

## SYSTEMATIC REVIEW



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## A Systematic Review on Nutritional Vulnerability and Opportunity during the First 1000 Days of Life for Ensuring Better Human Capital

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### Abstract

**Objectives:** To explore, compile facts, evidences regarding importance and nutritional vulnerability of first 1000 days and existing interventional opportunities. **Methods:** Conduction of a systematic review by surfing electronic databases including Pub Med, MEDLINE, Scopus, ProQuest, CINAHL, Web of Science, EMBASE, Science Direct, Google Scholar etc. The keywords used for searching the articles include First 1000 days, Maternal and Child health, early life, Malnutrition, economic impact of early life malnutrition, first 1000 days and impact on human capital etc. Review material which focused on the nutritional aspect of an individual's life starting from the point of conception to 2 year were analyzed and a concrete synthesis was reproduced. **Findings:** Approximately forty research and reviews were assessed and it was concluded that considering the entire life course the early life period is considered as critical in deciding health and wellbeing. First 1000 days have been recognized as period of maximum plasticity and greatest potential for introducing nutritional interventions. Any negligence during this period can reciprocate early disparities in children's functioning which can further cause problems in field of future education and employment opportunities. Economic development of any nation is directly influenced by its citizens health therefore health care providers should refer to existing services available for mother, infants and young children and also advocate nutritious diets. Public policies should ensure appropriate supply of nutrients for better foundation of early growth and development which in turn is key factor for long term good health. **Novelty/ Improvement:** Factors associated with nutritional vulnerability of first 1000 days suggest that interventions aiming at short term gains like improvement in birth weight and infant survival can further have a long-lasting effect during the entire life course.

**Keywords:** Nutritional Vulnerability; First 1000 Days; Human Capital; Programme Implication; Cognitive development; Stunting; Wasting

## 1 Introduction

The first 1000 days expanding from conception to child's second birthday are considered as critical window of interventional opportunity. It is the period when foundation of healthy life is laid in womb as well as early infancy. The Earliest phases of life including pre and post-natal phase are characterized by development of various pathways crucial for maintaining various life processes targeting metabolic, endocrine, neural and immune systems having direct bearing on child's growth potential and development (Robertson et al). This period is deeply associated with important consequences for survival, growth, development, resistance to infection through the life course. World Health Assembly emphasized in 2012 the adversities associated with low birth weight, stunting, wasting as well as anemia in females and suggested different measures to overcome the same<sup>(1)</sup>. This unique period of opportunity lays foundation for overall growth and development which is an important aspect considering the entire life span still in developing countries poverty as well as its attendant conditions like malnutrition have a debilitating effect thus resulting in earlier mortality, notable morbidity and insidiously significant loss of human capital<sup>(2)</sup>.

Researches have generated evidence based data highlighting that nations which fail to do investment targeting initial 1000 days of life might lose a higher amount of capital because it has direct bearing on individuals economic productivity later in life. Wellbeing of both women and children is compromised due to nutritional neglect thereby increasing health expenditure. This aspect has motivated leading economists globally to focus on greater investment in nutritional wellbeing of mother's, infants and toddlers thereby ensuring better, brighter and prosperous future. According to United Nations undernutrition reciprocated in form of restriction of growth during fetal period, wasting, stunting as well as deficiency of vitamins and minerals along with compromised breast feeding all adversely effects child survival. Thus, if under nutrition is not tackled can result into compromised physical and neuro cognitive growth as well as development too. Hence provision of right nutrition enhances capacity of learning and thus promoting appropriate mental and physical development thereby facilitating appropriate economic productivity in the future. This is furthermore essential to discontinue the vicious intergenerational cycle related to never ending malnutrition. Thus failure to provide adequate amount of calories and other key nutrients can result into stunting and irreversible deficit in brain functioning besides adding up other health risks like obesity, cardiovascular, metabolic and endocrine complications<sup>(3)</sup>. Hence this major influence of early life undernutrition along with weight gain in later period as well as development of NCDs has resulted into double burden of malnutrition<sup>(4)</sup>. Thus 'UN Decade of Action on Nutrition (2016-25) and Sustainable Developmental Goals' emphasized the need to resolve the issue of malnutrition by shifting focus to to early life nutrition of the program planners and policy makers<sup>(2,5)</sup>.

Correlational data elicited from various researches suggests that early life malnutrition is directly related to reduce capability of availing opportunities related to economic productivity resulting into alarming implications on human capital. Undernutrition during early stage of lifecourse is major predictor of compromised functional and intellectual output during adulthood<sup>(6)</sup>. This further gets worsen with fewer years of schooling thereby declining the household real income<sup>(7)</sup>. Several nutrition experiments conducted in past with focus on women and children have proved long term effect on the health of child thereby having direct bearing on human capital. The term Human Capital is associated with skills, knowledge levels and other tangible assests related to humans which can further help in creating economically valuable goods and services for other individuals, employers or community. Human capital includes some biological attributes like height, weight, body composition and work capacity along with other aspects like intelligence, cognition etc<sup>(8)</sup>.

## 2 Materials and Methods

### Study Design

A systematic review was conducted and for accomplishing this target various International and National online bibliographic databases were searched including Pub Med, MEDLINE, Scopus, Proquest, CINAHL, Web of Science, EMBASE, Science Direct, Google Scholar etc. The keywords used for searching the articles include First 1000 days, Maternal and Child health, early life, Malnutrition, economic impact of early life malnutrition, first 1000 days and impact on human capital etc. Articles published in English language were retrieved from indexed journals as well as peer reviewed journals. The study included were of an empirical work and should be the measure of economic output. Mainly, researches published during 2009 to 2021 were included.

### Data extraction and Outcome

Data was extracted from relevant articles and approximately 35 reviews with detailed information related to title, authors, country of research, publication year, age of participants, sample size were studied. Certain review article providing information related to determinants of malnutrition during first 1000 days of malnutrition, its economic impact particularly in terms of

human capital, its long-term consequences with regards to health and productivity. Furthermore for economic outcome we used the search terms like human capital, in terms of cognition, education and health including direct outcome ie income and wealth. The articles retrieved from the databases were critically analyzed to elicit their relevance in relation to the topic of the first 1000 days and its significance in terms of human capital. The major outcome of this review was to draw the attention of Nation towards planned investments on the First 1000 days of Human life to ensure economic prosperity.

### 3 Results and Discussions

#### 3.1 Nutritional vulnerability of the First 1000 Days

Vulnerability of first thousand days is well established because this period is marked with rapid growth and development which is well demonstrated with developmental changes initiating in brain and reflecting in all parameters including physical, neural, cognitive, language etc. Hence if during this early life there is deficiency of key nutrients including protective vitamins and minerals like iron and iodine, including essential amino acids and fatty acids along with poor social stimulation might result in long term and devastating impact on intellectual development, learning abilities, behavior and emotional quotient<sup>(8)</sup>. Considering it to be a very crucial period for growth and development and its long term health outcomes, many varied factors influence this period including maternal health, breast feeding, complementary feeding and underlying socio economic factors. This period serves as a window for child's and adult's health risks as both are programmed by the nutritional status of an individual during this period. According to the theory of 'Developmental Origin of Health and Diseases' suggested by David Barker, most of the human development is accomplished during the first 1000 days after conception<sup>(9)</sup>.

Major nutritional outcome of this period is reciprocated in form of biological and metabolic developments which might be adversely effected thus leading to certain patho physiological alterations which might precipitate in form of non communicable diseases like obesity, diabetes mellitus, cardiovascular and chronic respiratory complications, cancers and neuro degenerative disorders later in childhood or adulthood<sup>(10)</sup>. Breastfeeding is considered as idealistic option for proper growth and development as it supplies required hormones, growth factors along with variety of nutrients. It is considered as the only tailor made food providing first class nutrition necessary for shaping brain and hence it's critical for both cognitive and socio-emotional development<sup>(11)</sup>.

Besides its impact on brain development maternal eating behavior during pregnancy as well as complementary feeding practices adopted during first 2 years affects nutritional as well as metabolic programming of infants including food preference influence by flavor programming as infants food preferences find their roots in fetal exposure via amniotic fluid, once taste buds are developed it is much influenced by maternal diet preferences during pregnancy<sup>(12)</sup>. Another major Public health concern in developing countries is stunting which initiates in utero and increases for at least for first 2 years of life after birth. Considering this the first 1000 days are thereby considered as an opportunity window for nutritional interventions<sup>(13)</sup>.

Several evidence based researches have highlighted that the cessation of linear growth reciprocated as stunting is irreversible after completion of first 1000 days period thereby resulting into inter generational cycle of malnutrition as a female who is stunted during her childhood develops into a stunted adult and usually gives birth to a stunted offspring. Stunting has severe consequences reflected as compromised physical health as well as brain development associated directly with persistent poor learning and below average academic achievement later in life. Stunted children have compromised cognitive and motor skills in comparison to their healthy counter parts. Multifarious opportunities exist during the initial foetal stage which extends up to first two years of post partum thus considering this period for its greater vulnerability Government need to take initiatives targeting this period<sup>(14)</sup>. Socio economic, interpersonal, family as well as nutritional factors all collectively influence the nutritional status certain negative components like toxic stress, deprivation whether emotional or nutritional, infection or any kind of inflammation all together influence the process of growth and development. Early adverse experiences no doubt may have a lifelong medical or emotional impact thereby influencing scholastic achievement as well as productivity. Hence such long term issues are true cost which not only society but also nation as a whole has to bear. Hence it is therefore crucial to advocate the expansion of programmes which target nutrition as source of ensuring better platform for future nutrition interventions for prevention of early life loss thereby enhancing the chances of healthiest and productive life. Interventions targeting early life are most efficient and results obtained are best realized throughout later in life<sup>(15)</sup>.

According to Coleman- Jensen et al<sup>(16)</sup> during the year 2015 approximately 16.6% of children in US households were food insecure. In household with income below poverty line 36.8% were food insecure. In approximately 274,000 household children were suffering with hunger, some followed the practice of skipping meals because of food insecurity. Besides this deficiency of certain minerals during pregnancy particularly results in neuro cognitive impairment like neonatal iron deficiency anemia is linked with long term cognitive deficit<sup>(5)</sup>. If the deficiency sets in an early stage then likelihood of alteration in genes particularly in their structure which is important in neural plasticity is quite significant<sup>(17)</sup>. Also deficiency of Iodine in pregnant

women results into a permanent deficit in mental development thereby leading to cretinism in the children. If postnatal stage is shadowed with chronic iodine deficiency results in direct bearing on individuals' performance as well as IQ<sup>(18)</sup>.

### 3.2 First 1000 days and Human Capital

The period of First 1000 days is globally considered as a window of opportunity because any improvement in nutrition during this tenure ensures greater impact particularly in people with poor nutrition. Classical nutrition experiments conducted in Guatemala during past in tenure of 1969-1977 have reflected long lasting effect not only on health and wellbeing during adulthood stage but it also effected human capital. The term Human Capital encompasses 'collective skills, knowledge including other intangible assets of individuals that can be used to generate economic value for individual and community'. Human Capital is measured and evaluated by aspects like schooling, reading, intelligence and certain biological attributes like height, muscle mass including work capacity. Several evidence based researches have highlighted that a nations economic advancement find its roots in the first 1000 days of every child's life and malnutrition if seeps in during this tenure can haunt a child throughout his life. Since undernourished child is more susceptible to infections and has lower IQ along with compromised cognitive skills hence this can visibly impede a nation's economic growth. Researches have proved that weight at the time of birth followed by linear growth along with further weight increment with respect to height particularly during infancy and childhood extending till adulthood have direct relationship with size of individual's body as well as its composition. Besides this associated risk factors related to NCDs including blood pressure, plasma concentration of glucose, insulin resistivity and obesity all have impact on human capital outcomes thus emphasizing significance of first 1000 days in ensuring health and wellbeing in long phase<sup>(19)</sup>.

Five prospective birth cohort studies conducted in Brazil, Gutemala, India, Philippines and South Africa based on relationship of linear growth, weight gain during early life in comparison to adult health and human capital based on information and data analysis of 8362 participants highlighted that individuals who experiences poor early life nutrition showed higher prevalence of low height for age i.e., stunting. But on exposure to changing environment which further resulted in obesity which is in turn major risk factor for chronic disease risk later in life. According to their findings interventions targeting increase in birthweight and linear growth during first 2 years of life might result in improving the key aspects of human capital i.e., improvement in height and schooling thus providing protection from getting prey to adult chronic disease risk factors. However faster relative weight gain after 2 years has little benefit for human capital further more weight gain after mid childhood might result into enhanced cardiac risk as it is also not associated with height gain<sup>(19)</sup>. Countries undergoing repercussions associated with nutrition transition, dual burden of malnutrition reflected both as undernutrition as well as emerging obesity epidemic need detail research and evidence based information related to deep rooted impact of growth and development during early childhood. Adequate nutrition during early life is directly linked with approximately 5 percent return on annual income<sup>(20)</sup>.

According to review reported by Hoddinott et al in 2013<sup>(21)</sup> based on overview of Human Capital study of 2002-2004 justified that there is profound negative impact on human capital mainly because of reduced economic productivity because of stunting thus enhancing the risk of individual to remain poverty stricken. As per economist stunted don't perform well in marriage market, it is a common observation that such individuals get married at a very young age and are not qualified up to the mark. They start their family with females who are stunted too such females are quiet young at first birth and have more number of pregnancies thus reproducing more number of children thus having long lasting Maternal and Child Health along with socio economic implications.

'Lancet series on Maternal and Child Under nutrition Progress-1 published in 2021' based on review of progresses achieved on compiling global information gathered from 50 low to middle income countries by analyzing surveys extended from 2000 to 2015. The information gathered highlighted both stunting as well as wasting being major public health problems particularly effecting low income countries<sup>(13)</sup>. Results analyzed thus highlighted both short term and long term effects of under nutrition and its adverse association with adult human capital. Both women and children are equally affected with various forms of under nutrition of which social inequalities forms a base thus justifying strong role of poverty and illiteracy in worsening the situation. This further reinforces the need of multi sect oral approach to accelerate the progress in order to address this major global public health concern<sup>(22)</sup>.

### 3.3 Policy and Programme Implications

According to 2008 series on Maternal and Child Undernutrition released by Lancet highlighted the first 1000 days as crucial window for implementing related to health and nutritional intervention<sup>(23)</sup>. The corollary is that any measures adopted during the first 1000 days will result into highest impact not only of child's survival but also on child's health and nutrition. In present scenario scientist have flashed light on 'developmental origins of metabolic diseases' as these diseases find their presence and recognition in both scarcity and or may be excess in early life which may result in increased risk of chronic degenerative

diseases<sup>(24)</sup>. It has been observed that poor women residing in developing countries having short stature resulted from stunting during early life may enhance risk of certain micronutrient deficiencies and they might be obese as well as Diabetic. Presently researches are done on programme development intrauterine environment and with a strong belief that nutrition interventions in early life target short term gains like improvement in birth weight, survivals of infants along with long term effects on humans throughout the life course<sup>(14)</sup>. Thus it is advisable to pregnant women to attain desirable body composition at the time of conception ie she should neither be obese nor underweight.

The Globe at large and developing countries in specific are experiencing changes in dietary patterns as well as life style and this is reciprocated in form of fueling obesity on one hand and furthermore increased risk of chronic diseases. Recent researches have supported the fact of development of type 2 diabetes because of fetal undernourishment which further predisposes individuals to insulin resistance and decreased  $\beta$  cell mass and function<sup>(25)</sup>.

The decision making body of World Health Organization ie the World Health Assembly sets policies and in 2012 the members involved endorsed the target of reducing stunting in children less than 5 years by 40% by the year 2025<sup>(26)</sup>. The observational researches reported main issues associated with ecology of poor nutrition evolving in low as well as middle income countries include compromised maternal environment to which foetus is exposed this includes history of undernutrition and poor development during the first 1000 days resulting into short maternal stature an complication during delivery furthermore overweight, obesity as well as gestational diabetes too worsen the situation. Also, micronutrient deficiencies, faulty infant feeding practices and breast feeding practices, along with inadequately scheduled and nutritionally compromised complementary feeds have negative impact.

The conditions are also deteriorated by frequent occurrence of diarrheas because of unhygienic environment resulting into stunting and under nutrition with direct consequences for human capital as reported by Adair et al, 2013<sup>(19)</sup>. All such publications emphasize the need for a required political will, financial support for initiating evidence based policy and programs along with their properly planned and materialized implementation. For success of any program besides implementation careful monitoring and evaluation are equally important. Therefore nutrition specific and sensitive interventions need to be planned in order to address the challenge of promoting healthy growth without meshing up in trap of obesity.

## 4 Conclusion

Evidence based researches have highlighted that life course determinants of young adult human capital along with disease risk factors are directly linked with weight gain and faster linear growth particularly during the first 2 years of life. These factors are further associated with amount of schooling besides these adverse consequences reciprocated by fast weight gain is confined to mid childhood and adulthood. Thus, globally efforts should be invested promoting nutritionally adequate diets initiating from conception to age of 2 years. Thereafter, it is equally crucial to prevent rapid relative weight gain after 2 years. These findings support the fact that adequate growth pattern in early life results in reduced incidences of under nutrition, increased human capital, reduced risk of obesity and NCDs. Such efforts will no doubt help in reducing risk of obesity, NCDs will furthermore help us in raising productive human capital and address both under and over nutrition thus relieving from double burden of malnutrition.

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