority (8.2%) were from 25-29 years age group, followed by 6.9%, 6.6%, 5.3%, 4.3%, 3.1% & 2.1% in 20-24, 30-35, 35-39, 40-44, 45-49 & 15-19 years age group respectively. Majority mothers (9.5%) with a normal BMI of 18.5-22.9 kg/m² were in the 25-29 years age group and the least (2.1%) were in the 15-19 years age group. While, majority of the mothers i.e. 1.7 % & 2.5% from the 35-39 years age group were overweight & obese respectively. This says that, thinness was more prevalent in smaller age groups of mothers while overweight and obesity becomes more prevalent as the age increases.

The data showed that, almost one fourth (23.2%) of the mothers with BMI < 18.5 kg/m² had no education, and majority (3%) of the mothers who were overweight also had no education while, majority (4.1%) of the mothers with obesity had attained secondary education (Table 4.4.1).

The data shows that, of the total mothers (38.7%) who gave birth to 2 or fewer children, most (17.3%) of them had a normal BMI (18.5 – 22.9 kg/m²), very closely followed by 13.4% mothers with BMI less than 18.5 kg/m² which depicts thinness. While 3.3% of mothers who gave birth to 2 or fewer children were overweight with the BMI value 23-24.9 kg/m², and 4.6% were obese with BMI value >25 kg/m². The same pattern was also observed in mothers who gave birth to 3-5 children and 6 or

more children where in, majority of the mothers fell in normal BMI category (21% women with 3-5 births and 6.2 women with 6 or more births). Nearly 17.4% women with 3-5 births and 5.2 %women with 6 or more births showed thinness. The data also shows that, in all the categories of number of children born, obesity was more prevalent than overweight (Table 4.4.1).

Majority of the mothers with < 18.5 kg/m² had given first birth during the age of 15-19 years. Also the proportion of overweight & obesity was observed to be highest in mothers who had given first birth during the age of 15-19 years. This data shows that adolescent pregnancies are a risk factor for both underweight and overweight & obesity (Table 4.4.1).

The data shows that the prevalence of being Underweight (BMI < 18.5 kg/m²) was the highest (13.3%) among mothers whose partners had no education and lowest (3.8%) among mothers whose partners had attained higher education. This clearly shows that the educational status of husbands/partners does impact the nutritional status of the mothers. With the decrease in prevalence of thinness, prevalence in overweight and obesity increased simultaneously where 2.6% mothers whose partners had no education were overweight and obese while around 7.5 mothers whose partners had secondary education were overweight and obese (Table 4.4.1).

It was found that the prevalence of being thin (BMI<18.5 kg/m²) was highest (19.8%) among mothers whose partners were self-employed in agriculture, while the prevalence for the same was lowest (0.1%) for the mothers whose partners were employed in household and domestic works. The prevalence for overweight & obesity was found to be highest at 1.8% & 2.6% respectively in the mothers whose partners were involved in skilled manual work (Table 4.4.1).

The data showed that the prevalence of thinness was around 18.8% in mothers who were not working. The prevalence of overweight (5.6%) and obesity (8.3%) was found to be highest amongst mothers who were not working (Table 4.4.1).

Table 4.4.1: Interrelationship between BMI & variables of interest NFHS 2 (1998-99) (N= 69625)

	BMI % (n)						
	Lowest through 15.99 kg/m²	**16.00 – 18.5 kg/m²**	**18.51 – 22.99 kg/m²**	**23.00 – 24.99 kg/m²**	**> 25 kg/m²**	**Chi-Square**	**Total**
Place of residence							
Urban	1.2 (823)	4.8 (3370)	10.7 (7439)	3.6 (2523)	6.6 (4584)	**6542.73*** **	**26.9 (18739)**
Rural	5.8 (4004)	24.6 (17136)	33.7 (23474)	4.5 (3132)	4.5 (3140)		**73.1 (50886)**
Age (years)							
15-19	0.3 (204)	1.8 (1250)	2.1 (1465)	0.1 (80)	0.1 (40)	**3471.31*** **	**4.4 (3039)**
20-24	1.1 (764)	5.8 (4011)	7.5 (5249)	0.6 (440)	0.5 (348)		**15.5 (10812)**
25-29	1.4 (998)	6.8 (4725)	9.5 (6631)	1.5 (1013)	1.5 (1014)		**20.7 (14381)**
30-34	1.2 (849)	5.4 (3725)	8.4 (5825)	1.6 (1136)	2.2 (1517)		**18.7 (13052)**
35-39	1.1 (753)	4.2 (2890)	7.1 (4973)	1.7 (1215)	2.5 (1736)		**16.6 (11567)**
40-44	1 (670)	3.3 (2308)	5.5 (3831)	1.4 (986)	2.4 (1649)		**13.6 (9444)**
45-49	0.8 (590)	2.3 (1596)	4.2 (2938)	1.1 (786)	2 (1420)		**10.5 (7330)**
Highest education							
No education	4.5 (3136)	18.7 (12991)	24.3 (16904)	3 (2086)	2.6 (1835)	**6559.05*** **	**53.1 (3679)**
Primary	1.2 (829)	5.1 (3568)	7.7 (5391)	1.5 (1022)	2 (1357)		**17.5 (12185)**
Secondary	1 (721)	4.7 (3286)	9.4 (6574)	2.5 (1732)	4.1 (2861)		**21.8 (15174)**
Higher	0.2 (114)	0.9 (660)	2.9 (2043)	1.2 (815)	2.4 (1653)		**7.6 (5285)**
Total children ever born							
2 or less	2.3 (1610)	11.1 (7737)	17.3 (12031)	3.3 (2310)	4.6 (3228)	**170.19*** **	**38.7 (26916)**
3 – 5	3.5 (2432)	14.2 (9905)	21 (14587)	3.8 (2659)	5.3 (3682)		**47.8 (33265)**
6 or more	1.1 (786)	4.1 (2863)	6.2 (4295)	1 (686)	1.2 (813)		**13.6 (9443)**

	BMI % (n)						
	Lowest through 15.99 kg/m²	**16.00 – 18.5 kg/m²**	**18.51 – 22.99 kg/m²**	**23.00 – 24.99 kg/m²**	**> 25 kg/m²**	**Chi-Square**	**Total**
Age at first birth							
< 15	0.6 (422)	2.5 (1757)	3.1 (2164)	0.4 (279)	0.5 (315)	**1793.34*** **	**7.1 (4937)**
15-19	4.2 (2955)	18.2 (12684)	25.6 (17834)	3.9 (2794)	5 (3510)		**57.1 (39732)**
20-24	1.8 (1257)	7.5 (5223)	13.1 (9101)	3 (2068)	4.2 (2948)		**29.6 (20597)**
25-29	0.2 (167)	1.1 (738)	2.2 (1555)	0.7 (464)	1.2 (802)		**5.4 (3726)**
30-34	0.0 (23)	0.1 (87)	0.3 (226)	0.1 (82)	0.2 (129)		**0.8 (547)**
35-39	0.0 (2)	0.0 (15)	0.0 (30)	0.0 (12)	0.0 (20)		**0.1 (79)**
40-44	0.0 (2)	0.0 (2)	0.0 (2)	0.0 (1)	0.0 (1)		**0.0 (8)**
45-49	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)		0.0 (0)
Partner's education level							
No education	2.8 (1916)	10.5 (7296)	12.8 (8925)	1.4 (960)	1.2 (814)	**4823.99*** **	**28.6 (19911)**
Primary	1.6 (1080)	6.5 (4498)	8.8 (6164)	1.4 (952)	1.5 (1015)		**19.7 (13691)**
Secondary	2 (1410)	9.3 (6492)	15.4 (10744)	3.1 (2160)	4.4 (3095)		**34.3 (23900)**
Higher	0.6 (4826)	3.2 (2221)	7.3 (5098)	2.3 (1583)	4 (2801)		**17.4 (12123)**
Partner's occupation							
Did not work	0.2 (130)	0.7 (486)	1.1 (769)	0.2 (148)	0.4 (248)	**5191.21*** **	**2.6 (1781)**
Prof. tech. managerial	0.3 (187)	1.2 (849)	3.1 (2155)	1 (695)	1.8 (1272)		**7.4 (5158)**
Clerical	0.1 (103)	0.7 (467)	1.6 (1124)	0.5 (382)	0.9 (623)		**3.9 (2699)**
Sales	0.4 (304)	2.2 (1516)	4.4 (3092)	1.2 (836)	2 (1380)		**10.2 (7128)**
Agri-self employed	3.5 (2465)	14.3 (9987)	18 (12542)	2.2 (1479)	1.9 (1338)		**40 (27829)**
Household & domestic	0.0 (10)	0.1 (48)	0.1 (54)	0.0 (17)	0.0 (17)		**0.2 (146)**

	BMI % (n)						
	Lowest through 15.99 kg/m²	**16.00 – 18.5 kg/m²**	**18.51 – 22.99 kg/m²**	**23.00 – 24.99 kg/m²**	**> 25 kg/m²**	**Chi-Square**	**Total**
Services	0.2 (145)	0.9 (619)	1.8 (1256)	0.5 (354)	0.7 (502)		**4.1 (2876)**
Skilled manual	1.3 (931)	6 (4179)	9.5 (6625)	1.8 (1287)	2.6 (1795)		**21.3 (14817)**
Unskilled manual	0.7 (520)	3.2 (2222)	4.3 (3032)	0.5 (377)	0.6 (452)		**9.5 (6594)**
Don't know	0.0 (32)	0.2 (132)	0.4 (272)	0.1 (62)	0.1 (96)		**0.9 (594)**
Respondent currently working							
No	3.4 (2373)	15.4 (10738)	26.4 (18354)	5.6 (3881)	8.3 (5777)	**2091.68*** **	**59.1 (41123)**
Yes	3.5 (2449)	17.5 (20498)	18 (12548)	2.5 (1771)	2.8 (1942)		**40.9 (69593)**

Interrelationship between Body Mass Index and the variables of interest

National Family Health Survey 3 (2005-06)

The data shows that, the mothers (27.3%) residing in the rural areas were more prevalent to thinness than the mothers (5.9%) living in urban areas. While the scenario in the case of overweight & obesity was the opposite of underweight where, overweight & obesity was more prevalent in urban mothers (13.2%) than in rural mothers (11.7%). It was also observed that majority of the mothers (13.2%) in urban areas were Overweight & Obese (Table 4.4.2).

It is well known that the economic status of a household affects its purchasing power and food availability and ultimately affects the health of the household members. And the female gender gets affected the most. From the data it was clearly observed that the household wealth index was directly related to the mother's nutritional status. It was seen that as the wealth index increased the prevalence of thinness among mothers decreased. The most prevalent mothers were the ones who fell under 'Poorest' (9.5%) and 'Poorer' (9.1%) category, while the least prevalent were the mothers from 'richest' (2.3%) category. While the case for overweight and obesity was in the contrast where, as the wealth index increased, the prevalence of overweight and obesity increased with it. Prevalence of overweight and obesity were the least (1%) amongst Mothers from the 'poorest' category while mothers from the 'richest' category had (11.7%) highest prevalence (Table 4.4.2).

It was observed that the prevalence of thinness (BMI < 18.5 kg/m²) peaked (7.3%) in the age group of 25-29 years mothers while the lowest (1.5%) was in mothers of the age group of 15-19 years. Almost half (42%) of the mothers were falling in the normal BMI range of whom the most (9.1%) were also in the age group of 25-29 years. It was found that overweight and obesity was more prevalent among older age groups i.e. the prevalence of overweight and obesity was 5.5%, 5%, 4.9% & 4% in mothers of 35-39, 40-44, 30-34 & 45-49 years age groups respectively. (Table 4.4.2)

The data clearly shows that education of the mothers positively impacts her health, where the prevalence of thinness was observed to be highest (20%) among mothers who had no education compared to mothers with primary (5.1%), secondary (7.5%), and higher level (0.6%) of education. While it was also seen that, prevalence of

overweight and obesity was the highest (11%) among the mothers who had attained secondary level of education and lowest (3%) among mothers with higher level of education (Table 4.4.2).

It was observed that the prevalence of being thin (BMI < 18.5 kg/m²) was highest (15.4%) among mothers with 3-5 children followed by mothers (13.2%) with 2 or less children and the lowest (4.5%) in mothers with 6 or more children. Similar pattern was also seen in case of normal BMI, where the majority (19.2%) of the mothers with normal BMI had 3-5 children followed by 17.9% and 4.9% of mothers with 2 or less and 6 or more children respectively. While the prevalence of overweight and obesity was the highest (11.8%) in mothers with 2 or less children and lowest (2%) in mothers with 6 or more children (Table 4.4.2).

It is very widely known that a mother's age at birth plays a very important part in her health status. It was observed that, more than half (53.6%) of the mothers were only 15-19 years old when they first gave birth, and the majority (23%) had normal BMI but almost similar amounts (19.7%) were also found to be thin. The age group of 15-19 years had the highest prevalence of overweight (4.5%) & obesity (6.4%) too (Table 4.4.2).

The data shows that, the majority of the mothers (13%) who were thin, their partners had attained secondary level of education, followed by 11.9% of underweight mothers whose partners had no education. The most prevalence of normal BMI (18.6%) and overweight & obesity (4.8% & 8.2% respectively) was also observed in the mothers whose partners had attained secondary level of education (Table 4.4.2).

It was observed that the prevalence of thinness among mothers was the highest (13.8%) in mothers whose partners were employed in agricultural activities and the lowest (0.5%) in mothers whose partners were not employed. Mothers whose partners were employed in Skilled and Unskilled manual work were most prevalent to overweight (3.2%) & obesity (4.8%) and the least prevalent were the mothers whose partners were not employed (Table 4.4.2).

Women's employment helps in improving the household's economic status and ultimately improving food security in the household as it is said that women are most likely to spend their money on food and taking care of their children. The data shows

that mothers who were not working (18.5%) had higher prevalence of thinness than the mothers who were currently working (14.6%). The prevalence of being overweight & obese was also observed to be more prevalent in non-working mothers (6.4% & 4% respectively) (Table 4.4.2).

The data shows that, majority (14.3%) of the thin mothers were also found to be mildly anemic. While majority of the overweight (5.1%) and obese (8.6) mothers were found to be not anemic (Table 4.4.2).

Interrelationship between Anemia and the variables of interest

National Family Health Survey 3 (2005-06)

From the data it was evident that the anemia prevalence was higher in mothers residing in rural areas than mothers living in urban areas. Around 11.1%, 3.9% & 0.4% of mothers in urban areas were mild, moderate & severely anemic, while the figure in rural mothers comparatively was more than twice, as around 28.8%, 10.5% & 1.2% rural mothers were mild, moderate & severely anemic (Table 4.4.3).

It was seen that as the wealth index increased, the prevalence of no anemia amongst mothers gradually increased, from around 6.4% non-anemic mothers in the poorest wealth quintile to around 11.2% non-anemic mothers in the richest wealth quintile. The prevalence of anemia was highest among mothers (0.4% mild, 3.2% moderate & 8.4% severe anemic) from poorest and poorer wealth quintiles and lowest among mothers (0.2% mild, 2.3% moderate & 7.2% severe anemic) belonging to richest wealth quintile (Table 4.4.3).

It was seen that presence of anemia mostly was found to be higher in the mothers in the age group of 25-29 years, i.e. around 8.2% and 2.9% of mothers in the age group were mildly and moderately anemic respectively. It was found that mothers in the smallest age group of 15-19 years were least prevalent to anemia (1.6% mild, 0.7% moderate & 0.1% severe anemia) as compared to other older age groups (Table 4.4.3).

The data shows that, any form of anemia (mild, moderate, severe) was most prevalent (20.2%, 7.7%, 0.9% respectively) in mothers with no education and least prevalent (3%, 1.9%, 0.0% respectively) in mothers with higher levels of education. This

clearly shows that maternal education level may help in bringing down the anemia prevalence in the country (Table 4.4.3).

It was found that mild and moderate anemia was more prevalent in the mothers (18.2% and 6.7% respectively) who have had 3-5 children, and mothers with 2 or less children (16.8% and 5.9% respectively) (Table 4.4.3).

Women under the age of 19 are still in the adolescence phase of their life, where their bodies are still developing and nutritional requirements are also increased and pregnancy and motherhood during this phase puts extra pressure on these mothers to fulfil their and their developing fetus's nutritional needs, and this usually puts these mothers at an increased risk of being undernourished. And the data supports this as the mothers, whose age at first birth was less than 19 years, were the most affected by anemia. The rates of mild, moderate & severe anemia was found to be highest at 24.4%, 9.1% & 1 % respectively in the mothers who gave first birth under the age of 19 years (Table 4.4.3).

While it is known that partner's education level affects mother's health status, the data shows that the prevalence of anemia was highest (23.9% any anemia) among the mothers whose partners had attained secondary level of education, and the lowest (5.4% any anemia) among mothers whose partners had attained higher level of education (Table 4.4.3).

It was observed that, mothers whose partner's occupation was Skilled and Unskilled manual were more prevalent to being mildly (14.3%), & moderately (5.4%) anemic, while mothers whose partner's occupation was Skilled and Unskilled manual and Agriculture were equally prevalent of being severely (0.6%) anemic (Table 4.4.3).

Mother's working status usually signifies better maternal health status compared to the non-working. The data shows that mothers who were not working had higher prevalence of anemia. The prevalence of anemia was around 34.5% in non-working mothers while it was around 21.5% in working mothers. (Table 4.4.3)

Table 4.4.2: Interrelationship between BMI & variables of interest NFHS 3 (2005-06) (N= 74547)

	BMI % (n)						
	Lowest through 15.99 kg/m²	**16.00 – 18.5 kg/m²**	**18.51 – 22.99 kg/m²**	**23.00 – 24.99 kg/m²**	**> 25 kg/m²**	**Chi-square**	**Total**
Place of residence							
Urban	1.2 (870)	4.7 (3429)	11.2 (8356)	4.2 (3129)	9 (6690)	**7084.66*** **	**30.2 (22537)**
Rural	5 (3699)	22.3 (16653)	30.8 (22960)	5.4 (4022)	6.3 (4675)		**69.8 (52009)**
Wealth index							
Poorest	1.9 (1389)	7.6 (5701)	7.8 (5842)	0.6 (479)	0.4 (261)	**16251.14*** **	**18.3 (13672)**
Poorer	1.8 (1350)	7.3 (5407)	8.8 (6542)	1.1 (789)	0.9 (639)		**19.8 (14727)**
Middle	1.3 (965)	5.9 (4424)	9.4 (7039)	1.8 (1358)	1.8 (1354)		**20.3 (15140)**
Richer	0.8 (621)	4.2 (3102)	9.1 (6751)	2.6 (1940)	4 (2976)		**20.6 (15391)**
Richest	0.3 (244)	2 (1510)	6.9 (5141)	3.5 (2585)	8.2 (6135)		**20.9 (15615)**
Age (years)							
15-19	0.2 (133)	1.3 (981)	1.6 (1187)	0.1 (69)	0.1 (43)	**4275.87*** **	**3.2 (2413)**
20-24	1 (719)	5.4 (4025)	7 (5218)	0.8 (586)	0.7 (530)		**14.9 (11078)**
25-29	1.3 (953)	6 (4469)	9.1 (6771)	1.8 (1346)	2 (1505)		**20.2 (15044)**
30-34	1.2 (924)	5.2 (3897)	8.1 (6017)	2 (1463)	2.9 (2173)		**19.4 (14474)**
35-39	1.1 (810)	4 (3017)	7.1 (5282)	2 (1461)	3.5 (2624)		**17.7 (13194)**
40-44	0.8 (601)	3 (2229)	5.4 (4013)	1.7 (1247)	3.3 (2479)		**14.2 (10569)**
45-49	0.6 (428)	2 (1527)	3.8 (2828)	1.3 (979)	2.7(2011)		**10.4 (7773)**
Highest education level							
No education	3.9 (2882)	16.1 (12001)	21.3 (15897)	3.3 (2470)	3.7 (2788)	**6491.35*** **	**48.3 (36038)**
Primary	0.9 (657)	4.2 (3163)	6.7 (5004)	1.5 (1133)	2.3 (1703)		**15.6 (11660)**

	BMI % (n)						
	Lowest through 15.99 kg/m²	**16.00 – 18.5 kg/m²**	**18.51 – 22.99 kg/m²**	**23.00 – 24.99 kg/m²**	**> 25 kg/m²**	**Chi-square**	**Total**
Secondary	1.3 (960)	6.2 (4631)	12.2 (9086)	3.8 (2845)	7.2 (5341)		**30.7 (22863)**
Higher	0.1 (70)	0.5 (350)	1.8 (1330)	0.9 (703)	2.1 (1532)		**5.3 (3985)**
Total children ever born							
2 or less	2.3 (1707)	10.9 (8106)	17.9 (13369)	4.4 (3311)	7.4 (5543)	**500.59*** **	**43 (32036)**
3 – 5	2.9 (2183)	12.5 (9346)	19.2 (14317)	4.2 (3160)	6.7 (4992)		**45.6 (33998)**
6 or more	0.9 (679)	3.6 (2693)	4.9 (3629)	0.9 (681)	1.1 (830)		**11.4 (8512)**
Age at first birth							
< 15	0.4 (334)	1.7 (1244)	2.4 (1819)	0.5 (369)	0.6 (448)	**1924.88*** **	**5.7 (4214)**
15-19	3.6 (2688)	16.1 (1198)	23 (17130)	4.5 (3358)	6.4 (4783)		**53.6 (39939)**
20-24	1.8 (1316)	8 (5962)	13.7 (10181)	3.5 (2614)	6.1 (4553)		**33 (24626)**
25-29	0.3 (190)	1.1 (837)	2.5 (1891)	0.9 (667)	1.8 (1309)		**6.6 (4894)**
30-34	0.0 (34)	0.1 (107)	0.3 (249)	0.2 (125)	0.3 (242)		**1 (757)**
35-39	0.0 (7)	0.0 (15)	0.0 (37)	0.0 (17)	0.0 (25)		**0.1 (101)**
40-44	0.0 (0)	0.0 (0)	0.0 (4)	0.0 (1)	0.0 (5)		**0.0 (10)**
45-49	0.0 (0)	0.0 (0)	0.0 (3)	0.0 (0)	0.0 (0)		**0.0 (3)**
Partner's education level							
No education	2.4 (1759)	9.5 (7102)	11.6 (8665)	1.7 (1233)	1.7 (1244)	**5422.48*** **	**26.8 (20003)**
Primary	1.2 (872)	5 (3712)	7.4 (5486)	1.3 (1005)	1.8 (1317)		**16.6 (12392)**
Secondary	2.3 (1703)	10.8 (8029)	18.6 (13866)	4.8 (3606)	8.2 (6081)		**44.7 (33285)**
Higher	0.3 (201)	1.5 (1127)	4.2 (3108)	1.7 (1273)	3.6 (2679)		**11.3 (8388)**
Don't know	0.0 (35)	0.2 (174)	0.3 (190)	0.0 (35)	0.1 (44)		**0.6 (478)**

	BMI % (n)						
	Lowest through 15.99 kg/m²	**16.00 – 18.5 kg/m²**	**18.51 – 22.99 kg/m²**	**23.00 – 24.99 kg/m²**	**> 25 kg/m²**	**Chi-square**	**Total**
Partner's occupation							
Did not work	0.1 (78)	0.4 (325)	0.7 (524)	0.2 (149)	0.3 (257)	**5067.46*** **	**1.8 (1333)**
Prof. tech. managerial	0.2 (145)	0.9 (683)	2.6 (1915)	1 (751)	2.2 (1662)		**6.9 (5156)**
Clerical	0.1 (102)	0.7 (504)	1.6 (1200)	0.6 (480)	1.3 (992)		**4.4 (3278)**
Sales	0.5 (395)	2.4 (1813)	5 (3719)	1.5 (1116)	2.8 (2118)		**12.3 (9161)**
Agricultural	2.7 (2019)	11.1 (8288)	14.5 (10846)	2.4 (1809)	2.5 (1854)		**33.3 (24816)**
Services	0.3 (216)	1.1 (841)	2.2 (1659)	0.6 (480)	1.2 (872)		**5.5 (4068)**
Skilled and Unskilled manual	2.2 (1612)	10.3 (7684)	15.3 (11428)	3.2 (2365)	4.8 (3603)		**35.8 (26692)**
Don't know	0.0 (2)	0.0 (9)	0.0 (25)	0.0 (0)	0.0 (6)		**0.1 (42)**
Respondent currently working							
No	3.3 (2493)	15.2 (11345)	25.8 (19264)	6.4 (4794)	11.2 (8351)	**1099.46*** **	**62 (46247)**
Yes	2.8 (2076)	11.8 (8800)	16.2 (12051)	3.2 (2358)	4 (3014)		**38 (28299)**
Anemia level							
Severe	0.1 (94)	0.6 (468)	0.7 (549)	0.1 (50)	0.1 (56)	**1693.47*** **	**1.6 (1217)**
Moderate	1.1 (836)	4.7 (3473)	6.3 (4689)	1 (750)	1.3 (991)		**14.4 (10739)**
Mild	2.6 (1940)	11.7 (8754)	16.9 (12596)	3.4 (2562)	5.2 (3904)		**39.9 (29756)**
Not anemic	2.3 (1699)	10 (7451)	18.1 (13480)	5.1 (3790)	8.6 (6414)		**44 (32834)**

Table 4.4.3: Interrelationship between ANEMIA & variables of interest NFHS 3 (2005-06) (N= 74547)

	Anemia levels % (n)					
	Severe	**Moderate**	**Mild**	**Not anemic**	**Chi-square**	**Total**
Place of residence						
Urban	0.4 (318)	3.9 (2937)	11.1 (8280)	14.8 (11002)	**300.91*** **	**30.2 (22537)**
Rural	1.2 (899)	10.5 (7803)	28.8 (21476)	29.3 (21831)		**69.8 (52009)**
Wealth index						
Poorest	0.4 (261)	3.2 (2389)	8.4 (6225)	6.4 (4797)	**1325.55*** **	**18.3 (13672)**
Poorer	0.4 (281)	3.2 (2392)	8.4 (6287)	7.7 (5766)		**19.8 (14726)**
Middle	0.4 (303)	3 (2216)	8.1 (6060)	8.8 (6562)		**20.3 (15141)**
Richer	0.3 (231)	2.7 (2037)	7.8 (5798)	9.8 (7325)		**20.6 (15391)**
Richest	0.2 (140)	2.3 (1705)	7.2 (5387)	11.2 (8348)		**20.9 (15616)**
Age (years)						
15-19	0.1 (44)	0.7 (491)	1.6 (1167)	1 (711)	**404.39*** **	**3.2 (2413)**
20-24	0.2 (182)	2.4 (1794)	6.3 (4716)	5.9 (4387)		**14.9 (11079)**
25-29	0.3 (210)	2.9 (2128)	8.2 (6098)	8.9 (6609)		**20.2 (15045)**
30-34	0.3 (227)	2.6 (1913)	7.5 (5586)	9.1 (6748)		**19.4 (14474)**
35-39	0.3 (225)	2.5 (1871)	6.8 (5063)	8.1 (6036)		**17.7 (13195)**
40-44	0.3 (225)	2 (1506)	5.5 (4067)	6.4 (4803)		**14.2 (10569)**
45-49	0.2 (135)	1.4 (1038)	4.1 (3061)	4.7 (3540)		**10.4 (7774)**
Highest education level						
No education	0.9 (680)	7.7 (5740)	20.2 (15057)	19.5 (14561)	**653.68*** **	**48.3 (36038)**
Primary	0.3 (220)	2.3 (1721)	6.3 (4660)	6.8 (5060)		**15.6 (11661)**
Secondary	0.4 (300)	3.9 (2928)	11.6 (8646)	14.7 (10990)		**30.7 (22864)**
Higher	0.0 (17)	0.5 (352)	1.9 (1393)	3 (2223)		**5.3 (3985)**

	Anemia levels % (n)					
	Severe	**Moderate**	**Mild**	**Not anemic**	**Chi-square**	**Total**
Total children ever born						
2 or less	0.7 (525)	5.9 (4391)	16.8 (12545)	19.6 (14575)	**86.82*** **	**43 (32036)**
3 – 5	0.8 (561)	6.7 (5026)	18.2 (13582)	19.9 (14829)		**45.6 (33998)**
6 or more	0.2 (131)	1.8 (1323)	4.9 (3629)	4.6 (3429)		**11.4 (8512)**
Age at first birth						
< 15	0.1 (86)	0.9 (637)	2.4 (1788)	2.3 (1704)	**276.54*** **	**5.7 (4215)**
15-19	0.9 (638)	8.2 (6131)	22 (16384)	22.5 (16787)		**53.6 (39940)**
20-24	0.6 (424)	4.4 (3278)	12.7 (9460)	15.4 (11463)		**33 (24625)**
25-29	0.1 (60)	0.8 (590)	2.4 (1800)	3.3 (2444)		**6.6 (4894)**
30-34	0.0 (7)	0.1 (88)	0.4 (282)	0.5 (380)		**1 (757)**
35-39	0.0 (1)	0.0 (13)	0.1 (40)	0.1 (47)		**0.1 (101)**
40-44	0.0 (0)	0.0 (1)	0.0 (1)	0.0 (9)		**0.0 (11)**
45-49	0.0 (0)	0.0 (2)	0.0 (0)	0.0 (1)		**0.0 (3)**
Partner's education level						
No education	0.5 (399)	4.6 (3412)	11.4 (8512)	10.3 (7680)	**717.12*** **	**26.8 (20003)**
Primary	0.3 (211)	2.5 (1876)	6.9 (5160)	6.9 (5145)		**16.6 (12392)**
Secondary	0.7 (527)	6.1 (5412)	17.1 (12770)	20.8 (15477)		**44.7 (33286)**
Higher	0.1 (71)	1.1 (846)	4.2 (3099)	5.9 (4372)		**11.3 (8388)**
Don't know	0.0 (10)	0.1 (94)	0.3 (215)	0.2 (159)		**0.6 (478)**
Partner's occupation						
Did not work	0.0 (29)	0.3 (187)	0.7 (524)	0.8 (593)	**360.29*** **	**1.8 (1333)**
Prof. tech. managerial	0.1 (62)	0.8 (577)	2.5 (1883)	3.5 (2635)		**6.9 (5157)**
Clerical	0.1 (41)	0.5 (383)	1.6 (1204)	2.2 (1650)		**4.4 (3278)**
Sales	0.2 (119)	1.5 (1130)	4.9 (3624)	5.8 (4289)		**12.3 (9162)**
Agricultural	0.6 (442)	5.2 (3892)	13.8 (10283)	13.7 (10199)		**33.3 (24816)**

	Anemia levels % (n)					
	Severe	**Moderate**	**Mild**	**Not anemic**	**Chi-square**	**Total**
Services	0.1 (81)	0.7 (526)	2.1 (1552)	2.6 (1909)		**5.5 (4068)**
Skilled and Unskilled manual	0.6 (443)	5.4 (4042)	14.3 (10671)	15.5 (11536)		**35.8 (26692)**
Don't know	0.0 (0)	0.0 (2)	0.0 (15)	0.0 (23)		**0.1 (40)**
Respondent currently working						
No	1 (719)	8.6 (6387)	24.9 (18560)	27.6 (20582)	**41.88*** **	**62 (46248)**
Yes	0.7 (498)	5.8 (4353)	15 (11196)	16.4 (12252)		**38 (28299)**

Interrelationship between Body Mass Index and the variables of interest

National Family Health Survey 4 (2015-16)

It was found that the majority (14.5%) of the underweight/thin mothers were from rural areas. In addition, mothers from rural areas (8.7%) had a higher prevalence of overweight than urban mothers (5.7%). However, mothers from urban areas (14%) were found to be more prevalent of being obese than rural mothers (13%) (Table 4.4.4).

The data shows that as the wealth index increased, the prevalence mothers of thinness gradually decreased from 5.7% in poorest wealth quintile to 1.2% in the richest wealth quintile. While the prevalence of overweight and obesity increased along with the increase in the wealth index, from 1.4% & 1.1% mothers being overweight & obese respectively in poorest quintile to 3.9% & 10.4% of mothers being overweight & obese respectively in richest quintile. This shows that economic status is one of the major factors, which directly affects the nutritional status of an individual (Table 4.4.4).

The data shows that the majority (4.1%) of the mothers with thinness (BMI< 18.5 kg/m²) were from the age group of 25-29 years while the least number of mothers with underweight (0.5%) were from the age group of 15-19 years. The prevalence of overweight was observed to be highest (2.9%) in mothers belonging to the age group of 30-34 very closely followed by mothers (2.8%) in the 35-39 year age group, and it was the lowest (0.1%) in mothers from the 15-19 years age group. The prevalence of obesity was highest (5.6%) among mothers from the 35-39 years age group and lowest (0.1%) among mothers from the 15-19 years age group. This shows that mothers in the youngest age group of 15-19 years are very less susceptible to being underweight, overweight and obese. While mothers from age group 30-34 years onwards are very likely to be overweight or obese (Table 4.4.4).

It was observed that, the majority (5.3%) of mothers having BMI< 18.5 kg/m² have attained secondary education, followed by mothers (5.1%) having had no education. While it was observed that prevalence of both overweight (6.7%) & obesity (13.4%) were highest among mothers with secondary education (Table 4.4.4).

The prevalence of thinness (BMI< 18.5 kg/m²) was found to be highest (8.9%) among mothers who had given birth to a total of 2 or less children while it was lowest (1.3%) among mothers who had given birth to a total of 6 or more children. The case was same for overweight and obesity too, as 8.4% & 16.3% mothers who had given birth to a total of 2 or fewer children showed higher prevalence of overweight and obesity respectively and around 0.6% & 1% of mothers who had given birth to a total of 6 or more children had least prevalence of overweight and obesity respectively (Table 4.4.4).

The prevalence of BMI< 18.5 kg/m² was observed to be the highest at 7.8% among mothers who had their first birth during the age of 15-19 years. While the prevalence of both overweight (6.2%) & obesity (11.4%) was highest among mothers who had their first birth during the age of 20-24 years (Table 4.4.4).

Mothers whose partners had attained secondary education had the highest prevalence (8.5%) of thinness. Overweight and obesity were also most prevalent amongst mothers whose partners had attained secondary education (7.7% overweight and 15.1% obese) (Table 4.4.4).

The highest prevalence of thinness was observed to be 7.4% in mothers whose partners were employed in agriculture, while the least (0.3%) was in the mothers whose partners were employed in clerical works. The prevalence of overweight was found to be highest (4.3%) in mothers whose partners were employed in agriculture, and the prevalence of obesity was highest (7.7%) in mothers whose partners were employed in Skilled and Unskilled manual work (Table 4.4.4).

Mothers who were not-working (12.7%) during the survey had the highest prevalence of thinness, than the working mothers (4.9%). The prevalence of overweight (10.6%) and obesity (21%) was also observed to be highest in not-working mothers, and these figure were more than twice then observed in working mothers (3.8% overweight & 6.1% obese) (Table 4.4.4).

The data shows that, most of the (7.6%) thin (BMI<18.5 kg/m²) mothers were also mildly anemic, whereas majority of the overweight (7.3%) and obese (14.1) mothers were found to be not anemic. Also the majority (7.3%) of the mothers with normal

BMI were not anemic followed by moderate (5.6%) and mildly (5.5%) anemic. This shows that the problem of anemia mostly co-exists along with thinness (Table 4.4.4).

Interrelationship between Anemia and the variables of interest

National Family Health Survey 4 (2015-16)

Majority of the mothers having mild (26.6%), moderate (8.8%) & severe (0.9%) levels of anemia were the residents of rural areas, and the majority of the non-anemic mothers were also found to be living in rural areas (Table 4.4.5).

It was found that mild anemia was most prevalent (8.3%) in mothers belonging to richer wealth quintile, and prevalence of moderate & severe anemia was highest (2.8% & 0.3% respectively) in mothers from middle wealth quintile, while the prevalence of no anemia was found to be highest (11.3%) in the mothers from richest wealth quintile (Table 4.4.5).

It was found that mild & moderate anemia was most prevalent at 7.9% & 2.5% respectively in mothers belonging to the age group of 25-29 years and least prevalent at 0.6% & 0.2% respectively in mothers belonging to the youngest age group of 15-19 years. Majority of the non-anemic mothers were from the 30-34 years age group (Table 4.4.5).

It was observed that the majority (20.2%) of the mothers who were non-anemic had attained secondary level of education. While the prevalence of any anemia was also observed highest, in the mothers with secondary levels of education (Table 4.4.5).

Mild, moderate & severe anemia was found to be most prevalent at 22%, 6.9% & 0.6% respectively in mothers who has given 2 or less births followed by 3-5 births (15.5%, 5.2% & 0.5% respectively) and then 6 or more births (2.2%, 0.7% & 0.1% respectively). Also the majority of the mothers who were not anemic were also the ones with 2 or less births (Table 4.4.5).

The data shows that the majority (23.2%) of women with any anemia had their first birth during the age of 20-24 years followed by mothers (22%) who had their first birth when they were still adolescent, during the age of 15-19 years (Table 4.4.5).

Mothers whose partners had attained secondary education formed the majority among all non-anemic mothers. While it was also observed that prevalence of being mildly, moderately and severely anemic was highest at 20.4%, 6.5% & 0.6% respectively among mothers whose partners had attained secondary education. The least prevalence of both being anemic and non-anemic was observed in the mothers whose partners had attained higher level education (6.7% non-anemic, 5% mildly, 1.4% moderately & 0.1% severely anemic) (Table 4.4.5).

The prevalence of mild, moderate & severe anemia at 13%, 4.7% & 0.5% respectively was found to be highest in the mothers whose partners were working in agriculture. While the lowest prevalence for the same was observed at 1.1%, 0.3% & 0.0% in the mothers whose partners were working in clerical works (Table 4.4.5).

It was found that non-working mothers had the highest levels of mild, moderate & severe anemia at 29.8%, 9.2% & 0.9% respectively as compared to working mothers (Table 4.4.5).

Table 4.4.4: Interrelationship between BMI & Variables of interest NFHS 4 (2015-16) (N= 73708)

	BMI (kg/m²) % (n)						
	≤15.99	**16–18.5**	**>18.5–22.99**	**23–24.99**	**> 25**	**Chi-square**	**Total**
Place of residence							
Urban	0.6 (412)	2.7 (1987)	11.1 (8182)	5.7 (4202)	14 (10349)	**5008.01*** **	**34.1 (25132)**
Rural	2.4 (1733)	12.1 (8882)	29.8 (21949)	8.7 (6393)	13 (9618)		**65.9 (48575)**
Wealth index							
Poorest	1 (734)	4.7 (3468)	8.4(6191)	1.4 (1000)	1.1 (800)	**12018.56*** **	16.5 (12193)
Poorer	0.8 (582)	4.1 (2986)	9.4 (6950)	2.3 (1720)	2.7 (1973)		19.3 (14211)
Middle	0.6 (419)	3 (2248)	9.1 (6675)	3.2 (2363)	4.9 (3606)		20.8 (15311)
Richer	0.4 (315)	1.8 (1361)	7.7 (5697)	3.6 (2655)	8 (5901)		21.6 (15929)
Richest	0.1 (94)	1.1 (806)	6.3 (4619)	3.9 (2857)	10.4 (7688)		21.8 (16064)
Age (years)							
15-19	0.1 (43)	0.4 (287)	0.6 (465)	0.1 (49)	0.1 (98)	**3912.26*** **	**1.3 (942)**
20-24	0.6 (411)	2.8 (2100)	5.8 (4275)	1.2 (904)	1.3 (992)		**11.8 (8682)**
25-29	0.6 (442)	3.5 (2600)	9 (6615)	2.6 (1949)	3.8 (2772)		**19.5 (14378)**
30-34	0.5 (381)	2.7 (1961)	8 (5932)	2.9 (2114)	5.5 (4027)		**19.6 (14415)**
35-39	0.4 (317)	2 (1499)	7.2 (5280)	2.8 (2027)	5.6 (4149)		**18 (13272)**
40-44	0.4 (300)	1.8 (1311)	5.3 (3938)	2.5 (1825)	5.5 (4055)		**15.5 (11429)**
45-49	0.3 (251)	1.5 (1111)	4.9 (3626)	2.3 (1727)	5.3 (3873)		**14.4 (10588)**
Highest education level							
No education	1.4 (999)	3.7 (4955)	15.2 (11179)	4 (2950)	6.1 (4512)	**3115.87*** **	**33.4 (24595)**
Primary	0.5 (359)	2.2 (1657)	6.3 (4636)	1.9 (1411)	3.7 (2758)		**14.7 (10821)**
Secondary	1 (724)	5.2 (3831)	16.2 (11914)	6.7 (4922)	13.4 (9901)		**42.5 (31292)**

	BMI (kg/m²) % (n)						
	≤15.99	**16–18.5**	**>18.5–22.99**	**23–24.99**	**> 25**	**Chi-square**	**Total**
Higher	0.1 (62)	0.6 (427)	3.3 (2403)	1.8 (1313)	3.8 (2796)		**9.5 (7001)**
Total children ever born							
2 or less	1.4 (1019)	7.5 (5557)	22.5 (16572)	8.4 (6180)	16.3 (11987)	**450.66*** **	**56.1 (41315)**
3 – 5	1.3 (965)	6.1 (4532)	16 (11820)	5.4 (3961)	9.8 (7235)		**38.7 (28513)**
6 or more	0.2 (160)	1.1 (780)	2.4 (1739)	0.6 (455)	1 (745)		**5.3 (3879)**
Age at first birth							
<15	0.1 (55)	0.4 (316)	1.4 (1052)	0.4 (325)	1 (763)	**601.92*** **	3.4 (2511)
15-19	1.3 (966)	6.5 (4772)	16.7 (12276)	5.4 (4011)	10 (7389)		39.9 (29414)
20-24	1.2 (881)	6.5 (4776)	17.9 (13185)	6.2 (4578)	11.4 (8437)		43.2 (31857)
25-29	0.3 (203)	1.2 (871)	4.2 (3086)	1.9 (1416)	3.9 (2839)		11.4 (8415)
30-34	0 (28)	0.2 (112)	0.6 (450)	0.3 (230)	0.6 (428)		1.7 (1258)
35-39	0 (11)	0 (10)	0.1 (74)	0 (34)	0.1 (101)		0.3 (230)
40-44	0 (1)	0 (2)	0 (8)	0 (0)	0 (9)		0 (20)
45-49	0 (0)	0 (0)	0 (1)	0 (0)	0 (0)		0 (1)
Partner's education level							
No education	0.9 (638)	3.9 (2843)	8.9 (6573)	2.2 (1630)	3.3 (2453)	**2532.98*** **	**19.2 (14137)**
Primary	0.5 (403)	2.7 (1996)	6.8 (5033)	2 (1508)	3.5 (2580)		**15.6 (15.6)**
Secondary	1.4 (1018)	7.1 (5201)	20.5 (15099)	7.7 (5676)	15.1 (11134)		**51.7 (38128)**
Higher	0.1 (76)	1.1 (802)	4.6 (3360)	2.4 ()1768	5.1 (3776)		**13.3 (9782)**
Don't know	0.0 (10)	0.0 (27)	0.1 (66)	0.0 (14)	0.0 (24)		**0.2 (141)**

	BMI (kg/m²) % (n)						
	≤15.99	**16–18.5**	**>18.5–22.99**	**23–24.99**	**> 25**	**Chi-square**	**Total**
Partner's occupation							
Did not work	0.1 (90)	0.6 (469)	1.6 (1164)	0.5 (389)	1.1 (811)	**3143.83*** **	**4 (2923)**
Prof. tech. managerial	0.1 (55)	0.6 (433)	2.7 (1960)	1.5 (1097)	3.3 (2403)		**8.1 (5948)**
Clerical	0.0 (32)	0.3 (204)	0.9 (653)	0.5 (383)	1.2 (875)		**2.9 (2147)**
Sales	0.2 (120)	1.2 (858)	4.2 (3069)	1.8 (1348)	4.2 (3103)		**11.5 (8498)**
Agricultural	1.3 (949)	6.1 (4510)	15.2 (11210)	4.3 (3162)	6 (447)		**32.9 (24278)**
Services	0.2 (167)	1.1 (839)	3.7 (2719)	1.4 (1047)	3.4 (2487)		**9.8 (7259)**
Skilled and Unskilled manual	1 (702)	4.6 (3425)	12.3 (9057)	4.2 (3082)	7.7 (5651)		**29.7 (21917)**
Don't know	0.0 (28)	0.2 (131)	0.4 (300)	0.1 (86)	0.3 (191)		**1 (736)**
Respondent currently working							
No	2.1 (1537)	10.6 (7814)	30.2 (22235)	10.6 (7802)	21 (15487)	**158.44*** **	**74.4 (54875)**
Yes	0.8 (608)	4.1 (3055)	10.7 (7896)	3.8 (2794)	6.1 (4480)		**25.6 (18833)**
Anemia Level							
Severe	0.1 (37)	0.3 (237)	0.6 (431)	0.1 (58)	0.2 (124)	**1045.51*** **	**1.2 (887)**
Moderate	0.6 (417)	2.4 (1795)	5.6 (4105)	1.5 (1095)	2.8 (2070)		**12.9 (9482)**
Mild	1.3 (923)	6.3 (4649)	5.5 (4032)	5.5 (4032)	10 (7389)		**39.7 (29277)**
Not anemic	1 (767)	5.7 (4188)	18.1 (13311)	7.3 (5410)	14.1 (10384)		**46.2 (34060)**

Table 4.4.5: Interrelationship between ANEMIA & variables of interest NFHS 4 (2015-16) (N= 73708)

	Anemia levels % (n)					
	Severe	**Moderate**	**Mild**	**Not anemic**	**Chi-square**	**Total**
Place of residence						
Urban	0.3 (237)	4 (2959)	13.1 (9638)	16.7 (12300)	**136.81*** **	34.1 (25134)
Rural	0.9 (652)	8.8 (6523)	26.6 (19640)	29.5 (21760)		65.9 (48575)
Wealth index						
Poorest	0.3 (188)	2.4 (1794)	7.3 (5368)	6.6 (4843)	**543.06*** **	16.5 (12193)
Poorer	0.3 (205)	2.6 (1920)	7.9 (5845)	8.5 (6241)		19.3 (14211)
Middle	0.3 (215)	2.8 (2084)	8.1 (5965)	9.6 (7048)		20.8 (15312)
Richer	0.2 (161)	2.8 (2058)	8.3 (6136)	10.3 (7575)		21.6 (15930)
Richest	0.2 (120)	2.2 (1626)	8.1 (5964)	11.3 (8353)		21.8 (16063)
Age (years)						
15-19	0.0 (27)	0.2 (116)	0.6 (448)	0.5 (351)	**212.45*** **	1.3 (942)
20-24	0.1 (91)	1.7 (1232)	5.1 (3757)	4.9 (3604)		11.8 (8684)
25-29	0.2 (134)	2.5 (1841)	7.9 (5830)	8.9 (6574)		19.5 (14379)
30-34	0.2 (167)	2.4 (1749)	7.7 (5649)	9.3 (6850)		19.5 (14415)
35-39	0.2 (147)	2.3 (1700)	7.1 (5203)	8.4 (6221)		18 (13271)
40-44	0.2 (147)	2.1 (1569)	5.8 (4306)	7.3 (5390)		15.5 (11429)
45-49	0.2 (159)	1.7 (1275)	5.5 (4085)	6.9 (5070)		14.4 (10589)
Highest education level						
No education	0.5 (389)	4.9 (3586)	13.6 (10026)	14.4 (10593)	**308.37*** **	**33.4 (24594)**
Primary	0.1 (102)	2 (1462)	5.8 (4271)	6.8 (4984)		**14.7 (10819)**
Secondary	0.5 (357)	5.1 (3735)	16.7 (12326)	20.2 (14873)		**42.5 (31291)**
Higher	0.1 (39)	0.9 (698)	3.6 (2654)	4.9 (3610)		**9.5 (7001)**

	Anemia levels % (n)					
	Severe	**Moderate**	**Mild**	**Not anemic**	**Chi-square**	**Total**
Total children ever born						
2 or less	0.6 (467)	6.9 (5069)	22 (16246)	26.5 (19533)	**61.61*** **	56.1 (41315)
3 – 5	0.5 (368)	5.2 (3867)	15.5 (11429)	17.4 (12848)		38.7 (28512)
6 or more	0.1 (53)	0.7 (545)	2.2 (1678)	2.3 (1678)		5.3 (3878)
Age at first birth						
< 15	0 (27)	0.4 (308)	1.4 (1016)	1.6 (1161)	**124.21*** **	**3.4 (2512)**
15-19	0.6 (431)	5.4 (3978)	16 (11813)	17.7 (13192)		**39.9 (29414)**
20-24	0.5 (336)	5.5 (4050)	17.2 (12704)	20 (14767)		**43.2 (31857)**
25-29	0.1 (82)	1.3 (956)	4.3 (3175)	5.7 (4203)		**11.4 (8416)**
30-34	0 (9)	0.2 (171)	0.6 (461)	0.8 (617)		**1.7 (1258)**
35-39	0 (3)	0 (16)	0.1 (96)	0.2 (116)		**0.3 (231)**
40-44	0 (0)	0 (4)	0 (13)	0 (4)		**0 (21)**
45-49	0 (0)	0 (0)	0 (1)	0 (0)		0 (1)
Partner's education level						
No education	0.3 (221)	2.8 (2084)	7.9 (5845)	8.1 (5987)	**232.06*** **	19.2 (14137)
Primary	0.2 (151)	2.1 (1548)	6.3 (4628)	7 (5192)		15.6 (11519)
Secondary	0.6 (448)	6.5 (4789)	20.4 (15032)	24.2 (17859)		51.7 (38128)
Higher	0.1 (69)	1.4 (1046)	5 (3715)	6.7 (4951)		13.3 (9781)
Don't know	0.0 (0)	0.0 (13)	0.1 (57)	0.1 (71)		0.2 (141)
Partner's occupation						
Did not work	0.1 (51)	0.5 (377)	1.4 (1046)	2 (1449)	**210.02*** **	4 (2923)
Prof. tech. managerial	0.1 (46)	0.9 (630)	3.2 (2349)	4 (2924)		8.1 (5949)
Clerical	0.0 (14)	0.3 (242)	1.1 (827)	1.4 (1065)		2.9 (2148)
Sales	0.1 (85)	1.2 (906)	4.6 (3423)	5.5 (4085)		11.5 (8499)

	Anemia levels % (n)					
	Severe	**Moderate**	**Mild**	**Not anemic**	**Chi-square**	**Total**
Agricultural	0.5 (340)	4.7 (3500)	13 (9618)	14.7 (10820)		32.9 (24278)
Services	0.1 (66)	1.2 (916)	3.9 (2881)	4.6 (3395)		9.8 (7258)
Skilled and Unskilled manual	0.4 (273)	3.8 (2807)	12 (8857)	13.5 (9980)		29.7 (21917)
Don't know	0.0 (13)	0.1 (104)	0.4 (278)	0.5 (341)		1 (736)
Respondent currently working						
No	0.9 (628)	9.2 (6816)	29.8 (21932)	34.6 (25499)	**45.94*** **	74.4 (54875)
Yes	0.4 (261)	3.6 (2666)	10 (7346)	11.6 (8561)		25.6 (18834)

4.5 Assessment of the determinants of maternal thinness (BMI <18.5kg/m^2)

National Family Health Survey 2 (NFHS 2)

A binary logistic regression analysis was performed to ascertain the effects of selected characteristics on the likelihood that women had low BMI (<18.5 kg/m^2). The binary logistic regression model was statistically significant, Chi square = 207.21, p <0.0005. The model explained 10.1% (Nagellkerke R^2) of the variance in Low BMI and correctly classified 64% of cases.

Odds of thinness (BMI < 18.5 kg/m2) among mothers (15–49 years) by selected characteristics, India NFHS 2 (N= 69625)

Women residing in rural areas had 1.56 times higher risk for thinness as compared to women in urban areas (1.56: 95% CI [1.5-1.64]). Odds for thinness reduced significantly as the age of mother increased (0.81: 95% CI [0.74-0.88] to (0.44: 95% CI [0.40-0.49]). As the level of education amongst women increased the odds for thinness reduced (From 0.86 to 0.44). Women who had more than 6 children had the highest odds for thinness (1.17: 95% CI [1.1-1.24). (Table 4.5.1)

As husband's education level increased the odds for thinness amongst their spouses reduced significantly (from 0.92 to 0.68). Women whose husbands were having sales jobs or were professional or were in technical or managerial positions had significantly lower odds for thinness as compared to others. Odds of developing thinness were higher amongst women residing in male headed households. However, the difference was non-significant.

National Family Health Survey 3 (NFHS 3)

A binary logistic regression analysis was performed to ascertain the effects of selected characteristics on the likelihood that women had low BMI (<18.5 kg/m^2). The binary logistic regression model was statistically significant, Chi square = 160.43, p <0.0005. The model explained 16.2% (Nagellkerke R^2) of the variance in Low BMI and correctly classified 67% of cases.

Odds of thinness (BMI < 18.5 kg/m2) among mothers (15–49 years) by selected characteristics, India NFHS 3 (N= 74547)

Higher odds for thinness amongst women residing in rural areas were observed as compared to women in urban areas (1.22: 95% CI [1.16-1.28]). Odds for thinness

reduced significantly as the age of mother increased (0.82: 95% CI [0.74-0.90] to (0.47: 95% CI [0.42-0.53]). As the wealth quintiles improved reduction in thinness was observed significantly. Highest odds of thinness were observed amongst poor mothers (0.85: 95% CI [0.81-0.89]) as compared to lowest being observed for richest mothers ((0.21: 95% CI [0.19-0.23]). Several previous studies have shown that education helps in improving the nutritional status of women similar results revealed that as the level of education amongst women increased the odds for thinness reduced (From 0.91 to 0.71). Women who had more than 6 children had the highest odds for thinness (1.21 to 1.0). (Table 4.5.2)

Maternal malnutrition is a critical issue as along with low BMI mostly micronutrient deficiencies like Iron deficiency anemia usually co exists, making it all the more difficult to reduce malnutrition amongst women. It was observed that as the severity of anemia decreased it lead to a reduction in odds for thinness amongst women (0.78: 95% CI [0.68-0.88] to (0.54: 95% CI [0.48-0.61]). As husband's education level increased the odds for thinness amongst their spouses reduced significantly. Women whose husbands were professional or were having sales jobs had significantly lower odds for thinness as compared to others. Odds of developing thinness were higher amongst women residing in male headed households. However, the difference was non-significant.

National Family Health Survey 4 (NFHS 4)

A binary logistic regression analysis was performed to ascertain the effects of selected characteristics on the likelihood that women had low BMI (<18.5 kg/m^2). The binary logistic regression model was found to be statistically significant, Chi square = 40.020, p <0.0005. The model explained 15% (Nagellkerke R^2) of the variance in Low BMI and correctly classified 82.3% of cases.

Odds of thinness (BMI < 18.5 kg/m2) among mothers (15–49 years) by selected characteristics, India NFHS 4 (N= 73708)

Women residing in rural areas had higher odds for thinness as compared to women in urban areas (1.24: 95% CI [1.17-1.31]). As the age of mother increased the odds for thinness reduced significantly (4.4: 95% CI [3.7-5.2] to (1.2: 95% CI [1.1-1.3]). On analyzing low BMI and the wealth index quintiles it was observed that poor mothers had highest odds of thinness (4.6: 95% CI [4.2-5.1]) as compared to richest mothers ((1.5: 95% CI [1.4-1.7]). Educational attainment data revealed that as the level of

education amongst women increased the odds for thinness reduced (From 1.72 to 1.3). Women who had more than 6 children had the highest odds for thinness (8.43 v/s 6.9) indicating repeated pregnancies are a risk factor for women becoming thin. As the severity of anemia decreased so did the odds for thinness amongst women (2.3: 95% CI [2.0-2.7] to (1.24: 95% CI [1.19-1.3]). As husband's education level increased the odds for thinness amongst their spouses reduced. However, this change was found to be non-significant. Women whose husbands were in skilled or unskilled manual jobs had significantly higher odds for thinness as compared to others (0.82: 95% CI [0.67-1.00]). Odds of developing thinness were higher amongst women residing in male headed households. However, the difference was non-significant. (Table 4.5.3)

Table 4.5.1: Odds of thinness (BMI < 18.5 kg/m2) among mothers (15–49 years) by selected characteristics, India NFHS-2 (N=69625)

Parameters	Odds ratio	95% CI	
		Lower	Upper
Place of Residence			
Rural			
Urban	1.569***	1.502	1.641
Age in Years			
15-19			
20-24	.983	.905	1.069
25-29	.805***	.740	.875
30-34	.632***	.579	.689
35-39	.517***	.473	.565
40-44	.496***	.452	.544
45-49	.443***	.402	.488
Educational attainment			
No education			
Primary	.855***	.817	.895
Secondary	.644***	.613	.677
Higher	.443***	.403	.487
Parity			
<2			
3-5	1.095***	1.052	1.140
6 or more	1.171***	1.104	1.242
Husband's education			
No education			
Primary	.921**	.880	.965
Secondary	.789***	.755	.825
Higher	.677***	.634	.724
Husband's Occupation			
Not working/ manual labour			
Did not work			
Prof., Tech., Manag.	.702***	.619	.795
Clerical	.739***	.643	.849
Sales	.696***	.620	.781
Agric-self employed	1.057	.952	1.173
Household & domestic	1.104	.773	1.578
Services	.738***	.647	.842
Skilled manual	.877*	.788	.977
Unskilled manual	.956	.854	1.071
Sex of household head			
Male			
Female	1.037	.978	1.099

Table 4.5.2: Odds of thinness (BMI < 18.5 kg/m2) among mothers (15–49 years) by selected characteristics, India NFHS 3 (N= 74547)

Parameter	Odds Ratio	95% CI	
		Lower	Upper
Place of Residence			
Rural			
Urban	1.217***	1.162	1.275
Age in Years			
15-19			
20-24	1.053	.959	1.156
25-29	.815***	.741	.896
30-34	.695***	.630	.766
35-39	.558***	.504	.617
40-44	.501***	.451	.556
45-49	.473***	.424	.529
Wealth Index			
Poorest			
Poor	.852***	.812	.894
Middle	.604***	.574	.635
Richer	.404***	.381	.429
Richest	.210***	.194	.228
Educational attainment			
No education			
Primary	.909***	.866	.954
Secondary	.903***	.859	.948
Higher	.713***	.628	.809
Parity			
<2			
3-5	1.066**	1.022	1.111
6 or more	1.209***	1.135	1.289
Prevalence of Anemia			
Severe			
Moderate	.776***	.684	.880
Mild	.674***	.597	.761
No Anemia	.538***	.476	.608
Husband's education			
No education			
Primary	.931**	.886	.977
Secondary	.921***	.881	.962
Higher	.845***	.776	.920
Husband's Occupation			
Not working/ manual labour			
Professional	.797**	.686	.926
Clerical	.900	.770	1.052
Sales	.856*	.748	.979
Agricultural	1.004	.884	1.141

Parameter	Odds Ratio	95% CI	
		Lower	Upper
Services	.892	.772	1.031
Skilled and unskilled manual	.944	.831	1.072
Sex of household head			
Male			
Female	1.012	.956	1.071

Table 4.5.3: Odds of thinness (BMI < 18.5 kg/m^2) among mothers (15-49 years) by selected characteristics, India NFHS-4 (N=73708)

Parameters	Odds ratio	95% CI	
		Lower	Upper
Place of Residence			
Rural			
Urban	1.239***	1.171	1.311
Age in Years			
15-19			
20-24	4.392*** (3.735-5.164)	3.735	5.164
25-29	3.484***	3.187	3.810
30-34	2.210***	2.042	2.392
35-39	1.532***	1.416	1.657
40-44	1.161***	1.072	1.257
45-49	1.187***	1.095	1.287
Wealth Index			
Poorest			
Poor	4.594***	4.168	5.063
Middle	3.273***	2.984	3.590
Richer	2.299***	2.103	2.514
Richest	1.526***	1.396	1.667
Educational attainment			
No education			
Primary	1.722***	1.524	1.944
Secondary	1.420***	1.255	1.607
Higher	1.289***	1.153	1.440
Parity			
<2			
3-5	0.689***	0.628	0.756
6 or more	0.843***	0.774	0.917
Prevalence of anemia			
Severe			
Moderate	2.307***	1.978	2.692
Mild	1.586***	1.495	1.683
No Anemia	1.245***	1.191	1.301
Husband education			
No education			

Parameters	Odds ratio	95% CI	
		Lower	Upper
Primary	0.811	0.546	1.205
Secondary	0.809	0.545	1.203
Higher	0.808	0.545	1.199
Husband's Occupation			
Not working/ manual labour			
Professional	.936	.760	1.153
Clerical	.691**	.560	.853
Sales	.781*	.619	.985
Agricultural	.726**	.596	.885
Services	.939	.778	1.132
Skilled and unskilled manual	.818*	.671	.996
Professional	.936	.760	1.153
Sex of household head			
Male			
Female	0.969	0.910	1.032

4.6 Identification of the transition in the determinants of maternal thinness over the years (BMI <18.5kg/m^2)

Of all the variables of interest, tested for association with the study's dependent variable (maternal thinness), the majority were found to be significantly associated, albeit their magnitude varied across the surveys. In NFHS-2, place of residence, parity, partner's occupation, partner's education, mother's education & mother's age were the major determinants found to be significantly associated with maternal thinness (Figure 4.6.1). During NFHS-3, the major determinants identified to be significantly associated with maternal thinness were place of residence, parity, partner's education, mother's education, wealth index, mother's age & anemia level (Figure 4.6.2). While in NFHS-4, wealth index, mother's age, anemia level, mother's education, place of residence, parity & partner's occupation emerged as the major determinants of maternal thinness (Figure 4.6.3).

Over time, there had been a shift in the determinants. In NFHS-2, the top three determinants associated with maternal thinness in the decreasing order of their magnitude were Place of residence, parity and partner's occupation, whereas in NFHS-3, the top two determinants remained the same as in NFHS-2 with different magnitudes, while the top third determinant changed from partner's occupation to partner's education. The top three determinants in the NFHS-4 were completely different from the prior two surveys where, wealth index, emerged as the top determinant affecting maternal thinness with the highest magnitude, followed by mother's age and anemia level (Figure 4.6.4). This implies the need to make necessary improvisations in the existing policies and planning of interventions focusing on the identified determinants so as to reduce the levels of maternal thinness.

Figure 4.6.1: Major determinants of maternal thinness (NFHS-2)

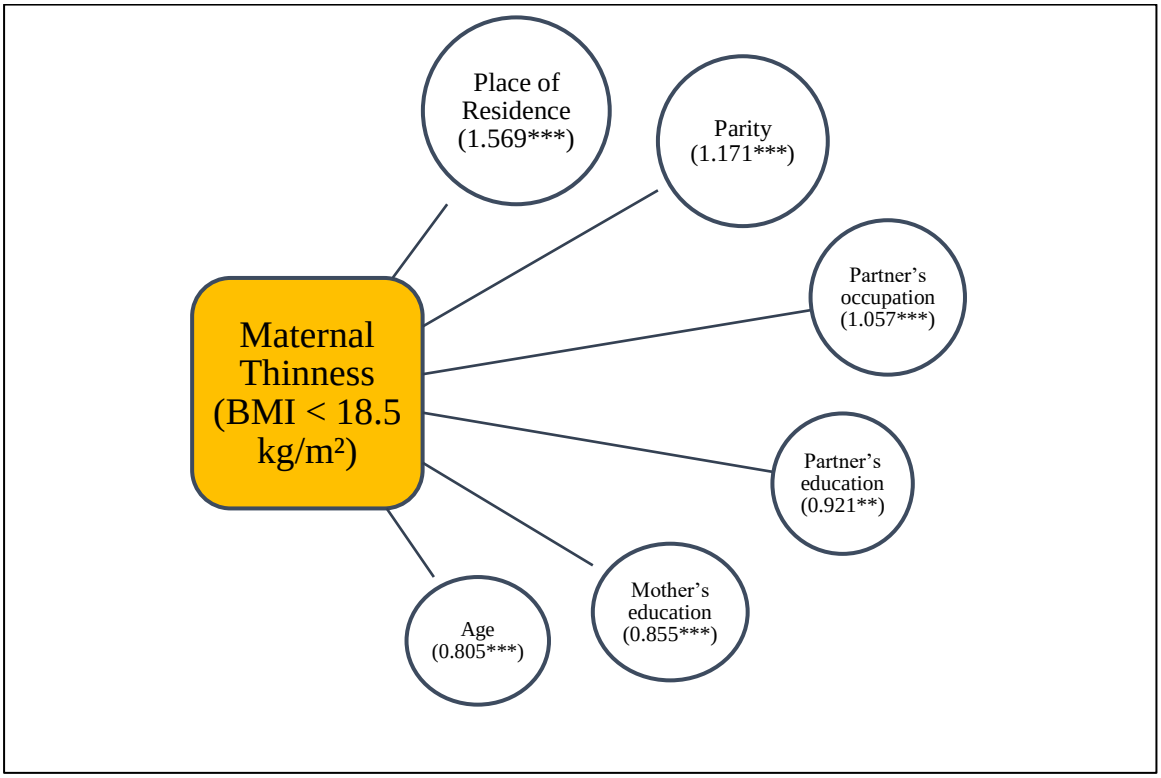


Figure 4.6.2: Major determinants of maternal thinness (NFHS-3)

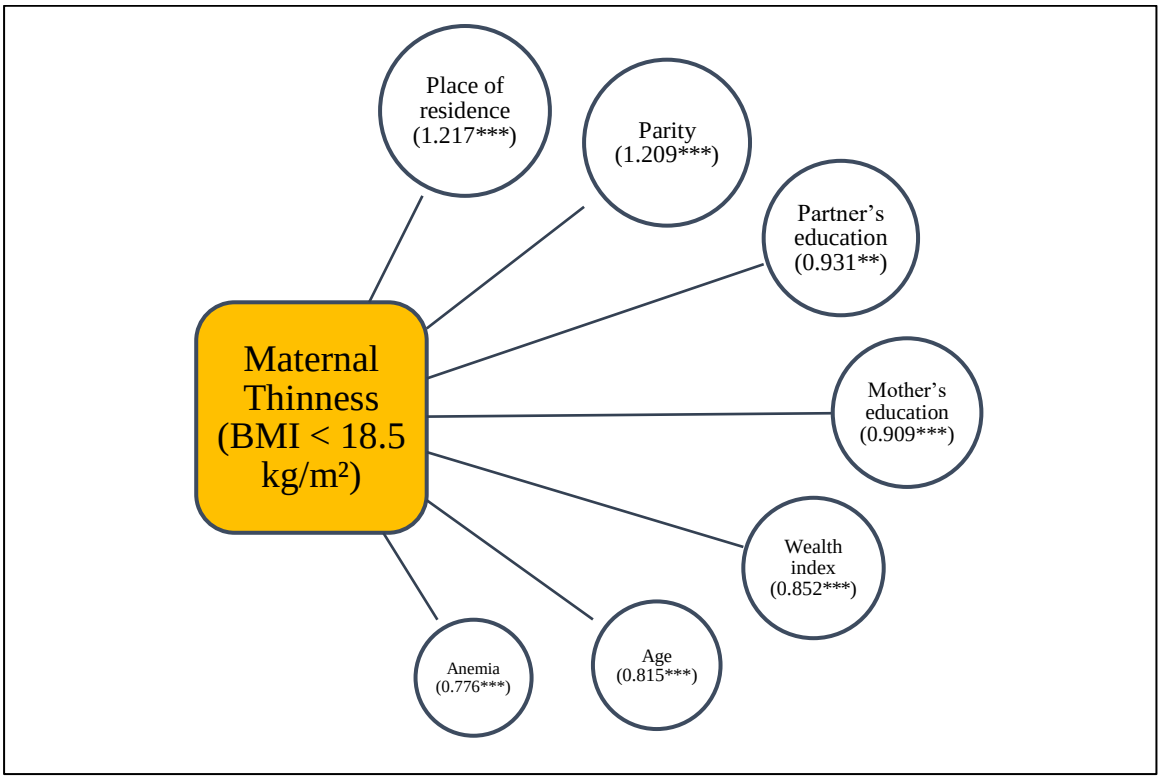


Figure 4.6.3: Major determinants of maternal thinness (NFHS-4)

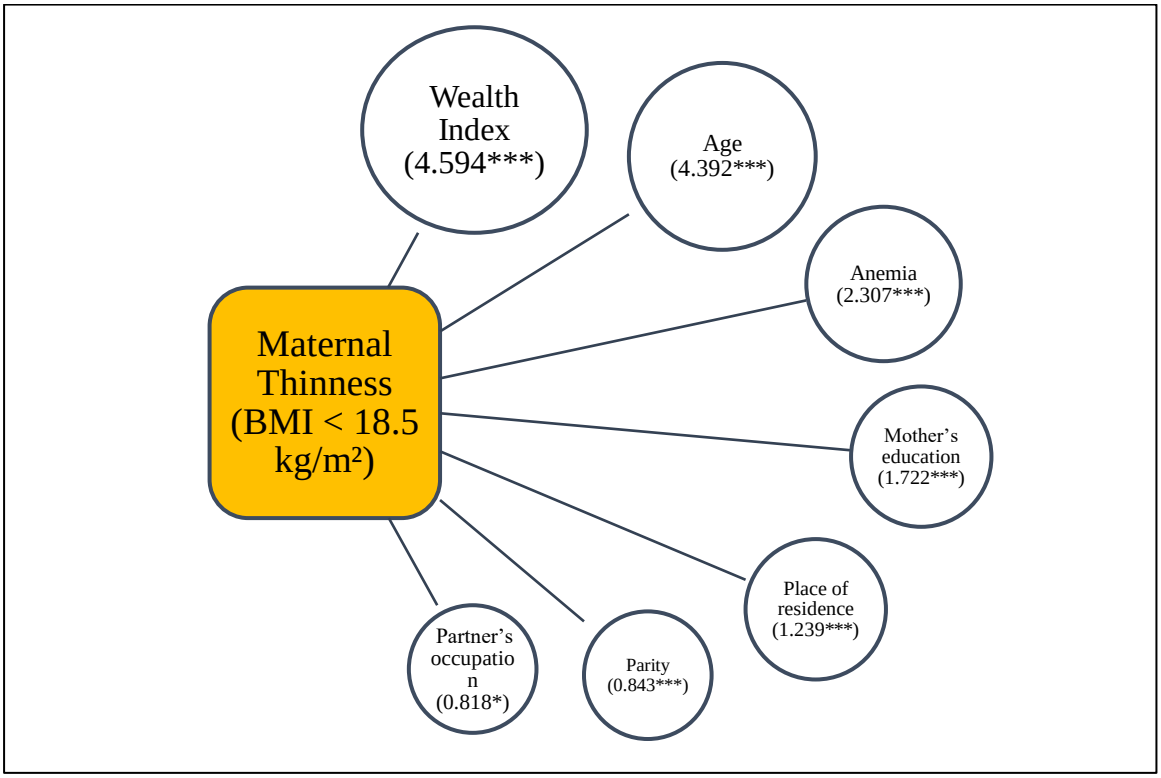
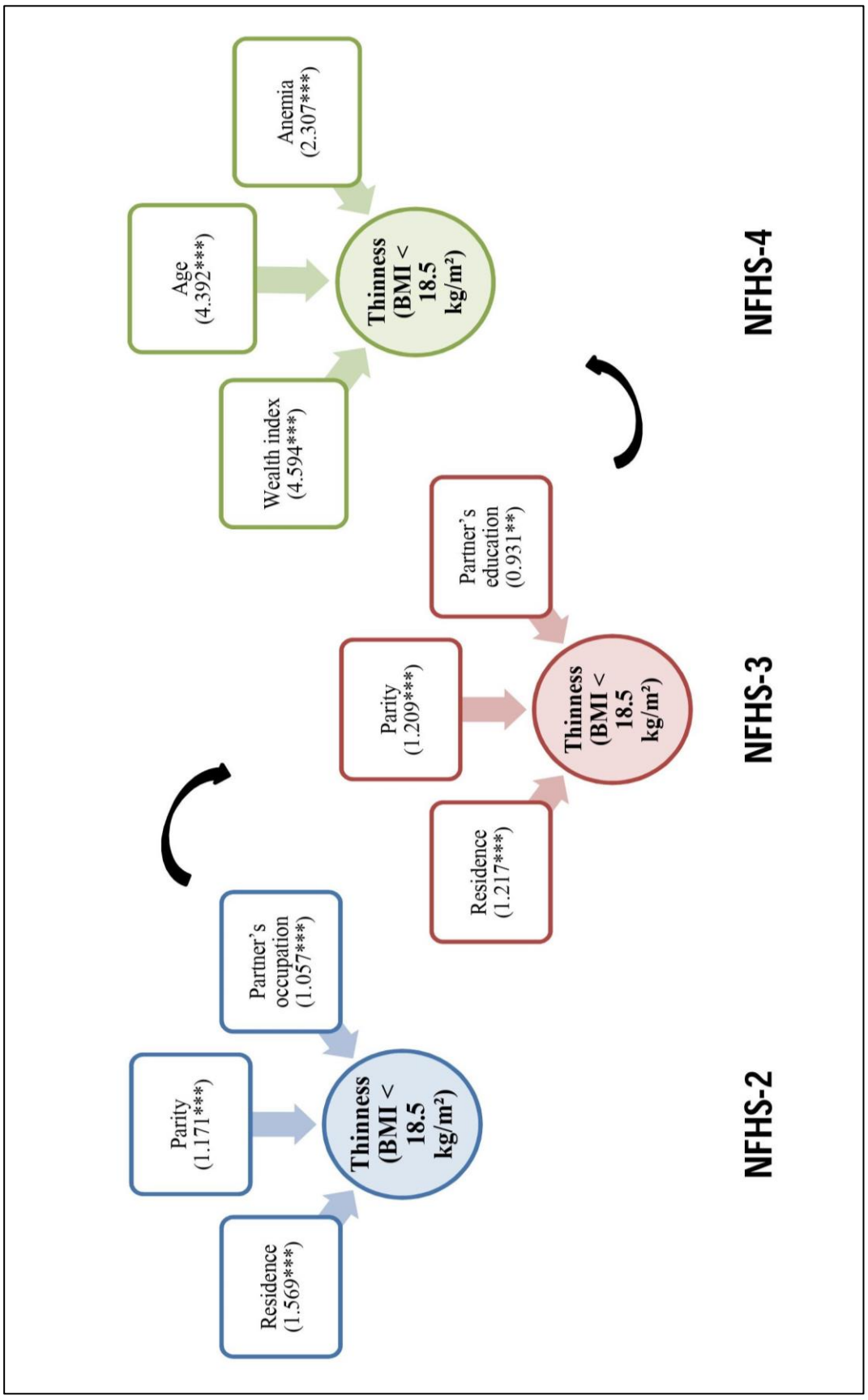


Figure 4.6.4: Transition in the determinants of maternal thinness over the years



DISCUSSION

"Undernutrition is both a consequence as well as a cause of perpetuating poverty, eroding human capital through irreversible and intergenerational effects on cognitive and physical development."

(Aayog, N. I. T. 2017)

Malnutrition is a big burden for developing countries like India. The most vulnerable are women & children. Tackling malnutrition in individual groups may not be helpful in eradicating it, as it exists in an intergenerational cycle, thus linking nutritional status of one to another. In addition, it is widely known that women supposedly being the weakest gender suffer more.

The present study with the aim to study the transition in the determinants of maternal malnutrition in India over a period of two decades, examined the prevalence and trends of different forms of malnutrition among mothers and their determinants. The major determinants of maternal malnutrition (thinness/BMI< 18.5kg/m²) identified in the study were mother's age, total number of children, place of residence, mother's education level, partner's education level, partner's occupation, anemia and socioeconomic status.

Results of the present study showed that the prevalence of thinness among mothers over the last two decades has seen 50% reduction from 36.4% (1998-99) to 17.6% (2015-16), whereas the prevalence of overweight & obesity increased by over 1.7 times & 2.5 times respectively. Very little change was observed in the prevalence of anemia over the last decade, where it decreased by only 2.2 percentage points (p.p.).

Mother's education has shown significant relation with maternal thinness. In NFHS-4, it was found that as the educational status of the mothers increased, the odds of thinness significantly decreased (from 1.72 to 1.3). Data revealed that during NFHS-2 (1998-99), the proportion of mothers with no education was more than half (53.1%). In 2000, then prime minister Atal Bihari Vajpayee initiated the 'Sarva Shiksha Abhiyan' program with the aim to provide free and compulsory elementary education to all children in the age group of 6-14 years. The impact of this initiative is visible in the improvement in the educational status of the mothers in the succeeding surveys of NFHS-3 (2005-06) & NFHS-4 (2015-16), where the proportion of mothers with no

education decreased and the proportion of mothers with secondary education increased significantly over the years. Despite the improvement, 1/3 of the mothers still have no education.

Partner/ husband's educational status also showed a significant relation to maternal thinness during both 1998-99 and 2005-06, but during 2015-16, this association to maternal thinness was not significant. This depicts that during NFHS-2 & 3, partner's education was a determinant of maternal thinness but currently it is not.

Age of the mother was significantly associated with thinness. As the mother's age increased, the odds for thinness significantly decreased. The younger mothers were more prone to being thin. Apparently, mothers in younger age groups get married early which leads to early childbearing. Early childbearing puts an additional nutritional demand on already nutritionally vulnerable adolescent girls, which further poses a burden on them. India has had laws to prevent early child marriage since 1992. Child Marriage Restraint Act (CMRA) popularly known as 'Sharda Act' which stipulated the minimum age of marriage for girls at 14 years and boys at 18 years. The act was then replaced by Prohibition of Child Marriages Act (PCMA) in 2006 under which the minimum age of marriage was raised to 18 years for girls and 21 years for boys. Despite the CMRA being in function since 1992, our findings shows that around 64% of the mothers during 1998-99 and around 59.3% during 2005-06, were under the age of 19 years at the time of their first births, which means they were married even younger.

The study found a strong relation between anemia and thinness. As the severity of anemia among mothers decreased, the prevalence of thinness also decreased. This means both macro and micronutrient deficiencies are prevalent amongst this group. This hints at the need to strengthen the anemia control program in India, as it will help in eradicating both anemia and may help in reducing thinness amongst women. Anemia Mukt Bharat is a very useful way to implement this. Along with the screening and testing of anemia under the program, thinness among school going adolescents (the future mothers) requires monitoring.

Parity was found to be significantly related to maternal thinness, where the mothers with 6 or more children were found to be most affected by thinness, indicating that frequent and repeated pregnancies diminishes the maternal nutritional stores and make

them susceptible to nutrient deficiencies. According to the regression analysis, if India wants to reduce maternal thinness, one of the ways would be through the medium of family planning. India launched a National Programme for Family Planning in 1952, becoming the first in the world. After the 2012 ‘London Summit on Family Planning’, the Government of India adopted a new approach, putting a well-defined priority on family planning initiatives under the bigger and more comprehensive umbrella of RMNCH+A (Reproductive, Maternal, Newborn and Child Health and Adolescents) program for improving mother and child (and adolescent) health in India as a wider goal. Since then, there has been a drastic decrease in the number of children being born to a woman. According to the findings from the present study, it was seen that from 1998-92 to 2005-06, the proportion of women with 3 or more children decreased very slightly, but from 2005-06 to 2015-16 in between which India made a paradigm shift to RMNCH+A, the decline was more drastically evident. As of the most recent data of 2015-16, it showed that around 38.7% & 5.3% of mothers had 3 to 5 & 6 or more children respectively. Thus, it seems that India may be able to bring down the proportion of women with more children, which will ultimately lead to reduction in maternal thinness.

The place of residence was significantly associated with maternal thinness. Mothers residing in the rural areas were at higher risk of being thin than the mothers from urban areas. Thus, to improve maternal nutritional status, one approach would be to focus more on mothers from rural areas, and for this the most appropriate approach would be through strengthening the Village Health, Sanitation and Nutrition Day (VHSND) activities as it caters to all the beneficiaries of our interest i.e. pregnant & lactating women, adolescent girls and also eligible couples. VHSND, earlier known as Village Health and Nutrition Day (VHND), has been implemented in the country since 2007.

Wealth index quintiles and poverty was another determinant found to be significantly associated with maternal thinness where mothers from poor households were at increased odds of being thin than the mothers from richest households. Poverty eradication is a vast and intergenerational concept. Though the wealth index has been a determinant, it emerged as the major highly significant determinants during 2015-16, reflecting that the need to focus on it has to be intensified now. As stated earlier, poverty is both a cause and consequence of undernutrition. Poverty often leads to

undernutrition in children, who grow out to be undernourished adults, which affects their productivity, hindering their economic growth and it ultimately leads to giving birth to undernourished children, thus perpetuating a cycle of poverty and undernutrition linking them both to each other. Various poverty alleviation programs launched by the incumbent government have been in force in India since 1979 with the launch of Integrated Rural Development Programme (IRDP) to address the issue directly or indirectly. Poverty alleviations programs have been in force in India since 1979 with the launch of Integrated Rural Development Programme (IRDP). Since the launch of IRDP in 1979, various modifications have been made along with the launch of various allied programmes. The study data showed that in the period of almost two decades (from 1998-99 to 2015-16) not much reduction has been observed in the proportion of mothers living in poorer and poorest households. With the passing of time, and improvement in the educational status of the women, women employment was expected to have increased along, but in reality a decline in the working status of the mothers was observed contradicting the expectations. This clearly shows the existence of gaps in the existing programmes/policies, and a crucial need to strengthen these programmes to create more employment opportunities and create a delivery mechanism for intended beneficiaries without any leakage or diversion in between the process.

Findings from the study showed that there are multiple determinants of maternal malnutrition, the majority of them have been the same over the past two decades, and all are needed to be focused upon. With the passing time, the need to focus on some has magnified. Focusing on these determinants will surely be helpful in reducing maternal malnutrition and building a better future for mothers and their children.

Summary and Conclusion

SUMMARY AND CONCLUSION

The present study was conducted to assess transition in determinants of maternal malnutrition in India over a period of two decades by secondary data analysis using data from National Family and Health Surveys (1998-2016).

The study was divided into 2 phases:

Phase I A – Selection of survey for analysis i.e., NFHS 2, 3, 4 and understanding the variables and the recodes.

Phase I B – Conducting descriptive statistical analysis for identifying determinants in individual datasets.

Phase II- Identify transition in determinants over the period of two decades comparing the datasets.

It was found that, over the years, though the majority of the mothers were residents of the rural areas, the proportion had reduced from 73.1% (NFHS-2) through 69.8% (NFHS-3) to 65.9% (NFHS-4). And the use of piped water as a source of drinking water has improved from 38.4% (NFHS-2) to 44.6% (NFHS-4) and the use of well water as a source of drinking water has gradually decreased from 58.5% (NFHS-2) through 53.8% (NFHS-3) to 45.5% (NFHS-4). The toilet facilities were also observed to have improved over the years where, use of flush toilets has more than doubled from 24.2% (NFHS-2) to 52.6% (NFHS-4). Though the proportion of no toilet facility or use of bush/field for defecation had gone down over the years from 63.4% (NFHS-2) to 36.2% (NFHS-4), it is concerning that, still more than 1/3rd of the mothers had no toilet facility. In NFHS-3, the proportion of mothers in all the wealth quintiles were almost similar, where the proportion of mothers living in the poorest quintile was the lowest at 18.3% and proportion of mothers living in the richest quintile was the highest at 20.9%. In NFHS-2, partners of majority (40%) of the women were employed in agricultural work which then decreased to 33.3% in NFHS-3 and 32.9% in NFHS-4 but still being the major profession, since India is an agricultural country.

During NFHS-2, the mean current age of mothers was 32.46 ± 8.46, and around 4.4% of mothers were in the youngest age group of 15-19 years, while around 10.5% of mothers were in the oldest age group of 45-49 years. In NFHS-3, the mean (± SD)

age of the mothers included in the analysis was 32.77 ± 8.17 (table 4.3.2). Very few women (3.2 %) were in the youngest age group and 10.4 % were in the oldest age group. In NFHS-4, the mean (± SD) age of the mothers included in the analysis was 34.10 ± 8.082 (table 4.3.2). Around 1.3% mothers were in the youngest age group and 14.4 % were in the oldest age group.

The data showed that the proportion of working women has continuously decreased from 39.3% mothers who were employed in NFHS-2 through 38% in NFHS-3 to 25.6% in NFHS-4.

Prevalence of thinness (BMI < 18.5 kg/m²) among mothers was found to be around 36.4% in NFHS-2, which reduced to around 33.1% during NFHS-3 which further reduced to around 17.6% in NFHS-4. The prevalence of overweight & obesity was observed to have increased over the years from 8.1% & 11.1% in NFHS-2 to 14.4% & 27.1& in NFHS-4.

Anemia was found to be prevalent during both the surveys of NFHS-3 & 4, where more than half of the mothers were found to be anemic. The situation over the years improved but not by much, where the proportion of mothers with mild anemia reduced from 39.9% (NFHS-3) to 39.7% (NFHS-4). During NFHS-3, around 14.4% and 1.6% mothers were moderately and severely anemic respectively, which then reduced to 12.9% and 1.2% in NFHS-4 respectively.

The interrelationship between BMI and variables of interest showed that thinness (BMI<18.5kg/m²) was more prevalent among mothers residing in rural areas and mothers belonging to poor households. Educational status of the mothers was also found to be associated with thinness, where mothers with no education were more prevalent of being thin. The data shows that, the prevalence of being thin(BMI < 18.5 kg/m²) was the highest (13.3%) among mothers whose partners had no education and lowest (3.8%) among mothers whose partners had attained higher education. Mothers whose partner/husband were employed in agriculture had the higher prevalence of thinness. Mothers with more children were found to be having a higher prevalence of thinness along with mothers who gave birth to their first child at the age of 15-19 years.

The binary logistic regression analysis performed to ascertain the effects of selected characteristics on the likelihood of thinness revealed that women residing in rural

areas had the higher odds for thinness as compared to women in urban areas. As the wealth quintiles improved, significant reduction in thinness was observed. The increase in educational levels reduced the odds of thinness. Parity was also found to be associated with the odd of thinness where women who had more than 6 children had the highest odds for thinness. As husband's education level increased, the odds for thinness amongst their spouses reduced significantly. It was observed that as the severity of anemia decreased it led to a reduction in odds for thinness amongst women.

A transition in the determinants was observed with the change in time. The findings showed that the determinants of maternal thinness identified across the surveys varied from each other, and this implies that a holistic approach is necessary to improve nutrition, education, and sanitation as well as wealth status of individuals. Focusing on the major determinants identified through this study would be useful in improving maternal nutritional status at a faster pace.

The high socioeconomic inequalities in the prevalence of thinness and overweight & obesity along with anemia is a cause for concern and calls for further in depth analysis of data. The coexistence of thinness and overweight & obesity and thinness and anemia implies the need to have policies that address challenges related to both undernutrition and overweight/obesity along with addressing the socioeconomic disparities.

It is critical to adequately treat maternal malnutrition in order to ensure optimum cognitive growth and development for children. As a result, policymakers, health-care providers, civil society organisations, and programme implementers must do more to combat this terrible condition.

The identification of the determinants will aid in determining the adequacy of the techniques used and the real cause, as well as readjusting measures/interventions to combat and reduce maternal malnutrition.

LIMITATIONS

Assessment and transition in the determinants of maternal malnutrition could not be performed across all the National Family Health Surveys, due to unavailability of required data on BMI & Anemia in NFHS-1(1992-93) and availability of only partial data (Phase-1 data) from NFHS-5 (2019-20) which cannot be used to represent the picture of whole India.

Assessment of the determinants of maternal anemia could not be performed due to insufficient data on anemia in the NFHS-2.

RECOMMENDATIONS

The approach of this study can be used to identify the current determinants of maternal malnutrition using the data from NFHS-5 once the whole data gets available in public domain.

Similar approach can also be used to identify the determinants at the individual state and district level, and the findings will be useful to provide necessary inputs to the policy makers to strengthen the existing policies and programs and to evolve new strategies for interventions at both state and district levels.

Determinants of maternal overweight and obesity can be identified using the approach used in the present study so as to reduce the burden of NCDs in near future.

State wise analysis of the datasets can be conducted in order to understand differences between performing and non performing states and to appreciate and learn from the best performing states.

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Appendices

Appendix I

Permission letter

Oct 06, 2020

Vijayata Sengar
Dept of Foods and Nutrition
India
Phone: +919879540227
Email: vijayata.sengar-fn@msubaroda.ac.in
Request Date: 10/06/2020

Dear Vijayata Sengar:

This is to confirm that you are approved to use the following Survey Datasets for your registered research paper titled: "Determinants of maternal malnutrition":

India

To access the datasets, please login at: https://www.dhsprogram.com/data/dataset_admin/login_main.cfm. The user name is the registered email address, and the password is the one selected during registration.

The IRB-approved procedures for DHS public-use datasets do not in any way allow respondents, households, or sample communities to be identified. There are no names of individuals or household addresses in the data files. The geographic identifiers only go down to the regional level (where regions are typically very large geographical areas encompassing several states/provinces). Each enumeration area (Primary Sampling Unit) has a PSU number in the data file, but the PSU numbers do not have any labels to indicate their names or locations. In surveys that collect GIS coordinates in the field, the coordinates are only for the enumeration area (EA) as a whole, and not for individual households, and the measured coordinates are randomly displaced within a large geographic area so that specific enumeration areas cannot be identified.

The DHS Data may be used only for the purpose of statistical reporting and analysis, and only for your registered research. To use the data for another purpose, a new research project must be registered. All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. Please reference the complete terms of use at: https://dhsprogram.com/Data/terms-of-use.cfm.

The data must not be passed on to other researchers without the written consent of DHS. However, if you have coresearchers registered in your account for this research paper, you are authorized to share the data with them. All data users are required to submit an electronic copy (pdf) of any reports/publications resulting from using the DHS data files to: references@dhsprogram.com.

Sincerely,

Bridgette Wellington

Bridgette Wellington
Data Archivist
The Demographic and Health Surveys (DHS) Program

530 Gaither Road, Suite 500, Rockville, MD 20850 USA +1.301.407.6500 +1.301.407.6501 fax icf.com

Appendix II

Ethical Certificate

Institutional Ethics Committee for Human Research (IECHR)

FACULTY OF FAMILY AND COMMUNITY SCIENCES
THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

Ethical Compliance Certificate 2020 – 2021

This is to certify that **Ms. Mullay Gurkiran Kaur**'s study titled, "**Assessing transition in determinants of maternal malnutrition in India over a period of two decades: Secondary analysis using National Family Health Surveys (NFHs)**" has been approved by the Institutional Ethics Committee for Human Research (IECHR), Faculty of Family and Community Science, The Maharaja Sayajirao University of Baroda. The study has been allotted the ethical approval number **IECHR/FCSc/2020/59.**

Prof Mini Sheth
Member Secretary
IECHR

Prof Shagufa Kapadia
Chairperson
IECHR