RAIS Journal for Social Sciences | VOL. 6, No. 2, 2022
ISSN 2574-0245 (Print) | ISSN 2574-1179 (Online) | DOI: 10.5281/zenodo.7347961

Theoretical Linkages between Status of Maternal and Child Health in India and Risk of Non-Communicable Diseases

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ABSTRACT: The Global Burden of Diseases Study 2019 reports that metabolic abnormalities and high BMI since childhood are the primary reasons for the increasing burden of Non-Communicable Diseases (NCDs) in India. Popularly, these conditions are associated with consumption and lifestyle patterns such as high fat, energy-dense foods, sedentary lifestyle, stress, etc. So, the government is focused on preventing NCDs by promoting healthy diets and physical exercise. Public knowledge of the link between adverse in-utero environment and metabolic abnormalities during childhood, which impact the future health of an individual is under-recognized. Given this background, this paper discusses the implications of adverse pregnancy or birth outcomes (such as low birth weight, premature deliveries, etc.) of an infant on its long-term health, thereby establishing that proper reproductive care can play an instrumental role in averting the risk of NCDs in the future. Essentially, this paper analyses how prenatal, neo-natal and early childhood conditions play a preemptive role in the future incidence of NCDs and their management through appropriate policies that can aid in averting the risk of NCDs.

KEYWORDS: Maternal and child health, non-communicable diseases, reproductive care, nutrition, socio-economic determinants of health

1. Background

The relevance of maternal and child health programs in preventing chronic diseases in adulthood is based on Barker's 'Fetal Origins of Adult Disease' hypothesis which has now been expanded into the 'Developmental Origins of Health and Disease' approach (Wadhwa 2009, 358-68). The hypothesis scientifically proves that the risk of obesity related NCDs in adulthood is rooted in the prenatal and postnatal period, when the fetus is exposed to a myriad of environmental modifications/conditions. Environment to which the fetus is exposed in the womb brings about permanent changes in the structure and function of the fetus, which is referred to as 'programming.' The hypothesis states that fetal and early life environment plays a deterministic role in the development of adult weight, metabolic conditions and adult chronic diseases.

The hypothesis is based on a study that linked mortality ratios with birth data of people born in Hertfordshire from 1911-1930. The data suggested that low birth weight, small head circumference and low ponderal index (mass/height^3) at birth was associated with an increased risk of coronary heart disease in adulthood (Skogen, Jens and Overland 2012, 59). These observations were then used to link prenatal exposures and other chronic conditions such as elevated blood pressure, type 2 diabetes and cholesterol. The first report suggested that an inverse relationship existed between

birthweight and blood pressure which was published in 1989, followed by a study reporting an inverse relationship between birthweight and cholesterol (Skogen, Jens and Overland 2012, 59). The study also linked diabetes with cardiovascular diseases and introduced the 'thrifty phenotype' hypothesis (Skogen, Jens and Overland 2012, 59). The hypothesis postulated that prenatal exposures bring about specific, irreversible changes (programming) in the fetus, which interact with various environmental factors after birth and pre-dispose an individual to chronic disorders. This is to say that, though obesity and type 2 diabetes are primary causes of cardiovascular diseases but, as argued by Osmond and Barker (2000), these risk-factors lead to chronic disorders only in predisposed individuals, such as the ones suffering from fetal growth retardation (Skogen, Jens and Overland 2012, 59). According to the hypothesis, if a fetus is subjected to malnutrition, it tends to downstream/down regulate various important development processes in the womb. This down streaming leads to insulin resistance and impaired glucose tolerance during prenatal stages itself thereby. After birth, if such babies are exposed to high-energy, nutritionally abundant food, then they are at an increased risk of developing type 2 diabetes. This hypothesis is firmly established now with affirmative evidences globally (Skogen, Jens and Overland 2012, 59).

Other fetal or prenatal factors that affect long-term growth of the infant are the mother's weight and nutrition before pregnancy and during pregnancy, blood sugar levels and smoking habits, etc. Early life factors, such as rate of increase in infant weight, initiation and duration of breastfeeding, nutrition, etc., determine metabolic conditions in adult life. For instance, children of women who begin their pregnancy with overweight or obesity have been observed to gain excessive amount of weight in early childhood period compared to children of mothers, who gain inadequate amount of weight during pregnancy (Hsph.Harvard 2020). It has been recognized that the most opportune time to prevent adverse fetal programming of NCDs is the peri-conception period i.e., the period before conception to early pregnancy. This makes a strong case for improving nutritional health of young girls as it can play an instrumental role in curbing the spread of NCDs. Such an approach is called 'primordial prevention.'

In India, the interdependent and inter-generational nature of maternal health, fetal and early childhood nutrition was recognized in the eleventh five-year plan (2007-2012). The main reasons identified for high maternal, infant and child mortality in India were malnutrition, premature deliveries, infections, non-institutional deliveries and inappropriate infant-feeding practices etc. Malnutrition, had previously also been linked to infant survival and its long-term health. Consequently, various nutritional supplementation programs for pregnant women (iron and folic acid supplementation), adolescent girls (National Programme for Adolescent Girls (NPAG) and infants and children (integrated management of neonatal and childhood illnesses) had been enacted as part of the ICDS program in the previous five-plans, starting fifth five-year plan. However, in the eleventh five-year plan, the government acknowledged that the effects of infant malnutrition were irreversible and it is a root cause of not only infections but also chronic, non-communicable diseases. So, as a marked departure from the previous approaches (of temporary nutrition supplementation), the government focused on adoption of the 'Life-Cycle Approach.' Within the life-cycle approach, appropriate interventions are undertaken at every stage of life starting from the intrauterine period to old-age, based on the understanding that health outcome at any stage of life is a potential determinant of future state of health. This was to be done by integrating various social, health and environmental sectors. With these new insights, the government introduced demand-side, financial incentive-based programs to enhance

utilization/uptake of programs as part of the second phase of the Reproductive and Child Health (RCH) strategy[1].

RCH-II focused extensively on educating communities on pre and post-pregnancy emergencies, promoting institutional deliveries and optimal breastfeeding through local agents (like Auxiliary Nurse Midwife (ANMs), *Anganwadi* Worker (AWW), Traditional Birth Attendants (TBA), village practitioners etc. and institutions (*panchayats*, NGOs, Self-Help Groups, etc.) and promote referral transport for routine deliveries and emergencies. It also focused on promoting skilled care at birth whether the child is born in a facility or at home. This included ensuring a warm, hygienic environment for delivery and undertaking preliminary examination, recording birth weight and initiating breastfeed. The eleventh five-year plan mentions that exclusive breastfeeding for the first six months could cut down infant mortality in India by 15% (Ministry of Women and Child Development 2006). Other than this, it focused on increasing the proportion of pregnant women receiving three antenatal care checks, in addition to improving coverage and quality of antenatal care. For this, a mother-baby linked card was provided to all pregnant women wherein important clinical and non-clinical details[2] pertaining to the pregnancy were recorded. The importance of post-partum care was also recognized and provisions were made for the AWW to visit the mother and newborn and guide them in the problems they face.

Under the 12th five-year plan, strategies to prevent premature births and manage deaths among preterm births were put in place. Strategies to prevent premature births included provision of antenatal check-ups wherein screening for high blood pressure, diabetes, etc. Secondly, pregnant mothers would be educated about behavior and lifestyle changes that would prevent preterm births. For children born preterm, the plan identified mechanisms to reduce mortality (Kramer 1987, 663-737; Planning Commission 2013).

2. Adverse birth outcomes and its link with NCDs

Poor birth/pregnancy outcomes namely low birth weight, premature delivery, etc., have been associated with increased susceptibility to chronic disorders in later stages of life.

2.1. Low birth weight

Birth weight- an indicator of health of a newborn, is an important determinant of health in adulthood. Low birth weight i.e., weight less than 2500 grams at birth irrespective of gestational age, in the short-term, increases the risk of neonatal and infant mortality (Kramer 1987). In the long-term, according to 'fetal origin of adult diseases hypothesis', it exposes an individual to a higher risk of obesity-related non-communicable diseases especially type 2 diabetes, hypertension and CVDs (Bhargava et al 1982, 123-9; Desai and Tandon 2009, 356-366; Barker 1998). The literature also points out an inverse relationship between birthweight and blood pressure, cholesterol (Barker et al. 1989. 564-7). The association between low birth weight and cardiovascular diseases has been observed in developed countries like Wales Sweden and USA and also in developing countries (Osmond and Barker 2000). A study based in South India found that prevalence of CVDs fell sharply from 18% in people who weighed 2.5kg at birth to 4% among people who weighed over 3kg (Stein et al. 1996, 1269-73). A study based on four-year-old children in Pune, Maharashtra State shows that children who were born with low birth weight were

[1] This was introduced as part of the second phase of Reproductive and Child health Strategy. The first phase of RCH was launched in 1997 with the aim to reduce infant mortality rate, maternal mortality rate and total fertility rate. For this, the government promoted institutional deliveries, immunization and contraception methods

[2] Non-clinical information includes danger signs, nutrition, iron-folic acid supplementation, birth spacing and newborn care.

highly insulin-resistant, independent of their current size (Yajnik et al. 1995, 330-6). Particularly, the ones who are born with low weight and become heavy during childhood or adolescence were the most insulin resistant (Bhavdekar et al. 1999). Further, studies point out that not only low birth weight but even high birth weight is positively linked to excess BMI gain (adiposity) in late childhood, adolescence and adult-life (Bhargava et al. 2004; Sachdev et al. 2005).

Interestingly, a thin Indian baby could still be fat. This happens when a thin baby with low BMI and lower abdominal circumference has relatively high fat mass than lean mass i.e., has high body fat. Such a physical characteristic is referred to as a 'thin-fat baby' phenotype. In fact, different physical features of the infant reflect different fetal adaptations to adverse fetal environment such as undernutrition, hypoxia (a condition in which the body or region of the body is deprived of adequate oxygen supply at the tissue level) and therefore is indicative of different long term consequences. For example, in Sheffield and Finland, it was found that among people who were born thin (i.e., having low ponderal index - a measure of leanness of person calculated as a relationship between mass and height), short and with small head circumference, morbidity due to cardiovascular diseases, diabetes and hypertension was high (Skogen, Jens and Overland 2012, 59). Studies in Helsinki suggest that those with accelerated growth in height (after retarded growth in utero) are more prone to hypertension and those with accelerated growth in weight are prone to diabetes (Binns et al. 2001, 68-73). These relationships between physical characteristics and NCDs were found to be independent of social class. In India, Yajnik et al. (2003) concluded in a regional study based on rural women in Pune that Indian babies exhibit a "thin-fat baby phenotype". This means that a fetus facing an impaired intra-uterine growth environment, retains the fat while compromising on the muscle mass i.e., higher fat mass and low lean mass (Yajnik et al. 2003, 173-80). Since babies tend to retain this fat throughout growing up it makes them particularly vulnerable to chronic diseases especially CVDs and diabetes irrespective of their adult unhealthy lifestyle. This implies that children with poor birth outcomes remain at an increased risk of NCDs even if they follow a healthy lifestyle while growing up i.e., they are pre-disposed to NCDs and risk factors since birth (Kuriyan 2020, 826-832; Yajnik and Chittranjan 2014, 8-17). In addition to this, the study also found that higher ponderal index at birth predicted diabetes later in life (Yajnik 2003, 173-80). Further, the study states that central adiposity contributes to insulin resistance.

Literature extensively discusses about socio-economic and biological determinants of a 'thin-fat' baby. The 'thin but fat' characteristic was observed in underweight babies born to mothers who were illiterate and had low pre-pregnancy weight. The study suggests that body composition of the neonate is determined by the mother's pre-pregnancy body composition such as fat mass, head circumference and maternal diet such as fat intake, frequency of consumption of green leafy vegetables, milk, fruits etc. during pregnancy. This means there is few associations between maternal macronutrient intake and neonatal size and more with intake of micronutrient-rich diet (Yajnik 2003, 173-80). The results of this study are supported by a Bangalore-based study that found that the 'thin-fat baby phenotype' did not exist among children born to relatively educated and nutritionally sound mothers (Kuriyan 2020, 826-832). Since visceral adiposity is present in Indians from their intrauterine life so interventions to reduce the risk of diabetes and CVDs should begin inter-generationally (Yajnik and Chittranjan 2014, 8-14). This implies taking into consideration nutritional history of the mother in the distant past as well as during pregnancy as it affects fetal adiposity and body composition. Stimuli and exposures after birth further add to the effects of fetal programming thereby increasing the chances of contracting a chronic disorder. For

instance, small, low birth weight babies who tend to gain excessive fat during childhood are at a higher risk of morbidity due to hypertension and diabetes. Biological mechanisms responsible for this association such as high maternal BP[3], fetal undernutrition, catch-up postnatal growth (Lever and Harrap 1992, 1642-5; Singhal and Lucas)[4] etc. are easily manageable through timely screening and diagnosis during pregnancy and lactation. Such interventions can go a long way in cutting off intergenerational transmission of chronic disorders. From this it can further be established that ensuring proper care through childhood, adolescence and reproductive ages especially for women, can go a long way in ensuring appropriate/desirable neonatal health outcome. This further advocates the cause of adopting a 'life-course approach' to maternal and child health in India.

Chabbra et al. (2004) found nearly three-fourth of low birthweight infants in an urban resettlement area of Delhi were born to highly undernourished mothers (weighing less than 40kgs). Further, mothers who were less than 140cm in height were four times more likely to deliver babies with low weight. The other important factors identified are maternal age and parity. Among teenage and adolescence pregnancies (less than 19 years) the incidence of low birth weight is high compared to mothers aged 25-29 years. Further, it was found that first pregnancies of mothers are likely to have low birth weight (Chakraborty et al. 1975, 73-9). With regard to this, Kramer (1987) argues that maternal weight-an important determinant, is modifiable over a short period of time with appropriate interventions (Kramer 1987, 663-737). Teenage and adolescence pregnancies- a result of early marriages, lead to unfavorable/poor birth outcomes because the girl is not physically mature for pregnancy. This was found to be independent of socioeconomic status (Chakraborty et al. 1975, 73-9).

Yajnik (2014) argues that undernutrition especially during the first 2 trimesters hinders the growth process such that it leads to overeating and obesity in the postnatal period (called the postnatal catch-up growth). In scientific terms, undernutrition in the third trimester is related to reduced risk of obesity because fewer number of fat cells are produced during this period. So, fetal undernutrition is linked to diabetes and CVDs independent of family history and body mass index in adulthood. This link between fetal undernutrition and incidence of chronic diseases in adult life has been referred to as the 'thrifty phenotype' hypothesis. Just like maternal undernutrition, maternal obesity and diabetes are predictive of high birth weight which is indicative of NCDs in adulthood. Therefore, we observe a U-shaped relationship between birth weight and obesity and diabetes. Yajnik also challenges the 'purely genetic' perception about diabetes and obesity by arguing that no concrete association was found between parental obesity and diabetes. Further, children born to mothers who had diabetes during pregnancy were more likely to be obese and glucose intolerant compared to children born to pre-diabetic and non-diabetic mothers.

Negandhi et al. (2014) emphasized on the importance of timely and regular antenatal checkup in promoting optimal birth weight. Especially in an undernourished population, the relevance of antenatal care is further magnified as it facilitates/enables adequate calorie intake and zinc supplementation which are important factors affecting birth weight. In addition to this, national programs (under RCH strategy) promoting prenatal care provide free micronutrient supplementation such as iron, folate, calcium etc. to pregnant women upon timely ANC registration. Unlike previous observations,

[3] High maternal BP during pregnancy indicates failure of mother's cardiovascular system to pregnancy which in turn leads to fetal undernutrition, low birth weight and high blood pressure in the offspring.

[4] Catch-up postnatal growth refers to a process of compensatory accelerated growth in the first year after birth after having experienced a period of poor growth in the womb. This may lead to hypertension during childhood which predicts adult hypertension.

this study found socioeconomic status and low birth weight risk associated with first birth of a women as insignificant factors in determining birth weight.

So, we infer that importance needs to be accorded to improvement in health and nutrition of women especially in their reproductive ages (19-45 years) as it would provide an intergenerational solution to the epidemic of obesity, diabetes and cardiovascular diseases. This is even more relevant for India since it has a history of multigenerational undernutrition. Doctors and social activists could be engaged who can improve the uptake of maternal and child health programs and encourage healthy practices. Social activists can play an influential role in delaying pregnancies in case of early marriages by promoting use of conceptive. In addition to this, it has been found that among the proportion of low birth weight is highest among first and last pregnancies. Also, women who deliver young are also highly likely to have low birth weight infants, especially as the birth order increases (Chakraborty et al. 1975, 73-9). Of these two, it is parity that is a more important factor in determining birth weight.

2.2. Premature delivery

According to the Global Burden of Disease 2017 estimates, premature/preterm birth is the topmost cause of mortality and morbidity among neonates in India. WHO reports that India has the largest number of preterm births in the world i.e., 3 519 100, followed by China (1 172 300), Nigeria (773 600) and Pakistan (748100) (Blencowe et al. 2012). Preterm delivery is when a baby is born alive before 37 weeks of pregnancy are completed. The major risk factors identified for preterm birth are young pregnancies, history of preterm birth, multiple pregnancies (like twins, triplets), infections and chronic conditions (like diabetes and high blood pressure), genetic influences, malnutrition (undernutrition, obesity, micronutrient deficiencies), smoking or alcohol consumption. However, in nearly 50% of pregnancies the cause of preterm birth is not identified (Nhp.gov.in 2020).

Preterm born children have been observed to have unfavorable body composition at birth and metabolic disorders in adulthood i.e., greater abdominal fat, high cholesterol, high insulin resistance and hypertension (Vasylyeva et al. 2012). In fact, among premature children, those with higher gestational age and birth weight have been seen to be at a higher risk of developing obesity during childhood and adolescence (Gaskins et al. 2010). Increased susceptibility to obesity during childhood and adolescence among preterm born children is due to high pre-pregnancy maternal weight, high birth weight and postnatal growth catch-up (Wood et al. 2013; Mathai et al. 2013). Postnatal growth catch-up is a process whereby a growth-restricted child shows accelerated growth during the first years after birth (Ong et al. 2000, 961-71). This happens if a growth-restricted infant is fed with nutrient-rich diet that typically leads to accelerated/rapid growth in height and weight of the child. On the other hand, if such infants are not fed properly, they would suffer further growth retardation (Hay 2008). Thus, there is a controversy in setting the right nutrition goal for such children. Adverse effects of premature birth persist across generations as children of parents born preterm have relatively higher body fat compared to children of parents born at term (Mathai et al. 2013). There is also a gender differential in effects of premature birth as premature born men on an average displayed greater capacity to store fat (Mathai et al. 2013).

Given the long-term implications of premature birth and its association with prenatal factors, high risk pregnancies must be identified timely, ideally starting before conception and managed till the completion of pregnancy. Special attention needs to be given during the first 1000 days between conception and two years of age. Women who are identified to be at a risk of preterm delivery must deliver at a health institution as it facilitates advanced and specialized care for the mother and the baby. For instance,

during preterm labor, necessary interventions are to be undertaken to improve the health and survival outcomes of the mother and baby, which are possible only at a facility.[5] Antibiotics are given to reduce premature baby's risk of death, respiratory diseases and developmental problems and at the same time improve infant's long-term health.[6] Second, a premature baby is incapable of surviving in a non-incubated environment outside the mother's womb as it does not have a fully developed brain, eye, lung functions and weak immunity so, a facility ensures a conducive (clean and hygienic) environment necessary for survival of baby. Third, professional health personnel are trained to undertake necessary precautions in case of high-risk pregnancies like ensuring baby breathing and initiating breastfeeding. Thus, appropriate antenatal and postnatal care is indispensable for a positive pregnancy outcome.

Antenatal care can manage high-risk pregnancies by regular growth monitoring of the fetus, which helps to determine the gestational age of the baby, providing counselling on healthy diet and optimal nutrition, deterrence of tobacco and substance abuse. It also helps to manage other risk factors and provides proper information on steps to be taken.

3. Components of maternal and child health programs

Below we discuss three main components of maternal and child health programs in India that are/could be relevant/instrumental in prevention of non-communicable diseases.

3.1. Natal care - antenatal care and postnatal care

Ante-Natal Care (ANC) refers to the preventive and curative health services provided by skilled professionals to pregnant women in order to ensure favorable health outcomes for the mother and the baby. Antenatal care has five main components- weight check, abdomen examination, Blood Pressure measurement, examination of urine and blood sample (Government of India, Ministry of Women and Child Development 2006). The National Family Health Survey 2015-16 (NFHS-4) reports that only 21% women in India availed complete antenatal care (National Health Profile 2018). The government of India recommends that at least 4 antenatal visits must be attended by a pregnant women wherein the first visit happens within the first trimester. NFHS-5 reports that only 58.1% women had 4 antenatal visits and of these 70% had antenatal visit in the first trimester.

There are three main purposes of ANC- maternal and fetal assessment, undertaking nutritional interventions and preventive measures (WHO 2016). A thorough and timely assessment of the mother and fetus is important to identify multiple acute and chronic conditions such as hypertension, anemia, diabetes, which can lead to maternal and perinatal mortality or cause long-term problems for the child. For instance, maternal diabetes during pregnancy (gestational diabetes) increases the chances of delivering a baby larger in size for gestational age, with higher fat mass and that in turn increases body mass index later in life. Similarly, hypertension among women leads to higher incidence of pre-eclampsia (25%), cesarean section (41%), preterm delivery (28%), low birth weight (17%), neonatal unit admission (20%), and perinatal deaths (4%). This necessitated and increased relevance of antenatal care to such women (Bramham 2014). Further, screening for various types of infections, tuberculosis and tobacco use which increases the risk of preterm delivery. Such conditions need to be properly managed through medication and counselling. The growth of the fetus also is

[5] Interventions to prolong pregnancy include the provision of tocolytic agents that inhibit uterine contractions to suppress labor (e.g. oxytocin, antagonists, betamimetics, calcium channel blockers, magnesium sulphate).

[6] Premature labor cases are managed through interventions- antenatal corticosteroids, pre-labor rupture membranes and magnesium sulphate.

to be regularly monitored in order to identify fetus that are small and to estimate their gestational age. This enables better management of pregnancies.

3.2. Nutritional Interventions

In addition to natal care, the poor nutritional status of the mother, which is characterized by undernutrition or overweight/obesity, leads to poor perinatal outcomes. The World Health Organization (WHO 2016) noted that natal-care helps to regulate diet and exercise through counselling and supplementation which promotes optimal birth weight of the infant. For example, Iron and folic-acid supplementation prevents anemia, preterm birth and low birth weight among infants. Folate status during pregnancy is a predictor of child's adiposity and insulin resistance. Similarly, energy and protein dietary supplements have been associated with reduced risk of stillbirths and, at the same time, promote proper growth of the child (so helps in targeting fetus and infants who are small-for-gestational age)[7]. Small for Gestational Age (SGA) are those babies who are smaller than expected for the number of weeks of pregnancy.[8] This happens when a baby is unable to get adequate necessary intrauterine nutrition. To this effect, Yajnik (2014) found that adequate/sufficient levels of Vitamin-C, Vitamin-D, Vitamin-B12, and Iron are associated with optimal fetal growth. The National Family Health Survey (NFHS-4 2015-16) reported that merely 30% of the women consumed iron and folic-acid (IFA) tablets for the recommended period of 100 days (or at least 3 months). Since it has been observed that nutritional supplementation leads to increased attendance of antenatal check-ups, nutritional supplementation could be used as an incentive to promote uptake of antenatal care.

Thus, given the advantages of ANC and its limited uptake, the government launched the Pradhan Mantri Surakshit Matritva Abhiyan **(**PMSMA) program in 2016. This program was envisioned to reduce the high Maternal Mortality Ratio (MMR) and neonatal mortality in India. As per RGI-SRS (2011-13), the MMR of India is 167 per one lakh live births. Every year nearly 44000 women die due to pregnancy-related causes and nearly 6.6 lakh infants die within the first year of birth (Ministry of Health and Family Welfare 2020). Given the scenario, the government recognized that even a single ANC visit coupled with proper follow-up mechanism would play an instrumental role in averting maternal and infant deaths. Thus, as part of PMSM program, the government provides quality antenatal care services in the form of early screening and diagnosis (usually during the second trimester) of pregnancy related clinical conditions on a fixed day every month. Through a proper follow-up mechanism, it helps to manage multiple clinical and co-morbid conditions such as anemia, pregnancy induced hypertension, gestational diabetes etc. In addition to this, it provides medicines such as iron and folic-acid supplements and calcium supplements to pregnant women. Special attention is given to women with complicated or high risk pregnancies in addition to reaching out to women who either are not registered for ANC or have dropped out.

Another equally important but underrated component of natal care is, Post Natal Care (PNC). Postnatal care reinforces proper infant growth by managing and following up on early motherhood behaviors such as breastfeeding, growth monitoring of the infant, examining the mother and baby for possible infections etc. compared to women who received only antenatal care or obstetric care (Su et al. 2007).

Thus, there are two main areas where public health nutrition interventions must be beneficial, not only on grounds of fetal origin hypothesis but also because of inherent public health value are, prenatal care and postnatal care. Nutrition and health interventions in prenatal period would minimize number of low birth weight babies and

[7] Small for Gestational Age for those babies who fall below the 10th percentile of birthweight.

[8] Small for gestational age babies could be born preterm, at term and also post term

thin infants. Postnatal interventions to avoid undernutrition or over nutrition during childhood. Maintaining normal growth rates must be priority for both undernourished and over nourished children.

3.3. Infant feeding practices-breastfeeding

During the Tenth Five-Year Plan, the goals for infant and young child feeding indicators were set for the first time. On the lines of international recommendations of WHO and UNICEF, the government has recommended that the infant must be exclusively breastfed for the first 6 months. Breast milk is the complete source of nutrition for the child for the first 6 months and supplementing it with other foods reduces the benefits of breast milk. Sometimes, supplementation may lead to contamination of breast milk which could lead to diarrhea and increased risk of neonatal mortality (Jatrana 2003). Breastfeeding must be initiated within an hour of birth to ensure successful lactation for the mother and 'colostrum' for the baby. Colostrum is the first thick, yellowish milk of the mother and is a concentrated source of vitamin-A, protein and anti-infective properties which plays a paramount role in infant survival by strengthening immunity. After six months, breast milk must be complemented with semi-solid food in order to provide adequate nutrition for rapid, sustained growth of the baby. Breastfeeding must be continued for 2 years or more along with complementary foods (UNICEF 2020). According to the NFHS-5, about 64% of infants in India are exclusively breastfed for the first six months and for only 41% of neonates are breastfed within an hour of birth. Unfortunately, of these only 11% infants receive adequate diet from 6 months till 2 years of age (National Health Profile 2018).

Breastfeeding has various short- and long-term health benefits for the both the mother and the baby. It promotes cognitive and physical development of the infant and also provides protection against various chronic disorders by preventing childhood obesity (Binns et al. 2001, 68-73; Binns et al. 2016). Studies have pointed out that exclusively breastfeeding for first 6 months provides a protective effect against some risk factors for type 1 diabetes in children and adolescents and type 2 diabetes and cardiovascular diseases in adults (Ravelli et al. 2000, 248-52; Binns et al. 2016). Particularly for mothers, breastfeeding is associated with reduced rates of ovarian and breast cancer, obesity, type 2 diabetes, heart diseases and postnatal depression (Binns et al. 2016). Especially, women with gestational diabetes, who breastfed for more than 6 months had lowest risk of continuing postpartum diabetes. The literature also suggests that the longer an infant is breastfed the lower is the risk of obesity in childhood and adolescents (Binns et al. 2001, 68-73; DeMattia and Denney 2008; Lamb et al. 2010). Promotion of breast-feeding practices is an intrinsic action point in the WHO framework for prevention of non-communicable diseases, to halt the increasing burden of obesity and diabetes (WHO-Government of India 2012-13 Biennial Workplan). Infants, who are breastfed have slightly lower rates of growth after 6 months of age when compared to those put on artificial formulae. With respect to this, Lamb et al. (2009) points out that there is a difference in the nutritional content of breast milk and formula milk. Breast milk has high fat and low protein while, formula food has low fat and high protein. So there is early adiposity rebound and greater subsequent childhood obesity in formula-fed infants. Second, it notes that the protective effect of breast milk is due to lower plasma concentrations of insulin (hormone that promotes fat storage) in breastfed infants compared to formula-fed infants. Further, blood pressure was significantly raised in children with a mean age of 7-8 years who were exclusively formula fed (Wilson et al. 1998, 21-5). Binns et al (2001) also points out towards the "dose-response" effect of breastfeeding with lowest rates of obesity being seen in those children and adolescents who are continued to breastfeed even after 6 months of birth. In a study of children aged below 6 years, it was found that children who were breastfed

for at least 12 months were leaner than formula fed infants (Oddy and Sherrif, 2003). Exclusive breastfeeding has been seen to lower the risk of obesity even in cases where mothers experience excessive gestational weight gain and newborn had high birth weight (Zhu et al. 2015). This way breastmilk is a low cost, effective and readily available strategy to help prevent childhood and adolescent obesity. So timely introduction of breastmilk to infant's diet is paramount.

Duration of breastfeeding is influenced by a variety of social, cultural, geographic and economic factors. Huffman points out that as modernization occurs, the duration of breastfeeding is often reduced which leads to decreased nutrient intake, decreased immunologic protection, increased contamination of nutrient sources and decreased birth spacing (Huffman and Lamphere 1984, 93-116). Other factors like maternal education, access to health services, employment status of women and availability of breastmilk substitutes also determine the duration of breastfeeding. Mother's education, age and parity have been observed to be negatively linked to the duration of breastfeeding (Akter and Rahman 2010, 595-601). Women occupation and its relation to duration of breastfeeding varies across countries. For example, while in Taiwan there is no association of work with breastfeeding but in Malaysia and Philippines it is seen that child care activities take a back seat as women go out to work (Huffman 1984). Type of work is also seen to have an implication on breastfeeding. For example, women involved in activities like dressmaking, food and beverage makers, weavers were more likely to have children less than ten years of age with them compared to ones involved in professional occupations, management, clerical work and service occupations.

In India, the ICDS program (operational through *Anganwadi* Centers) is the primary scheme aimed at promoting and improving infant and child nutritional health by providing micronutrient food supplementation to children from infancy till six years of age, pregnant and lactating mothers. Other key services provided by *Anganwadi* Centers include health and nutrition education to adult women and immunization, health check-ups and pre-school education etc. to children till the age of 6 years. Currently, the program has expanded its focus to adolescent girls and provides nutrition, health, awareness, skill development and income-generation schemes to them.

3.4. Institutional delivery

The importance of skilled care at delivery has been emphasized in the health planning in India because it provides specialized care and so greatly reduces probability of neonatal death. Skilled assistance at birth refers to delivery at a private or public hospital/clinic and home delivery conducted by some skilled health personnel such as a doctor, nurse, Lady Visitor (LHV), Auxiliary Nurse Midwife (ANM). As highlighted above, institutional deliveries assure a clean, hygienic environment, conducive for child birth. It ensures all guidelines meant for delivery and post-delivery processes such as cleaning the baby, noting the birth weight, initiating breastfeeding etc. are undertaken. NFHS-5 Reports that 89.4% births in India are assisted by as skilled health person (doctor, nurse, LHV, ANM, others) and 88.6% births are institutional births (National Health Profile 2018, 13.

As part of the Reproductive, Maternal, Neonatal and Child and Adolescent Health (RMNCH+A) strategy, the government has launched various programs pertaining to maternal, child and adolescent health, nutrition and family planning. However, most of these programs are concentrated mostly on promoting institutional deliveries. The most prominent is the Janani Suraksha Yojana (JSY - a modified version of the National Maternity Benefit Scheme), launched in April 2005, aimed at reducing maternal and infant mortality by facilitating institutional deliveries, antenatal and postnatal services and eliminating female infanticide and feticide (Government of India, Ministry Of Women And Child Development 2006). Under the scheme, pregnant women belonging

to BPL families were provided financial assistance for delivery in a government facility or accredited private medical facility.[9] The cash given differs in rural and urban areas. It emphasized on the role of the Traditional Birth Attendants (TBAs) in creating awareness and improving utilization of skilled reproductive health care services and provided cash incentives to TBAs in order to motivate them. In addition to this, the program also identified the influential role of ASHA workers in promoting institutional deliveries. An examination of selected districts in seven states with least percentage of women delivering in an institution found that the program faired exceedingly with respect to increase in institutional deliveries and receipt of monetary incentives (Dongre and Kapur 2013, 53-59). The positive effect of JSY on opting for institutional delivery among rural, illiterate and primary literate persons belonging to lower socioeconomic strata was also found in a hospital based study in Madhya Pradesh (Gupta et al. 2012). The JSY has removed the financial burden related to institutional delivery and has therefore motivated even those people who has home deliveries previously.

Other than JSY, the government also launched the program was launched Janani Shishu Suraksha Karyakram (JSSK) in 2011 to make institutional deliveries affordable. Under the program, the government provided free pregnancy-related services to the mother and sick infant such as medicines, diagnosis, deliveries (both normal and caesarean), transport to hospital and return, in addition to other hospitalization expenditures. The program identifies the importance of postnatal check-ups and provides free services to women for up to 42 days and infants until 1 year after birth in government health institutions. Other services include free transportation from home to health institutions, provision of blood transfusion and exemption from all user chargers. In 2014, the benefits of the program were also extended to avail antenatal care services.

4. Conclusion

This paper concludes that the birth outcomes of a child such as birth weight and preterm birth are modifiable by appropriate policy interventions in the area of reproductive, maternal and child health. For example, regular antenatal check-ups help to monitor the nutritional status of the mother and growth of the fetus. Through multivitamin supplementation it significantly improves the health of the mother and fetus in a short period of time, thereby preventing them from future risk of NCDs. Institutional deliveries ensure a hygienic delivery and adoption of appropriate feeding practices, which play an instrumental role in averting the risk of obesity later in life. Thus, by promoting effective and efficient utilization of maternal health programs for natal care, infant feeding, institutional delivery etc. can be instrumental in averting the risk of chronic disorders namely obesity and related conditions such as diabetes, hypertension and cardiovascular diseases. Conclusively, the role of maternal health program components is instrumental in preventing NCDs.

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[9] The program aimed at improving rates of institutional delivery especially among women in Low Performing States (LPS), BPL pregnant women aged 19 years and above in High Performing States (HPS) and ST and SC pregnant women pan India.

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