Risk factors associated with stunting during the first 1000 days of life in Bangladesh: Literature Review

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Bangladesh

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by

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Abbreviations and Acronyms

ANC	Antenatal Care
aOR	Adjusted Odd Ratio
BASE	Bielefeld Academic Search Engine
BCG	Bacillus Calmette–Guérin
BMI	Body Mass Index
CI	Confidence Interval
DPT	Diphtheria, Pertussis (whooping cough), and Tetanus
EBF	Exclusive Breastfeeding
EmOC	Emergency Obstetric Care
FY	Fiscal Year
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
HAZ	Height-for-Age Z
ICDS	Integrated Child Development Services
IMCI	Integrated Management of Childhood Illness
LBW	Low birth weight
LBW-FT	Low birth weight-full term
LMIC	Low and middle-income country
LNS	Lipid-based nutrient supplement
MAD	Minimum accepted diet
MoHFW	Ministry of Health and Family Welfare
OPV	Oral Polio Vaccine
RR	Risk Ratio
RCT	Randomised controlled trial
STOBE	Strengthening the Reporting of Observational Studies in Epidemiology
UNICEF	United Nations Children's Fund
USD	United States Dollar
VU	Vrije Universiteit
WAZ	Weight-for-age Z
WHA	World Health Assembly
WHO	World Health Organization

Glossary

Colostrum: 'The sticky, yellowish substance produced by the mother soon after birth' (World Health Organization, n.d.).

Complementary feeding: "The process starting when breast milk alone is no longer adequate to meet the nutritional requirements of baby, and therefore other foods and liquids are needed, along with breast milk. The transition from exclusive breastfeeding to family foods – referred to as complementary feeding – typically covers the period from 6–24 months of age" (World Health Organization, n.d.).

Diarrhoea: "Diarrhoea is defined as having loose or watery stools at least three times per day, or more frequently than normal for an individual" (UNICEF and WHO, 2009).

Early initiation of breastfeeding: 'Provision of mother's breast milk to infants within one hour of birth'(World Health Organization, 2017).

Exclusive Breastfeeding (EBF): "Exclusive breastfeeding means that the infant receives only breast milk. No other liquids or foods are given – not even water – with the exception of oral rehydration solution, or drops/syrups of vitamins, minerals or medicines"(World Health Organization, 2019)

Food security: "access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (Napoli et al., 2011).

Food insecurity: "A situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and active and healthy life" (Napoli et al., 2011).

Low birth weight: Birth weight "less than 2500 g (up to and including 2499 g)"."For live births, birth weight should preferably be measured within the first hour of life before significant postnatal weight loss has occurred" (World Health Organization, 2009).

Malnutrition: "Malnutrition refers to deficiencies, excesses or imbalances in a person's intake of energy and/or nutrients" (World Health Organization, 2016a).

Minimum acceptable diet (MAD): "An indicator measures both the minimum feeding frequency and minimum dietary diversity, as appropriate for various age groups. If a child meets the minimum feeding frequency and minimum dietary diversity for their age group and breastfeeding status, then they are considered to receive a minimum acceptable diet" (USAID, n.d.).

Stunting/chronic undernutrition: "Child defined as stunted if their height-for-age is more than two standard deviations below the median of WHO Child Growth Standards (World Health Organization, 2014a).

Undernutrition: "defined as the outcome of insufficient food intake and repeated infectious diseases. It includes being underweight for one's age, too short for one's age (stunted), dangerously thin for one's height (wasted) and deficient in vitamins and minerals (micronutrient malnutrition) (UNICEF, 2006).

Z-score: "A Z-score is a numerical measurement used in statistics of a value's relationship to the mean (average) of a group of values, measured in terms of standard deviations from the mean" (Hayes, 2019).

Abstract

Introduction: Stunting is a major problem in Bangladesh, with a prevalence of 36%. The annual reduction rate of stunting in children aged under two is just 0.6%. After children reach two years of age, the consequences of stunting are almost irreversible. This paper seeks to examine and analyse the factors associated with stunting during the first 1000 days of life to provide recommendations for the development of evidence-based interventions in Bangladesh.

Methodology: A comprehensive literature review and desk study were performed on all relevant peer-reviewed and grey literature. The existing data was examined using the World Health Organization conceptual framework for stunting.

Results: Consistent evidence suggests low weight, lack of education of mother, severe food insecurity, lack of access to suitable nutrition, pathogen-specific diarrhoea, and low weight and height at birth, poorest wealth quintile c to early childhood stunting in Bangladesh. Literature about the association between stunting and factors such as the political economy, education systems, and agriculture and food systems was not found.

Multisectoral approaches, the empowerment of women, supplements, and education about lipid-based nutrient can help to reduce the risk of stunting during the first 1000 days of life in Bangladesh.

Discussion: This synthesis shows that the determinants of stunting are multisectoral. As such, a multisectoral approach is required in Bangladesh that employs evidence-based interventions to address the factors that contribute to stunting risk in order to achieve the global nutrition target by 2025.

Keywords: stunting, factors, Bangladesh, Intervention, '1000 days'.

Word count: 12,542

Introduction

Child health has improved significantly over the era of Millennium Development Goals. Globally, the under-five mortality rate declined by 50%, from 90 per 1,000 live births in 1990 to 43 in 2015 (United Nations, 2016). The world also achieved impressive progress in declining the prevalence of stunting among children under 5, from 47% in 1985 to 21.9% in 2018. However, a little improvement has been acquired in some regions, especially South Asia (Stevens et al., 2012; UNICEF et al., 2019). A total of 39% of all stunted under-5 children live in this region (UNICEF et al., 2019). The progress of childhood growth in Bangladesh is still worse. The burden of stunting place Bangladesh in the top 20 countries of the world. In Bangladesh, an average of 36% of children under five was stunted in 2014 (NIPORT et al., 2016; UNICEF, 2013). Bangladesh needs to accelerate the reduction rate of stunting to achieve the target of Sustainable Development Goals (SDG). Bangladesh can save 160,000 children's lives by preventing stunting over the next 10 years (Bhutta et al., 2013).

World Health Organization (WHO) defines 'children as stunted if their height-for-age is more than two standard deviations below the median of WHO Child Growth Standards' (World Health Organization, 2014a). Stunting mostly occurs during the period between conception and second birthday of children (de Onis and Branca, 2016). Stunting during this first 1000 days of life has both immediate and long-term consequences. After 2 years of age, it often irreversible to get back normal growth. In immediate consequences, short stature children show more apathy, fussier and low exploratory behaviour (Gardner et al., 1999). Stunting is also associated with poorer brain and motor development (WHO, 2017). Failing to optimize brain development appears to have poor cognitive, academic performance, and mental health in late adolescence (Walker et al., 2005).

Linear growth faltering in the first 1000 days is the important determinants of adult height (Victora et al., 2010). It results in low job potential in adulthood. Girls who were stunted in childhood remain short stature in adulthood. It sets the transgenerational cycle of undernutrition, and they tend to have stunted offspring (Black et al., 2013; Dewey and Begum, 2011). Undernutrition on this development stage effects and alters body growth, metabolism and composition. This results with an increased chance of cardiovascular disease, metabolic syndrome and type-2 diabetes mellitus (Barker et al., 2002).

I am from a medical background. I have completed Bachelor of Medicine and Surgery degree in 2014. During my placement in the paediatrics ward of my school hospital, I experienced about childhood nutrition. I realized the importance of proper nutrition at an early age of life. Working with United Nation Child's Fund (UNICEF) as a nutrition trainer motivated me about childhood nutrition. Therefore, I have chosen this topic to review.

Psychologists and neuroscientists use phrases such as 'sensitive period' and 'critical period' to express the first 1000 days of opportunity and vulnerability (Bornstein, 1989). The neurodevelopment like neural cell proliferation, differentiation, myelination and synaptogenesis are started and accelerated in fetal life and in shortly after birth. Physical growth also occurs rapidly in this period (de Onis and Branca, 2016). The brain is more vulnerable this period to environmental factors such as nutritional deficiencies (Bornstein, 1989). The first 1000 days is the 'window of opportunity' for both ensuring optimal growth and preventing brain vulnerability (Cusick et al., n.d.). Intervention in this period to improve the undernourished status of children has the greatest impact on society. (Martorell et al., 2010). In this thesis, I analyse the factors correlated with stunting during the first 1000 days of life in Bangladesh to recommend the government and the stakeholders to progress the pace of stunting reduction.

Chapter 1: Background Information

1.1 Geography and Demography

Bangladesh is the most densely populated country in the world, located in South Asia. It is bordered mostly by India, except for a small trip in the southern-east part, bordered by Myanmar. The total southern border match with the coastline of Bay of Bengal (Ministry of Health, Bangladesh, n.d.). Its lands dominated by Ganges-Brahmaputra delta, the largest delta in the world. The average annual temperature of this tropical country was 26°c, where annual rainfall was 203 cm in 2016 (Bangladesh Bureau of Statistics, 2018a). The total area of land is 147,630 square kilometres (*map* Figure 1). Bangladesh has a population of 163,046 with a density of 1,253 people per square kilometre in 2019 (United Nations, 2019). The male-female ratio was 100.4/100 and population growth was 1.28% in 2017 (Bangladesh Bureau of Statistics, 2018a). The population in urban settlement is increased by 1.69% a year (The World Bank, 2015a).

Figure 1. Map of Bangladesh.(Worldatlas.com, n.d)

1.2 Macroeconomic situation

Bangladesh is in the top five fastest-growing economies of the world (The World Bank, 2019). Gross domestic product (GDP) per capita of Bangladesh reached 1,752 USD with 7.65% GDP growth in the fiscal year (FY) 2017-18 (Ministry of Finance, Bangladesh, 2018). The unemployment rate of the labour force was 4.2%, however, the unemployment rate in the female was more than twice than the rate in the male in 2017 (Bangladesh Bureau of Statistics, 2018b). Around two-thirds of people are now in working age in Bangladesh (FAO, 2014). Half of GDP contributed by the service sector. Due to the rapid growth of economic, Bangladesh achieved a lower middle-income country status in FY 2014-15 (The World Bank, 2015b). However, the poverty rate was high, 23.2% in 2017 (Bangladesh Bureau of Statistics, 2018a).

1.3 Education

To ensure complete free, equitable and quality primary and secondary education for both boys and girls, the government of Bangladesh finance all expenditure in public schools. Around 11.7% of the budget was spent on the education sector in FY 2019-20 (CPD, 2019). The enrolment rate in primary school increased to 98%, where girl's enrolment was at 99% in 2016 (Reza and Islam, 2017). A total of 83.6% of girls completed grade-5 in 2017. However, only 54% of girls completed the secondary level (grade-10) in 2015 (BANBEIS, 2016). Overall literacy rate (7+) reached 72.3% in 2016. The literacy rate was the highest in Khulna division (region) (Bangladesh Bureau of Statistics, 2018a). Literate rate of women 15-49 years old was 66% in 2013. However, the literacy rate of women was lower in the rural area (NIPORT et al., 2016).

1.4 Housing characteristics

The household size in Bangladesh reduced to 4.2 persons while 37% of the household had five or more members in 2017. The headship status in households is changing over time, however, only 16% household was headed by women in 2017. Bangladesh reached almost universal access to safe water. A total of 98% of the household had access to safe water in 2017. Three-fourths of all households had access to the sanitary latrine in 2017. However, the huge disparity was seen between urban and rural. 72% of households in urban had sanitary latrine while the rate was 40.4% in the rural area. In Khulna division, 82.2% household had the sanitary latrine that was the highest among administrative divisions. 85% of households had electricity facilities in 2017 (Bangladesh Bureau of Statistics, 2018a). Overall, 89% household had at least a mobile phone while only 53% of women in reproductive age had access to mass media in 2014 (NIPORT et al., 2016).

1.5 Food production

Diets availability have improved significantly in both quantity and quality. The availability of dietary energy was 2413 Kcal/person/day. Daily protein availability improved to 56 gm/person while the daily fat availability rose to 28 gm per person in 2010-12. Despite this improvement, diets still persist unbalanced, where cereals usually attribute for more than 70% of total dietary energy (FAO, 2014). Only 25% of infants received adequate dietary diversity in rural areas in contrast to 32% of urban infants in 2014 (NIPORT et al., 2016).

1.6 Health care

The ministry of health and family welfare (MoHFW) is primarily responsible for policy and decision making at the macro level. Four directorates, director-general of health services, family planning, nursing services and drug administration are working under the umbrella of MoHFW (Ministry of Health, Bangladesh, n.d.). The health system is centralized in nature, where both public and private providers deliver health services. Qualified health workforce density was low, 6.3 per 10,000 population while 28% health position was vacant in 2017 (*Health Bulletin*, 2017).

Health care financing of Bangladesh mostly comes from 3 sources, the government scheme, foreign aid and out of pocket payment by user (Islam et al., 2015). The majority share come from out of pocket payment by user (72%) in 2016 (Figure 2). Bangladesh spent a total of 3.5% of GDP on health in 2016. Total health expenditure was USD 35 per capita in 2016 (World Health Organization, 2016b).

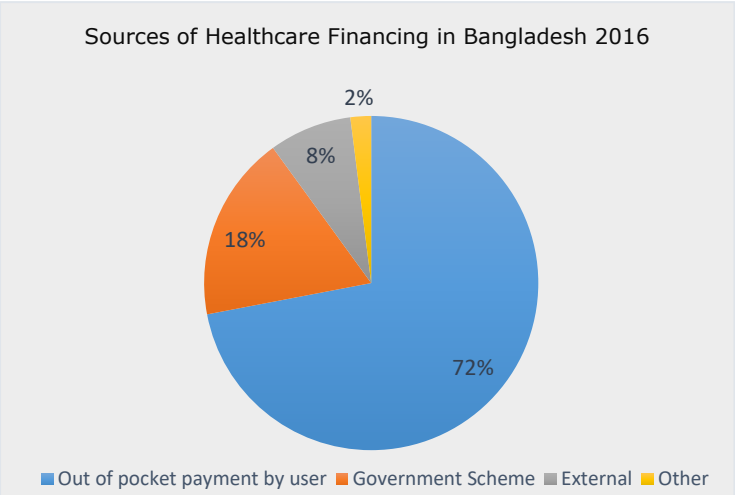

Figure 2. Sources with the percentage of healthcare financing in Bangladesh, 2016

1.7 Health status

Life expectancy at birth in Bangladesh reached at 72 years in 2016 (Bangladesh Bureau of Statistics, 2018a). Total fertility rate declined to 2.1 per women in 2017. However, adolescent (15-19 years) fertility rate was high, 83 birth per 1000 women in 2017 (United Nations, 2019). Child marriage rate 59% in 2014 (NIPORT et al., 2016). Only 39% of facilities had normal delivery care, and 10% of sub-district health facilities have emergency obstetric care (EmOC). Delivery at the health facility was 37% of

total birth in 2014. The proportion of caesarean section increased surprisingly, from 12% in 2010 to 31% in 2016. Maternal mortality ratio was 176 per 100,000 live birth in 2015 (NIPORT et al., 2017). Nineteen percent of women in reproductive age were underweight (Body Mass Index, BMI<18.5%). 30% of adolescent age of 10-18 years were short in height (<-2SD) (Helen Keller International and BIGH, 2014).

A total of 64% of women visited at least once for antenatal care in 2014. Total 55% of children received exclusive breastfeeding for 6 months, where 23% of children aged 6-23 months received age-specific complementary feeding in 2014 (NIPORT et al., 2016). The mortality rate of children aged 0-5 years was 33 per 1000 live birth, where 28 children per 1000 live birth died within 1 year of age. The top cause of premature died in Bangladesh was neonatal disorder in 2017 (IHME, 2017). The prevalence of undernutrition was high, 36% of children under 5 were stunting while the rate of underweight and wasting was 33% and 14% respectively, among the same-aged group in 2014. The rate of vaccination of BCG, 3 doses OPV, 3 doses DPT and measles was 84% in 2014 (NIPORT et al., 2016).

Chapter 2: Problem Statement, Justification, Objectives and Methodology

2.1 Problem Statement

Undernutrition attributes half of the total death of children aged 0-5 years in the world (Black et al., 2013). It is one of the major public health concern due to its negative health and economic consequences (de Onis and Branca, 2016). Stunting causes cognitive impairments. Cognitive impairment in childhood has long-term negative effects in working memory, learning and visuospatial ability (Victora et al., 2008). The children who had stunting before 24 months of age were 16% more risk of failing at least one grade than the non-stunted children (Martorell et al., 2010).

Stunting is associated with reduced height in adulthood, 9.0 cm for men and 6.6 cm for women (Coly et al., 2006; Stein et al., 2010). In adulthood, the income of the stunted child is 20% less than a non-stunted child (Grantham-McGregor et al., 2007). It also causes the reduction of gross domestic product by average 3% in one country (The World Bank, 2006). One more estimate showed that one dollar investment to decrease stunting returns 18.4 dollars in the economy of Bangladesh (Bhutta et al., 2013). Investment in nutrition, Bangladesh would gain economic productivity exceeding USD 5 billion by 2021 (Howlader et al., 2012).

South Asia is one of the most prevalent regions of stunting, with a prevalence of 32.7%, where the global rate was 21.9% in 2018 (UNICEF et al., 2019). However, the prevalence of stunting among under 5 was higher in Bangladesh (36%) (Appendix 1) (NIPORT et al., 2016). Although the annual rate of reduction of stunting in children under 5 in Bangladesh is 2.7%, the prevalence among children under 24 months decreased by only 0.6% in a year (NIPORT et al., 2016, 2005). Linear growth faltering often starts in utero. Most of the risk factors of stunting are usually developed in early age (<2 years) (Kuklina et al., 2006). Stunting among children under 2 years of age is reversible and can catch up with normal growth. However, it is paradoxical that the reduction rate of stunting among the children under 24 months is low, even lower than the rate of under 5 children in Bangladesh.

Children less than 2 years old demand higher nutrient to assist their fast growth and neural development. WHO recommends to feed them with high and dense nutrient frequency, however, the opposite practice seen in Low and middle-income countries, like Bangladesh (Dewey, 2013). Children of mothers who have a low level of education are more stunted (Frongillo et al., 1997). However, in Bangladesh, the prevalence of stunting among children whose mother had received 10 years of formal education or more is still high, 30% of children of those mothers were stunted (Semba et al., 2008).

It is not clear the current nutritional actions are aligned with evidence in Bangladesh. WHO also recommends context-specific factors should be considered to determine the action and intervention to accelerate the rate of reduction (World Health Organization, 2014b). Identification of factors related to stunting is a precondition in implementing interventions on progress stunting reduction.

2.2 Justification

The prevalence of stunting among children below 24 months of age decreased by only 6% between 2004 and 2014, where the rate among under 5 reduced by 15% over the period in Bangladesh (NIPORT et al., 2016). The World Health Assembly (WHA) has set a target to reduce the number of a stunted child under five by 40% (to 3.7 million) by 2025 in Bangladesh (EC, 2018), this resolution is also adopted in SDG. It can be stated that with this pace of reduction, Bangladesh will not reach the target of WHA (World Health Organization, 2014c).

To achieve the WHA target, sustainable strategies to implement evidence-based interventions have to be implemented. Similarly, evidence has proved that interventions for mothers during pregnancy and lactation period have intergenerational effects in growth development (MAL-ED Network Investigators, 2017). WHO Multicentre Growth Reference Study shows that the height of offspring can be increased 8 cm than mean parental height in just one generation receiving improved nutrition and health prior to conception to first 2 years of offspring life (Garza et al., 2013). This finding encourages to implement evidence-based intervention focused at this vital stage in order to achieve a faster transgenerational improvement in height (World Health Organization, 2014b). On the other hand, failing to catch normal growth during the first 1,000 days brings long term irreversible consequences in their lives (Black et al., 2008). In order to design better sustainable interventions, the analysis of risk factors of stunting during the first 1000 days in Bangladesh is essential.

Many studies have identified the determinants of stunting during the first 1,000 days in Bangladesh. Surprisingly, there is no literature review found that examine and analyse the evidence of published literature. To address this gap, this literature review will explore and analyse the determinants correlated with stunting during this crucial of life in Bangladesh. This would assist the government and development agencies in order to design better sustainable approaches to reduce or prevent stunting in early life.

2.3 Objectives

2.3.1 General Objective

To explore and analyse existing evidence on the factors associated with stunting in the first 1000 days of life to recommend to the government and civil organizations towards developing targeted, evidence-based interventions in order to progress on stunting reduction in Bangladesh.

2.3.2 Specific Objectives

i. To examine and analyse factors correlated with stunting during the first 1000 days of life in Bangladesh.
ii. To review the evidence-based interventions to prevent stunting from Bangladesh.
iii. To recommend to the government and the civil organizations to intensify policy, and implement evidence-based interventions to accelerate the reduction rate of stunting.

2.4 Methodology

2.4.1 Search Strategy

This study consists of a literature review and desk study. I used five computerized bibliographic databases to search for literature comprehensively. To identify peer viewed literature, I used PubMed, Cochrane Library and Vrije University (VU) library. To review grey literature related to this topic, I used two databases, science.gov and BASE (Figure 3). I stratified searching according to specific objectives to identify paper systematically. It included both keywords and controlled vocabulary (when available) with combinations boolean operation like 'OR' and 'AND'. There were two attempts taken to search for literature using the five databases. The first attempt was a broad search to find literature using the combination of the following keywords (*details in* Appendix 2).

a. ('factor*' OR Determinants OR Causes)
b. (Stunt* OR 'Linear Growth Retardation' OR undernutrition OR IUGR OR Growth)
c. (Under-two OR '24 months' OR baby OR infant OR '1000 days' OR Fetal)
d. Bangladesh

In the second attempt, I narrowed down the search. I applied each element of the framework (*see* Figure 4) combined with other keywords of the first attempt to the five databases (*details in* Appendix 2). I used the snowballing method, the references list of found literature where inclusion criteria met to get the missed articles.

To get related literature on second specific objectives, I used the keywords, effect*, intervention, impact combination with keywords of first specific objectives (detail in Appendix 2).

2.4.2 Inclusion and Exclusion Criteria

I considered the studies for this review basis on some specific criteria. Articles, which covered fetal linear growth restriction and stunting among children under 2 years, were included. However, I included some studies conducted on the children age of 0-59 months when stratified results for the children under 2 years available or when results show relevancy for the children under 2 years of age. The studies, which conducted in Bangladesh, are included. However, sometimes, the study conducted in multiple countries was also included when results for Bangladesh found separately. Both peer-reviewed and grey literature examined. Only the papers published in English were included.

Qualitative studies were excluded from this review. Articles that published before 2004 excluded to avoid compiling outdated information. If any paper was not accessible, a request emailed to authors. If the author did not reply with the articles, the papers were excluded.

2.4.3 Data Extraction

For the first specific objective

I screened the title of articles after applying every search set. If I found a relevant article, I collected the full article. Then, I removed duplicate articles manually. I reviewed the abstract of 185 articles. At the stage of abstract reviewing, 69 articles were left for full-text assessment. I read the articles critically and assessed quality. A total of 27 articles were selected for this review (details in Figure 3).

For second specific objective

I reviewed the abstract of 38 articles about interventions on stunting in Bangladesh. After applying inclusion and exclusion criteria, nine studies were selected.

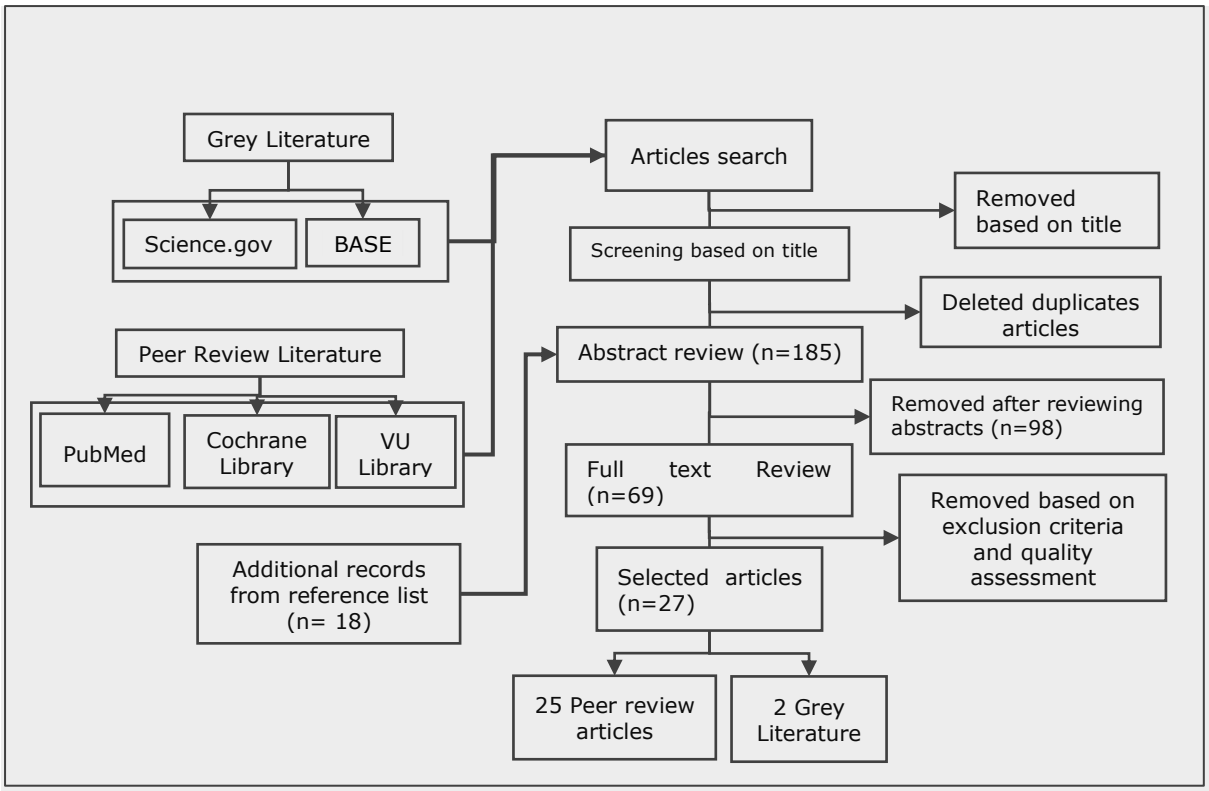

Figure 3. Flowchart of literature selection for the first specific objective.

2.4.4 Quality Assessment

I assessed the quality of the observational studies using the checklist of strengthening the reporting of observational studies in epidemiology (STROBE) (Von Elm et al., 2014). 7 elements of quality appraisal criteria from the checklist were used for assessing the quality of articles in this review. The seven elements consist of sample size, methodology, outcome measures, response rate, study limitation, consideration of ethics and confounder control. I rated each studies fulfilling the 7 criteria. Fitting each criterion, the article got 1 point.

I examined the quality of experimental studies using 4 criteria. The criteria are sample limitations of the study, the inconsistency of results, bias and possible confounders.

2.4.5 Limitation

Five computerized bibliographic databases used to retrieve articles. However, besides those databases, there are many more databases. Relevant articles might be missed. The articles, which were not accessible excluded. Those missing articles might be important. Only quantitative studies were included in this review. Qualitative studies might give important findings. I only included articles published in English. Finding another language's literature is missed in this review. In spite of this, the literature and studies, which investigated were adequate to answer the research questions.

2.4.6 Conceptual Framework

I used the WHO conceptual framework for childhood stunting to guide in this literature review (Figure 4). This analytical framework adapted from the UNICEF framework on the causes of malnutrition (UNICEF, 1990). This adaptation has been developed for the purpose that stunted growth and development share common causes in the highly sensitive time, from -9 to 24 months (Stewart et al., 2013). This framework is segmented

into three sectors: context, causes and consequences of stunting. I did not use the consequence section of this framework as it was not objective in this review.

In the causes section, there are four broad elements that are household and family factors, inadequate complementary feeding, breastfeeding and infection. All broad elements are again divided into sub-elements. In household and family factors, the maternal factors include the mothers existing and during pregnancy and lactation factors which may have transgenerational impacts on offspring length growth. Factors included in the home environment illustrate the necessity of a safe, clean and stimulating environment to get proper growth of the child (Engle et al., 1997). The elements of complementary feeding were placed adequately in this framework. It consists of essential factors to measure the quantity, quality and hygiene of complementary feeding which may have influence in growth faltering of children aged 6 to 23 months. However, the children growth will not be adequate if they do not get age-specific breastfeeding which is described in the breastfeeding element. It is also necessary for a child not get the infection to gain healthy growth which is included in infection element (Stewart et al., 2013).

The contextual (community and societal) factors impact on the different underlying causes of childhood stunting which described above. Besides health and healthcare, it also consists of political, economic, education, society, culture, agriculture, water and environment disciplines. It indicates that transdisciplinary approaches with vertical and horizontal integration crucial to reduce childhood stunting (del Carmen Casanovas et al., 2013).

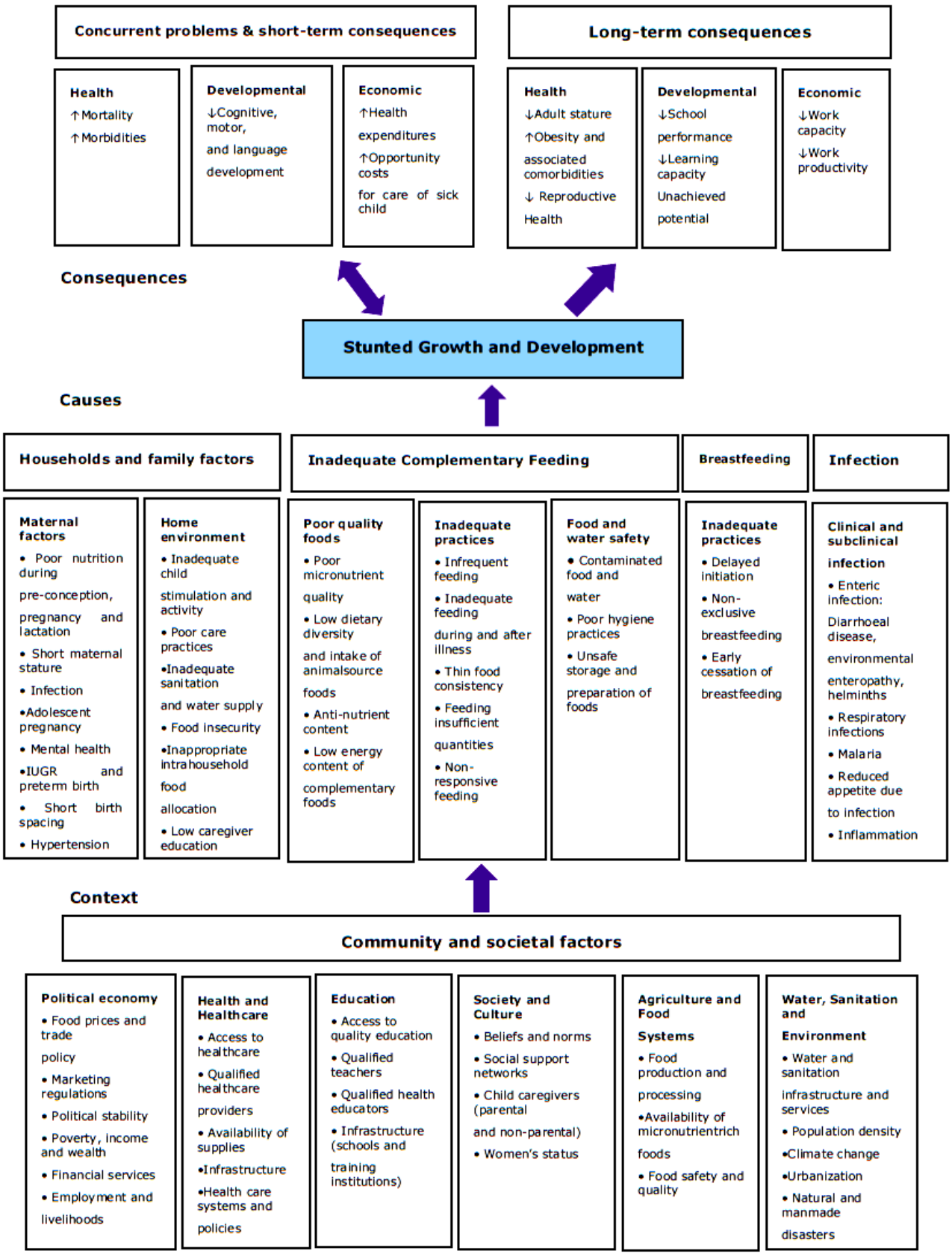

Figure 4. WHO conceptual framework for Childhood Stunting: Context, Causes and Consequences (Stewart et al., 2013:P.29)

Chapter 3: Results

In this chapter, I have examined and analysed the finding I found reviewing the selected articles for the first specific objectives. I have organized the chapter according to the framework I used in this review. However, first, I have described an outline of the characteristics of articles I have selected for the first specific objectives. I have also described the prevalence of stunting in Bangladesh. Then, I have analysed the finding for the first specific objectives.

3.1 Characteristics of selected studies for the first specific objective

The selected studies were carried out in both urban and rural setting. Out of them, 8 conducted in the urban area, 10 carried out in a rural setting, and 9 studies covered both urban and rural area. The research was organized between 2004 and 2019, however, the majority of studies conducted from 2007 to 2016. The sample size varied a lot, ranged from 147 to 304,856. Out of all selected articles, 19 are primary research and 8 are secondary investigations. Out of them, 15 are cross-sectional, 3 are case-control, 6 are cohort studies, and 3 are randomized control trials. I tabulated the selected articles with an area of research in Table 1.

3.2 Prevalence of early childhood stunting

The prevalence of stunting was higher in children whose mother's body mass index (BMI) was lower. A total of 35.5% of children were short stature whose mother's BMI< 18.5, compared to 29.2% for those mother's BMI 18.5-24.5, and 25.4% for those mother's BMI 25.0-29.9. The prevalence of stunting was also significantly decreased with the increase of maternal schooling (38.7% for those mother had no education, 28.3% and 22.0 % respectively, among those mothers had grade 5-9 and grade 10 or more). The prevalence was significantly lower among the children whose mother received iron supplements during the antenatal period (28.7% vs 33.69%) (Mistry et al., 2019).

Stunting prevalence rose with children's age. The prevalence of stunting among children 0-5 months was 15.4% while the rate among the children 6-11 months and 12-23 months was 21.7% and 43.2% respectively. The prevalence of stunting was considerably lower among girls. The prevalence for boys was 32.6% while 27.1% was for girls. The prevalence of stunting was higher among children with low birth weight (<2.5 kg) (42.0 vs 28.9%) (Mistry et al., 2019).

Exclusive breastfeeding (EBF) for 6 months reduce the prevalence of stunting. A total of 17.0% of children who received EBF for 6 months was stunted while the prevalence was almost twice (32.9%) among those did not receive EBF for 6 months. The prevalence was high among children who did not receive minimum acceptable diet (58.2% vs 49.7% at 24 months). The prevalence of stunting was greater among the children those had history of diarrhoea last 3 months (34.7%vs 29.4%) (Mistry et al., 2019).

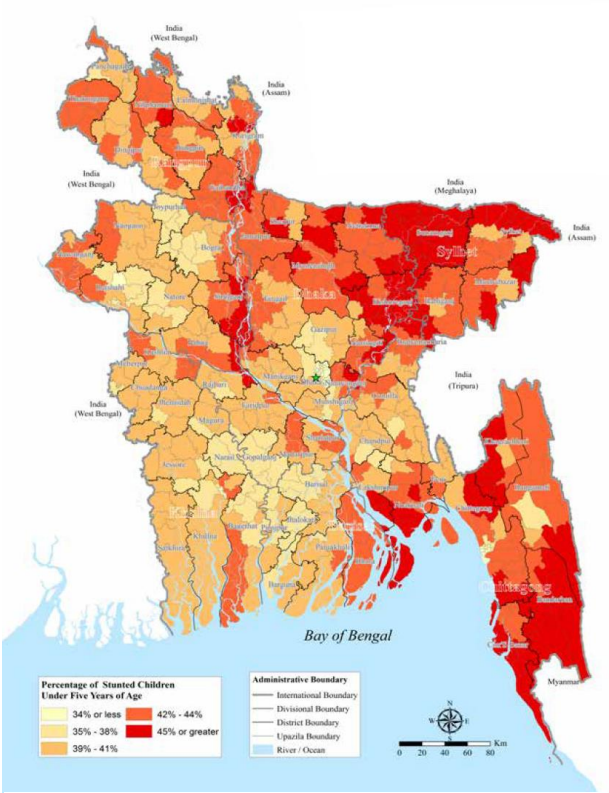

Figure 5. Stunting map of Bangladesh by sub-district level in 2012 (FAO et al. 2014: P.11)

The prevalence of stunting varied among different administrative divisions (Figure 5). Sylhet division had the highest prevalence (41.4%) while the stunting rate was lowest in Khulna with 24.5%. The prevalence among children living in a poorer household was higher. The prevalence of stunting was 33.2% in poorest household and 24.9% in richest households. The prevalence was lower among children living in the household with food-secure (28.2% vs 34.9%) and with improved toilet (24.8% vs 31.4%) (Mistry et al., 2019).

Table 1. Summary of studies selected for first specific objective in this review

	Articles	Study period	Sample size	Age of children (months)	Settings focus	Study Design	Data Source	Quality Assessment (0-7 points)
1	Mistry et al. (2019)	2015-2016	6539	0-23	Nationwide	Cross-sectional	Primary	7
2	Alam et al. (2017)	2009-2012	689	6-24	Urban	Case-control	Primary	4
3	Islam et al. (2018)	2010-2012	265	9-24	Urban	Cohort	Primary	5
4	Choudhury et al. (2017)	2011-2013	10,291	0-23	Nationwide	Cross-sectional	Primary	7
5	Ahmed et al. (2012)	2004	8,858	0-23	Rural	Cross-sectional	Primary	4
6	Zongrone et al. (2012)	2007	2096	6-23	Nationwide	Cross-sectional	Secondary	7
7	Raihan et al. (2018)	2009-2012	732	0-23	Urban	Cross-sectional	Primary	6
8	Hasan et al. (2019)	2016-2017	296	0-23	Urban	Case-control	Primary	5
9	Sanin et al. (2018)	2010-2012	265	12-24	Urban	Case-control	Primary	6
10	Asling et al. (2009)	2001-2003	3,164	0-23	Rural	Cohort	Primary	5
11	Nasreen et al. (2013)	2008	720	0-8	Rural	Cohort	Primary	6
12	Black et al. (2009)	No mentioned	211	6-12	Rural	Cross-sectional	Primary	6
13	Khan et al. (2017)	2011, 2014	6,584	0-59	Nationwide	Cross-sectional	Secondary	6
14	Goyal and Canning	2004, 07,11,14	1,980	0-59	Nationwide	Cross-sectional	Secondary	6
15	Kim et al. (2017)	2014	18,586	0-23	Nationwide	Cross-sectional	Secondary	5
16	Saha et al. (2012)	2001-2003	2,372	0-23	Rural	Cross-sectional	Primary	6
17	Donowitz et al. (2018)	2011-2014	371	0-23	Urban	Cohort	Primary	5
18	Korpe et al. (2016)	2008-2014	392	0-23	Urban	Cohort	Primary	5
19	Owais et al. (2016)	2011	2,400	-9-24	Rural	Cross-sectional	Primary	5
20	Mondal et al. (2012)	2008-2009	147	0-12	Urban	Cross-sectional*	Primary	5
21	Rashid et al. (2017)	2001-2003	3,267	-9-0	Rural	Random Control Trial	Primary	5
22	Svefors (2018)	2002-2003	2,723	0-23	Rural	Cohort	Secondary	5
23	Campbell et al. (2009)	2000-2005	304,856	0-59	Nationwide	Cross-sectional*	Secondary	4
24	Del nino and Lungery	1998-1999	4,433	0-59	Nationwide	Cross-sectional*	Secondary	4
25	Chakraborty (2009)	2004	10,420	0-23	Nationwide	Cross-sectional	Secondary	5
26	Christan et al. (2015)	2012-2014	5,536	0-23	Rural	Random Control Trial	Primary	6
27	Mridha et al. (2015)	2011-2012	4,011	0-12	Rural	Random Control Trial	Primary	6

* It was surveillance data.

3. 3 Risk factors of early childhood stunting

3.3.1 Maternal Factors

WHO framework includes poor nutrition of the mother during pre-conception, pregnancy and lactation, short stature, infection, adolescent pregnancy, mental health, IUGR, preterm birth, short birth spacing and hypertension as maternal factors of stunting.

Poor nutrition of mothers

Total 8 studies investigate the influence of mother's poor nutrition on stunting among children aged 0-23 months (Ahmed et al., 2012; Alam et al., 2017; Choudhury et al., 2017; Donowitz et al., 2018; Khan et al., 2017; Kim et al., 2017; Mistry et al., 2019; Mondal et al., 2011). All reported a significant positive relationship between underweight mothers and poor linear growth of children (Figure 6). Donowitz et al. (2018) reported maternal weight at birth as the strongest predictor of linear growth at the age of 2 years. Mistry et al. (2019) reported about the children age of 0-23 months. The children of underweight (BMI<18.5) mothers had 1.11 (95% confidence interval, CI: 1.02 to 1.20) times risk to be stunted than those of normal-weighted mothers. Choudhury et al. (2017) found the odds of mothers BMI<17 in children age of 6-11 months was higher (aOR 1.85, 95% CI: 1.42-2.40) than the odds of mothers BMI<17 in children of other age groups.

In urban slum area, the influence of mother's low BMI on child's stunting was worse. The odds of mothers with BMI<18.5 was 3.55 times higher (adjusted Odd Ratio, aOR 3.55, 95% CI: 2.34-5.38) among stunted children than non-stunted children (Alam et al., 2017). The rate of underweight was more in the disadvantaged group, like mothers in the slum area. In general, 82% of mothers in the rural area were underweight (BMI<18.5) (Khan et al., 2017). In a randomized control trial, Mridha et al. (2015) observed lipid-based nutrient supplement during pregnancy and lactation increased mother's weight and reduced the risk of newborn stunting significantly (risk ratio, RR: 0.83; CI: 0.71-0.97).

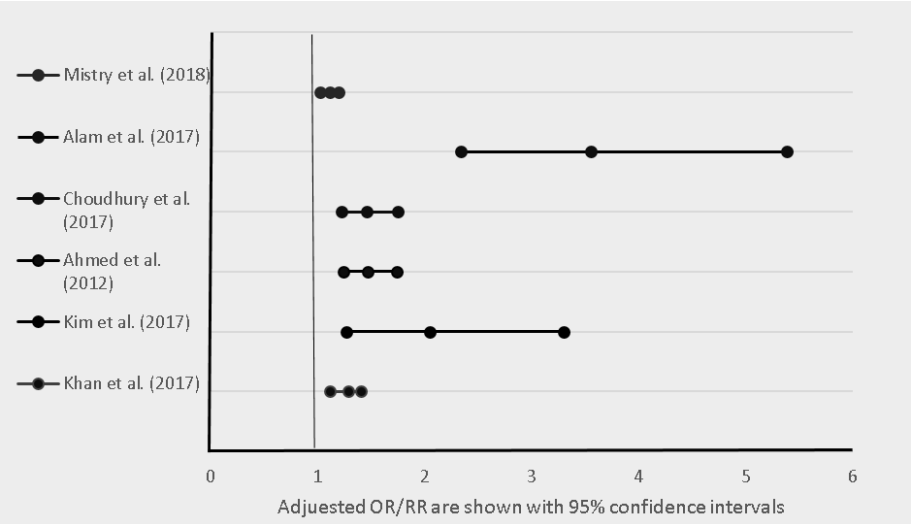

Figure 6. Adjusted OR/RR for underweight mothers found by different studies correlated with stunting

Maternal overweight was a protective factor in childhood stunting. However, obesity during pregnancy increases the chance of pregnancy complication such as caesarean section prolonged labour, stillbirth and perinatal mortality (Khan et al., 2017).

Short maternal stature

Another strong determinant among children 0-2 years of age is mother short height (<145 cm) reported by Ahmed et al. (2012), Hasan et al. (2019), and Svefors (2018). The mothers with short height (<145 cm) had 4.78 (95% CI: 2.28-9.56) times adjusted odds among stunted children than non-stunted children (Hasan et al., 2019).

Maternal depressive symptoms

Antepartum depressive symptoms of mothers associated with stunting among children 6-8 months, while mothers' depressive symptoms at age of 2-3 months of children were not related to stunting in children at 6-8 months (Nasreen et al., 2013). However, Black et al. (2009) documented the odds of mothers' depressive symptoms was 2.17 times (95% CI: 1.24-3.81; P=0.007) higher among stunted infants at 6-12 months than non-stunted infants in Bangladesh. Depressive symptoms of mothers were more prevalent in poorer households. These mothers also give birth to low weight baby more (Nasreen et al., 2010).

Stunting of children at 6-8 months was associated with the perceptions of mothers about the child's temperament as fussy, difficult and unpredictable (Nasreen et al., 2013).

Adolescent Pregnancy

Goyal and Canning (2017) reported the mother's age at birth <18 years is also a risk factor for children to be short stature. The children whose mother age less than 18 years old were 1.15 times (95% CI: 1.08-1.122) higher risk being stunting.

3.3.2 Home Environment

In home environment sub-element of the WHO framework, low caregiver education, inadequate child, food insecurity, inadequate sanitation and water supply, poor care practices and inappropriate intra-household food allocation are mentioned as factors of stunting.

Low caregiver education

All of 11 studies reported a negative association between mother's education and stunting among the children aged 0-23 months. I tabulated both crude and adjusted OR and RR with 95% confidence interval for maternal education in Table 2. Chakraborty (2009), Choudhury et al. (2017) and Mistry et al. (2019) found the risk of child's stunting reduced more with the increase of mother's education. The children whose mother had 10 or more years education had a 22% reduction in risk, and mother had 5-9 years education had a 12% decrease in risk being stunted than the children whose mother had no education (Mistry et al., 2019). However, only 12% of the mother had 10-year formal education in 2013 (Choudhury et al., 2017). Alam et al. (2017) reported mother education was a more important determinant of childhood stunting in low socio-economic households. The odds of mothers with education for more than five years was 50% lower among stunted children than non-stunted children in urban Bangladesh. Svefors (2018) found father's education was also a protective factor for childhood linear growth faltering.

Table 2. Crude and adjusted odds/ risk ratios with 95% CI for maternal education found by different studies correlated with offspring stunting

Articles	Crude OR		Adjusted OR		Characteristics
	OR	95%CI	OR	95%CI	
Choudhury et al. (2017)	4.06	3.18, 5.19	2.21	1.67, 2.92	No education
Hasan et al. (2019)	2.73	1.16, 6.42	2.05	0.82, 5.13	illiterate
Raihan et al. (2018)	1.58	1.10, 2.26	1.03	0.67, 1.58	Never attend school
Ahmed et al. (2012)	_	_	0.47	0.34, 0.65	Education ≥ 10 years
Kim et al. (2017)	_	_	1.78	1.17, 2.70	illiterate
Alam et al. (2017)	_	_	1.87	1.38, 2.54	Education <5 years
Chakraborty (2009)	_	_	0.46	0.36, 0.59	Education ≥ 10 years
Svefors (2018)	_	_	1.74	1.17, 2.81	Education <5 years
Mondal et al. (2012)	1.11	0.45, 2.71	_	_	illiterate

Articles	Crude RR		Adjusted RR		Compared category	Referance catergory
	RR	95%CI	RR	95%CI		
Mistry et al. (2018)	0.61	0.52, 0.70	0.78	0.67, 0.92	Education ≥ 10 years	No education

Food insecurity

The influence of household food insecurity on childhood stunting measured by 5 studies. Chakraborty (2009), Alam et al. (2017) and Mistry et al. (2019) documented a significant negative association between food insecurity and stunting among children under 2 years old. However, the other two studies which investigate according to the severity of food security, they reported only severe food insecurity was responsible significantly for being short stature among children under 2 years old (Choudhury et al., 2017; Raihan et al., 2018). 42.7% of household in Bangladesh experienced severe food insecurity in 2013. The odds of severe food insecurity in households was 17% higher in stunted children 6-23 months (Choudhury et al., 2017).

Inadequate sanitation

Improved and hygiene toilet were protective factors to prevent children from being stunted (Ahmed et al., 2012; Alam et al., 2017; Chakraborty, 2009; Mistry et al., 2019). The children lived in a household with improved latrine were 12% (aRR 0.88, 95% CI: 0.79-0.98) less likely short stature that those living in a household with an unimproved latrine (Mistry et al., 2019). The household that used the field for defecation had more odds (aOR 1.23, 95% CI: 1.03-1.50) than those had pit latrine among stunted children (Chakraborty, 2009). However, another study identified the presence of improved latrine was not associated (uOR 0.99, 95% CI: 0.54-1.82; aOR 0.80, 95% CI: 0.38-1.68) with stunting among 12-24 month aged children in Bangladesh (Sanin et al., 2018).

Quality of drinking water

Mistry et al. (2019) identified the quality of drinking water is not significantly associated with being short stature among children 0-2 years in Bangladesh. However, in the slum area, Alam et al. (2017) reported the odds of drinking untreated water was higher (aOR 1.51, 95% CI: 1.03-1.2.21) among stunted children than non-stunted children.

Maternal dietary diversity

The study by Hasan et al. (2019) found a significant association between dietary diversity of mother and child growth deficit. The odds of mother consumed less than 5 food groups, (such as who did not eat pulse, egg, vitamin-A rich fruits and vegetables) had 1.7 times (aOR 1.72, 95%CI: 1.04 to 2.87) higher among the children with poor linear growth than their counterparts. 45% of mothers received less than 5 food groups (Choudhury et al., 2017)

3.3.3 Poor Quality Foods

This sub-element of the WHO frameworks includes low dietary diversity and intake of animal source foods, poor micronutrient quality, anti-nutrient content and low energy complementary feeding.

Low dietary diversity

In Bangladesh, only 30% of children 6-23 months of age received complementary feeding with ≥ 4 out of 7 food groups in 2013 (Choudhury et al., 2017). Choudhury et al. (2017) observed low dietary diversity (less than four groups) in children was a risk factor of stunting. The children who received at least four out of six food groups, their height-age Z score was higher by 0.20 (p=0.024) than the children who did not receive (Zongrone et al., 2012). Length for age Z-score (adjusted β=0.25, 95% CI: 0.13-0.37) was higher in 24 months age among the children who get minimum acceptable diet (MAD). However, only 31% of children fed MAD at 6-23 months of age in 2013 (Choudhury et al., 2017). Kim et al. (2017) also identified an association between MAD and stunting by analysing data of Bangladesh Health and Demographic Survey 2014.

Poor micronutrient quality

Sanin et al. (2018) did not find any evidence of an association between poor micronutrient adequacy and linear growth deficits among children at 12-14 months of age in Bangladesh. However, Campbell et al. (2009) observed the children under 2 years old who lived in a household spent more money on staple food, rice was more likely stunted. Evidence shows typical Bangladeshi diet are strongly dependent on grain or ' staple ' foods, rice posing a danger of poor consumption of micronutrients (Thorne-Lyman et al., 2009).

Low energy content of complementary feeding

Conducting a randomized control trial, Christian et al. (2015) observed supplementation of fortified complementary foods reduced the prevalence of stunting significantly in Bangladesh. The prevalence of stunting at 18 months of age was a 6.2% decrease (95% CI: 10.6%- 1.8%) in risk in the chickpea supplementation at 6 to 18 months of age than the control group.

3.3.4 Inadequate Feeding Practices

Forty-six percent of children were initiated complementary feeding timely in 2011. Late initiating complementary feeding was associated with poor linear growth. Initiation of complementary feeding at or after 7 months of age increased the risk of stunting by 1.23 times (adjusted β=1.23, 95% CI: 1.05-1.44) than those started at age 5-6 months while complementary feeding before age of 5 months was not associated (adjusted β=1.25, 95% CI: 0.92-1.44) with chronic malnutrition (Owais et al., 2016).

The children who took less than minimum frequent food, their risk being stunting was higher (Owais et al., 2016; Hasan et al., 2019). Age-appropriate consistency of complementary feeding is a protective factor of childhood stunting. The children who received soft, semi-solid and solid food according to their age, the chance of chronic malnutrition was 1.34 times (p=0.005) lower (Zongrone et al., 2012).

3.3.5 Food and Water Safety

Hand washing of mother after child defecate (aOR 1.40, 95% CI: 1.02-1.93) and using the toilet (aOR 1.54, 95% CI: 1.08-2.21) is strongly associated with children become stunting (Alam et al., 2017). Mistry et al. (2019) observed mother's using soap after defecation (uRR 0.87, 95% CI: 0.81-0.94) and before eating (uRR 0.86, 95% CI: 0.78-0.96) associated with offspring stunting in Bangladesh. However, in multivariate analysis, the association became insignificant.

3.3.6 Breastfeeding

The WHO framework includes delayed initiation, non-exclusive breastfeeding and early cessation of breastfeeding

Delayed initiation of breastfeeding

Chakraborty (2009), Choudhury et al. (2017) and Mistry et al. (2019) studies on the timing of initiation of breastfeeding. All documented early initiation of breastfeeding (within 1 hour of birth) was not associated with childhood stunting. However, Chakraborty (2009) found the odds of initiating breastfeeding after 24 hours of birth was 1.21 times (aOR 1.21, 95% CI: 1.06-1.40) higher in stunted children than the counterpart.

Non-exclusive breastfeeding

Chakraborty (2009) reported that the odds of receiving any food or liquid at 4-6 months had 1.18 times (aOR 1.18, 95% CI: 1.02-1.40) higher in stunted children than in non-stunted children. The odds of receiving any food at <4 months of age was higher, 1.4 times (aOR 1.40, 95% CI: 1.20-1.60) then the odds of the group age of 4-6 months. However, Owais et al. (2016) reported exclusive breastfeeding even at 3 months was not associated (adjusted β=0.91, 95% CI: 0.78-1.07) with stunting in Bangladesh.

Deprivation of colostrum

Choudhury et al. (2017) found that the deprivation of colostrum was a strong risk factor of stunting. The adjusted odds of not getting colostrum was 1.56 times (aOR 1.56, 95% CI: 1.15- 2.12) higher among the children than their counterpart.

3.3.7 Infection

Chakraborty (2009) reported a significant relationship (aOR 1.23 95% CI: 1.40-1.80) between diarrhoea and stunting among children aged 0-23 months. The odds of having diarrhoea past 15 days were 1.27 times higher in stunted children than in non-stunted children. However, they did not investigate the association between stunting and diarrhoea according to causing-pathogen. Schnee et al. (2018) identified the association between stunting and diarrhoea was pathogen-specific. All-cause diarrhoea was not related to linear growth faltering of children in Bangladesh. The diarrhoea caused by *Cryptosporidium, Campylobacter* and *Shigella* associated with stunting in the first year of life and persisted up to 24 months, but not viral diarrhoea (Schnee et al., 2018). *Cryptosporidium* infection rose the severity of stunting. The odds of *Cryptosporidium* infection had 2.69 times (aOR 2.69, 95% CI: 1.17-6.15) more in stunted children at 24 months, even this association existed non-diarrheal both asymptomatic and symptomatic *Cryptosporidium* infections. About 9% of all diarrhoea was caused by *Cryptosporidium* in Bangladesh (Korpe et al., 2016). *Shigella* infection attributed to an average decrease of 0.24 cm (95% CI: 0.03-0.49) in height per episode per year (Schnee et al., 2018).

3.3.8 Community and Societal Factors

Community and societal factors are the contextual factors mentioned in the WHO framework. It includes political economy, health and healthcare, education, society, culture, agriculture, food systems, water, sanitation and environment sub-elements.

Household Wealth and Income

Seven studies investigated the influence of household wealth on childhood short stature and concluded a significant association (Table 3). However, the association of stunting with different wealth quintile varied in different studies. All studies reported the child in poorest wealth quintile house were more likely stunted. However, Choudhury et al. (2017) documented the relation between poorest wealth quintile and stunting was not significant. They found a significant association between poorer, middle, richer wealth quintile and

stunting. On the other hand, Islam et al. (2018) reported the households with poor asset had 2.81 times more odds among stunted children than non-stunted children. However, they also found an association between stunting and the children who live in wealthy households was not significant. Evidence from Mistry et al. (2019) shows the children living in the wealthiest household were 16% (aRR 0.84, 95% CI: 0.72-0.98) less likely stunted than those living in the poorest families. However, the association between middle wealth household and childhood stunting found not significant. In Bangladesh, 20% of households were in poorest quintile in 2013 (Choudhury et al., 2017).

Alam et al. (2017) reported monthly family income < 100 USD played a negative role being stunting among children under 24 months (aOR 1.98, 95% CI: 1.38-2.84). Hasan et al. (2019) reported the association between monthly income and childhood stunting was not significant (Table 3)

Table 3. Crude and adjusted odds/ risk ratios with 95% CI for household wealth quintile/ monthly income found by different studies correlated with offspring stunting

Articles	Crude OR		Adjusted OR		Characteristics	
	OR	95%CI	OR	95%CI		
Choudhury et al. (2017	1.76	1.44, 2.16	1.17	0.96, 1.44	Lowest	
Islam et al. (2018)	2.95	1.49, 5.82	2.81	1.44, 5.52	Poor	
Ahmed et al. (2012)			0.49	0.38, 0.63	Highest	
Kim et al. (2017)			1.98	1.08, 3.63	Lowest	
Chakraborty (2009)			0.45	0.37, 0.55	Highest	
Hasan et al. (2019)	1.83	1.10, 3.07	1.19	0.65, 2.17	<11,480 BDT	
Alam et al. (2017)	2.34	1.72, 3.18			<100 USD	
Articles	Crude RR		Adjusted RR		Compared category	Referance catergory
	RR	95%CI	RR	95%CI		
Mistry et al. (2019)	0.68	0.59, 0.79	0.84	0.72, 0.98	Highest	Lowest
Goyal and Canning (2018)			0.55	0.50, 0.6	Highest	Lowest

Health and Healthcare

Antenatal or postnatal care visit of mothers was a protective factor of childhood stunting (Choudhury et al., 2017). Chakraborty (2009) analysed the correlation between the number of antenatal care and childhood stunting. The odds of antenatal care (ANC) visit of mothers was significantly higher in the stunted child when the mother had less than two ANC. The odds mothers with one ANC or no ANC visit was 1.22 (aOR 1.22, 95% CI: 1.04, 1.44) and 1.32 (aOR 1.32, 95% CI: 1.15-1.50) times respectively, higher in stunted children than non-stunted children (Chakraborty, 2009).

Chakraborty (2009) reported that the association between healthcare seeking for children from a qualified healthcare provider and stunting was not significant in Bangladesh.

Society and Culture

Mothers' exposure to any form (what so ever) of family violence increased the risk of children being short stature at birth, and this effect continued up to 24 months for both girls and boys in Bangladesh. Moreover, length at birth was shorter among the offspring of a mother who had history of a high degree of controlling behaviour in marriage. In Bangladesh, 50% of mothers had experienced family violence in their life (Åsling-Monemi et al., 2009).

Resources access in the household is a marker of the women's status in the household. Svefors (2018) reported the children born to a mother who had less than 5 saris *(traditional women dress)* had the highest probability of lower LAZ score. Mistry et al. (2019) observed no relationship between working outside of mother and offspring stunting both in univariate and in multivariate analysis.

Water, Sanitation and Environment

Season

The influence of season was studied by Choudhury et al. (2017). They identified the odds of post-a*us* (August- November) was significantly higher (aOR 1.20, 95% CI: 1.03-1.40) in stunted children

Temperature and birth length is associated. The neonate born in the colder season were significantly shorter than those born in the summer season. The high temperature at 8 weeks of the gestational period increased the chance of shorter birth length. Reversed direction observed at last month of gestation. Hot weather increased birth length (Rashid et al., 2017; Svefors, 2018).

Flood

Flood is one of the most common natural disasters in Bangladesh. Association between flood and childhood linear growth faltering investigated by Del Ninno and Lundberg (2005). Flood-exposed children had around 1 inch lower height or about 0.2 less standard deviations than non-exposed children in Bangladesh.

Geographical location

Mistry et al. (2019) found the children from Sylhet division (region) had 35% (aRR 1.35, 95% CI: 1.12-1.164) more chance being short stature than those from Dhaka division (region), while the risk was 16% (aRR 0.84%, 95% CI: 0.72-0.99) lower among children from Khulna division than Dhaka division.

Lead poisoning

Raihan et al. (2018) documented the positive association between lead poisoning and stunting. The odds of elevated blood lead concentration was 1.78 times (aOR 1.78, 95%CI: 1.07-2.99) higher among stunted children under 2 years old.

Arsenic and cadmium poisoning

Kippler et al. (2012) reported arsenic and cadmium exposure during pregnancy increase the risk of children being short stature at birth. Stratification result showed cadmium exposure was more associated with fetal size in poorer than in richer households and in girls than in boys. Postnatal arsenic exposure was significantly and more associated with linear growth faltering than prenatal exposure among only girls age less than 2 years, not boys (Saha et al., 2012).

3.3.9 Child Characteristics

The WHO framework does not mention this sub-element. However, I found low weight and length at birth, age and being male was associated with stunting.

Low birth weight and length

Low weight and length at birth were negatively correlated with stunting under 2 year-child (Mondal et al., 2011; Nasreen et al., 2013; Sanin et al., 2018; Svefors, 2018). Svefors (2018) performed conditional random forest plot ranking on the relative importance of 30

determinants and reported HAZ (Height-for-age Z) and WAZ (Weight-for-age Z) score at birth were the most significant risk factors of short stature at 24 months of age. Sanin et al. (2018) found the odds of a history of low birth weight were 3-times (aOR 3.03, 95% CI: 1.69- 5.44) higher among stunted child in an unprivileged area of Dhaka. In Bangladesh, 16.3% and 28.6% of the newborn had low length and weight respectively, at birth in 2009 (Mondal et al., 2011).

Gender

The relevance of gender investigated by nine studies in Bangladesh. 8 studies reported that the chance of being short stature was higher among boys than girls among 0-2 years age group. Only Alam et al. (2017) found an insignificant relationship between gender and stunting in an unprivileged area of Bangladesh. However, they only presented a crude ratio with 95% CI (OR 0.77, 95% CI: 0.57, 1.04). Figure 7 shows the different adjusted OR/RR with 95% confidence interval of gender with stunting found by different studies. Boys had a 21% (aRR 1.21, 95% CI: 1.12-1.30) higher risk being short stature than girls at an early age in Bangladesh (Mistry et al., 2019). Stratification of age shows the odds of boys age of 6-11 months was higher than the odds of boys age of 0-5 months or 12-23 months (Choudhury et al., 2017).

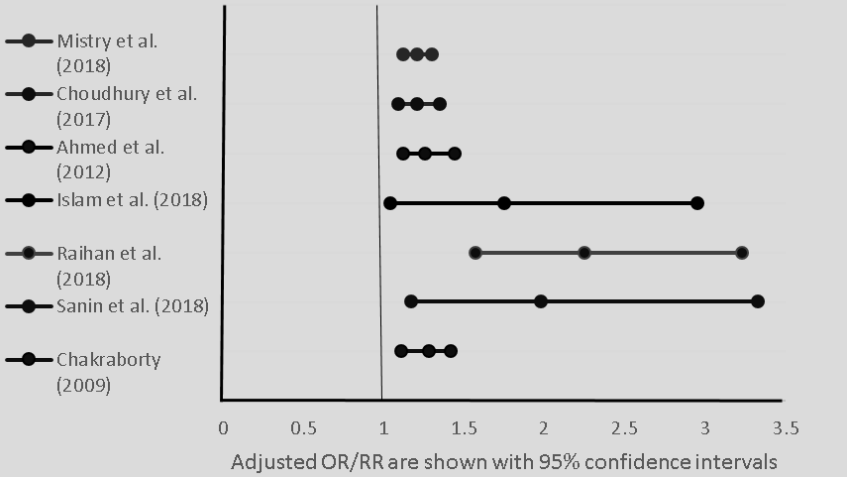

Figure 7. Adjusted OR/RR for being male found by different studies correlated with stunting

Age

Age is an inherited factor of a child that has been investigated extensively. The association between child's age and stunting was observed by 6 studies (Alam et al., 2017; Chakraborty, 2009; Choudhury et al., 2017; Islam et al., 2018; Mistry et al., 2019; Sanin et al., 2018). All identified child length growth faltering became significantly more common with the increase of age. The children 12-23 months of age were 2.65 (aRR 2.65, 95% CI: 2.20, 3.20) times more likely being stunting while the children in 6-11 months group had 1.34 (aRR 1.34, 95% CI: 1.11-1.62) times chance than 0-5 months old children in Bangladesh (Mistry et al., 2019).

In summary of the evidence, underweight, short height, low education level, mother's age <18 years, depressive symptoms and severe food insecurity are the maternal and households factors associated with stunting. Overweight of mothers, minimum acceptable diet and food supplementation act as a protective factor. The association of inadequate sanitation, water, hygiene, exclusive breastfeeding and stunting are not clear in Bangladesh. Pathogen-specific diarrhoea, flood, lead and arsenic poisoning, healthcare

facility, family asset and violence were also factors of childhood stunting. Low weight and length at birth, gender and age also consistent factors of stunting during the first 1000 days in Bangladesh. The factors, maternal infection and hypertension, inadequate child stimulation and activity, poor care practices, anti-nutrient content and non-responsiveness feeding, malaria, respiratory infection, political economy, education quality, agriculture and food system, urbanization, climate change were not assessed due to lack of literature.

Chapter 4: Evidence-based Interventions

Analyzing the factors of stunting in Bangladesh, I have recognized the determinants of stunting is multi-sectoral. In this chapter, I will describe the findings of the second specific objective. However, I will first mention the findings of the assessment of national nutrition services in Bangladesh and recommendations of WHO to progress on stunting reduction. Then, I review the intervention trial those had a huge impact to reduce the prevalence of stunting in Bangladesh (*summary in* Table 4).

4.1 Assessment of national nutrition services in Bangladesh

National nutrition policy 2015 of Bangladesh prioritized to implement both nutrition-specific and sensitive interventions. However, the prioritization of the first 1000 days of life is absence (MoHFW, 2015). In 2011, national nutrition services (NNS) was implemented in Bangladesh according to World Bank recommendations (scaling up nutrition interventions). Assessment of this programme reported NNS included interventions from different platforms. However, the intervention had low quality and coverage, except for antenatal care. Antenatal care service had good quality, however, the skills of weight and height measurement and counselling of mothers was poor. Persistent change of leadership, lack of coordination among sectors and high workload resulted in inadequate supportive supervision, monitoring and reporting (Saha et al., 2015).

4.2 Recommendations of WHO

WHO recommends to understand stunting and scale-up coverage of prevention activities of stunting. Considering specific contextual factors, government strengthen interventions related to maternal health and nutrition. Implementation of interventions to promote breastfeeding practices and complementary feeding are the most effective measures at 0-23 months of age. Protection of children from infectious diseases could be ensured implementing community-based interventions, like improving water, sanitation and hygiene (WASH) (World Health Organization, 2018, 2014b). Several households, socio-economic, environmental and cultural factors should be addressed to progress the reduction rate of stunting. Brazil, Peru, Plurinational State of Bolivia and the Maharashtra State of India are the example who made marked progress on stunting reduction. Analysis of their nutrition plan and strategies shows political commitment, multisectoral collaboration, integrated service delivery and community engagement in intervention activities are common approaches to assist in the success of stunting reduction (World Health Organization, 2018).

4.3 Intervention trials in Bangladesh

Multisectoral approaches

CARE Bangladesh conducted a project named CARE's SHOUHARDO in Bangladesh. It was a large scale project to accelerate the reduction of malnutrition among the children age of 6-24 months. The package of intervention consists of- 1) food supplementation for mother and child, 2) health and nutrition education, 3) providing arsenic-free and safe water, 4) empowering women through education and rights advocacy, 5) training people to increase income and food production at household level, 6) economic support providing employment services, 7) increasing capacity in disaster management. Evaluation of this project showed a sharp reduction of stunting among the children of 6-24 months, by 15.7% from 2006 to 2009 in project area while a little reduction was observed in national rate over the period (Smith et al., 2013).

Enhanced homestead food production (EHFP) programme in Bangladesh and Nepal was a programme of the integrated intervention package to improve diverse food production in

household level, change behaviour about breastfeeding and complementary feeding, increase healthcare services, increase household income and empower mothers. Evaluation of this programme showed a 10.25% reduction of stunting among children age 6-59 months from 2003 to 2007 in Bangladesh. Evaluation of women's empowerment activities shows this intervention reduced stunting by 18% over the same period (Haselow et al., 2016).

Prevention of stunting

In a cluster-randomized trial, researchers provided lipid-based supplements (LNS) containing a small quantity of essential fatty acid and 22 minerals and vitamins in the intervention group. Only iron and folate acid were provided in the control group. LNS decreased the chance of stunting (18.7% vs 22.6%; RR: 0.83; 95% CI: 0.71 to 0.97) among newborn in intervention group. This effect was more among the children who live in a food-insecure house or whose mothers age ≤24 years (Mridha et al., 2015).

Christian et al. (2016) conducted a double-blind randomized control trial between 2008 and 2012 in Bangladesh to examine the effectiveness of prenatal multiple micronutrient supplements compared with routine iron and folate acid supplement in improving birth length. The authors reported prenatal multiple micronutrient supplementation reduced the prevalence of low length at birth (RR 0.95; 95% CI: 0.92-0.98). The effect of multiple micronutrients continued on postnatal period, up to 3 months of age (RR 0.91; 95% CI: 0.88-0.94).

Comparing the length of newborn between vitamin D3 supplementation and placebo among women during the third trimester of pregnancy in a randomized control trial in Bangladesh, Roth et al. (2013) reported there was no difference in length between the two groups at birth. However, the infants at 1 year of age whose mother received vitamin D3 supplementation during the third trimester was 1.1 cm taller (95% CI, 0.06 to 2.0) than those mothers were in the placebo group.

Education and supplementation

In a randomized control trial in Bangladesh, the researcher found counselling mother about appropriate child nutrition and lipid-based nutrient supplementation increased child's LAZ score significantly (0.25, 95% CI: 0.15-0.36). However, individual water, handwashing, sanitation, and combine water, sanitation and handwashing had no effect on linear growth of children (Luby et al., 2018).

Education about nutritious food consumption during the last trimester of pregnancy among mother increased early initiation of breastfeeding (within 1 hour of birth), the weight of mothers, and reduced low-birth-weight of offspring in Bangladesh. Conducting a randomized control trial, Jahan et al. (2014) observed mothers gained 60% higher weight (8.60 vs. 5.38 kg, $p = .011$) in the intervention group during the last trimester. The low-birth-weight was 94% lower (2.7% vs 44.7%, $p < .001$) in the intervention group compared with the control group among the newborn. This 3 months-long education also increased the early initiation of breastfeeding in the intervention group. Early breastfeeding was 52% higher in intervention group (86.0% vs. 56.7%, $p < .001$).

Shafique et al. (2016) performed a randomized cluster trial among the low-birth-weight full-term (LBW-FT) infants age of 6-12 months. Researchers allocated micronutrient powder (MNP) containing calcium, phosphorus, manganese, magnesium, vitamin K, biotin and pantothenic acid among the intervention group, and compared with the no-MNP group in Bangladesh. They observed the risk of stunting was significantly lower among the infants with low birth weight full-term who received MNP than who did not receive MNP (95% CI: 0.15, 0.84).

Treatment of child

Integrated management of childhood illness (IMCI) programme was inaugurated by UNICEF and WHO in the 1990s to reduce child mortality and malnutrition. Arifeen et al. (2009) conducted a randomized trial to assess the effect of IMCI on health and nutrition of child in Bangladesh. They reported the prevalence of stunting reduced more rapidly in IMCI area (difference of differences –7·33, 95% CI –13·83, –0·83) than non-IMCI area.

Summary of evidence-based interventions

Evidence shows only nutritional action cannot address the effect of factors on linear growth faltering. Integrated, multi-sectoral and collaborative nutrition-specific and nutrition-sensitive interventions will have a synergistic effect on stunting reduction. Empowerment of women had a great impact on stunting reduction. Supplement and education about appropriate feeding practices and multiple micronutrients and availability of healthcare for the child also reduced stunting (Table 4).

Table 4. Evidence-based interventions to reduce stunting in Bangladesh					
Authors	Study/ Evaluation design	Intervention type	Year of study	No of partici pants	Effect
Smith et al. (2013)	Evaluation of the project. Mix, Randomis ed controlled trial (RCT) and quasi-experime ntal technique	1) food supplementation for mother and child, 2) health and nutrition education, 3) providing arsenic-free and safe water, 4) empowering women through education and rights advocacy, 5) training people to increase income and food production at the household level, 6) economic support providing employment services, 7) increasing capacity in disaster management.	2006 - 2009	3,200	Reduction of stunting prevalence by 15.7% among 6-23 months old in the project area.
Haselow et al. (2016)	Interventi on– compariso n evaluation	*Nutrition-specific* 1) promote appropriate breastfeeding and complementary feeding, 2) micronutrient supplementation, 3) management of acute malnutrition, 4) balanced energy and protein supplements to women *Nutrition-sensitive* 1) agriculture & food security, 2) social safety nets, 3) women's empowerment, 4)water, sanitation & hygiene, 5) health and family planning services, 6) early child development & child protection programmes.	2003 - 2007	Not mention ed	10.25% reduction of the prevalence of stunting (difference in difference analysis between intervention and control groups).
	Making Markets Work for Women	Engaging men, women and community leaders in planning to improve nutrition and improve access for women.	2003 - 2007	450	18% reduction of stunting prevalence among 6-59 months old in the project area.
Mridha et al. (2015)	Cluster-randomi zed trial	Lipid-based supplement (LNS) to mothers in the intervention group. Iron and folate acid supplementation in control group	2011 - 2013	4,011	RR: 0.83; 95% CI: 0.71 to 0.97 in intervention group
Christian et al. (2016)	Double-blind RCT	Prenatal multiple micronutrient supplements in intervention group. Routine iron and folate acid supplement in control group	2008 - 2012	8,529	RR 0.95; 95% CI: 0.92-0.98 at birth. RR 0.91; 95% CI: 0.88-0.94 at 3 months of age
Roth et al. (2013)	RCT	Vitamin D3 supplementation and placebo among women during the third trimester of pregnancy	2010 - 2012	145	1.1 cm taller (95% CI, 0.06 to 2.0) at the age of 1 year.
Shafique et al. (2016)	RCT	Micronutrient powder (MNP) among LBW-FT infants 6-12 months the intervention group and compared with the no-MNP group in Bangladesh.	2010 - 2011	467	OR: 0.35; 95% CI: 0.15, 0.84
Arifeen et al. (2009)	Cluster-randomi zed trial	Evaluation of Integrated Management of Childhood Illness (IMCI) programme	2001 - 2002	4,400	Stunting reduced. difference of differences –7·33, 95% CI –13·83, –0·83
Luby et al. (2018).	RCT	1) Counselling mother about appropriate child nutrition and lipid-based nutrient supplementation, 2) Intervention of water, handwashing, sanitation, and combine water, sanitation and handwashing.	2012 - 2013	5,551	LAZ score higher 0.25, (95% CI: 0.15-0.36) in lipid-based supplement group. Individual water, handwashing, sanitation, and combine water, sanitation and handwashing had no effect
Jahan et al. (2014)	RCT	Education about nutritious food consumption during the last trimester of pregnant	2007 - 2008	384	Mother gained 60% higher weight, LBW was 94% lower, early initiation of breastfeeding was 52% higher in the intervention group

Chapter 5: Discussion

To my knowledge, this is the first literature review examines the determinants associated with stunting during the 1000 days of life in Bangladesh. This review shows the scientific endeavour that recognized a number of barriers and facilitators correlated stunting in Bangladesh over the past two decades. The findings of this review indicate early childhood stunting not only related to feeding practice of child, but also maternal health, child health, and contextual factors have influence. I also found many interventions conducted systematically which have an impact on stunting reduction in Bangladesh. In this chapter, I will explain the study findings, express my opinion and connect with situational analysis on the basis of the conceptual framework I used in this review.

5.1 Maternal Factors

In this review, I found several maternal factors had a relation with early childhood stunting. Maternal weight, maternal height, depressive disorders, age of mothers are the maternal factors correlated with linear growth among children 0-23 months of age in Bangladesh.

Poor nutrition of mothers

Maternal underweight during pregnancy and lactation is the determinant of early childhood stunting supported by the many studies (Figure 6). Mother BMI< 18.5 increase the risk of stunting both at birth and children under 2 years old. It could be explained through fetal optimal growth intently depends on mother nutrition in the prenatal period. Poor nutrition of mother increased the chance of preterm birth. Underweight was more prevalent in disadvantaged areas, such as rural and slum area. In situation analysis, I found those areas are characterized by low literacy rate, poor access in healthcare, early marriage, violence and poor sanitation. All these factors aggravate the effect of maternal underweight on child stunting. Evidence proved that counselling about appropriate food, lipid-based supplementation and multiple micronutrient supplementation increase maternal weight, and reduce low birth length (Table 4).

This study shows overweight of mothers performs a protective function against poor linear growth of children. However, obesity increases pregnancy-related complications. It also increases stillbirth and prenatal mortality.

Short maternal stature

I found short maternal height is another consistent maternal factor correlated with linear growth deficits of children in Bangladesh. This intergenerational transmission occurs due to sharing of genetic characteristics. In Bangladesh, adolescent pregnancy rate still high, and 30% of the adolescent had an inadequate height (Helen Keller International and BIGH, 2014). To break this vicious cycle, girls' nutrition is more important. Investment in women nutrition can give more returns (Table 4).

Maternal depressive symptoms

Reviewed studies recognized maternal depressive symptoms as a risk factor of stunting among infants. An explanation could be that children under 12 months of age depend on breastfeeding and family diets. They learn self-feeding, walking and talking. They demand substantial assistance and caregiving. Mothers with depressive symptoms could fail to manage their requirement. Mothers who have depressive symptoms were mostly from poorer households, experience family violence and give birth low weight baby (Nasreen et al., 2010). Around 23% of people in Bangladesh lived under the poverty line, and most of them experienced food insecurity (Bangladesh Bureau of Statistics, 2018a). Food insecurity and poverty often exacerbate the influence of maternal depressive symptoms on chronic malnutrition of infants.

This analysis found the mother's perception about the infant's temperament as fussy, and unpredictable correlated with poor linear growth. In the rural area of Bangladesh, mother commonly guides children according to their perception about children's attitude, not the actual ability of child-rearing they have.

Intervention related to women nutrition engaging community can improve the situation. It could increase mother's education, status in the household and maternal health, which turn out reduction maternal depressive symptoms (Table 4).

Adolescent pregnancy

Adolescent pregnancy is another risk factor for stunting. The adolescent pregnancy rate was 35% in Bangladesh. A major part of these adolescents are from low socioeconomic status and experience poor nutritious food. It can be explained that adolescents in Bangladesh manifest various form of undernutrition including stunting. Poor nutrition during pregnancy increases pregnancy complication (Helen Keller International and BIGH, 2014). The child marriage rate was 59% in Bangladesh in 2014 (NIPORT et al., 2016). Adolescent pregnancy should be reduced by decreasing child marriage and counselling newly married couples.

5.2 Home Environment

Low caregiver education

The highest number of selected studies in this review reported a correlation between mother's education and linear growth among the children between 0 and 2 years old (Table 2). The risk of a child's stunting reduced more with the increase of maternal education level. Mother's higher education exhibits higher knowledge about caregiving, have higher hygiene practices, received health care services and have a higher status in the family. In addition, mothers can take part in the decision making of family planning and contribute economically to the family. All these eventually improve the standard of living. However, only 12% of mothers had a grade-10 education in 2013. The rate of girls' education at grade-10 level increased to 55%. However, the percentage of receiving primary education for girls was 83.7% in 2017 (BANBEIS, 2016). One of the reasons of this drop-out might be early marriage. The government could take initiatives to reduce child marriage.

It is reported father's education was also a protective factor against chronic malnutrition of child. High father's education increased household income, and turn out food security for the family. All these facilitate improved nutrition for children.

Food insecurity

Severe food insecurity in the household was a common risk factor of stunting among the children age of 6-23 months, where mild and moderate food insecurity has an insignificant association with stunting. The rate of severe food insecurity in Bangladesh was high, 43% in 2013. Firstly, food insecurity has adverse impacts on child daily dietary intake. Secondly, food insecurity is mostly experienced in households with low socioeconomic status, poor hygiene and sanitation. All these factors amplified the effects of food insecurity and stunting in Bangladesh. Increasing food production in own household was an effective initiative, and proved in reducing stunting (Table 4).

Inadequate sanitation

Several studies identified improved and hygiene toilet was a protective factor in the linear growth of children 0-23 months. The children who live poor sanitation condition, they are more prone to chronic diarrhoea. Clean household protects the child from parasitic infection, and result in better gut function. Perhaps, the household with poor sanitation has poor hygiene practice in food preparation of children. However, this association could

be underreported. The mother might hesitate to share information about using the field for defecation, especially in front of other women. Unimproved latrine also correlates with poor socioeconomic status. Sanin et al. (2018) found an insignificant association between improved latrine and stunting. However, the study conducted in an area where the rate of the improved latrine was high, and the sample size was small. Evidence from intervention trial shows intervention related to sanitation had an insignificant effect on stunting (Table 4). More research should be conducted to understand the impact of WASH-related intervention on stunting in Bangladesh

Quality of drinking water

Studies found the quality of drinking water was not correlated with stunting in Bangladesh. Inadequate access to safe water is a barrier to maintain hygiene practice during preparing food for children and safe disposal of faecal waste. It results in an increase in the incidence of infectious disease among children. However, in Bangladesh, 98% of the household had a safe water supply in 2017 (Bangladesh Bureau of Statistics, 2018a). It attenuates the effects of quality of drinking water on childhood stunting. It is also identified untreated drinking water was associated with poor linear growth. It is because the study had been conducted in a slum area of Dhaka. It is obvious that children live in a poor environment with food insecurity, poor sanitation and lack of education. They are recurrently affected by different infectious diseases and get inadequate health services. Water intervention in the unprivileged area might reduced infection. Evidence shows water intervention had no effect on stunting. However, the trial did not conduct in the disadvantaged areas like slums.

Maternal dietary diversity

This study found mother's food diversity correlated with offspring stunting. Mothers perform an important role in shaping their child's dietary practice. It can be presumed that mother practice this dietary habit for a long time. It eventually had an influence on the child's eating habit. Furthermore, the mother also holds a high status in the household, where she gets diverse food. She could take part in decision making about her and child health. Intervention related to women's empowerment could improve the situation.

5.3 Poor Quality Foods

Taking low dietary diversity and minimum acceptable diet (MAD) both individually contribute to linear growth faltering. The rate of receiving diverse complementary food was low in Bangladesh. The children with low dietary diversity usually receive poor nutrient diet, depriving of high protein and micronutrient-rich food, like meat, egg, fruits and vegetables. These children have low body-immunity and suffer from different infectious diseases. This reduces their growth rate. Supplementation of fortified complementary food impact on stunting reduction in Bangladesh.

In Bangladesh, national data shows the food production is sufficient to meet child food requirement (FAO, 2014). However, only 31% of children 6-23 months received MAD. The reason not to get MAD is an inequitable distribution of resources, lack of mother's knowledge about complementary feeding. Interventions also proved increasing household food production, lipid-based supplementation, multiple micronutrient supplementation increased child height significantly. Education of mother about complementary feeding is also effective to increase child food diversity (Table 4).

5.4 Inadequate Feeding Practices

Reviewing articles, I found late initiating (after 7 months) complementary feeding was associated with poor linear growth in Bangladesh. However, only 44% of children initiate complementary feeding timely. With the increased infant age, their nutrition requirement

enhanced. After the age of 6 months, breastfeeding cannot provide sufficient nutrition. Age-specific complementary feeding on time is crucial for normal growth.

Minimum frequent food and age-appropriate consistency of complementary feeding both have an impact on child linear growth among children age of 6-23 months. Children under 2 years old had a small stomach capacity. However, they have high nutrient demand. To meet their requirement, age-specific consistency of food and frequent offer of food is suggested. Education and counselling mothers about appropriate complementary feeding is an effective intervention to increase the rate of age-specific complementary feeding (Table 4).

5.5 Food and Water Safety

In this review, one study found hand washing after using the toilet and child defecate is a protective factor against stunting. Another study found the association of mother's using soap before eating and after defecation and offspring stunting was insignificant in Bangladesh. Evidence from intervention shows the insignificant effect of the hygiene-related intervention on stunting (Table 4). More research is needed to explore the relationship between hygiene behaviour and stunting in Bangladesh.

5.6 Breastfeeding

Delayed initiation of breastfeeding

Early initiation (within 1 hour of birth) of breastfeeding is not associated with stunting. As stunting is chronic undernutrition, breastfeeding within 1 hour of birth did not have influence. However, initiation of breastfeeding after 24 hours increased the chance of stunting. It could be reason mothers who initiated breastfeeding after 24 hours, they also gave pre-lacteal feeding to the newborn.

Exclusive breastfeeding (EBF) for 6 months reduce the prevalence of stunting. A total of 17.0% of children who received EBF for 6 months was stunted while the prevalence was almost twice (32.9%) among those did not receive EBF for 6 months.

Exclusive breastfeeding

This review found exclusive breastfeeding (EBF) for the first 6 months reduces the risk of stunting among infant. EBF for the first 6 months reduces the risk of gastrointestinal infection. However, another study found EBF even up to 3 months was not correlated with stunting in Bangladesh. In the 3.2 Prevalence of early childhood stunting shows stunting was twice prevalent among the children who did not get EBF for 6 months than those received 6 months EBF. Rigorous research needed to understand this relationship.

Deprivation of colostrum

In this review, it is reported deprivation of colostrum and receiving pre-lacteal feeding increased linear growth shortfalls. Colostrum includes many more protective elements than mature mothers milk. This helps the newborn immunity system to mature. Pre-lacteal feeding, on the other side, increases pathogenic contamination in the gastrointestinal and renal system and inhibits newborn to initiate breastfeeding.

5.7 Infection

In this review, studies identified the association between stunting and diarrhoea is pathogen-specific (Schnee et al., 2018). Diarrhoea caused by *Cryptosporidium, Campylobacter* and *Shigella* was responsible for stunting. This enteropathogen could increase intestinal inflammation and reduce the permeability of the intestine. Precisely this link to poor linear growth. To reduce the infection, the WHO recommends WASH-related interventions. However, evidence in Bangladesh shows WASH-related programme was not

effective to reduce stunting (Table 4). Intensive intervention is needed to understand the association.

5.8 Community and Societal Factors

Household Wealth and Income

Household wealth status was reported as one of the consistent determinants correlated with linear growth among children under 2 years in Bangladesh. All reported household wealth was associated with stunting. However, stratification according to wealth quintile showed the association became insignificant for some quintiles. This could be due to the small sample size of the studies made stratification insignificant.

Through healthcare service is free for all. However, patients had spent 72% out-of-pocket money (World Health Organization, 2016b). A high wealthy household can access better healthcare services in Bangladesh. Poor wealthy families deprive of access not only in the health sector but also in education. High family income also gives better food security. To improve the situation, the reduction of poverty is important. At the same time, the government should contribute more on total health expenditure.

Health and Healthcare

Antenatal care or postnatal care of the mother act as a proxy indicator of healthcare service here. Visiting for antenatal or postnatal care of the mother reduced the chance of stunting of their children. Utilization healthcare service indicates the mother are more aware of their and newborn health than those who do not utilize. Perhaps they may have better socio-economic status.

In this review, I found receiving healthcare service from qualified practitioners for childhood illness was not correlated with childhood stunting. In Bangladesh, mothers did not want to visit qualified doctors unless the children had severe diseases. Families usually treat children at a pharmacy. Perhaps only severe sick children visited qualified doctors. The integrated management of childhood illness (IMCI) service is being implemented in Bangladesh, however, it is implementing on a limited scale. Evidence also provided its effectiveness to progress the stunting reduction. The government should extend IMCI service at the community level (Table 4).

Society and Culture

Family violence exposure of mother influence negatively on low birth length of the child. It is a proxy indicator of women's status in society. The mechanism is violence increase the depression of mothers, make less confident and socially isolated. All these turns to reduce the capability of mothers to take care of the child. The violence of mothers might be associated with low maternal education and low socioeconomic status.

Working outside and resource access in the household are another two proxy indicators of women's status. In this review, I found resource access of women reduces the chance of child stunting, where working outside of mother was not associated with poor linear growth of children. Resource access makes sure the women have right in her family. They can receive a healthy diet and access to healthcare services.

Women's empowerment related interventions could give significant result to improve the women's status in family and society.

Water, Sanitation and Environment

Season

The high temperature at last trimester was a contributor of higher length at birth, where the high temperature at the first-trimester related with low linear growth at birth. The mechanism is mother receive vitamin D from sunlight during summer. Vitamin D increases bone mineralization in the third trimester. Roth et al. (2013) found vitamin D supplementation did not increase the length at birth. However, they did not consider the season. Stratification of their finding may give more information.

Flood

In this review, it is reported the association between flood and linear growth faltering. It could be explained by rising food insecurity, increasing infectious diseases, and lack of access to healthcare services in the flood-affected area. Flood mostly occurs in rural and slum area in Bangladesh.

Geographical Location

The risk of stunting was higher among the children in Sylhet, and lower in Khulna (region). The prevalence of stunting in Sylhet division was 41.4% while the prevalence was 24.5% in Khulna. This disparity is seen because Khulna is characterized by the highest literacy rate, high access to sanitation and water among divisions in Bangladesh, where Sylhet had the opposite scenario (Bangladesh Bureau of Statistics, 2018a). Decentralization of public administration could increase the equitable distribution of resources. Government and civil organizations could prioritize Sylhet division in the nutrition-related interventions.

Lead, arsenic and cadmium poisoning

Lead, arsenic and cadmium poisoning had a significant association with child growth faltering. Lead restrains the activities of bone marrow and causes anaemia (Anticona and San Sebastian, 2014). Cadmium accumulation in placenta reduced zine supply to the fetus. The larger proportion of diet in poorer people is rice that is one source of cadmium exposure. It turns in more risk among people of low-socioeconomic status (Kippler et al., 2010).

5.9 Child Characteristics

Low birth weight and length

Low weight and length at birth strongly correlated with linear short shortfalls among children under 2 years old in Bangladesh. The prevalence of stunting among low-birth-weight children was higher (42.0 vs 28.9%) than children with normal birth weight (Mistry et al., 2019). The mechanism is the children with LBW were more susceptible to infection, a complication of anaemia, jaundice and loss of appetite. Bangladesh has the rate of low birth weight and length. Education about nutritious food during last trimester increased birth weight. Food and multiple micronutrient supplementation increased the length at birth.

Gender

All articles in this review male were more likely to be stunted than girls (Figure 7). In Bangladesh, girls unequally receive food in the household. They receive less, especially protein than boys receive. However, girls have better HAZ score than boys. The explanation for gender is still not clear. Further research needed to understand this relationship.

Age

The risk of stunting increased with the increase of age. With the increase of age, nutrition demand of children increased considerably. Children interact also more with the environment. Crawling, walking and play on muddy yard increase their risk to get infectious diseases. The caregiver should give more attention to children during the period.

5.10 Reflection on the analytical framework

The WHO conceptual framework for Childhood Stunting: Context, Causes and Consequences I used in this review was useful in determining a broad range of the factors influence on stunting during the first 1000 days of life. I found child characteristics, such as age, sex and low birth weight and length are also associated with early childhood stunting. However, this framework did not suggest these determinants. In this framework, factors are grouped critically. However, I found individual determinants of different groups are interlinked that is absent in this framework. These two recommendations can be added. All elements of this framework are relevant to identify the factors of stunting in early age. I will use this framework in my future research work.

5.11 Limitation of the study

The primary limitation of this study is that I did not apply meta-analysis to understand the relationship between factors and stunting. It might be effective for a few determinants where heterogeneity observed. Another limitation is that some factors mentioned in the WHO framework are not assessed due to the lack of studies in Bangladesh. Some studies I found conducted on poor linear growth during the prenatal period. However, the studies did not cover all factors of stunting mentioned in the WHO framework. The missing factors might correlate with the linear growth of children.

Another limitation is that the review, some studies conducted in the urban area, most of them were performed among the population with low-socioeconomic status. The associated might be overestimated. Association of some the determinants such as open latrine and history of violence might be underestimated because of stigma. Some studies investigated secondary data or survey data collected for different purposes. Caution is essential to interpret those finding. I excluded qualitative literature that might be led to a selection bias. However, I included both peer-reviewed articles and grey literature. Overall conclusions from this literature review demonstrate similar findings. I believe the review will be worthwhile for future research and action planning on stunting.

Chapter 6: Conclusion and Recommendations

6.1 Conclusion

In this review, literature identified maternal undernutrition and education, severe food insecurity, poor wealth household, low birth weight, the biological factors age and gender factors as common determinants of stunting among children age of 0-23 months. Several factors, especially community and societal factors, which were recognized in the WHO framework were not assessed in this review owing to the absence of studies. Those missing factors may have an association with childhood stunting in Bangladesh. These knowledge gaps are needed to address by conducting research. I have analysed some factors correlated with linear growth retardation during the pregnancy period in this review. However, I have identified there is fewer studies researched in this period. In prenatal linear growth restriction, many factors mentioned in the framework has not explored yet. More research required to understand the relationship between them.

It is surprising that literature documented the quality of drinking water was not associated with childhood stunting in Bangladesh. Association between exclusive breastfeeding for 6 months and early childhood stunting is not clear yet. Boys were dominantly stunted than girls, however, the cause is not still identified. With the increase of age, the child was more likely to be stunted. More attention they demand. Some factors, like mother's education and underweight, had more influence on childhood stunting in low socioeconomic settings.

Various successful programme and interventions demonstrate positive outcomes in reducing stunting during the first 1000 days of life in Bangladesh. Evidence shows intervention should be initiated before conception. Multi-sectoral programmes reduced stunting with high rate in Bangladesh. Empowerment of women intervention had a huge impact on stunting reduction. An individual approach such as education and supplement of lipid-based nutrient and multiple micronutrients works in preventing and reducing linear growth faltering in Bangladesh.

6.2 Recommendations

I analysed the factors correlated with stunting during the first 1000 days of life in this review. The interventions which increase the pace of stunting reduction are also identified. According to all these, I propose the following recommendations to prevent and stimulate the rate of stunting reduction. I have categorized the recommendations as policy level intervention level and research level.

Policy level

a. Set objectives and prioritize nutrition for both mother and baby during the 1000 days of life in national nutrition policy and national nutrition services.
b. Strategic plan to increase intersectoral collaboration on the issue of nutrition which found missing in the 4.1 Assessment of national nutrition services in Bangladesh. Minister of Health and Family Welfare, Minister of Food and Minister of Education should plan multisectoral approaches together to prevent stunting.

Intervention level

a. Ministry of Health and Family Welfare should extend Integrated Management of Childhood Illness (IMCI) services at the community level. Community engagement could be done at this level. Slum and the most prevalent areas could be implemented (Figure 5).

Research level

Ministry of Health and Family Welfare should lead the research activities. However, research organizations on nutrition, food and health should conduct the research. Funding of the research could be contributed from the nutrition budget of government as well as from donors. Following studies are crucial to understand stunting in Bangladesh.

a. Carrying out more studies to identify the factors mentioned in the framework that are not explored yet in Bangladesh. For some risk factors, the quantitative study would be an appropriate method. For example, the association of hypertension, preterm birth and malaria infection with childhood stunting could be explored organizing quantitative studies. The qualitative studies will give in-depth information about some determinants, like poor care practices, inadequate child stimulation and activity.

   Factors influence on linear growth restriction during the prenatal period are less explored in Bangladesh. This period could also be prioritized.

b. Conducting both quantitative and qualitative research to understand the effect of exclusive breastfeeding for 6 months on stunting as findings show a mixed result about the association between exclusive breastfeeding and stunting.

c. Carrying out randomized control trial on the impact of water, sanitation and hygiene (WASH) intervention and vitamin D supplementation on stunting reduction. The study area could be both urban and rural area, and both unprivileged area and privileged area. In intervention of vitamin D supplementation during the third trimester of pregnancy, the winter season could be considered.

d. Research on the nutritional strategies and plan the government of Brazil, Peru, Plurinational State of Bolivia and Maharashtra State of India taken to significant progress on stunting reduction. The countries have succeeded to reduce stunting within a short period (see 4.2 Recommendations of WHO) .

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Appendices

Appendix 1. Age-standardized prevalence (%) of stunting among children under 5 years old

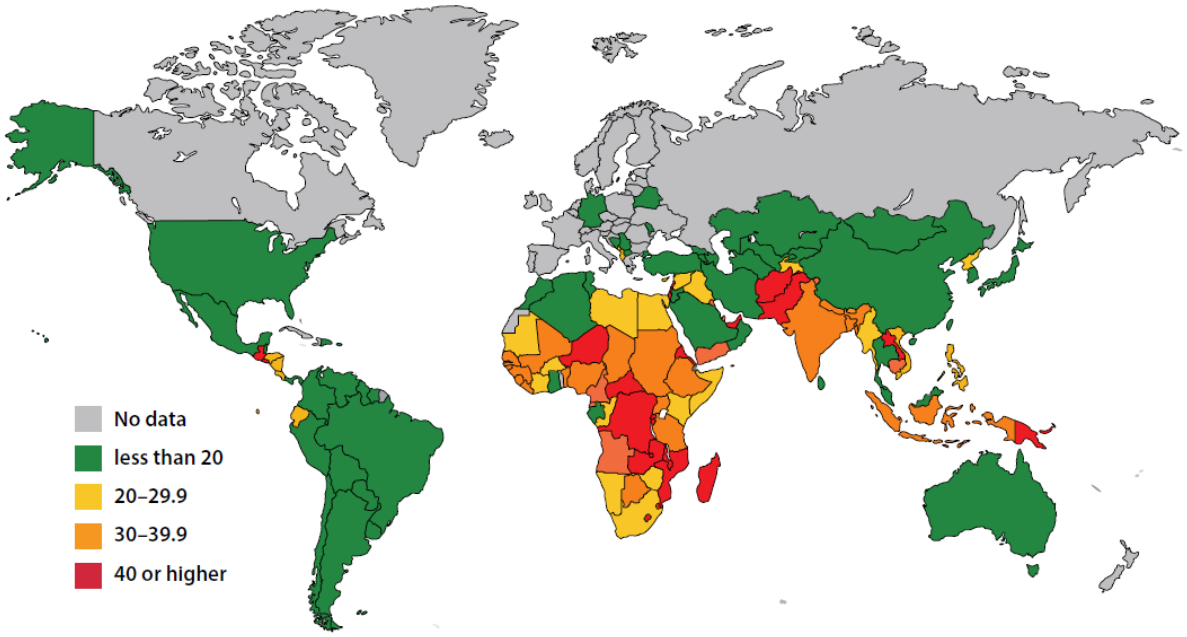

Figure. Age-standardized prevalence (%) of stunting among children under 5 years old, comparable estimates, latest prevalence available.
Source: WHO. Global targets tracking tool. Mapping indicator. (http://www.who.int/nutrition/trackingtool)

Appendix 2. Keywords and combination in two search attempts

First Attempt					
	AND				
OR	*For the first specific objective*				*For second specific objective*
	Factor*	Stunt*	'1000 day'	Bangladesh	Intervention
	Determinants	Undernutrition	'24 months'		Impact
	Cause	'Linear growth retardation'	Under-two		Effect*
		Growth	Fetal		
		IUGR	infants		
			baby		

Second Attempt					
	AND				
OR	*For the first specific objective*				*For second specific objective*
	'Maternal Factors'	Stunting	'1000 day'	Bangladesh	Intervention
	'Home environment'	Undernutrition	'24 months'		Effect*
	'Complementary feeding'	'Linear growth retardation'	Under-two		Impact
	Breastfeeding	Growth	Fetal		
	Infection	IUGR	infants		
	'Political economy'				
	Healthcare				
	Education				
	Agriculture				
	Water				
	Sanitation				
	Flood				