



DETERMINANTS OF CHILD UNDERNUTRITION IN BANGLADESH LITERATURE REVIEW



MQSUN REPORT

Authors:

Nabeela Ahmed, Inka Barnett and Richard Longhurst

April 2015

ABOUT MQSUN

MQSUN aims to provide the Department for International Development (DFID) with technical services to improve the quality of nutrition-specific and nutrition-sensitive programmes. The project is resourced by a consortium of six leading non-state organisations working on nutrition. The consortium is led by PATH.

The group is committed to:

- Expanding the evidence base on the causes of undernutrition
- Enhancing skills and capacity to support scaling up of nutrition-specific and nutrition-sensitive programmes
- Providing the best guidance available to support programme design, implementation, monitoring and evaluation
- Increasing innovation in nutrition programmes
- Knowledge-sharing to ensure lessons are learnt across DFID and beyond.

1.1.1 MQSUN partners are:

Aga Khan University
 Agribusiness Systems International
 ICF International
 Institute for Development Studies
 Health Partners International, Inc.
 PATH

1.1.2 Contact

PATH, 455 Massachusetts Avenue NW, Suite 1000
 Washington, DC 20001 USA
 Tel: (202) 822-0033
 Fax: (202) 457-1466

1.1.3 About this publication

This report was produced by Nabeela Ahmed, Inka Barnett and Richard Longhurst, as part of the qualitative work contributing to the Department for International Development (DFID)-funded MQSUN project, ‘Impact Evaluation of the DFID Programme to Accelerate Improved Nutrition for the Extreme Poor in Bangladesh’

This document was produced through support provided by UKaid from the Department for International Development. The opinions herein are those of the author(s) and do not necessarily reflect the views of the Department for International Development.




Contents

1	Introduction.....	6
2	Typology of undernutrition.....	6
3	Methodology	7
4	Immediate factors	7
4.1	Diet and illness	8
4.1.1	Micronutrients	8
4.1.2	Diarrhoeal infection	8
4.2	Infant Feeding Practices (IFP).....	9
4.2.1	Breast-feeding.....	9
4.2.2	Complementary feeding practices	10
5	Underlying factors	10
5.1	Food security.....	10
5.1.1	Food prices.....	11
5.1.2	Food security and gender.....	11
5.1.3	Corruption.....	12
5.2	Maternal health	12
5.2.1	Nutritional status of mothers.....	12
5.2.2	Health and wellbeing of caregivers.....	13
5.2.3	Maternal age	13
5.2.4	Care-giving	14
5.3	Water, sanitation and hygiene (WASH)	14
5.4	Access to healthcare	15
5.4.1	Vaccinations	16
6	Basic Factors	16
6.1	Socio-Economic Factors	16
6.1.1	Poverty	16
6.1.2	Tobacco use.....	18
6.1.3	Gender disparities/Cultural Factors	19
6.2	Female Empowerment.....	20
6.2.1	Education	20
6.2.2	Gender-based violence	21
6.3	Natural Disasters.....	21
7	Conclusions.....	21
	References.....	23

LIST OF ABBREVIATIONS

BDHS	Bangladesh Demographic Health Survey
BMI	Body Mass Index
CMD	Common Mental Disorders
EBF	Exclusive Breast Feeding
GDP	Gross Domestic Product
HAZ	Height for Weight
HKI	Helen Keller International
HFA	Height for Age
IFP	Infant Feeding Practices
IPV	Intimate Partner Violence
LSHTM	London School of Hygiene and Tropical Medicine
MQSUN	Maximising the Quality of Scaling up Nutrition Programmes
MUAC	Middle Upper Arm Circumference
NSP	Nutritional Surveillance Project
ULS	Urban Livelihoods Study
UNICEF	United Nations Children's Emergency Fund
WASH	Water, Sanitation and Hygiene
WFA	Weight for Age
WFH	Weight for Height

EXECUTIVE SUMMARY

This literature review identifies and summarises existing evidence on the determinants of undernutrition in children under the age of two years in Bangladesh. The review gathers evidence on the immediate, underlying and basic determinants of child undernutrition. While these determinants fall into various thematic categories, they are by no means discrete. Instead they are interconnected by multiple overlapping causal factors.

Diet and illness are immediate factors closely bound up with maternal health and nutritional status as well as care-giving practices. Gender, poverty and vulnerability are key cross-cutting themes, with those of low socio-economic status suffering higher food insecurity and vulnerability to infections. The poor are especially vulnerable to natural disasters and economic shocks.

Poor dietary diversity and inadequate breastfeeding practices can be attributed to food insecurity, income-poverty and lack of access to education and health services. Infant feeding practices pose risks if poor in terms of portion size, feeding frequency and diversity. Undernutrition and infection interact in a vicious cycle: the severity and duration of infections are greater among malnourished children. Diarrhoeal and acute respiratory infections are the cause of two-thirds of all deaths of children under one year.

Underlying factors include income poverty; household food insecurity and water, sanitation and health (WASH). Food insecurity affects infant feeding practices and dietary diversity, often influenced by seasonality – where low income households are at higher risk during the monsoon season than during the dry season. Food price increases are positively associated with the prevalence of underweight children and inversely associated with household non-grain expenditures, an indicator of dietary quality. WASH factors impact the infective environment of children.

The gender dimension is a strong element. Female-headed households are more vulnerable to food insecurity. The intergenerational effects of poor maternal health, where malnourished adolescent girls are more likely to become malnourished mothers highlights the importance of health among young women and girls. Maternal age, educational status, birth order and birth interval are key predictors of nutritional status.

Finally, basic factors encompass the wider socio-economic, ecological and cultural context of child undernutrition in Bangladesh. Poverty, vulnerability and socio-cultural attitudes can all contribute to child undernutrition from pregnancy and infancy on to the later stages of child development. Factors such as the educational status and income level of parents can have a significant impact on a child's nutritional status. Much evidence has been found on the negative impacts of tobacco use. Gender disparities in terms of care-giving practices, and the level of female empowerment of caregivers can shape outcomes. Bangladesh is also prone to flooding which can impact the poor and vulnerable worst. Disaster impacts can lead to both short-term and long-term effects on child undernutrition.

1 INTRODUCTION

The purpose of this literature review is to identify, review and summarise existing research evidence on the determinants of undernutrition in children aged two years and below in Bangladesh. The review gathers available evidence on the immediate, underlying and basic determinants of child undernutrition in accordance with the UNICEF conceptual framework of malnutrition (1990).

Child undernutrition is a ‘multi-faceted complex phenomenon’ (Ahmed, T.; Mahfuz, M.; Ireen, S.; Ahmed, A.M.; Rahman, S.; Islam, M.M.; Alam, M.N.; Hossain, M.I.; Rahman, S.M.; Ali, M.M.; Choudhury, F.P. and Cravioto, A. 2012a) and is both an outcome and trigger of health issues. A broad review of the literature concerning child undernutrition in Bangladesh reveals multiple causal factors that are inter-correlated, and thus makes it difficult to ‘empirically determine the key driving factors and underlying pathways’ (Foraita, R.; Klasen, S. and Pigeot, I. 2008). These multiple causal factors differ in terms of nature and proximity to the outcome.

This review takes its reference from the UNICEF Conceptual Framework (1990) and the recently updated version in the Lancet (Black et al. 2013) which identifies the **basic causes** of undernutrition as: household access to resources (such as land, income, technology and income) inadequate social, physical and human capital and the surrounding socio-cultural, political and economic context. These in turn are connected to the **underlying causes**: household food insecurity, inadequate care and feeding practices, unhealthy household environment and lack of access or inadequate health services. These then feed into the **immediate causes**, identified as diet and disease/illness. Each category is subdivided into more specific thematic sub-categories, however these sub-divisions should not be considered as discrete as many are cross-cutting and connect with different causal pathways for child undernutrition in the Bangladeshi context. The temporal impact of these factors on nutritional status can be short-term, long-term and intergenerational.

2 TYPOLOGY OF UNDERNUTRITION

Malnutrition is an umbrella term which covers under- and over-nutrition.¹ Undernutrition can manifest itself in different forms and affect the physical and mental development of children in different ways. Each type of undernutrition depends on age, duration and nutrient composition of diet.

- The most basic kind is called ‘protein energy undernutrition’ caused by a diet lacking in energy and protein due to a deficit of all major macronutrients, such as carbohydrates, fats and proteins. Marasmus is caused by a lack of protein and energy with sufferers appearing skeletally thin. In extreme cases, it can lead to kwashiorkor.
- Other forms of undernutrition are usually the result of vitamin and mineral deficiencies (micronutrients), which can lead to anemia, scurvy, pellagra, beriberi and xerophthalmia and, ultimately, death.²

¹ Source: The Micronutrient Initiative.

[www.micronutrient.org/nutritiontoolkit/ModuleFolders/13.Manuals_and_resources/WFP_Measuring_and_Interpreting_Malnutrition_and_Mortality/3\)_Chapter_1_-_Defining_&_measuring_malnutr_\(pgs_15-32\).pdf](http://www.micronutrient.org/nutritiontoolkit/ModuleFolders/13.Manuals_and_resources/WFP_Measuring_and_Interpreting_Malnutrition_and_Mortality/3)_Chapter_1_-_Defining_&_measuring_malnutr_(pgs_15-32).pdf) (Accessed in January 2014).

² Taken from World Food Programme website: www.wfp.org/hunger/malnutrition/types. Accessed January 2014.

Undernutrition in Bangladesh is most commonly identified through measurement of growth and body composition, known as anthropometric indicators. Underweight, stunting, and wasting, are the nutritional status conditions measured in an anthropometric assessment.

- Underweight (Weight for age) is the most common assessment of child nutrition status. It is routinely collected in growth promotion programmes, and is a good indicator for children under 24 months because of the need to do precise measurements of weight for these age groups. Weight for age (WFA) is a simple index, but this index does not take height into account. Children who are taller would be expected to weigh more than other children, just as children who are shorter would be expected to weigh a little less and still be healthy;
- Stunting (Height for age) is a measure of linear growth. Stunting refers to shortness, and reflects linear growth achieved pre- and postnatal with its deficits it is generally assumed to indicate long-term, cumulative effects of inadequate nutrition and poor health status. Height for age (HFA) is considered a measure of past nutrition, because a child, who is short today, maybe did not have adequate nutritional intake at some point in the past;
- Wasting (Weight for Height) is a measure of acute or short-term exposure to a negative environment. It is sensitive to changes in calorie intake or the effects of disease. Wasting can be calculated without knowing the age of a child. Weight for height (WFH) is a measure of current body mass. It is the best index to use to reflect wasting undernutrition, when it is difficult to determine the exact ages of the children being measured.

A child is considered malnourished or severely undernourished if any of these indices fall below the accepted median values set by the World Health Organization international reference (de Onis, M.; Onyango, A.W.; Borghi, E.; Garza, C. 2006).

3 METHODOLOGY

The literature on determinants of child undernutrition in Bangladesh was located by generating initial keywords to create search strings, within the date range of 2000-13, and within the geographical parameters of Bangladesh. These search strings were applied to a number of indexes: Web of Science/Knowledge abstracts from Proquest (Medline/IBSS), Scopus and PubMed. Each database searches across thousands of online journals. The initial search yielded approximately 1200 findings. Following a review of the abstracts of these initial findings and elimination of duplicates, the results were narrowed down to 217 relevant articles.

4 IMMEDIATE FACTORS

The immediate causes of child undernutrition are related to diet and illness. According to widely-accepted public health conventions, an initial period of exclusive breast-feeding (EBF) should be followed by an adequate and balanced diet consisting of all the micronutrients required for healthy child development. Illness and undernutrition can interact to create a vicious cycle. Major illnesses and infections such as diarrhoea and measles can damage a child's digestive system to the extent where even a nutritious and adequate diet cannot be absorbed into the body, thus posing the risk of undernutrition. Diet and illness are determined by a wider set of underlying factors: availability, access and utilisation of food (food security) - which in itself can be informed by socio-economic conditions; access to healthcare services and immunisation against illness; water, sanitation and health (WASH)

facilities to combat the presence of diarrhoea and the health and awareness of caregivers themselves are among these factors.

The health and nutritional status of the mother herself during pregnancy, exclusive breast-feeding, and the infant-feeding practices (IFP) she undertakes also determine a child's diet and risks of illness, and are thus considered immediate causes of undernutrition.

4.1 Diet and illness

4.1.1 Micronutrients

Undernutrition is widely attributed to a deficiency of the four key micronutrients necessary for the physical and mental development of a child. Also referred to in the literature as 'hidden hunger,' this deficiency can lead to all types of child undernutrition. The key micronutrients are: iodine, zinc, vitamin A and iron (Ahmed et al. 2012a). In the context of Bangladesh, the composition of complementary (post-EBF) feeding is often inadequate and/or inappropriate and initiated either too early or too late, thus causing low micronutrient intake among children (Ahmed et al. 2012a; Kimmons, J.E.; Dewey, K.G.; Haque, E.; Chakraborty, J.; Osendarp, S.J. and Brown, K.H. 2005).

Dietary diversity is a way of conceptualising optimal nutrient intake and many studies have linked household dietary diversity indicators to improved nutrient intake in both developed and developing countries (Arsenault, J.E; Yakes, E.A.; Islam, M.M.; Hossain, M.B.; Ahmed, T.; Hotz, C.; Lewis, B.; Rahman, A.S.; Jamil, K.M. and Brown, K.H. 2012; Arimond, M. and Ruel, M.T. 2004; Smith, L.C.; Ruel, M. T. and Ndiaye, A. 2004). Micronutrient-rich foods, animal proteins and dietary diversity are acknowledged as key components of a nutritious diet for children (Ruel, 2003; Murphy, S.P. and Allen, L.H. 2003). Limitations in dietary diversity can increase micronutrient deficiencies – a major cause of child nutrition in Bangladesh (Thorne-Lyman, A.L.; Valpiani, N.; Sun, K.; Semba, R.D.; Klotz, C.L.; Kraemer, K.; Akhter, N.; de Pee, S.; Moench-Pfanner, R.; Sari, M. and Bloem, M.W. 2010) and is associated with stunting (Rah, J.H.; Akhter, N.; Semba, R.D.; de Pee, S.; Bloem, M.W.; Campbell, A.A.; Moench-Pfanner, R.; Sun, K.; Badham, J. and Kraemer, K. 2010). The literature identifies the typical Bangladeshi diet as limited in variety, heavily reliant upon grain or 'staple' foods, and thus poses a risk of insufficient micronutrient intake (Thorne-Lyman et al. 2010).

There is a growing interest in the role of genetics in child undernutrition apparent in the literature on diet and illness as immediate causes of undernutrition. The inability to absorb micronutrients can also be attributed to a genetic predisposition, and further research is required in the use of metagenomics to understand the genetic causes of undernutrition (Ahmed, T.; Haque, R.; Mansur, A.; Ahmed, S.; Petri Jr, W.A. and Cravioto, A. 2009).

4.1.2 Diarrhoeal infection

In Bangladesh, diarrhoea and acute respiratory infections are the cause of two-thirds of all deaths of children less than one year of age (Baqui, A.H.; Sabir, A.A.; Begum, N.; Arifeen, S.E.; Mitra, S.N. and Black, R.E. 2001). Although breast-feeding initiation is almost universal in Bangladesh, approximately 70 per cent of mothers do not exclusively breastfeed for the recommended first six months of life for various environmental, cultural and economic reasons (Giashuddin and Kabir 2004). This is compounded by numerous other issues: many families lack access to clean water or adequate complementary foods and consequently, babies are fed unhygienic and inappropriate foods before six

months of age. This trend undermines child growth and development and contributes significantly to child diarrhoeal disease and death (Arifeen, S.E.; Black, R.E.; Caulfield, L.E.; Antelman, G. and Baqui, A.H. 2001).

There is a significant amount of evidence on the inhibiting impacts of diarrhoea on physical growth, an indicator of undernutrition (Das and Hossain 2008; Ahmed and Ahmed 2009a). A study by Ahmed and Ahmed (2009a) attributes the persistently high rates of child undernutrition in Bangladesh to, among other things, repeated attacks of infectious illnesses and widespread micronutrient deficiencies. The severity and duration of infections—such as diarrhoeal diseases—are greater in malnourished children than in those who are not. The highest rates of diarrhoea occurred among malnourished children, likely due to the vicious cycle of the undernutrition–infection interaction (Ahmed and Ahmed 2009a). Findings from one survey show that among the children who experienced diarrhoea, about 17 per cent and 39 per cent were found severely and moderately underweight respectively, while among those children who did not suffer from diarrhoea within two weeks prior to the survey about 12 per cent and 32 per cent were found severely and moderately underweight respectively (Das and Hossain 2008).

Other associations between infections and undernutrition have been observed in the literature. A link was observed between exclusive breast-feeding and clinical outcomes regarding acute viral bronchiolitis among infants (Dornelles, C. T. L.; Piva, J. P. and Marostica, P. J. C. 2007). In a case-controlled study in Sylhet, Bangladesh, an association between acute respiratory-tract infection in early childhood and vitamin D status was observed (Roth, D.E.; Shah, R.; Black, R.E. and Baqui, A. 2009).

4.2 Infant Feeding Practices (IFP)

4.2.1 Breast-feeding

Breast-feeding for the first year of a child's life is a common practice in Bangladesh, however the rate of undernutrition remains high (Ahmed 1986.), and this is widely attributed to incorrect infant feeding practices (Haider, R.; Rasheed, S.; Sanghvi, T.G.; Hassan, N.; Pachon, H.; Islam, S. and Jalal, C.S. 2010; Faruque, A.S.; Ahmed, A.M.; Ahmed, T.; Islam, M.M.; Hossain, M.I.; Roy, S.K.; Alam, N.; Kabir, I. and Sack, D.A. 2008). Data from a nationwide programme reported that 98 per cent of 28,584 newborn babies were fed colostrum but only 37 per cent of infants were exclusively breast-fed for an average of five months in 58 sub-districts of Bangladesh (Faruque et al. 2008). A mixed-methods study also identified significant gaps which exist in breast-feeding behaviours among mothers in Bangladesh, mostly due to lack of awareness as to why medically recommended breast-feeding practices are beneficial, the risks of not practicing them, as well as how to practice them. Health workers' interactions for promoting and supporting optimal breast-feeding are extremely low (Haider et al. 2010). Misunderstanding about exclusive breast-feeding practices whereby other liquids were also given, is also common during the first six months of infancy.

The importance of maternal health is also indicated in adequacy of breast-milk that can be provided for infants. One study used the physical growth of breastfed infants as an indirect measure of breast-milk adequacy, particularly during the early months and these were shown to be lower for mothers who were undernourished during pregnancy (Alam et al. 2010). The duration and timing of breast-feeding have been identified as key factors in undernutrition: less than six months of breast-feeding can pose a risk, and the initiation of breast-feeding within one hour after birth may reduce risk of underweight children (Hien and Hoa 2009).

4.2.2 Complementary feeding practices

The initiation of complementary feeding is recommended after six months of exclusive breast-feeding. Appropriate IFP are associated with positive outcomes in weight and length during infancy (Saha, K.K.; Frongillo, E.A.; Alam, D.S.; Arifeen, S.E.; Persson, L.A. and Rasmussen, K.M. 2008a). Portion size, feeding frequency, micronutrient-rich foods, and active encouragement to eat are all observed as optimal IFP and have been shown to contribute to better growth and overall nutritional outcomes for infants (Saha et al. 2008a). Around 26 per cent of mothers gave complementary food to their children less than four times a day according to a Dhaka-based study (Jesmin, A.; Yamamoto, S.S.; Malik, A.A. and Haque, M.A. 2011), and this has potentially damaging effects on a child's nutritional status. The prevalence of undernutrition is found to be highest for children above seven months of age (Das and Hossain 2008), with inadequate supplementary food (given post-exclusive breast-feeding) cited as the main cause of this (Das and Hossain 2008; Ahmed and Ahmed 2009a).

5 UNDERLYING FACTORS

The underlying determinants of child undernutrition include income poverty - which is concomitant with household food insecurity - exacerbated by the Bangladeshi context of food price fluctuations (although fluctuations have been modest compare to other countries); deficiencies in care (both within the household and from external healthcare services); and an unhealthy household environment (Ahmed et al. 2009). The importance of gender in influencing these underlying factors is also recurrent in the literature and can intensify or modify the impacts of food security and caregiving. Water, sanitation and health facilities (WASH) determine the infection environment which children are exposed to and thus their risk of suffering undernutrition outcomes. Infection and disease interacts with child undernutrition and health outcomes, and thus WASH should be considered as a causal factor which underlies child undernutrition.

5.1 Food security

Food insecurity has been defined as a condition that exists 'when people do not have adequate physical, social or economic access to food,' (FAO 2010). Food security has major impacts on hunger and undernutrition (Rahman and Karim 2013). Food and its access and availability are cited as one of the most important long-term factors that could prevent undernutrition. The quantity and nutritional quality of food can determine the intake of energy, protein and vitamins, which affects growth, development and resistance to disease and infection. A lack of nutrients can lead to a vicious cycle of illness and undernutrition (Das and Hossain 2008; Ahmed and Ahmed 2009). A strong positive association has been observed between household food insecurity and poor infant feeding practices (IFP) (Saha, K.K.; Frongillo, E.A.; Alam, D.S.; Arifeen, S.E.; Persson, L.A. and Rasmussen, K.M. 2008). In the Bangladeshi context, another factor to take into consideration is how food security itself is influenced by seasonality. One study based in northern Bangladesh shows evidence of low-income households exposed to a higher risk of food insecurity during the monsoon season than during the dry season. In terms of specific undernutrition outcomes, a strong association has also been observed between household food insecurity and child wasting (Ali, D.; Saha, K.K.; Nguyen, P.H.; Diressie, M.T.; Ruel, M.; Menon, P. and Rawat, R. 2013). There are extensive overlaps here with the basic socio-economic and gender-based factors of child undernutrition, discussed elsewhere in this review.

5.1.1 Food prices

Recent studies have looked at the relationship between food prices and undernutrition. In Bangladesh, rice prices are known to be positively associated with the prevalence of underweight children and inversely associated with household non-grain food expenditures, an indicator of dietary quality. Low dietary diversity during the period prior to major food price increases indicates a potential risk for intensified micronutrient deficiencies and consequent child undernutrition in Bangladesh (Thorne-Lyman et al. 2010).

As poor households spend a relatively high proportion of income to purchase food, food prices can directly affect the amount and type of food consumed and will subsequently impact nutrient intake. Previous studies have shown that increases in food prices lead to greater levels of stunting among children, decreased maternal micronutrient status, and impaired growth of infants (Gitau, R.; Makasa, M.; Kasonka, L.; Sinkala, M.; Chintu, C.; Tomkins, A. and Filteau, S. 2005). In rural Bangladesh, a 2012 study showed that households with higher expenditure on rice have increased risks of child stunting, and conversely households spending more on non-rice foods have lower risks of child stunting. A similar relationship was also observed between rice and non-rice expenditure and maternal underweight status (Campbell, A.; de Pee, S.; Sun, K.; Kraemer, K.; Thorne-Lyman, A.; Moench-Pfanner, R.; Sari, M.; Akhter, N.; Bloem, M.W. and Semba, R.D. 2012).

Household dietary diversity has been identified as a potential food security indicator, although it is relatively underexplored in the literature. The availability of non-grain and non-staple foods (that ensure micronutrient intake of household members) is an important factor in combating child undernutrition and some scholars argue it should allow for a broader definition of food security, in relation to undernutrition (Thorne-Lyman et al. 2010). The most recent Demographic and Health Survey for Bangladesh (BDHS 2011) included a module to assess household food insecurity during the previous 12 months (National Institute of Population Research and Training (NIPORT) 2013). The module found that food insecurity was more common in rural (39% of households reported some degree of food insecurity) than in urban households (24.2%) and that poorer households were more affected than better-off ones (65% versus 10.3%). There was also some variation in the level of food insecurity across different divisions of Bangladesh.

5.1.2 Food security and gender

The literature also conveys the gendered dimension of food security. One study based on women in the north-west region of Bangladesh where food insecurity is prevalent, identifies socio-economic variables which predict food insecurity, such as level of education, gender of the head of household and house ownership. Female-headed households were shown to be more vulnerable to food insecurity (Rahman and Karim 2013). Findings from a recent ethnographic study showed chronic food insecurity to be pervasive among ultra-poor women, who were commonly single mothers or widowed women. Such women are often marginalised and excluded from government programmes which seek to address food insecurity (McIntyre, L.; Rondeau, K.; Kirkpatrick, S.; Hatfield, J.; Islam, K.S. and Huda, S.N. 2011). The study found that it was poverty, lack of resources and purchasing power, rather than lack of nutritional knowledge that constrained these women from providing an adequate and nutritious diet for their children. The study concludes that a governance system which focuses more on ways to address chronic income poverty, vulnerability, and exclusion rather than ‘food and nutrient’ issues would be more effective in resolving the problems faced by the ultra-poor in Bangladesh, and subsequently the rates of child undernutrition (McIntyre et al. 2011).

These findings on gendered food security and its impacts on undernutrition, is consistent with evidence from a recent focused-ethnographic study by Levay, A.V.; Mumtaz, Z.; Rashid, S.F. and Willows, N. (2013). The study indicates that women face challenges in accessing adequate and nutritious food due to the increase of market food prices. An overall observation is that increased food prices and consequent food insecurity due to insufficient spending power can overall negate efforts to boost women's empowerment and knowledge of how to combat undernutrition for themselves and their children.

5.1.3 Corruption

Although relatively underrepresented in the literature, corruption within the agricultural sector can be an important factor in food security, and thus undernutrition. There is some limited evidence of corruption such as the extortion of bribes for food in Bangladesh's rural areas. Micro-level survey data on food security and corruption was collected from 210 Bangladeshi rice farmers and the findings indicated that corruption adversely affected household consumption. The marginal impact of corruption was more significant for low-expenditure households as they were less flexible in adjusting budgets and were thus forced to compromise spending on food (Anik, A.R.; Manjunatha, A.V. and Bauer, S. 2013).

5.2 Maternal health

The determinants of child undernutrition can spiral out to have intergenerational effects. Malnourished adolescent girls are likely to become malnourished mothers, and this can have impacts spanning from the intra-uterine development phase through to the health and nutritional status of birth outcomes. Maternal health is a key factor in determining the nutritional status of children, particularly in the first stage of infancy (zero to five years) (Deolalikar 2005). Maternal health - during pregnancy and exclusive breast-feeding and while caring for a child - is a useful predictor of pregnancy outcomes and the subsequent nutritional status of a child. Malnourished mothers can contribute the likelihood of giving birth to children with anaemia or low birth weight (Jamil, K.M.; Rahman, A.S.; Bardhan, P.K.; Khan, A.I.; Chowdhury, F.; Sarker, S.A.; Khan, A.M. and Ahmed, T. 2008; Hosain, G.M.M.; Chatterjee, N.; Begum, A. and Saha, S.C. 2006) .

5.2.1 Nutritional status of mothers

In many instances, undernutrition stems from the pre-pregnancy nutritional status of the mothers (Khan and Ahmed 2005). The findings of a study drawn from a Bangladesh Demographic Health Survey (BDHS) (National Institute of Population Research and Training (NIPORT), Mitra and Associates, and Macro International. 2009;) reveal that maternal factors had significant effects on both severe and moderate acute undernutrition in Bangladesh. Low maternal nutrition levels were associated with a higher risk of wasting, low birth weight and acute undernutrition in children (Rahman, A.; Chowdhury, S. and Hossain, D. 2009). Several studies have illustrated that the nutritional condition of mothers can affect the foetal growth and birth size of children (Rahman et al. 2009). The higher the quality of maternal care, the lower the prevalence of child undernutrition according to findings from a 2008 study (Das and Hossain 2008). Mother's body mass index (BMI) and age is used as predictor of undernutrition and a strong association has been observed between these factors and rates of underweight children (Das and Hossain 2008). In urban Bangladesh, anaemia and vitamin A deficiency were found to be prevalent among pregnant mothers (Ahmed, F.; Mahmuda, I.; Sattar, A. and Akhtaruzzaman, M. 2003).

5.2.2 Health and wellbeing of caregivers

The overall health and wellbeing of mothers (or caregivers) whilst caring for their child is also an important underlying factor in a child's nutritional status. Deficits in nutrients such as vitamin A in mothers can affect the nutritional status of children they bear (Milton, A.H.; Smith, W.; Rahman, B.; Ahmed, B.; Shahidullah, S.M.; Hossain, Z.; Hasan, Z. and Sharmin, S. 2010). Demographic factors such as birth order and birth interval of children consistently show up in the literature as predictors of nutritional status, and are strongly associated with levels of undernutrition in Bangladesh. Short birth intervals can exacerbate the health outcomes and constraints on the caregiver of children, and birth order can also predict the level of care given toward a child, thus impacting their nutritional status. There is evidence that a birth-interval of more than 24 months decreases the risk of stunting and wasting among children in urban areas, and stunting in rural areas of Bangladesh (Khan and Raza 2013). Women in rural Bangladesh report substantial morbidity in the first trimester (Kim, J.M.; Labrique, A.; West, K.P.; Rashid, M.; Shamim, A.A.; Ali, H.; Ullah, B.; Wu, L.; Massie, A.; Mehra, S.; Klemm, R. and Christian, P. 2012).

There is a lacuna in the literature on impacts of maternal mental health specifically for Bangladesh, and the potential relationship with child undernutrition. Much of what exists has been deemed as conflicting (Nasreen, H.E.; Kabir, Z.N.; Forsell, Y. and Edhborg, M. 2010). However, researchers are starting to address this knowledge gap. One multi-country study indicates a strong association in Bangladesh between mothers with common mental disorders (CMD) and incidence of diarrhoea and stunting among their children (Nguyen, P.H.; Saha, K.K.; Ali, D.; Menon, P.; Manohar, S.; Mai, L.T.; Rawat, R. and Ruel, M.T. 2013). A study which focused on maternal depressive symptoms as independent indicators showed that depressive symptoms at pre- and post-natal both had negative health and nutrition outcomes for their children. Post-partum depressive symptoms were found to be associated with low birth weight and impaired motor development in infants, and ante-partum depressive symptoms were shown to be predictors of infant stunting (Nasreen et al.;2010; Nasreen, H.E.; Kabir, Z.N.; Forsell, Y. and Edhborg, M. 2013). Another study undertaken in a low-income rural community in Bangladesh observed delayed cognitive development among infants between six and 12 months of age, and linear growth faltering which can predict stunting. The study also identified that mental health can have a particularly inhibiting effect on caregiving from the age of six months onward. The findings of this study were also consistent with previous studies on the correlation between low-income, low-education and depressive symptoms (Black, M.M.; Baqui, A.H.; Zaman, K.; Arifeen, S.E. and Black, R.E. 2009).

5.2.3 Maternal age

Mother's age is shown to be a determinant in birth outcomes (Chowdhury, F.; Chisti, M.J.; Hossain, M.I.; Malek, M.A.; Salam, M.A. and Faruque, A.S.G. 2011). Earlier studies indicate that child undernutrition was more prevalent among those born to mothers under the age of 18 or over 34 years (Desai 1993; Somerfelt and Stewart 1994). This has been corroborated in more recent studies (Das and Hossain 2008). The children of adolescent mothers were shown to have a higher risk of undernutrition in a study of 539 first birth-order children of adolescent mothers and non-adolescent mothers (Abdullah, K.; Malek, M.A.; Faruque, A.S.; Salam, M. A. and Ahmed, T. 2007). Such mothers are also likely to be illiterate thus compounding the risk of continued undernutrition as the children become older.

Adolescence is considered a key stage in physical development as it is the last stage in which interventions can alter outcomes of nutritional deficiencies (Chowdhury, F.; Khan, A.I.; Hossain, M.I.; Malek, M.A.; Faruque, A.S.G.; Ahmed, T. and Salam, M.A. 2006). Adolescence is also a common reproductive period for girls in Bangladesh and thus nutritional status in this phase can be a predictor

of child undernutrition. The prevalence of malnourishment among adolescent girls and pregnant women is high in Bangladesh: one third of such women have low BMI and anaemia (Ahmed et al. 2012a). Findings from a survey which randomly sampled 4,993 unmarried adolescent girls in rural areas, showed that the prevalence of thinness and stunting among the adolescent girls aged 13-18 years was widespread and persistent (Alam et al. 2010). The children of well-nourished mothers were shown to have a lower risk of being underweight compared to children of malnourished mothers (Rayhan and Khan 2006). This was cited as a possible cause of insufficient breast-milk from thin mothers. Nutritional deficits among adolescent girls working in garment factories were identified in a cross-sectional study by Khan and Ahmed (2005). The underlying causes of undernutrition status were attributed to inadequacy of dietary patterns and a lack of the key micronutrients (Khan and Ahmed 2005).

5.2.4 Care-giving

As children are vulnerable and dependent upon others, the role of mothers/caregivers is important for determining nutritional status and health outcomes. The literature shows that both the quality and quantity of care are important.

There is conflicting evidence regarding the impact of mothers' working outside the household on the nutritional status of their children. It can have differential impacts depending on the age of the child. Maternal employment can lead to a neglect in exclusive breast-feeding (Rasheed, S.; Frongillo, E.A.; Devine, C.M.; Alam, D.S. and Rasmussen, K.M. 2009), thus indicating that lack of maternal care can lead to a risk of undernutrition. On the other hand, there is evidence from qualitative studies which suggest a causal relationship between women's autonomy and (financial) control over a household and positive child nutritional status (Pryer, J. A.; Rogers, S. and Rahman, A. 2003). A more recent study shows that height-for-weight (HAZ) indicators for nutritional wellbeing were better for the children of working mothers compared with those who were full-time housewives (Jesmin et al. 2011).

An emerging conceptual framework in the literature on causes of child undernutrition focuses on the caregiver-child relations and 'responsive feeding behaviours'. This framework argues that undernutrition can be partly attributed to the caregiver-child interaction during feeding practices. Evidence of heterogeneous nutritional status within the same household can be explained by differing relationships between the caregiver and each child (Moore, S.; Prentice, A.; Wagatsuma, Y.; Fulford, A.; Collinson, A.; Raqib, R.; Vahter, M.; Persson, L. and Arifeen, S. 2006). The literature categorises feeding practices into three types: active, social and responsive, each of which can garner differing nutrition outcomes depending on how responsive the child is to feeding and the amount of intake during feeding times. Negative feeding behaviours such as force-feeding were shown to be ineffective in a 2006 study (Moore et al. 2006).

5.3 Water, sanitation and hygiene (WASH)

The most recent Demographic and Health Survey for Bangladesh (BDHS 2013) found that access to improved water sources is almost universal in Bangladesh (99% of households). Access to improved sanitation is less good with 33.7% of households reporting access to improved, not shared facilities and 18.9% to improved shared facilities (National Institute of Population Research and Training (NIPORT) 2013).

The literature conveys the sustained negative impact of repeated infections combined with poor nutrition, and how this can create a cyclical vulnerability to undernutrition and infection. An impaired

gut caused by repeated infection can damage the ability to absorb nutrients thus perpetuating the impacts of undernutrition (Lin et al., 2013). Water, sanitation and hygiene (WASH) become relevant here as key factors which can combat the root causes of infection and illness, and thus the risk of undernutrition.

High rates of wasting, one form of child undernutrition, can be partly attributed to frequent bouts of diarrheal disease among slum-dwelling children in South Asia. According to estimates, the prevalence of diarrheal episodes within a two-week time frame stands at 28 per cent of infants under one year of age in Dhaka (Rahman and Shahidullah 2001). A recent analysis of data from Demographic and Health Surveys across different low-income countries found that 4.6% of all children below the age of 5 years suffered from diarrhoea in the two weeks preceding the survey in Bangladesh (Kothari et al. 2014). Bутtenheim's study (2008) looks at weight-for-height indicators - which capture short-term changes in food intake and disease status and respond quickly to changes in the environment, care behaviours, or household food security - as a measure of undernutrition. The findings of the study indicate that an increased use of improved latrines has a positive effect on weight-for-height measure for undernutrition among children (Buttenheim, 2008) (Cairncross et al. 2006).

Combined access to appropriate water and sanitation facilities is shown to have significant impact on reducing the incidence of diarrhoea – and the concomitant risk of undernutrition – in low-income communities (Begum, S.; Ahmed, M. and Sen, B. 2011). Children born into houses without access to clean water were shown to be at risk of disease, according to a study based on findings from the Bangladesh National Health Survey from 2004 (Hong, R.; Banta, J.E. and Betancourt, J.A. 2006). Specifically, children from households without access to a toilet facility were observed as more likely to suffer from growth-stunting (50 per cent of respondents) than in households with access to a toilet facility (38 per cent of respondents) (Hong et al. 2006). This association with growth-stunting was not found with availability of safe drinking water and water with arsenic.

Evidence of the positive impact of water and sanitation facilities on effective diarrhoea control implies the need to establish effective WASH facilities in order to combat child undernutrition (Fewtrell, L.; Kaufmann, R.B.; Kay, D.; Enanoria, W.; Haller, L. and Colford, J.M. 2005). However, there is a lack of consensus in the literature on the importance of availability versus quality of water, and the independent impact of sanitation facilities (Begum et al. 2011).

Access to potable water that is naturally rich in micronutrients can also help to combat risks of low-intake of vital micronutrients needed to combat undernutrition. A study of a rural population in North Bangladesh indicates that the local iron-rich potable water was attributable to the absence of iron-deficiency among the women tested (Merrill, R.D.; Shamim, A.A.; Ali, H.; Jahan, N.; Labrique, A.B.; Schulze, K.; Christian, P and West Jr., K.P. 2011). This indicates the role of groundwater in helping to alleviate some of the risks of undernutrition and related diseases.

5.4 Access to healthcare

The literature concerning the relationship between access to healthcare and child undernutrition is restricted largely to evaluations of programmatic interventions. In terms of the broader peer-reviewed literature, there is less information available. One study, by Hong et al. (2006), did not find any correlation between lack of access to prenatal and maternal healthcare services and nutritional status. One of the most prevalent topics in this area of the literature is the impact of immunisation on child undernutrition.

5.4.1 Vaccinations

Vaccinations are one of the most important healthcare services required to protect against the risk of child undernutrition. A strong association has been observed in the literature between vaccination and nutritional status. Undernutrition is cited as a common consequence of measles (Bhaskaram, P.; Reddy, V.; Raj, S. and Bhatnagar, R.C. 1984; Bhaskaram 1995; Chowdhury et al. 2006; Ahmed, A.M.S.; Tahmeed, A.; Roy, S.K.; Alam, N. and Hossain, I. (2012). Vomiting and diarrhoea during or following measles leads to a reduction in food intake and nutrient absorption, and this is known to cause protein loss. Measles infection and undernutrition are thus interlocked into a vicious cycle, where the infection can lead to nutritional deficits, and malnourishment itself can heighten the risk of contracting measles (Chowdhury et al. 2006).

6 BASIC FACTORS

The basic factors deal with the wider socio-economic, ecological and cultural contexts of child undernutrition in Bangladesh. As seen in this review, gender is a cross-cutting issue across many of the determinants and sub-categories of child undernutrition. Household gender dynamics, the level of female empowerment and broader cultural attitudes regarding gender roles can all determine a child's nutritional status at a basic level. Poverty and vulnerability must also be taken into account when looking at basic factors – these are related with food security, WASH and access to healthcare services which in turn are linked with the immediate factors of diet and illness. Finally, Bangladesh is prone to natural disasters - heavy flooding in particular - and lacks a robust disaster-response infrastructure. The impacts of such disasters are compounded for the poor and vulnerable, who tend to live in areas served poorest or neglected by infrastructure. Undernutrition has been observed as both a short-term and long-term outcome of such disaster situations.

6.1 Socio-Economic Factors

Poverty, vulnerability and social/cultural attitudes can all contribute to the risk, presence and continuation of child undernutrition from pregnancy and infancy on to the later stages of child development. Factors such as the educational status and income level of parents can have a significant impact on a child's nutritional status (Alom, J.; Quddus, M. and Islam, M.A. 2012). Poverty is measured in the literature not just by income and assets, but also by access to credit and stability of livelihoods. Vulnerability takes into account the gender of the head of household, exposure to risks including those that are economic, social and environmental. There is a strong gendered dimension to poverty as has been widely discussed in the general literature concerning Bangladesh. Rural Bangladeshi women have been identified in the literature as particularly vulnerable. Both the economic and health outcomes of undernutrition among such women are significant, and are widely cited as a factor of widespread child nutrition in rural areas (Milton, A.H.; Smith, W.; Rahman, B.; Ahmed, B.; Shahidullah, S.M.; Hossain, Z.; Hasan, Z. and Sharmin, S. 2010).

6.1.1 Poverty

The existing literature suggests a strong link between poverty and child undernutrition (Ahmed et al., 2012; Giashuddin, M.S.; Kabir, M. and Hasan, M. 2005; Corsi et al. 2011; Dancer et al. 2008; Foraita, R.; Klasen, S. and Pigeot, I. 2008; Haddad, L.; Alderman, H.; Appleton, S.; Song, L. and Yohannes, Y. 2003). Households characterised by low-income based poverty are strongly associated with the presence of child undernutrition (Milton et al. 2010; Jesmin et al. 2011).

Studies in Bangladesh have shown the rate of child undernutrition (as defined by underweight and stunting indicators) to be consistently high among those living in households of low socio-economic status. With childhood growth-stunting, the risk declines consistently as the wealth index increases. This relationship remains strong even when controlling for health, demographic and social factors (Hong et al. 2006). The risk of child undernutrition takes a different form after the exclusive breastfeeding period ends and the child begins to consume what the rest of the household is eating, thus household income status can have specific temporal impacts on the risk of undernutrition (Deolalikar 2005). Higher living standards have been observed with an improvement in overall rates of child nutrition (Ahmed et al. 2012a). The economic conditions of the household can be considered among the most important factors of child undernutrition according to a study of causal dependence chains of undernutrition in Bangladesh (Foraita et al. 2008).

There is widespread consensus in the literature that a reduction in poverty leads to improved nutritional status. Haddad et al. (2003) have shown that an increase in income at the household and national levels can significantly improve the nutritional status. In Bangladesh, when nutritional status was modelled against GDP per capita for 1970 through to 2000, a reduction of 23.1 per cent and 22.4 per cent in stunting and underweight respectively could be attributed to GDP growth alone.

Much of the literature that is focused on socio-economic factors of child undernutrition in Bangladesh is preoccupied with geographical patterning and the rural-urban divide, and within urban areas, the slum versus non-slum divide. Implications for undernutrition according to gender, degree of intensity and type can vary along such lines according to these studies, with a higher rate of undernutrition found among children in rural areas (Hasan, M.M.; Hoque, M.A.; Hossain, M.A.; Mollah, A.H.; Islam, M.N.; Ahsan, M.M. and Chowdhury, B. 2013; Khan and Raza 2013; Corsi, D.J.; Chow, C.K.; Scott, A.; Lear, M.; Rahman, O.; Subramanian, S.V. and Teo, K.K. 2011; Deolalikar, 2005). Despite numerous programmatic interventions in child undernutrition in Bangladesh, the persistence of significant economic disparities suggests the importance of this basic factor in child undernutrition (Deolalikar, 2005).

The stratification of nutritional status along socio-economic lines in different livelihood groups has been explored in a study by Pryer, J.A.; Rogers, S.; Normand, S. and Rahman, A. (2002). Drawing from data collected from 850 households for the Urban Livelihoods Study,³ four different clusters were identified according to socio-economic, demographic and occupational variables. The study signifies that low-income slum-based communities in urban Bangladesh are not socio-economically homogenous and differentiations in assets-based and income-based wealth and access to credit, as well as vulnerability i.e. gender of head of household, are strong determinants of nutritional status. The poorest socio-economic cluster was shown to have the worst nutrition outcomes. Measures for child undernutrition, weight-for-age height-for-age and weight-for-height were shown to be highest in the low-income, most vulnerable cluster (signified by female-headed, poor households) (Pryer et al. 2002). Different types and intensities of undernutrition are associated with different factors. Severe undernutrition declines more steeply with economic status than non-severe undernutrition (Deolalikar 2005). However, figures also showed undernutrition still exists among the richest 20 per cent of the

³ The Urban Livelihoods Study is based in the slum settlements of Mohammadpur sub district and consists of both quantitative and qualitative research. The Urban Livelihoods Study (ULS) is a collaborative project between Proshika, the London School of Hygiene and Tropical Medicine (LSHTM) and Bath University. The study is funded by the Department of International Development (UK).

Bangladeshi population suggesting that cultural and social factors, as well as economic, are at play here (Deolalikar 2005).

An analysis of the multi-pathway causal chains of dependence for child undernutrition in Bangladesh by Foraita et al. (2008) defined ‘goods’ as clean toilet facilities, food security, access to protein, mothers with a high BMI, access to modern healthcare and vaccinations. Those households with a better economic situation, educated mothers and the aforementioned goods tended to have children with positive nutritional status. In terms of livelihoods or employment, those households with mothers who did not work were seen to have better impacts on the wasting form of undernutrition than those mothers who took on unpaid work (Foraita et al. 2008). The study also looked at the proximity of such impacts on child undernutrition, stating that the multiple impacting factors identified all had a direct impact. These findings are further bolstered when a positive deviance is taken: a study by Pryer, J. A.; Rogers, S. and Rahman, A. (2004) explores factors which underlie households with positive nutrition outcomes. Cluster analysis showed that better nourished children were more likely to have taller mothers, tend to come from female-headed households and from families with higher income indicated by such amenities as electricity in the home, better latrines, and greater floor space.

The overall findings of a study of 5,799 children indicate that household wealth inequality is strongly associated with childhood undernutrition. Children in the poorest 20 per cent of households were three times as likely to suffer from adverse growth rate, and this is consistent with more recent studies (Hong et al. 2006; Jesmin et al. 2011). A correlation has also been observed between parents with tertiary-level education or higher and if the mother had a good job, extending the evidence of a link between socio-economic factors and child undernutrition (Jesmin et al. 2011)

Within low-income groups, different types of livelihoods can have differential impacts on a child’s nutritional status. Findings from one study suggest that children of skilled employees were less likely to be suffering from moderate wasting than children of unskilled employees. Unskilled employees were commonly found to be illiterate and lacked a stable income (Rahman et al. 2009).

6.1.2 Tobacco use

A key socio-economic area of enquiry that has emerged in the literature is the potential link between household tobacco consumption and child undernutrition. A recent study by Chowdhury et al. (2011) shows that fathers of 49 per cent of a sample of 13,555 under-five children in Bangladesh, were found to be smokers. The findings from multivariate logistic regression models adjusting for potential confounders indicated that fathers’ smoking was significantly associated with increased risk of underweight status and stunting. This also correlates with those belonging to middle and lower socio-economic strata, where the risk of moderate to severe child undernutrition was found in households headed by smokers.

This is part of a growing evidence-base which suggests tobacco expenditure in low-income households can exacerbate the effects of poverty, and diverts household income away from food, clothing, housing, health, and education (Best, C.M.; Sun, K.; de Pee, S.; Bloem, M.W.; Stallkamp, G. and Semba, R.D. 2007; Efroymson, D.; Ahmed, S.; Townsend, J.; Alam, S.M.; Dey, A.R.; Saha, R.; Dhar, B.; Sujon, A.I.; Ahmed, K.U. and Rahman, O., 2001; Nonnemaker and Sur 2007). The average male cigarette smoker in Bangladesh is estimated to spend more than twice as much on cigarettes than the per capita expenditure on clothing, housing, health, and education combined (Efroymson et al. 2001).

A study by Best et al. from 2007, sought to explore whether smoking is a contributing factor to undernutrition among children using data on household expenditures and child nutritional status collected from 77,678 households.⁴ In the analysis, the characteristics of households in which the father and/or mother used tobacco were compared with households in which neither parent used tobacco. In households with tobacco use, the levels of paternal and maternal education were found to be lower and maternal age was older. Indicators for undernutrition, based on UNICEF measurements, were shown to be higher in households with tobacco use compared with those households with no tobacco use. The mean total monthly household expenditure per capita and mean monthly household expenditure on food were lower in households with tobacco use than in households with no tobacco use. The relationship between multiple indicators of undernutrition (stunting; underweight; wasting; severe stunting; severe underweight and severe wasting) and parental tobacco use was consistent and significant in each quintile of total monthly per capita household expenditure (Best et al. 2007). Poorer households were found to spend proportionally more money on tobacco products than wealthier households, suggesting tobacco addiction imposes the greatest strain on the household budgets of the poorest sector of society. These are the same households in which children are most likely to have undernutrition. Based on the consensus that as household spending on food increases, the risk of undernutrition decreases (Efroymson et al. 2001; Hosain et al. 2006), this suggests a strong link between expenditure on tobacco in low-income households and the risk of child undernutrition.

6.1.3 Gender disparities/Cultural Factors

The literature on gender disparities in child undernutrition in Bangladesh is varied and conflicting, depending on the methodology, typology of undernutrition and timing of the research. Studies from the 1970s and 1980s focused on female discrimination in overall health-seeking behaviour, and following on from this, a study in 2000 indicates a gender gap when tested for multiple variables, according to middle-upper-arm circumference (MUAC) measurements of child undernutrition (Choudhury et al. 2000). However more recent studies among Bangladeshi children have not found sex to be a predictor of undernutrition in either chronic or acute forms (Das and Hossain 2008; Ahmed et al. 2012). A multivariate analysis of the under-two year's population in Bangladesh indicates that undernourished children are less likely to be female, and attributing factors for undernutrition include age, measles vaccinations and recent experience of diarrhoea (Ahmed et al. 2012). Female children were found to be more likely than male children to have poor weight-for-height and height-for-age Z-scores according to 2008 study which looked at anthropometric measures of children who were aged at least one year (Dancer et al. 2008).

Bangladesh is one of the few low income countries in which the prevalence of undernutrition among female children is higher than the prevalence among male children. This suggests gender discrimination in terms of household allocation of food. Education level of the mother, but not the father, was shown to be an important predictor of child survival, particularly for female children (Dancer et al. 2008). Cultural factors for the gender gap when it comes to breast-feeding duration were also identified in a qualitative study by Hackett, K.M.; Mukta, U.S.; Jalal, C.S. and Sellen, D.W. (2012).

In terms of the broader impact of gender norms among adults on child undernutrition: a strong statistical correlation has been drawn between child undernutrition and the educational status of mother and/or

⁴ The study drew its sample from the 77,678 households that participated in the Nutritional Surveillance Project (NSP) of Bangladesh in 2005–6. The NSP has been conducted by Helen Keller International (HKI) and the Institute of Public Health Nutrition of the Government of Bangladesh since 1989.

head of household (Chowdhury 2006) and the association between maternal education will be discussed in the section dealing with female empowerment below.

Levay et al. (2013) look at the structural factors behind the status of women in Bangladeshi society and explore the impact of this on access to food. This can in turn determine the nutritional status of children. The ethnographic study observed that limitations on women's decision-making, dependency and mobility constrained them from being involved in food provisioning. These constraints were stronger in rural contexts, where women often lacked any control over how household food budgets were managed. Such gender dynamics can lead to sustained poor nutritional status, particularly when combined with multiple pregnancies and strenuous labour (Levay et al. 2013). This is consistent with another recent ethnographic study which focuses on the vulnerability of ultra-poor women in Bangladesh, and found that gender and cultural norms were a constraint on food provisioning and thus potentially had damaging impact on nutritional status of the women and their households (McIntyre et al. 2011).

6.2 Female Empowerment

The gender dimension of some of the basic and underlying factors of child undernutrition have already been discussed in this review. Mothers are usually the primary care-givers of children: responsible for breast-feeding in the correct manner for the first six months, and subsequent feeding of complementary foods. The empowerment of women is thus an important basic factor of the nutritional status of children. (Pelletier, D.; Shekarb, M.; Dua, L. and Kostermansb, K. 2005). Household gender dynamics, educational status and access to practical knowledge are all aspects of female empowerment that can contribute to whether or not a child is sufficiently nourished.

6.2.1 Education

Numerous studies suggest that maternal education is significantly associated with severe child undernutrition. Mother's level of education has been identified as a key risk factor in nutrition outcomes for children, and a lack of education has been associated with different types of undernutrition (Ahmed et al. 2012a). Chronic undernutrition was found to be highest among children with illiterate mothers (Rayhan and Khan 2006). However, while some scholars claim that education status of women can have a negative impact on child nutrition (Milton et al. 2010), others suggest that mothers with practical knowledge rather than high educational level are more effective in ensuring the positive nutritional status of children (Jesmin et al. 2011).

The overall lack of knowledge among poor and ultra-poor women regarding medically recommended pregnancy dietary requirements, and a preference to follow alternative traditional beliefs and practices can lead to an insufficient intake of the necessary nutrients (Levay et al. 2013). The mothers of malnourished children have been observed as having low exposure to mass media (television, radio and newspapers) and with little or no formal education. For example, there is little awareness among households with illiterate mothers that iodised salt should be used in cooking to provide adequate nutrients (Ahmed et al. 2012a).

Among female adolescents - an age group where reproductive activity commonly begins in Bangladesh - a lack of awareness has been found regarding the benefits of exclusive breast-feeding newborn children and of appropriate IFP (Hackett et al. 2012).

6.2.2 Gender-based violence

Bangladesh's persistently high rate of child undernutrition has been in part attributed to the social environment, in particular intimate partner violence (IPV) in the household, although at present it is a relatively under-researched topic. (Rahman, M.; Nakamura, K.; Seino, K. and Kizuki, M. 2013a). IPV can have both direct and indirect impacts on child nutrition. The psychological stress when witnessed by children in the household, which can in turn lead to immune system reactions. Such reactions can potentially cause severe and chronic infections such as diarrhoea (Åsling-Monemi, K.; Naved, R.T. and Persson, L. Å. (2009)). More directly, IPV can be wielded through household circumstances where abusive family members may withhold food, or through physical or psychological maternal health outcomes Rahman, M.; Poudel, K.C.; Yasuoka, J.; Otsuka, K.; Yoshikawa, K. and Jimba, M. (2012).

Data drawn from the BDHS (2007) was the basis of a sample frame of over 11,000 married women aged between 15 and 49 years across Bangladesh. Thirty two per cent of the sample was found to be undernourished or thin and approximately 70 per cent were found to be correlated with stunting. Maternal IPV of either a sexual or physical nature has been associated with these findings related to stunting and underweight status. IPV was also shown to have potentially long-term effects on maternal mental health thus compromising her ability to provide adequate care for her children, and potentially their nutritional status (Rahman et al. 2012).

6.3 Natural Disasters

Bangladesh is vulnerable to widespread flooding, and some of the literature explores the downward spiralling effect of such disasters on vulnerable populations, suggesting the outcomes of such vulnerabilities can include child undernutrition (Del Ninno and Lundberg 2005). Women and children in particular are the worst affected by disaster situations (Akter 2004). Data collected on pre-flood and post-flood status indicates an adverse and gender-differentiated impact of the 1987 flood on children's intake of vitamin A (Chowdhury, A.Y. and Bhuiya, A. 1993). A 2005 study provides evidence of a link between children who were exposed to the 1998 flood in Bangladesh, and lack of growth, which indicates impact of poor nutrition (Del Ninno and Lundberg 2005). The study also observed the impacts of flooding beyond the initial shocks, and found a sustained negative impact on health and nutrition outcomes.

Slum populations are particularly prone to flooding hazards and negatively impact child nutritional and health status (Goudet, S.; Faiz, S.; Bogin, B.; Griffiths, P. 2011). A mixed method Dhaka-based study looks at the long-term impacts of repeated flooding in Bangladesh. The study observed that child undernutrition factors which are already present in slum contexts such as insufficient breast-milk; food insecurity and hunger; burden of working mothers and challenges in infant and child food preparation are exacerbated when flooding occurs. Mothers were found to take on the burden of hunger and food insecurity by allocating diminished food provisions to children instead of themselves, thus impacting the level of maternal care provided (Goudet et al., 2011).

7 CONCLUSIONS

A number of key themes emerge from this review of the available literature on the determinants of child undernutrition in Bangladesh: the importance not only of maternal health, but of girls who reach reproductive age; the risks posed by chronic poverty and food insecurity and the intensified impact of all the determinants on the poorest and most vulnerable – a group dominated by women.

The main challenges seem to emerge in the interconnectedness between basic, underlying and immediate factors of undernutrition among both children and mothers (including potential mothers). The immediate factors of diet and illness are closely bound up with issues of caregiving and maternal health which have recurred in this review and highlight the need to address challenges in child, maternal and adolescent girls' healthcare in an integrated manner. The findings of this review thus suggest a holistic policy approach which encompasses social, education and economic factors as well as public health is necessary. A policy approach should also be reflective of the different needs of rural and urban slum communities, and of the differing socio-economic categories even within low-income groups. Poverty and vulnerability are also key cross-cutting issues which can entrap children in undernutrition, leading to intergenerational impacts. Such impacts have been observed in both rural and urban areas, although those in rural areas have been found to be more vulnerable.

Gender is a key theme in the literature: while there is conflicting evidence regarding gender disparities in child undernutrition, there is a consensus on the significant impact of gender in terms of caregiving and the surrounding household environment of a child, for example whether the mother is head of the household or empowered to make household decisions can influence the nutritional status of a child. The compounding impact of gender and vulnerability on those who are of a low socio-economic status is a recurring theme in the literature ranging from food insecurity and poverty, through to women's awareness and cultural factors. The constraints on women such as poverty, food insecurity, disease and illness and poor health outcomes are particularly vulnerable to natural disaster or economic shocks, thus resulting in more serious negative impacts on child undernutrition.

A paucity of literature has been identified in terms of the impacts of maternal mental health on child undernutrition – a factor influenced by household dynamics, domestic violence and access to healthcare services. This review has also identified new areas of enquiry, such as the role of dietary diversity in ensuring household food security in the nutritional sense, the impact of caregiving practices such as feeding and the role of genetics in child undernutrition, all areas in which further evidence and research is required for a more detailed understanding of their role in determining child nutritional outcomes in Bangladesh.

REFERENCES

- Abdullah, K.; Malek, M.A.; Faruque, A.S.; Salam, M. A. and Ahmed, T. (2007) 'Health and nutritional status of children of adolescent mothers: experience from a diarrhoeal disease hospital in Bangladesh', *Acta Paediatrica*; 96.3: 396-400
- Ahamed, M.M. (1986) 'Breastfeeding in Bangladesh', *Journal of Biosocial Science*; 18.4: 425-34
- Ahmed, A.M.S.; Tahmeed, A.; Roy, S.K.; Alam, N. and Hossain, I. (2012) 'Determinants of Undernutrition in Children Under 2 years of Age From Rural Bangladesh', *Indian Pediatrics*; 49.10: 821-4
- Ahmed, F.; Mahmuda, I.; Sattar, A. and Akhtaruzzaman, M. (2003) 'Anaemia and vitamin A deficiency in poor urban pregnant women of Bangladesh' *Asia Pacific Journal of Clinical Nutrition*; 12.4:460-66
- Ahmed, T.; Mahfuz, M.; Ireen, S.; Ahmed, A.M.; Rahman, S.; Islam, M.M.; Alam, M.N.; Hossain, M.I.; Rahman, S.M.; Ali, M.M.; Choudhury, F.P. and Cravioto, A. (2012a) 'Nutrition of children and women in Bangladesh: trends and directions for the future' *Journal of Health, Population and Nutrition*; 30.1
- Ahmed, T. and Ahmed, A.M. (2009a) 'Reducing the burden of malnutrition in Bangladesh', *British Medical Journal*; 339:4490
- Ahmed, T.; Haque, R.; Mansur, A.; Ahmed, S.; Petri Jr, W.A. and Cravioto, A. (2009) 'Use of metagenomics to understand the genetic basis of malnutrition' *Nutrition Reviews*; 67.S2:S201-S206
- Akter, N. (2004) 'BRAC's Experience on Flood Disaster Management' BRAC Research and Evaluation Division Working Paper. Dhaka: BRAC.
- Alam, N.; Roy, S.K.; Ahmed, T. and Shamsir Ahmed, A.M. (2010) 'Nutritional status, dietary intake, and relevant knowledge of adolescent girls in rural Bangladesh', *Journal of Health, Population and Nutrition*; 28.1:86-94
- Ali, D.; Saha, K.K.; Nguyen, P.H.; Diressie, M.T.; Ruel, M.; Menon, P. and Rawat, R. (2013) 'Household food insecurity is associated with higher child undernutrition in Bangladesh, Ethiopia, and Vietnam, but the effect is not mediated by child dietary diversity' *Journal of Nutrition*; 143.12:2015-21
- Alom, J.; Quddus, M. and Islam, M.A. (2012) 'Determinants of undernutrition in under-5 children in Bangladesh: A multi-level analysis', *Journal of Biosocial Science*; 44.5:525-35
- Anik, A.R.; Manjunatha, A.V. and Bauer, S. (2013) 'Impact of farm level corruption on the food security of households in Bangladesh', *Food Security*; 5.4: 565-74

Arifeen, S.E.; Black, R.E.; Caulfield, L.E.; Antelman, G. and Baqui, A.H. (2001) 'Determinants of infant growth in the slums of Dhaka: size and maturity at birth, breastfeeding and morbidity', *European Journal of Clinical Nutrition*; 55.3:167-178

Arimond, M. and Ruel, M.T. (2004) 'Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys' *Journal of Nutrition*; 134(10):2579-2585

Arsenault, J.E.; Yakes, E.A.; Islam, M.M.; Hossain, M.B.; Ahmed, T.; Hotz, C.; Lewis, B.; Rahman, A.S.; Jamil, K.M.; and Brown, K.H. (2012) 'Very low adequacy of micronutrient intakes by young children and women in rural Bangladesh is primarily explained by low food intake and limited diversity', *Journal of Nutrition*; 143.2:197-203

Åsling-Monemi, K.; Naved, R.T. and Persson, L. Å. (2009) 'Violence against women and increases in the risk of diarrheal disease and respiratory tract infections in infancy: A prospective cohort study in Bangladesh', *Archives of Paediatric and Adolescent Medicine*; 130 (1): 300-310.

Baqui, A.H.; Sabir, A.A.; Begum, N.; Arifeen, S.E.; Mitra, S.N. and Black, R.E. (2001) 'Causes of childhood deaths in Bangladesh: an update' *Acta Paediatrica*; 90:682-90

Begum, S.; Ahmed, M. and Sen, B. (2011) 'Do water and sanitation interventions reduce childhood diarrhoea? New evidence from Bangladesh', *Bangladesh Development Studies*; 34.3

Best, C.M.; Sun, K.; de Pee, S.; Bloem, M.W.; Stallkamp, G. and Semba, R.D. (2007) 'Parental tobacco use is associated with increased risk of child malnutrition in Bangladesh' *Nutrition*; 23 10: 731-8

Bhaskaram, P. (1995) 'Measles and malnutrition', *Indian Journal of Medical Research*; 102:195-9

Bhaskaram, P.; Reddy, V.; Raj, S. and Bhatnagar, R.C. (1984) 'Effect of measles on nutritional status of preschool children' *Journal of Tropical Medical Hygiene*; 87:21-5

Black RE, Victora CG, Walker SP, and the Maternal and Child Nutrition Study Group (2013). 'Maternal and child undernutrition and overweight in low-income and middle-income countries.' *Lancet*; published online June 6. [http://dx.doi.org/10.1016/S0140-6736\(13\)60937-X](http://dx.doi.org/10.1016/S0140-6736(13)60937-X)

Black, M.M.; Baqui, A.H.; Zaman, K.; Arifeen, S.E. and Black, R.E. (2009) 'Maternal depressive symptoms and infant growth in rural Bangladesh' *American Journal of Clinical Nutrition*; 89.3: 951S-7S

Buttenheim, A. (2008) 'The sanitation environment in urban slums: implications for child health', *Population and Environment*; 30.1:26-47

Cairncross, S.; Shordt, K.; Zarcaria, S. and Govindan, B.K. (2005) 'What causes sustainable changes in hygiene behaviour? A Cross section study for Kerala, India' *Soc.Sci. and Medicine*; 61, 10 2212-2220.

- Campbell, A.; de Pee, S.; Sun, K.; Kraemer, K.; Thorne-Lyman, A.; Moench-Pfanner, R.; Sari, M.; Akhter, N.; Bloem, M.W. and Semba, R.D. (2012) 'Household expenditure and maternal and child nutritional status' *The Journal of Nutrition: Supplement: The Impact of Climate Change, the Economic Crisis, and the Increase in Food Prices on Malnutrition*; 140.1: 189S-94S
- Choudhury, K.K.; Hanifi, M.M.; Rasheed, S. and Bhuiya, A. (2000) 'Gender inequality and severe malnutrition among children in a remote rural area of Bangladesh' *Journal of Health, Population and Nutrition*; 8.3:123-130
- Chowdhury, A.Y. and Bhuiya, A. (1993) 'Effects of biosocial variables on changes in nutritional status of rural Bangladeshi children, pre- and post-monsoon flooding' *Journal of Biosocial Science*; 25. 3: 351-357.
- Chowdhury, F.; Chisti, M.J.; Hossain, M.I.; Malek, M.A.; Salam, M.A. and Faruque, A.S.G. (2011) 'Association between paternal smoking and nutritional status of under-five children attending Diarrhoeal Hospital, Dhaka, Bangladesh', *Acta Paediatrica*; 100.3:390-395
- Chowdhury, F.; Khan, A.I.; Hossain, M.I.; Malek, M.A.; Faruque, A.S.G.; Ahmed, T. and Salam, M.A. (2006) 'Young children non-immunized against measles: Characteristics and programmatic implications', *Acta Paediatrica, International Journal of Paediatrics*; 95.1: 44-49
- Corsi, D.J.; Chow, C.K.; Scott, A.; Lear, M.; Rahman, O.; Subramanian, S.V. and Teo, K.K. (2011) 'Socioeconomic and geographic patterning of under- and over-nutrition among women in Bangladesh', *Journal of Nutrition*; 14.6: 951-959
- Dancer, D.; Rammohan, A. and Smith, MD (2008) 'Infant mortality and child malnutrition in Bangladesh', *Health Economic*; 17(9): 1015-103.
- Das, S. and Hossain, M.Z. (2008) 'Levels and determinants of child undernutrition in Bangladesh', *Pakistan Journal of Statistics*; 24.4: 301-323
- Del Ninno, C. and Lundberg, M. (2005) 'Treading water: the long-term impact of the 1998 flood on nutrition in Bangladesh.' *Economic Human Biology*; 2005; 3: 67-96.
- Deolalikar, A. (2005) 'Poverty and malnutrition in Bangladesh', *Journal of Developing Societies*; 21: 55.
- Desai, S. (1993) 'The impact of family size on children's nutrition status: Insights from a comparative perspective', *Fertility, Family Size and Structure: Consequences for Families and Children*; New York: Population Council
- Dornelles, C. T. L.; Piva, J. P. and Marostica, P. J. C. (2007) 'Nutritional status, breastfeeding, and evolution of infants with acute viral bronchiolitis', *Journal of Health, Population and Nutrition*; 25.3: 336-343
- Efroymsen, D.; Ahmed, S.; Townsend, J.; Alam, S.M.; Dey, A.R.; Saha, R.; Dhar, B.; Sujon, A.I.; Ahmed, K.U. and Rahman, O. (2001) 'Hungry for tobacco: an analysis of the economic impact of tobacco consumption on the poor in Bangladesh', *Tobacco Control*; 10:212-7

Faruque, A.S.; Ahmed, A.M.; Ahmed, T.; Islam, M.M.; Hossain, M.I.; Roy, S.K.; Alam, N.; Kabir, I. and Sack, D.A. (2008) 'Nutrition: basis for healthy children and mothers in Bangladesh', *Journal of Health, Population and Nutrition*; 26.3:332-339

Fewtrell, L.; Kaufmann, R.B.; Kay, D.; Enanoria, W.; Haller, L. and Colford, J.M. (2005) 'Water, sanitation, and hygiene interventions to reduce diarrhoea in less developed countries: a systematic review and meta-analysis', *Lancet Infectious Diseases*; 5.1:42-52

Food and Agriculture Organization of the United Nations (2010) 'The state of food insecurity in the world (2010): addressing food insecurity in protracted crisis' Rome:FAO.

Foraita, R.; Klasen, S. and Pigeot, I. (2008) 'Using graphical chain models to analyze differences in structural correlates of undernutrition in Benin and Bangladesh', *Economics and Human Biology*; 6 .3: 398-419

Giashuddin, M.S.; Kabir, M. and Hasan, M. (2005) 'Economic disparity and child nutrition in Bangladesh', *Indian Journal of Pediatrics*; 72.6: 481-7

Giashuddin, M.S. and Kabir, M. (2004) 'Duration of breast-feeding in Bangladesh', *Indian Journal of Pediatrics*; 72.6: 481-7

Gitau, R.; Makasa, M.; Kasonka, L.; Sinkala, M.; Chintu, C.; Tomkins, A. and Filteau, S. (2005) 'Maternal micronutrient status and decreased growth of Zambian infants born during and after the maize price increases resulting from the southern African drought of 2001–2002', *Public Health Nutrition*; 8:837–43

Goudet, S.; Faiz, S.; Bogin, B. and Griffiths, P. (2011) 'Pregnant Women's and Community Health Workers' Perceptions of Root Causes of Malnutrition Among Infants and Young Children in the Slums of Dhaka, Bangladesh' *American Journal of Public Health*; 101, 1225-1233

Hackett, K.M.; Mukta, U.S.; Jalal, C.S. and Sellen, D.W. (2012) 'Knowledge, attitudes and perceptions on infant and young child nutrition and feeding among adolescent girls and young mothers in rural Bangladesh' *Maternal and Child Nutrition*

Haddad, L.; Alderman, H.; Appleton, S.; Song, L. and Yohannes, Y. (2003) 'Reducing child malnutrition: How far does income growth take us?' *World Bank Economic Review*; 17:107- 31

Haider, R.; Rasheed, S.; Sanghvi, T.G.; Hassan, N.; Pachon, H.; Islam, S. and Jalal, C.S. (2010) 'Breastfeeding in infancy: identifying the program-relevant issues in Bangladesh', *International Breastfeeding Journal*; 5:21

Hasan, M.M.; Hoque, M.A.; Hossain, M.A.; Mollah, A.H.; Islam, M.N.; Ahsan, M.M. and Chowdhury, B. (2013) 'Nutritional status among primary school children of Mymensingh', *Mymensingh Medical Journal*; 22.2:267-74

Helen Keller International (2006) 'Household and Community Level Determinants of Malnutrition in Bangladesh. Dhaka.' *Bangladesh Nutritional Surveillance Project Bulletin*; 17. Singapore: HKI

Hien, N. and Hoa, N. (2009) 'Nutritional Status and Determinants of Malnutrition in Children under Three Years of Age in Nghean, Vietnam', *Pakistan Journal of Nutrition*; 8.7:958-964

Hong, R.; Banta, J.E. and Betancourt, J.A. (2006) 'Relationship between household wealth inequality and chronic childhood under-nutrition in Bangladesh', *International Journal for Equity in Health*; 5.15

Hosain, G.M.M.; Chatterjee, N.; Begum, A. and Saha, S.C. (2006) 'Factors associated with low birth weight', *Journal of Tropical Pediatrics*; 52.2: 87-91

Jamil, K.M.; Rahman, A.S.; Bardhan, P.K.; Khan, A.I.; Chowdhury, F.; Sarker, S.A.; Khan, A.M. and Ahmed, T. (2008) 'Micronutrients and Anaemia', *Journal of Health, Population and Nutrition*; 26.3:340-355

Jesmin, A.; Yamamoto, S.S.; Malik, A.A. and Haque, M.A. (2011) 'Prevalence and determinants of chronic malnutrition among preschool children: a cross-sectional study in Dhaka City, Bangladesh', *Journal of Health, Population and Nutrition* 29.5: 494-499.

Khan, M.R. and Ahmed, F. (2005) 'Physical status, nutrient intake and dietary pattern of adolescent female factory workers in urban Bangladesh', *Asia Pacific Journal of Clinical Nutrition*; 14.1: 19-26

Khan, R.E.A. and Raza, M.A. (2013) 'Child malnutrition in developing economies: a case study of Bangladesh', *Quality and Quantity*; March 19:1-20.

Kim, J.M.; Labrique, A.; West, K.P.; Rashid, M.; Shamim, A.A.; Ali, H.; Ullah, B.; Wu, L.; Massie, A.; Mehra, S.; Klemm, R. and Christian, P. (2012) 'Maternal morbidity in early pregnancy in rural northern Bangladesh', *International Journal of Gynaecology and Obstetrics*; 119.3:227-233

Kimmons, J.E.; Dewey, K.G.; Haque, E.; Chakraborty, J.; Osendarp, S.J. and Brown, K.H. (2005) 'Low nutrient intakes among infants in rural Bangladesh are attributable to low intake and micronutrient density of complementary foods', *Journal of Nutrition*; 135.3:444-451

Kothari, M.T., Abderrahim, N., Coile, A. and Cheng, Y. (2014). 'Nutritional Status of Women and Children' Rockville, Maryland, USA: ICF International.

Levay, A.V.; Mumtaz, Z.; Rashid, S.F. and Willows, N. (2013) 'Influence of gender roles and rising food prices on poor, pregnant women's eating and food provisioning practices in Dhaka, Bangladesh' *Reproductive Health*; 10.1:53

Lin, A.; Bik, E.M.; Costello, E.K.; Dethlesfsen, L.; Haque, R.; Relman, D.A. and Singh, U. (2013) 'Distinct Distal Gut microbiome Diversity and Composition in Healthy Children from Bangladesh and the United States', *Plos One*; 8.1: 1-19

National Institute of Population Research and Training (NIPORT), Mitra and Associates, and ICF International. (2013). *Bangladesh Demographic and Health Survey 2011*. Dhaka, Bangladesh and Calverton, Maryland, USA: NIPORT, Mitra and Associates, and ICF International

McIntyre, L.; Rondeau, K.; Kirkpatrick, S.; Hatfield, J.; Islam, K.S. and Huda, S.N. (2011) 'Food provisioning experiences of ultra-poor female heads of household living in Bangladesh' *Social Science and Medicine*; 72.6:969-976

Merrill, R.D.; Shamim, A.A.; Ali, H.; Jahan, N.; Labrique, A.B.; Schulze, K.; Christian, P. and West Jr., K.P. (2011) 'Iron status of women is associated with the iron concentration of potable groundwater in rural Bangladesh' 141.5:944-949

Moore, S.; Prentice, A.; Wagatsuma, Y.; Fulford, A.; Collinson, A.; Raqib, R.; Vahter, M.; Persson, L. and Arifeen, S. (2006) 'Responsive complementary feeding in rural Bangladesh', *Social Science and Medicine*; 62.8:1917-19

Milton, A.H.; Smith, W.; Rahman, B.; Ahmed, B.; Shahidullah, S.M.; Hossain, Z.; Hasan, Z. and Sharmin, S. (2010) 'Association between chronic arsenic exposure and nutritional status among the women of child bearing age: a case-control study in Bangladesh', *International Journal of Environmental Health and Research*; 7.7:2811-2821

Murphy, S.P. and Allen, L.H. (2003) 'Nutritional importance of animal source foods', *Journal of Nutrition*; 133.S3:932-5

Nasreen, H.E.; Kabir, Z.N.; Forsell, Y. and Edhborg, M. (2013) 'Impact of maternal depressive symptoms and infant temperament on early infant growth and motor development: Results from a population based study in Bangladesh', *Journal of Affective Disorders*; 146.2: 254-61

Nasreen, H.E.; Kabir, Z.N.; Forsell, Y. and Edhborg, M. (2010) 'Low birth weight in offspring of women with depressive and anxiety symptoms during pregnancy: results from a population based study in Bangladesh', *BMC Public Health*; 10:51.

National Institute of Population Research and Training (NIPORT), Mitra and Associates, and Macro International. (2009) *Bangladesh Demographic and Health Survey 2007*. Dhaka, Bangladesh and Calverton, Maryland, USA: National Institute of Population Research and Training, Mitra and Associates, and Macro International (USAID).

Nguyen, P.H.; Saha, K.K.; Ali, D.; Menon, P.; Manohar, S.; Mai, L.T.; Rawat, R. and Ruel, M.T. (2013) 'Maternal mental health is associated with child undernutrition and illness in Bangladesh, Vietnam and Ethiopia', *Public Health Nutrition*; 1-10

Nonnemaker, J. and Sur, M. (2007) 'Tobacco expenditures and child health and nutritional outcomes in rural Bangladesh', *Social Science & Medicine*; 65:2517-26

de Onis M.; Onyango, AW; Borghi, E. and Garza, C. (2006) 'Comparison of the World Health Organization (WHO) Child Growth Standards and the National Center for Health Statistics

(NCHS)/WHO international growth reference: implications for child health programmes' *Public Health Nutrition* 2006; 9:942-7

Pelletier, D.; Shekarb, M.; Dua, L. and Kostermansb, K. (2005) 'The Bangladesh Integrated Nutrition Project: Effectiveness and Lessons' Bangladesh Development Series Paper 8. Washington, DC: World Bank.

Pryer, J. A.; Rogers, S. and Rahman, A. (2004) 'The epidemiology of good nutritional status among children from a population with a high prevalence of malnutrition', *Public Health Nutrition*; 7.2: 311-317

Pryer, J. A.; Rogers, S. and Rahman, A. (2003) 'Factors affecting nutritional status in female adults in Dhaka slums, Bangladesh', *Biodemography and Social Biology*; 50.3:259-269

Pryer, J.A.; Rogers, S.; Normand, S. and Rahman, A. (2002) 'Livelihoods, nutrition and health in Dhaka slums' Study Urban Livelihoods Project. *Public Health Nutrition*; 5.5: 613-8

Rah, J.H.; Akhter, N.; Semba, R.D.; de Pee, S.; Bloem, M.W.; Campbell, A.A.; Moench-Pfanner, R.; Sun, K.; Badham, J. and Kraemer, K. (2010) 'Low dietary diversity is a predictor of child stunting in rural Bangladesh', *European Journal of Clinical Nutrition*; 64.12:1393-8

Rahman, A. and Karim, R. (2013) 'Prevalence of food insecurity among women in rural area of North West Bangladesh' *Pakistan Journal of Nutrition*; 12:329-33

Rahman, A.; Chowdhury, S. and Hossain, D. (2009). 'Acute malnutrition in Bangladeshi children: levels and determinants' *Asia Pacific Journal of Public Health*; 21.3:294-302

Rahman, M.; Nakamura, K.; Seino, K. and Kizuki, M. (2013a) 'Intimate partner violence and chronic undernutrition among married Bangladeshi women of reproductive age: are the poor uniquely disadvantaged?' *American Journal of Public Health*; 102.7:1336-1345

Rahman, M.; Poudel, K.C.; Yasuoka, J.; Otsuka, K.; Yoshikawa, K. and Jimba, M. (2012) 'Maternal exposure to intimate partner violence and the risk of undernutrition among children younger than 5 years in Bangladesh' *American Journal of Public Health*; 102.6:1336-1345

Rahman, M. M. and Shahidullah, M. (2001) 'Risk factors for acute respiratory infections among the slum infants of Dhaka city' *Bangladesh Medical Research Council Bulletin* 27.2: 55-62

Rasheed, S.; Frongillo, E.A.; Devine, C.M.; Alam, D.S. and Rasmussen, K.M. (2009) 'Maternal, infant, and household factors are associated with breast-feeding trajectories during infants' first 6 months of life in Matlab, Bangladesh', *Food Nutrition Bulletin*; 32.3:192-200

Rayhan, M.I. and Khan, M.S.H. (2006) 'Factors causing malnutrition among under Five children in Bangladesh' *Pakistan Journal of Nutrition*; 5.6: 558-62

Roth, D.E.; Shah, R.; Black, R.E. and Baqui, A. (2009) 'Vitamin D status and acute lower respiratory infection in early childhood in Sylhet, Bangladesh', *Acta Paediatrica*; 99.3:389-393

Ruel, M.T. (2003) 'Operationalizing dietary diversity: a review of measurement issues and research priorities' *Journal of Nutrition*; 133:S3911–26

Saha, K.K.; Frongillo, E.A.; Alam, D.S.; Arifeen, S.E.; Persson, L.A. and Rasmussen, K.M. (2008) 'Household food security is associated with infant feeding practices in rural Bangladesh', *Journal of Nutrition*; 138.7: 1383-1390

Saha, K.K.; Frongillo, E.A.; Alam, D.S.; Arifeen, S.E.; Persson, L.A. and Rasmussen, K.M. (2008a) 'Appropriate infant feeding practices result in better growth of infants and young children in rural Bangladesh', *American Journal of Clinical Nutrition*; 87.6: 1852-1859

Somerfelt, A.E. and Stewart, M.K. (1994) 'Children Nutritional Status', Comparative Studies No. 12. Demographic and Health Surveys, Calverton: Macro International Inc.

Smith, L.C.; Ruel, M. T. and Ndiaye, A. (2004) 'Why is child malnutrition lower in urban than rural areas?' Food Consumption and Nutrition Division (FCND) Discussion Papers 176, International Food Policy Research Institute (IFPRI).

Thorne-Lyman, A.L.; Valpiani, N.; Sun, K.; Semba, R.D.; Klotz, C.L.; Kraemer, K.; Akhter, N.; de Pee, S.; Moench-Pfanner, R.; Sari, M. and Bloem, M.W. (2010) 'Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis', *European Journal of Clinical Nutrition*; 66.2: 237-243