IMPACT ON NUTRITION THROUGH MID DAY MEALS: BUILDING A COMPREHENSIVE ASSESSMENT MODEL

A Report

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TABLE OF CONTENTS

SUMMARY

We find reliable evidence that poor health and nutrition during childhood affects educational access, social participation, income and academic achievement of a person throughout his life. School-based health and nutrition programs are providing a cost-effective and low-cost solutions to dealing with long term well-being of the population. The need for school health and nutrition programs as part of education for all (EFA) gets recognized by almost all the countries and international organizations including WHO, World Bank and UNICEF. The report details some of the models in Section 3.

Child health and nutritional interventions are moderated by several factors. Research studies have identified the risk factors of a child's well-being, which include genetic factors; infections and diseases; maternal health; socio-economic factors; water, sanitation and hygiene; and community-based variables like access to food, health practices, and community social and health predispositions as directly influencing nutritional outcomes. The report details these determinants in Section 2.

The framework proposed in the report incorporates all the above-mentioned factors to build a comprehensive mid-day meal (MDM) assessment model. The framework is detailed in Section 1, page 7. The framework will provide the foundation to evaluate the multi-level impacts of the MDM scheme on a child's nutritional health. The inter-sectoral convergence in the framework ensures a balanced and holistic view of the MDM scheme. The framework also gives us the potential to identify effective, high potential, policy interventions for improved nutritional health of a child in India.

List of Figures

Terms and Acronyms

1. Height for age (Stunting): Stunting is defined as below minus two standard deviations from median height for age of reference population (UNICEF, 2020)

2. Weight for height (Wasting): Wasting is defined as below minus two standard deviations from median weight for height of reference population (UNICEF, 2020).

3. Weight for age (Underweight): Underweight is defined as below minus two standard deviation from the median of the World Health Organization Child Growth Standards among children under 5 years of age (WHO, 2017).

4. Undernutrition: Undernutrition includes underweight, stunting, wasting and deficiency in vitamins and minerals i.e., micronutrient malnutrition (UNICEF, 2020).

5. BMI: BMI refers to Body mass index is a measure of body fat based on height and weight. It is calculated as the weight in kilograms divided by the square of the height in metres (kg/m^2) (WHO, 2020).

6. Infant and child mortality: Infant mortality rate refers to death of child during the first year of child birth while child mortality refers to the death of child between 1-5 years (WHO, 2017).

7. Neonatal mortality: Death during first 28 days of life (WHO, 2017).

8. MDM: Mid-day Meal

9. UNICEF: United Nations Children's Fund

10. WHO: World Health Organization

11. NITI Aayog: National Institution for Transforming India

Section 1:
Investigating the Value of Mid-day Meal Schemes:
The Proposed Nutritional Framework

Better health and well-being of children poses a big challenge for both developing and developed countries (Kamiya, 2011). Almost one third of the global population, i.e., about 2.2 billion, are under 18 years and forms about 50% of the population of low and middle income countries (Kieling et al., 2011). What makes child health and nutrition important? Research shows children and adolescents suffering from poor health and nutrition demonstrate significantly higher learning time in school, effecting the overall educational outcome of a nation and globe (Glewwe and Miguel, 2007). Education, in turn, gets linked to the economic development of a nation and thereby, the key to improve national economy lies in improving the quality of life of children and adolescents.

Undernourishment of children has severe implications in later life (Ferreira and Schady, 2009). For instance, Case and Paxson (2008) and Currie and Thomas (1999) identified low level of cognitive development in children of United State and United Kingdom who were undernourished during the first 22 months of their life. Similarly, stunting[1] in children in Jamaica during early childhood resulted in poor emotional and behavioral outcomes along with cognitive deficit and academic achievements in their adolescence (Walker et al., 2005). On the other hand, higher cognitive development and increased wages were found to be associated with better nutritional interventions to the children during their childhood in Guatemala (Hoddinott et al., 2008). In India, undernutrition has been found to severely affect child development and growth, intelligence, academic performance, and emotional intelligence in later stages of the life (Moestue and Huttly, 2008). Additionally, poor health and nutrition of children manifests in underweight, stunting and early deaths as well (UNICEF, 2020; WHO, 2017; World Bank, 2020). These studies demonstrate a close association between child health, child nutrition and developmental parameters like cognitive abilities, emotional well-being, and mental intelligence in later stages of life. The importance of understanding the factors driving the nutritional content of children, thus, becomes imperative.

[1] Stunting refers to the impaired growth and development experienced by children from poor nutrition, repeated infection, and inadequate psychosocial stimulation.

In this concept paper we develop a comprehensive health and nutrition framework for school going children with the aim of using the framework to develop value linkages for the MDM schemes running across India. Synchronizing the main determinants of child health and nutrition, as found in various studies and reports, with the MDM scheme becomes imperative for a thorough and clear understanding of the health and nutrition status of the children being served the MDM by Akshaya Patra.

A comprehensive framework for health and nutrition of children and adolescents gets determined by a number of factors, including child feeding practices, sanitation and hygiene, micronutrient and mineral deficiency, undernutrition in mothers, neighborhood healthcare services, livelihood patterns, socio-economic factors, and governmental policies such as public distribution systems (Cavatorta et al., 2015; Gillespie et al., 2012; Gulati et al., 2012; Kadiyala et al., 2012; Kanjilal et al., 2010).

The proposed framework is based on the global and Indian literature, World Bank, UN, WHO and NITI Aayog report on health and nutrition. Multi-sectoral inputs are required to tackle the health and nutrition challenge effectively and thereby, the proposed framework will incorporate multiple, direct and indirect, nutritional interventions such as recurring infections and diseases; genetic factors; maternal health factors; access to food, health and mental well-being, parental knowledge and decision making practices towards food, and community variables like beliefs, support systems, access and genetic predispositions. **Figure 1 illustrates the framework.**

The framework will provide the foundation to evaluate the multi-level impacts of the MDM scheme on a child's nutritional health. The inter-sectoral convergence in the framework ensures a balanced and holistic view of the MDM scheme. The framework also gives us the potential to identify effective intervention with high potential to improve child health and nutrition.

Further, the study can also help to identify: a) Potential role of different factors towards health and nutrition of children, b) Comprehensive framework for child and adolescent health and nutrition for India, c) Hot-spots in terms of low child and adolescent health and nutrition, and d) Region-specific, and community specific prioritization of factors contributing towards child and adolescent health and nutrition.

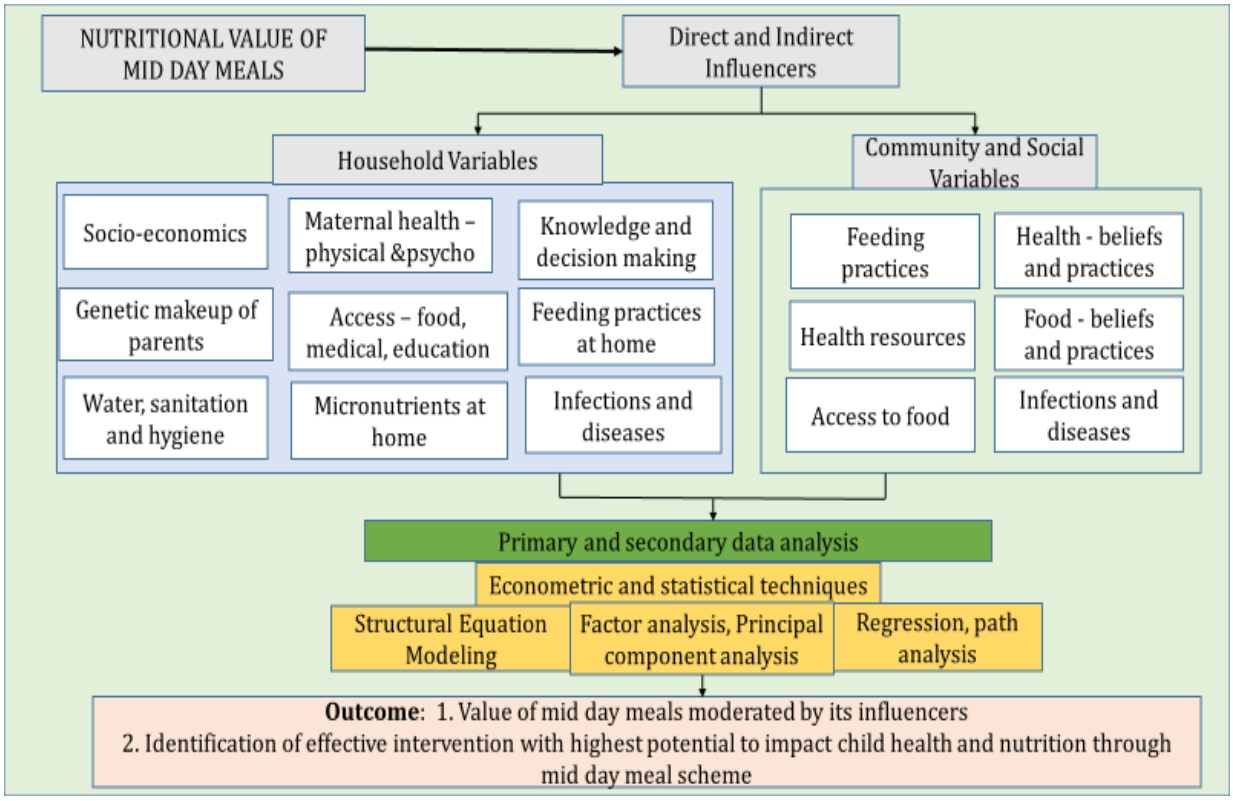

Fig.1: Proposed framework for study of child's nutritional health and MDM impact

Data will be obtained from National Family Health Survey 2016-17 which provides extensive dataset for stunting, wasting, undernutrition in children along with maternal care indicators such as anaemia, zinc, iodine in women, BMI of women, exclusive breastfeeding in India; water and sanitation related data i.e., availability of safe drinking water, provision of toilet in the house etc. The dataset will be used to identify the poorly performing states with regard to child and maternal health and nutrition.

Extensive field survey will be carried out in the different states of India where data will be collected on the various parameters listed in the framework. Furthermore, household survey will also be conducted where data on maternal health, water, sanitation and hygiene, socio-economic status, micronutrients and environmental factors will be collected. Additionally, implementation scenario of various state and national level governmental schemes and programs will be understood by asking a specific set of questions to the people involved in survey.

Both, qualitative and quantitative methods, will be applied to estimate the effect of different factors on MDM based nutrition. The econometric and statistical techniques include regression, path analysis, factor analysis, principal component analysis and structural equation modelling to analyse how different components are interacting with each other and how they are individually affecting the MDM nutritional intervention. Along with, we will also formulate a common index by integrating all the factors to understand how different factors cumulatively affect the health of children. Analysis will be performed using SPSS, R, MATLAB, ArcGIS and MS-Excel.

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Section 2:
Determinants of Child Nutritional Health:
Global and Indian perspectives

Studies across the globe, and India, have attributed several underlying factors determining a child's nutritional health. Fig. 2 highlights the overall vulnerabilities facing a human being, including nutritional vulnerabilities as a child. In other words, the figure summarizes the risk factors of child well-being at different stages which impacts the child's health all along. While malnutrition remains one of the factors, a comprehensive assessment of child nutritional health also includes maternal deprivation, socio-economic status, educational status of mother and father, responsive care, and access to better nutritional practices.

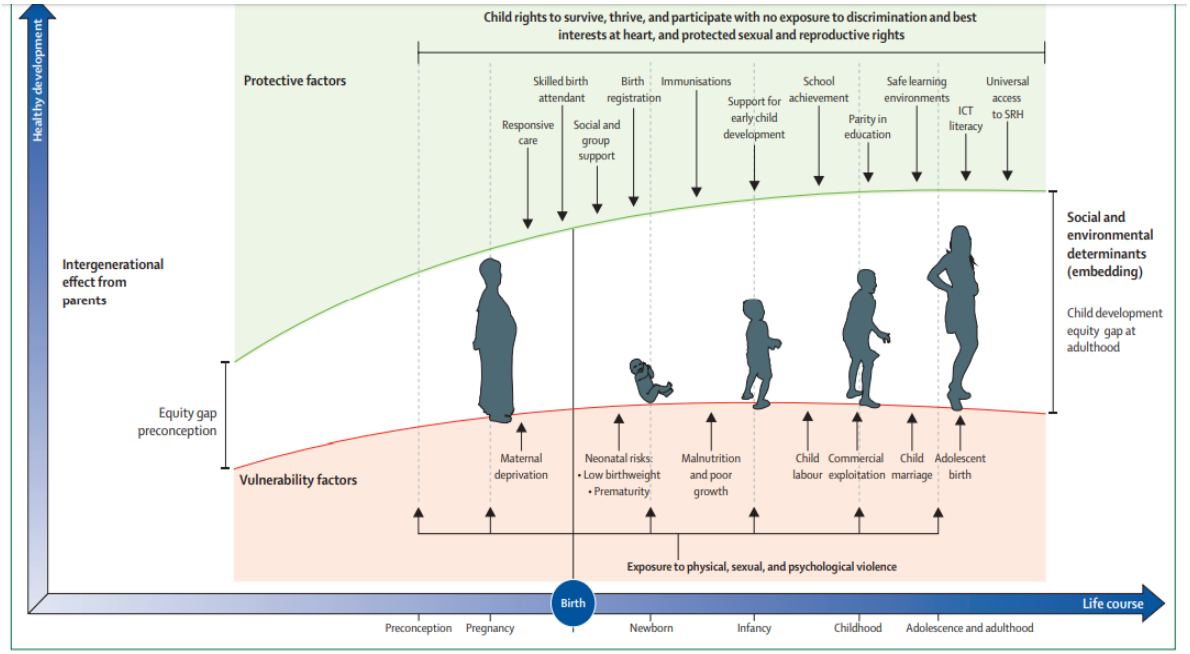

Fig. 2: Risk factors for child well-being across life
Adapted from (Clark et al., 2020)

Fenske et al., (2013) has given the most comprehensive framework (Fig. 3) and the factors within the framework are discussed in detailed .

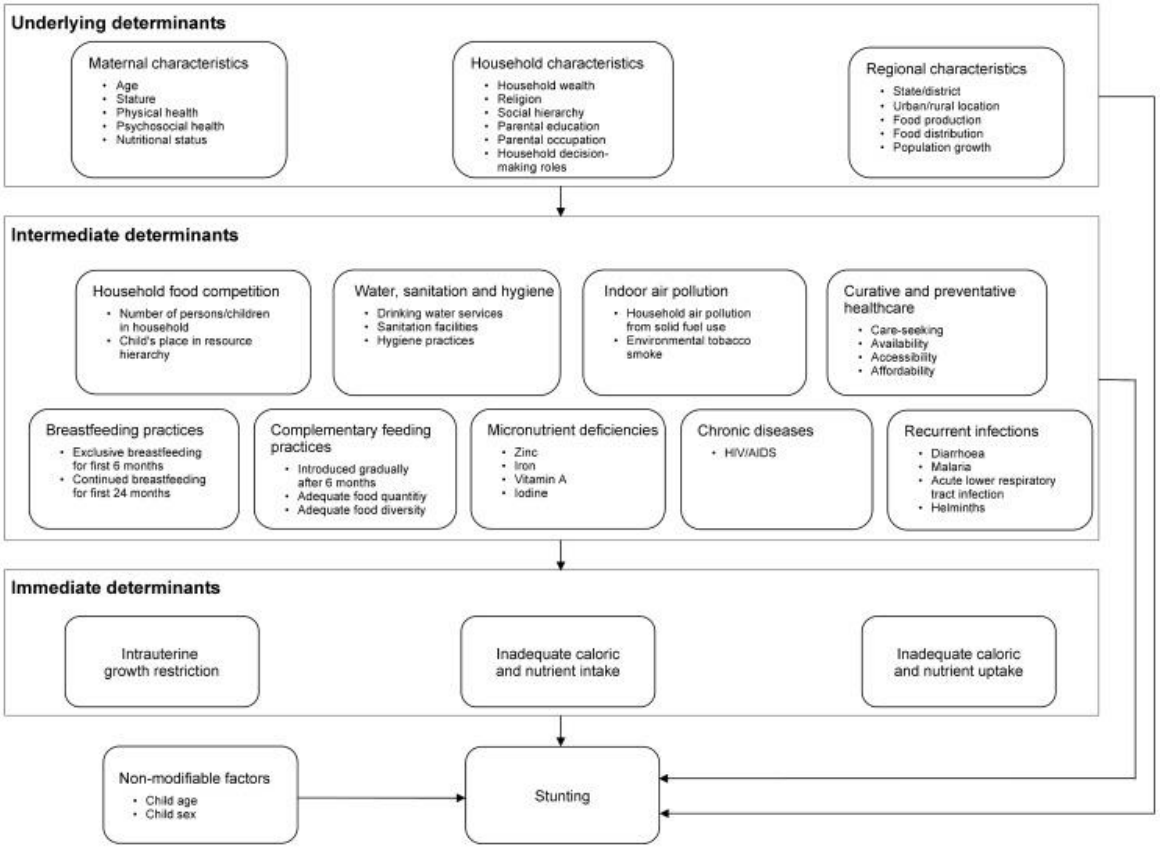

Fig.3: Multiple determinants of child stunting
Adapted from (Fenske et al., 2013)

Infections and diseases

From recurring common cold to communicable disease like malaria, infections and disease graph of a child has direct implications on the child's nutritional and health status. Black et al. (2010) used a multi cause proportionate mortality model and regression to estimate the number of child deaths for different regions of Asia, Europe, Africa, America, and Western Pacific countries, taking support from expertise of WHO, UNICEF and UN. The study identified pneumonia, diarrhoea, malaria, injury, meningitis or encephalitis, and measles as the leading causes for significant negative impact on child health and also children death. In the Indian context, Patel et al. (2015) reported 68% of children with severe health deterioration (leading to death as well) due to diarrhoea, pneumonia, lower respiratory infections, malaria, and typhoid.

Nutritional inputs given to a child over a constant time of period influences the disease and infection in the body. For instance, Rondanelli et al. (2018) reported common cold being associated with deficiency of zinc, vitamin C and vitamin D. Another study by Mahalanabis et

al.(2004) and Prasad et al., (2008) found deficiency of zinc as a micronutrient in the body leading to fever and lower respiratory infection, cough and nasal discharge because zinc is directly associated with the functioning of cytotoxic T lymphocyte cells in the body (Barnett et al., 2016). Pneumonia occurs due to deficiency of Vitamin A and zinc in the body (Bhandari et al., 2002) and measles is cured by providing dosage of Vitamin A (Huiming et al., 2006).

Other infections and diseases demonstrate the same. For example, anaemia is associated with deficiency of iron, leading to neurological impairment, and deficiency of iodine leading to mental retardation (Caulfield et al., 2006). Prevalence of these disease in body such as diarrhoea leads to malnutrition (Mata, 1992), measles lead to increased cases of infant and child mortality (Huiming et al., 2006). Other infections and disease leads to stunting, wasting and impaired cognitive ability of a child (Clark et al., 2020; UNICEF, 2020; WHO, 2020).

Genetic factors

Genetic factors play a highly significant role in determining the weight, height and nutritional status of a person. For instance, Wood et al. (2014) identified the relevant genes associated with height of an individual and further analyzed how these genes determine the skeletal growth of a person. Visscher et al. (2010) found genetic variations leading to significant impact on height of an individual. Similarly, weight of an individual gets determined by the genes of an individual as well. For example, Barsh et al. (2000) reported during their study on American, French and Indians that chromosome location controls the BMI and body fat percentage. Furthermore, MorenoAliaga et al. (2005) identified genetic make-up of an individual as playing an important role in appetite control, lipid metabolism and energy expenditure regulation, which in turn determine the weight of an individual. Wilson et al. (1999) highlighted weight of an individual being controlled by synthesis of leptin hormone in the body which gets mediated by the genes responsible for agouti related protein and its receptor. These studies highlight the genetic make-up determining the health, weight and nutrition.

Micronutrients

Micronutrients i.e., vitamins and minerals, are important for optimal health and development of children. Deficiency of micronutrients interacts with protein and energy deficiency, adversely affecting a child health and growth (NITI Aayog, 2018). Several studies highlight the same. Caulfield et al. (2006) found provision of vitamin, iodine, zinc and iron supplements to mother and child help in reducing the stunting and wasting among children. Fenske et al.

(2013) identified Iron, Vitamin A supplements, and Iodine-in-salt as vital measures of children health and nutrition in India.

Water, sanitation and hygiene

Poor sanitation, unsafe drinking water and unhygienic practices have resulted in increased cases of diarrhoea which led to death of around 11% children worldwide. Further, 10% increase in open defecation lead to 0.7% increase in stunting and severe stunting and increased cases of child death in India (NITI Aayog, 2018). The Indian National Family Health Survey (2005-06) data analyzed by Fenske et al. (2013) found improved quality of drinking water and better sanitation facilities leading to negative impact on stunting and severe stunting among children.

Horta et al. (2013) conducted a study of 6075 children across 123 villages in four Brazilian regions and identified the cases of underweight, stunting and wasting were less for inside home piped drinking water in comparison to the outside home piped drinking water. Number of children with stunting, wasting and undernutrition also reduced with prevalence of indoor toilet facilities rather than outdoor defecation facilities. The villages with trash cleaning services were found to be less prone to stunting, wasting and undernutrition of children. Access to sanitation services helped in improving the health and nutrition profile of children in Brazil.

A survey of 385 households in Bangladesh and 448 households in Philippines by Lee et al. (1997) to estimate the impact of water and sanitation on child's health and nutrition found that use of wells and ponds as source of drinking water led to negative impact while use of river/canal water had significantly positive impact on child's health in Bangladesh manifesting in terms of their better height and weight. Along with, households with place of waste disposal also had positive impact on child's health. In Philippines, provision of drinking water in wells and waste disposal sites also led to positive outcome on child's health.

Maternal health

Maternal health is considered a prime indicator governing the health and nutrition of children. Fenske et al., (2013) identified maternal education, mother's employment status, maternal age and maternal BMI[2] significantly effecting a child's stunting and severe stunting. In India, Devi and Geervani (1994) used multistep linear regression to estimate how education, occupation,

[2] BMI refers to Body mass index is a measure of body fat based on height and weight. Mother's BMI is directly associated (50%) with infant weight as well as weight gain during childhood (https://www.ncbi.nlm.nih.gov/pubmed/30412742).

health status during pregnancy, health during the study period, help received from parents, help from family members for household activities, and nutritional awareness of mothers affect the nutritional status of their children. The study identified health status of mother during pregnancy, help received by mother's parents, and nutritional awareness of mothers as the positively influencing factors for nutritional status of children in India.

Ramakrishnan et al. (2012) identified age of mother, anemia percentage during pregnancy, vitamin, iron and zinc supplements taken by mother and maternal hygiene as important determinants of child's stunting, wasting and undernutrition in Uttar Pradesh and Tamil Nadu. Paul et al. (2011) argued for younger age at child birth leading to poor health and well-being of the children born to such mothers.

Further, weaning practices impact the child's physical and psychological growth and development (Kohlhuber et al., 2008; Negayama et al., 2012; Victora et al., 2011). The weaning age of the child, and the feeding process that follows after weaning impacts the nutritional levels of the child. Harpham et al. (2005) conducted a study of 2000 mothers and their children in each of the four developing countries namely India, Ethopia, Peru and Vietnam and identified maternal age, education and breastfeeding practices as positively impacting factors for child health in India and Vietnam, and strongly recommended improving maternal health for better health and nutrition of child.

Socio-economic factors

Building from the earlier section, socio-economic factors such as poverty, women empowerment, social living, and uncertain future prospects play a vital role in determining child health and nutrition (Rigby et al., 2003). Amin et al. (2010) analyzed the data of 3498 people from 128 villages in three divisions of Bangladesh and proposed a framework (Fig. 4) where they attributed socio-demographic factors of age, parity and education of mother, education of father, women's decision-making power and access to media as the socio-demographic factors affecting nutrition of children.

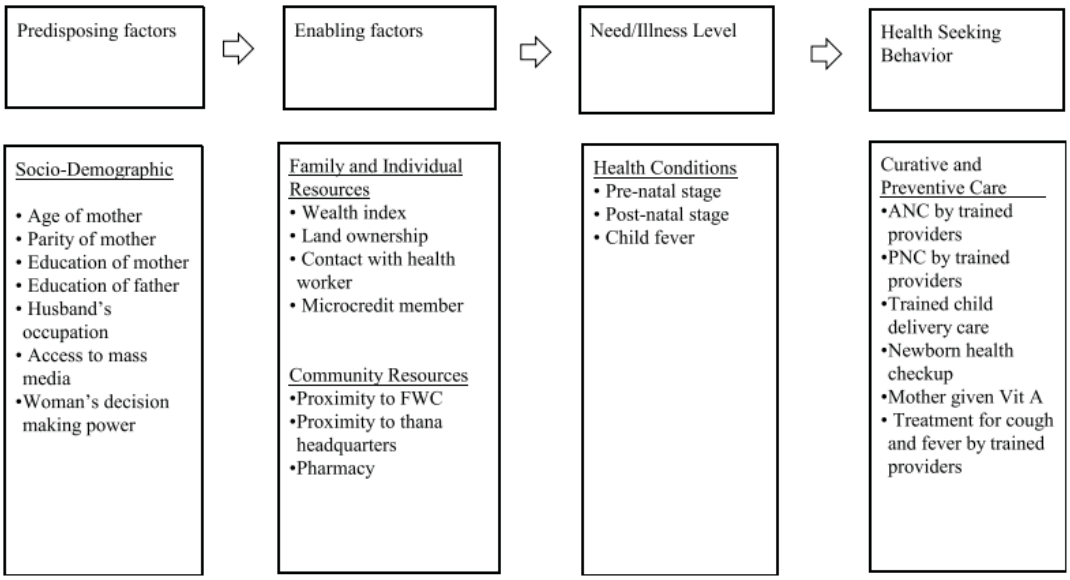

Fig.4: Conceptual framework for child's health and nutrition in Bangladesh
Adapted from (Amin et al., 2010)

In India, Devi and Geervani (1994) identified some socio-economic factors during their study of 197 children from low-income households in Andhra Pradesh. The authors found type of family, size of the family, per capita income, land availability, income from land, per capita food expenditure, source of drinking water, and number of children in the family attending school or college as the main factors in determining children's nutrition status in the house.

Mazur and Sanders (1988) found similar results when they analyzed the data of 277 children in peri urban Zimbabwe. The authors identified disparities in income, education, occupation, housing tenure, expenditure on food, protein and low crowding determining a child's health and nutritional graph. Kamiya (2011) estimated the data of 5894 households using multilevel linear model to understand the effect of socio-economic factors and found education level of mother and father significantly influencing undernutrition, stunting and wasting in children of Laos. Further, economic factors i.e., increased wages were found to be associated with better nutritional interventions to the children during their childhood in Guatemala (Hoddinott et al., 2008).

Community variables

The next level variables impacting a child's nutritional status are the community factors. Kamiya (2011) surveyed 5894 households in Laos and identified community variables like use of skilled birth attendance, child vaccination, vitamin A for child, incidence of childhood

diarrhea, availability of basic assets such as toilet, TV, radio, mode of communication and water as the governing factors for stunting, wasting and undernutrition in children.

WHO highlights community practices of neglecting caregiver, non-responsive feeding practices, inadequate child stimulation and inadequate care for nutrition as impeding factors for growth and development resulting in child stunting. WHO also targets to reduce stunting by 40% by the year 2025 (WHO, 2020)

Cooking practices like use of charcoal/coal and kerosene can also lead to more cases of stunting and severe stunting in children while use of gas/electricity for cooking reduced the stunting and severe stunting in children (Fenske et al., 2013). Similarly, Coneus and Spiess (2012) assessed the impacts of outdoor pollution and cigarette smoking on health of children manifesting in terms of low weight in Germany. The study measured the impact of five different air pollution namely carbon monoxide (CO), ozone (O_3), particulate matter (PM_{10}), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2) on fetal and child health where they reported the lowering of weight by 298 g due to high exposure of outdoor air pollution. Wilhelm et al.(2007) evaluated the impacts on health of 1000 children aged from 5-8 years living in close proximity to industrial sources i.e., coke oven plant, metal refinery and steel production. The study reported children living in these locations suffering from asthma, allergies, lung and skin disorders. In such cases, the next level impact, on a child's nutritional status, is expected.

Climate change is also one of the most important variable indirectly affecting the child health and nutrition by affecting food access and availability. For instance, climate change manifesting as monsoon and temperature variability, droughts, and floods have serious implications on soil fertility, land productivity, groundwater availability, soil erosion, rate of evapotranspiration, farmers and labor's health and productivity (Ghosh et al., 2011; O'Brien et al., 2004; Shukla et al., 2011; Swami et al., 2018). These factors cumulatively lead to negative impacts on crop quantity i.e., poor nutritional content in crops subsequently resulting in poor health and nutrition (Lobell and Gourdji, 2012; Singh et al., 2014).

Section 3

Some Comprehensive Frameworks of Child Nutrition (and Health)

This section puts forth some comprehensive frameworks from different countries and global organizations. Willows et al. (2012) provides the model determining the child health and nutrition in Canada, shown in Fig. 5. The model shows community and household socio-economic status including household structure, household food security, community feasts, school food and physical activity environment, environmental health and community self-awareness as the prime factors governing the child health and nutrition. Furthermore, the model in Fig. 5 shows socio-ecological, social justice, health equity, environmental and community-oriented factors as indicators of nutritional health of a child.

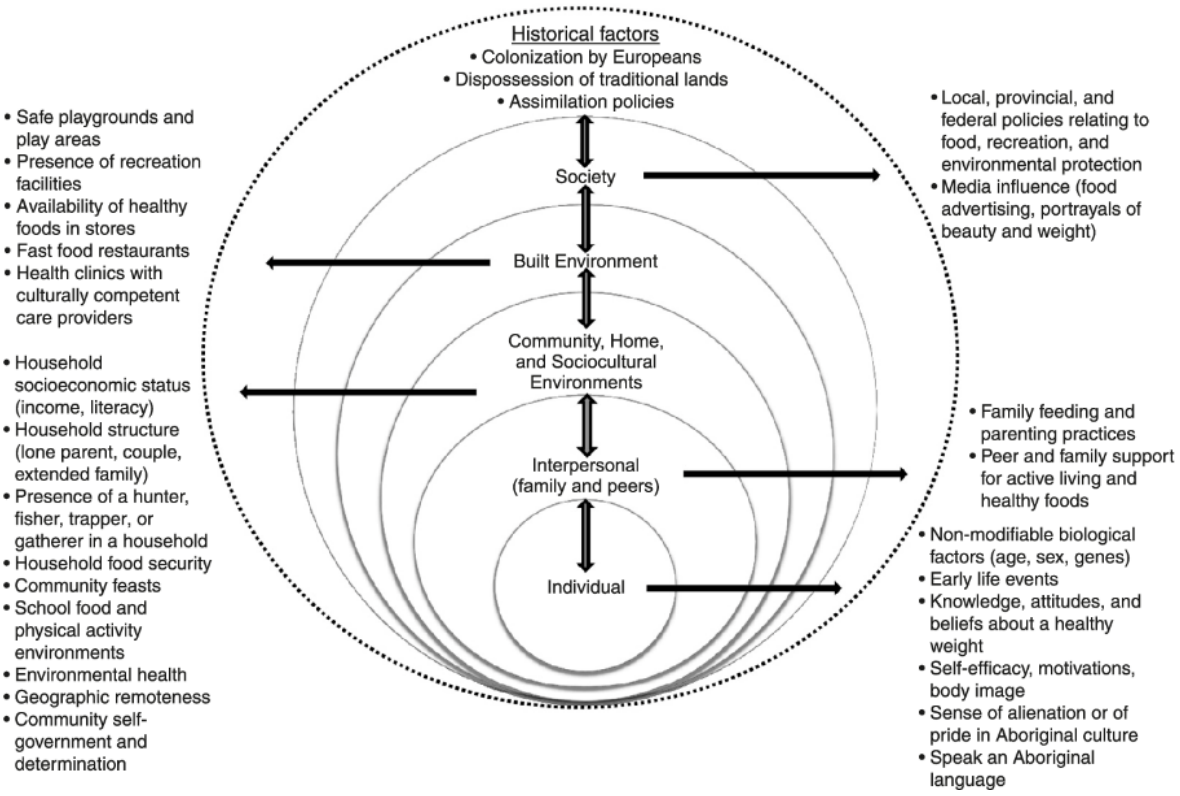

Fig. 5: Conceptual framework for child health in Canada
Adapted from (Willows et al., 2012)

Australia has been doing quite well in maintaining child health and nutrition. For instance, infant mortality rate in Australia has dropped significantly from five deaths per 1000 live births in 1998 to 3.3 deaths per 1000 live births in 2017. Similarly, child mortality rate has halved

from 20 to 10 deaths per 100 thousand children during the same time period (Australian Institute of Health and Welfare, 2020). Australian children often suffer from chronic conditions such as asthma, high fever, food allergy, allergy, short sightedness and rhinitis which has significant negative impact on their height and weight (Australian Institute of Health and Welfare, 2020).

Fig. 6: Model for child development in Australia
Adapted from (Australian Institute of Health and Welfare, 2020)

Considering the situation, Australian government has formulated a child health and nutrition model which intermixes multiple factors, as shown in Fig. 6 (Australian Institute of Health and Welfare, 2020). The model explains housing such as number of children per household, household income, kind of employment of mother and father, dietary intake such as protein, carbohydrate, vitamin intake per household as determining the child health and nutrition in Australia. Similarly, social and emotional well-being i.e., happiness, optimism, emotional regulation, sadness, perseverance, satisfaction with life; education of mother and father; social justice; nutritional intake and breastfeeding are also significant factors affecting the child's health and nutritional status (Australian Government Health Department, 2020).

Fig. 7 shows the framework developed for improving child health and nutrition in Europe by Cattaneo et al. (2012) and is referred by the Europe Child and Adolescent Report of the World Health Organiation (2018) as well. Main factors affecting child's nutritional graph include factors like family attachment, maternal and paternal nutritional habits; social policies

including environmental and gender policies, family benefits, welfare, and educational level of the family (Fig. 7).

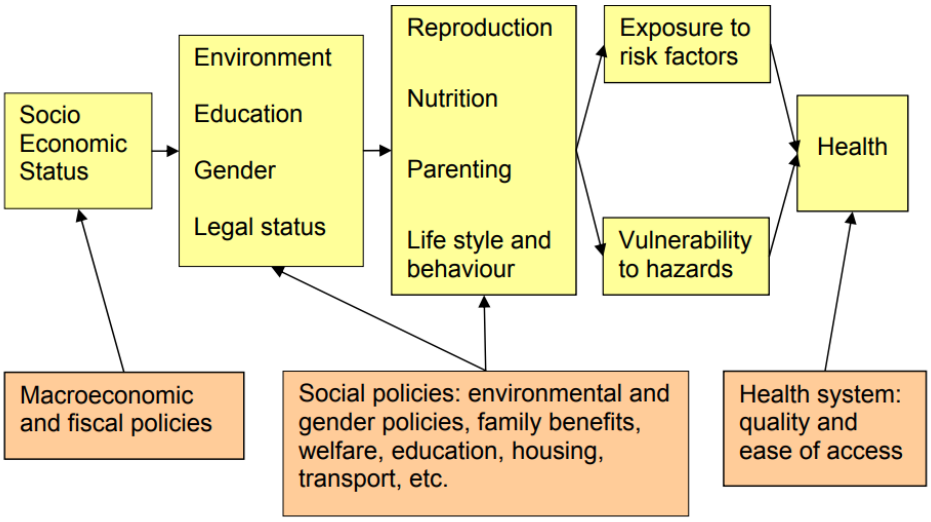

Fig. 7: Determinants of child health in European Union
Adapted from (Cattaneo et al., 2012)

In order to address the undernutrition of children, UNICEF has provided a multifactorial conceptual framework (Fig. 8). Stunting and other forms of undernutrition act as a major barrier for optimal health and growth of a child resulting in adverse effect on cognitive ability, academic performance and future income (UNICEF, 2013). UNICEF (2013) reported the main determinants of child's nutritional status as food, health and care which are dependent on social, economic and political factors of a region. Fig. 8 explains the socio-cultural, economic and political factors manifest as inadequate financial, human, physical and social capital. This further reflects in terms of household access to adequate quantity and quality of resources: land, education, employment, income, and technology. Further, these factors manifest as household food insecurity, inadequate care and feeding practices, unhealthy environment and inadequate health services. They lead to immediate causes i.e., inadequate diet and diseases resulting in adverse effect on maternal and child health and nutrition which is observed as stunting, mortality, morbidity, and disability. They get hereditarily transferred from one generation to another which leads to long-term effect manifesting in terms of adult height, cognitive ability, economic productivity, reproductive performance, metabolic and cardiovascular disease (Fig. 8). The model provided by (UNICEF, 1990) forms the basic model of child health and nutrition which has been adopted by the World Bank as well for studying improvements in child and maternal health across various regions.

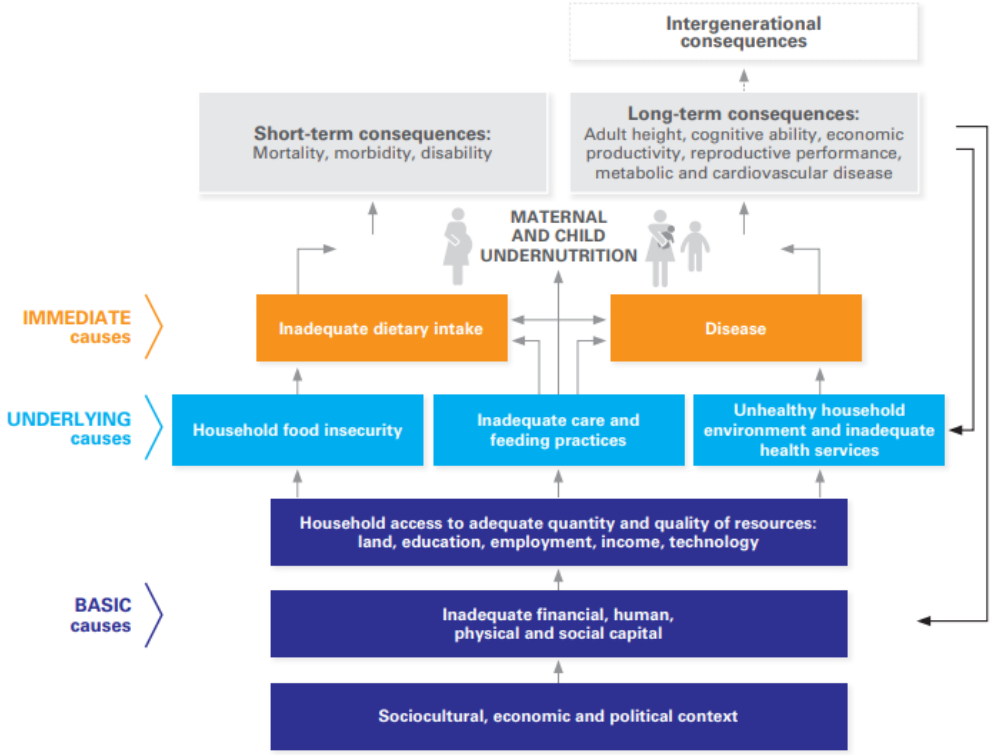

Fig. 8: Conceptual framework for determinants of child undernutrition
Adapted from (UNICEF, 1990)

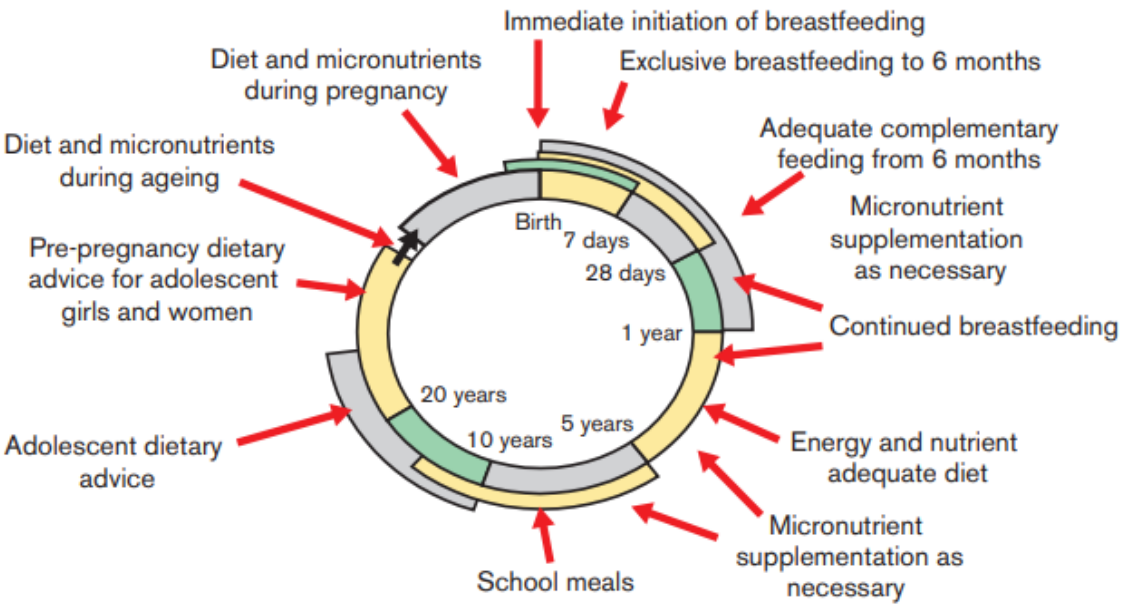

Fig. 9: Improving nutrition around the life-course
Source: (WHO, 2013)

Child's health, growth and development depends on nutrition during infancy and early childhood (World Health Organization, 2009). Globally, 165 million children were stunted, 101 million were underweight, and 43 million were obese under the age of five (WHO, 2013). Therefore, WHO targets to reduce the percentage of stunted children by 40% by the year 2025 (UNICEF, 2013). Along with, around 6.9 million children died from preventable causes such as pneumonia, diarrhoea and malaria, and 190 million children under five are Vitamin A deficient (WHO, 2013). Main reasons for depriving health and nutrition of child includes lack of exclusive breastfeeding and nutritionally inadequate feeding at a later age which leads to chronic diseases in children during later stage of their life (World Health Organization, 2009). WHO (2013) has provided a framework to improve the nutrition during life, as explained in Fig. 9.

The model shows after one year child should be provided energy and nutrient adequate diet along with all essential micronutrients in school meals. Simultaneously, maternal health should be the topmost priority of any region and women should be provided with proper diet and sufficient micronutrients during pregnancy (Fig. 9). Complementary feeding, provision of micronutrients, vitamins and maternal health are the main priorities of World Health Organization.

Conclusion

There is reliable evidence that poor health and nutrition during childhood affects educational access, social participation, income and academic achievement of a person throughout his life. Hence, school-based health and nutrition programs are providing a cost-effective and low-cost solution. The need for school health and nutrition programs as part of education for all (EFA) actions is now recognized by almost all the countries and international organizations including WHO, World Bank and UNICEF. These child health and nutritional interventions of international organizations, developing and developed countries were explored during the current study where we identified the risk factors of a child well-being mainly include genetic factors; infections and diseases; maternal health; socio-economic factors; water, sanitation and hygiene; and community based variables including environmental and climate change factors having implications in terms of food access as well as availability.

Based on these factors and India's current situation of child health and nutrition, we proposed a comprehensive framework consisting of household, community and social variables (Fig. 1) to improve the child health and nutritional status for the nation as a whole. The model proposed by the study considers a number of moderators and mediators of the relationship between mid-day meal and child nutrition. For example, the child's dietary intake is mediated by the caregiver's feeding practices and feeding style; and the access and quality of services by food markets and healthcare facilities. Similarly, nutrient content of food served in mid-day meal is mediated by the child's genetic make-up and community-based factors which have not been explored so far. Thereby, our study is an attempt to fill the gap in existing literature and models by incorporating the multiple interventions i.e., infant and young child care and nutrition; maternal care; adolescent care; infections and disease; addressing micronutrient deficiency; and community nutrition in one common framework. Along with improving the child health and nutrition, these interventions will also provide the additional benefits in improving the nutritional quality of mid-day meals served throughout the country. The current framework, if successfully implemented, can act as a stepping stone towards the improvement of child health related policies in India.

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