Risk factors and consequences of maternal perinatal depressive and anxiety symptoms: A community-based study in rural Bangladesh

Hashima-E-Nasreen
MBBS, MPH

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ABSTRACT

Background: There is a paucity of research on maternal depressive and anxiety disorders and its association with infant birth outcome and growth in the South Asian region including Bangladesh. This study aims to investigate the prevalence and risk factors of depressive and anxiety symptoms surrounding childbirth and their impact on infant birth outcomes and physical development at 2–3 months and 6–8 months postpartum in rural Bangladesh.

Methods: This thesis is based on four studies originating from a community-based, prospective cohort study of 720 women in late pregnancy (I), delivery (II), 2–3 months postpartum (III, IV) and 6–8 months postpartum (III, IV) in two rural sub-districts of Bangladesh. Due to attrition (8.3%), the samples differed for different studies: 720 pregnant women in Study I, 583 women and infants in Study II, 588 women in Study III, and 652 women and infants in Study IV. The validated Bangla version of the Edinburgh Postnatal Depression Scale (EPDS-B) was used to measure depressive symptoms during pregnancy and postpartum, and the trait-anxiety scale of the State-Trait Anxiety Inventory (STAI) was used to assess general anxiety during pregnancy. Trained interviewers carried out structured interviews at the respondents’ homes to elicit relevant background information during pregnancy; infant height and weight at birth; infants height, weight, illness, and feeding practices at 2–3 months; and additional information on infant temperament and motor development at 6–8 months postpartum. Multiple linear regression (I, IV), logistic regression (I, II), and Cox regression models (III) were used to find the study-specific determinants.

Results: Prevalence of antepartum depressive symptoms (ADS) was 18% and antepartum anxiety symptoms (AAS) 29% (I). The incidence proportion of postpartum depressive symptoms (PDS) was 8% at 2–3 months postpartum and 18% at 6–8 months postpartum (III). The associated factor for ADS were women’s literacy (OR 0.59, CI95% = 0.37–0.95), poor partner relationship (OR 2.23, CI95% = 1.37–3.62), forced sex (OR 1.95, CI95% = 1.01–3.75), physical violence by spouse (OR 1.69, CI95% = 1.02–2.80), and previous depressive symptoms (OR 4.62 CI95% = 2.72–7.85) (I). Similarly, poor socioeconomic status (HR 2.62, CI95% = 1.83–3.73), physical partner violence during pregnancy (HR 1.65, CI95% = 1.08–2.50), anxiety symptoms during pregnancy (HR 1.69, CI95% = 1.16–2.46), and previous depressive symptoms (HR 2.95, CI95% = 1.80–4.84) were identified as risk factors for PDS (III). ADS and AAS were twice as likely to be associated with LBW (≤2.5 kg) over and above the effect of conventional risk factors such as poverty and maternal malnutrition (II). Likewise, maternal PDS independently predicted infant underweight and impaired motor development, and ADS predicted infant stunting (IV).

Conclusion: This population-based study confirms that, in rural Bangladesh, depressive and anxiety symptoms are common during pregnancy and postpartum, and that they effect infant birth weight and infant growth and motor development at 6–8 months, consequently extending the burden of disease to the next generation. Policies aimed at the detection and effective management of depressive and anxiety symptoms during pregnancy and 6–8 months postpartum may reduce the burden on mothers and also act as an important measure in the prevention of LBW, underweight, and stunting among offspring in Bangladesh.

Key words: Depression, anxiety, antepartum, postpartum, low birth weight, underweight, stunting, rural Bangladesh
LIST OF PUBLICATIONS


III. Nasreen, H.E., Edhborg, M., Petzold, M., Forsell, Y., & Kabir, Z.N. Incidence and risk factors of postpartum depressive symptoms in a cohort of women from a rural district in Bangladesh. (Submitted)

IV. Nasreen, H.E., Kabir, Z.N., Forsell, Y., & Edhborg, M. Impact of maternal depressive symptoms and infant temperament on early infant growth and motor development: Results from a population based study in Bangladesh. (Submitted)

The papers will be referred to in the text by their Roman numerals I–IV

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<th>Description</th>
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<tbody>
<tr>
<td>AAS</td>
<td>Antepartum anxiety symptoms</td>
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<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
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<tr>
<td>ADS</td>
<td>Antepartum depressive symptoms</td>
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<tr>
<td>ANC</td>
<td>Antenatal consultation</td>
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<tr>
<td>ARI</td>
<td>Acute Respiratory Infection</td>
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<tr>
<td>BBS</td>
<td>Bangladesh Bureau of Statistics</td>
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<tr>
<td>BRAC</td>
<td>Formerly, Bangladesh Rural Advancement Committee; written both as BRAC or Brac (<a href="http://www.brac.net">www.brac.net</a>)</td>
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<tr>
<td>BDHS</td>
<td>Bangladesh Demographic and Health Survey</td>
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<tr>
<td>CHW</td>
<td>Community health worker</td>
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<tr>
<td>CIS-R</td>
<td>The revised Clinical Interview Schedule</td>
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<td>DSM-IV</td>
<td>Diagnostic and Statistical Manual of Mental Disorder, 4th edition</td>
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<tr>
<td>EPDS</td>
<td>Edinburgh Postnatal Depression Scale</td>
</tr>
<tr>
<td>EPDS-B</td>
<td>Edinburgh Postnatal Depression Scale–Bangla</td>
</tr>
<tr>
<td>GoB</td>
<td>Government of Bangladesh</td>
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<tr>
<td>HAZ</td>
<td>Height-for-age</td>
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<tr>
<td>HDI</td>
<td>Human development index</td>
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<tr>
<td>HR</td>
<td>Hazard ratio</td>
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<tr>
<td>ICD-10</td>
<td>International Classification of Disease</td>
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<tr>
<td>ICQ</td>
<td>Infant Characteristic Questionnaire</td>
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<tr>
<td>LBW</td>
<td>Low birth weight</td>
</tr>
<tr>
<td>MDG</td>
<td>Millennium development goal</td>
</tr>
<tr>
<td>MOHFW</td>
<td>Ministry of Health and Family Welfare</td>
</tr>
<tr>
<td>MUAC</td>
<td>Mid upper arm circumference</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-government (development) organization</td>
</tr>
<tr>
<td>OR</td>
<td>Odds ratio</td>
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<tr>
<td>PBQ</td>
<td>Postpartum Bonding Questionnaire</td>
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<td>PDS</td>
<td>Postpartum depressive symptoms</td>
</tr>
<tr>
<td>PSE</td>
<td>Personal State Examination</td>
</tr>
<tr>
<td>SCID-IV</td>
<td>Structured Clinical Interview for DSM-IV</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>SES</td>
<td>Socioeconomic status</td>
</tr>
<tr>
<td>STAI</td>
<td>State and Trait Anxiety Inventory</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Program</td>
</tr>
<tr>
<td>UNFPA</td>
<td>United Nations Population Fund</td>
</tr>
<tr>
<td>WAZ</td>
<td>Weight-for-age</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>WHZ</td>
<td>Weight-for-height</td>
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</tbody>
</table>
Glossary and definitions

Depressive symptoms: Symptoms scored ≥10 on the EPDS are categorized as depressive symptoms in this thesis.

Antepartum depressive symptoms: Depressive symptoms (score ≥10) during the third trimester of pregnancy (from seven months to term).

Postpartum depressive symptoms: Depressive symptoms (score ≥10) with the onset within four weeks of delivery (DSM-IV) to 6–8 months postpartum.

Perinatal depressive symptoms: Depressive symptoms (score ≥10) at antepartum and postpartum periods.

Anxiety symptoms: General anxiety symptoms scored ≥45 on the trait-anxiety scale of the State Trait Anxiety Inventory (STAI).

Antepartum anxiety symptoms: Anxiety symptoms (score ≥45) at the third trimester of pregnancy (from seven months to term).

Low birth weight (LBW): Infants considered as LBW if birth weight is 2500 grams or less.

Prematurity: Prematurity is defined if infants born before 37 weeks of gestation.

Underweight: Child’s weight-for-age is < −2 z-score.

Stunting: Child’s height-for-age is < −2 z-score.
1 INTRODUCTION

The World Health Organization (WHO) has proposed that there can be no health without mental health (WHO, 2005a), a view also endorsed by the Pan American Health Organization, the EU Council of Ministers, the World Federation of Mental Health, and the UK Royal College of Psychiatrists. Mental disorders accounts for 14% of the global burden of disease worldwide (WHO, 1992–1994) and depression is one of the major causes of disability (Mathers and Loncar, 2006). Furthermore, depression is increasing, currently affecting 121 million people worldwide, and is predicted to become the fourth leading cause of the global disease burden by 2020 (Balch, 2006). However, the size of contribution varies between countries according to income level (Mathers and Loncar, 2006). Ten years after the first WHO report raising this unexpected finding, however, mental health remains a low priority in most low- and middle-income countries (Prince et al., 2007).

1.1 MATERNAL MENTAL DISORDER

Maternal mental disorder following childbirth was first mentioned by Hippocrates (approx. 400 BC), but Louis Marcé, a French psychiatrist wrote the first accepted description of postpartum mental illness in 1858 (Barclay and Lloyd, 1996). Maternal distress is a phenomenon that offers a new, alternative and women-centered approach to understand women’s psychological health in the transition of motherhood (Barclay and Lloyd, 1996). Traditionally this has been viewed with a bio-medical focus on anxiety, depression and dysfunction. Barclay and Lloyd (1996) argued that this approach denied recognition of and exposure to the real experience of women in the transition of motherhood. They proposed a need for alternate views that consider women’s social contexts, and the physical and emotional changes that affect their lives. Hence, a new concept emerged to encompass the psychosocial context, normal stress responses, and responses indicating that there could be mental health problems. Variation in terms used was noted, including terms such as distress, mental distress, distressed mood, psychological distress, emotional distress, prenatal maternal stress, and depressive and anxiety symptoms (Emmanuel and John, 2010). Despite the range of terms used to describe the phenomena, an underlying theme of stress and distress was common to all studies (Emmanuel and John, 2010). Maternal mental disorder is a public health concern because of its associations with low birth weight (LBW), poor mother-infant bonding, and a host of other ramifications that affect the well-being of women, their children, and their families.

1.2 MATERNAL PERINATAL DEPRESSIVE AND ANXIETY SYMPTOMS

Depression is a disabling disorder with symptoms such as low mood, lack of energy and interest, poor concentration and sometimes suicidal ideation. Women have been found to have a two to threefold increased risk of depression during the perinatal period, which includes pregnancy (antepartum) and the first 12 months following delivery (postpartum) (Dossett, 2008; Gavin et al., 2005). Evidence indicates a
threefold higher incidence of depressive symptoms during the first month postpartum (Cooper, Campbell, Day, Kennerley, and Bond, 1988). Except for this time period, it has not been demonstrated that depression is more common in the first year after childbirth than at other times in the female reproductive life (O’Hara, Schlechte, Lewis, and Wright, 1991; Cox, Murray, and Chapman, 1993). A meta-analysis of numerous studies found that the global prevalence rates range between 0.5–61% (Halbreich and Karkun, 2006). The wide variation depends on the study population, the assessment method and the timing of the postpartum period (O’Hara and Swain, 1996). Research has shown that 40–44% of women with postpartum depressive symptoms also experience depressive symptoms at early/mid or late pregnancy (Austin, 2004; Heron, O’Connor, Evans, and Glover, 2004).

In high-income countries, depression affects approximately 12% of women during pregnancy (Bennet, Einarson, Taddio, Koren, and Einarson, 2004) and 15% postpartum (O’Hara and Swain, 1996). But recent research has found that the prevalences in low-income countries tend to be even higher than in high-income countries (Patel, Rodrigues, and De Souza, 2002; Rahman, Iqbal, and Harrington, 2003) and often goes unrecognized and untreated (Oxman and Sengupta, 2002; Patel, De Souza and Rodrigues, 2003).

Table 1. Prevalence of postpartum depression in different countries

<table>
<thead>
<tr>
<th>Country/Author</th>
<th>Design</th>
<th>Settings</th>
<th>Measures</th>
<th>Time frame (postpartum)</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hong Kong</td>
<td>Prospective</td>
<td>Regional hospital</td>
<td>EPDS (cutoff ≥13)</td>
<td>6 weeks</td>
<td>24.2</td>
</tr>
<tr>
<td>Lee et al. (2007)</td>
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</tr>
<tr>
<td>India</td>
<td>Cross-sectional</td>
<td>Antenatal clinic</td>
<td>CIS-R*</td>
<td>6–12 weeks</td>
<td>19.8</td>
</tr>
<tr>
<td>Chandran et al. (2002)</td>
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<tr>
<td>Patel et al. (2002)</td>
<td>Prospective</td>
<td>Hospital setting</td>
<td>EPDS (cutoff ≥12)</td>
<td>6 months</td>
<td>22.0</td>
</tr>
<tr>
<td>Pakistan</td>
<td>Cross-sectional</td>
<td>Community setting</td>
<td>ICD-10**</td>
<td>10–12 weeks</td>
<td>28.0</td>
</tr>
<tr>
<td>Rahman et al. (2004)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Japan</td>
<td>Cross-sectional</td>
<td>Hospital setting</td>
<td>EPDS (cutoff &gt;9)</td>
<td>3 weeks</td>
<td>17.0</td>
</tr>
<tr>
<td>Yoshida et al. (2001)</td>
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<tr>
<td>South Africa</td>
<td>Cross-sectional</td>
<td>Community setting</td>
<td>SCID-IV†</td>
<td>2 months</td>
<td>34.7</td>
</tr>
<tr>
<td>Cooper et al. (1999)</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>United Arab Emirates</td>
<td>Cross-sectional</td>
<td>Community setting</td>
<td>PSE‡</td>
<td>8–30 weeks</td>
<td>15.8</td>
</tr>
<tr>
<td>Ghubash and Abou-salhe (1997)</td>
<td></td>
<td></td>
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</tbody>
</table>

Source: Klainin and Arthur, 2009

*CIS-R is the revised Clinical Interview Schedule, **ICD-10 is the International Classification of Disease, †SCID-IV is the Structured Clinical Interview for DSM-IV, ‡PSE is the Personal State Examination.
In South Africa, for instance, postpartum depression is three times higher (35%) than in high-income countries (Cooper et al., 1999), and twice as much (20–28%) as South Asian countries (Patel et al., 2003; Anoop, Saravanan, Joseph, Cherian, and Jacob, 2004; Rahman et al., 2003) (Table 1).

A meta-analysis of 41 prevalence studies shows that the lifetime prevalence rates of any anxiety disorder was 17% (Somers, Goldner, and Waraich, 2006). Women are two to three times more likely to suffer from generalized anxiety disorder than men; although this finding appears to be restricted to high-income countries, the spread of general anxiety disorder is somewhat equal in low-income nations (Cameron, 2004). There has also been current recognition that new mothers are at increased risk of getting affected by acute anxiety disorders (Emmanuel and John, 2010). Although maternal anxiety related to childbirth has not captured the same attention as maternal depression, recent studies have shown high prevalence, 24% during antepartum (Sutter-Dallay, Giaconne-Marcesche, Glatigny-Dallay, and Verdoux, 2004) and 25% postpartum (Britton, 2005) in high-income countries. Estimates of the prevalence of postnatal maternal anxiety range from 3% (Wenzel, Haugen, Jackson, and Robinson, 2003) to 43% (Kuo et al., 2004). It is recognized that similar numbers of women suffer from both anxiety and depression during pregnancy (Matthey, 2004; Austin, Tully, and Parker, 2007). Heron et al. (2004) showed that 64% of women who reported elevated levels of anxiety symptoms in pregnancy also reported elevated levels of anxiety postpartum. Field et al. (2010) reported on the co-morbidity of depression and anxiety in antepartum women, and Gamble and Creedy (2005) in postpartum women. One study found that 16% of postpartum mothers had pure anxiety symptoms, while only 6% exhibited pure depression, and 4% of the sample had comorbid anxiety and depression (Matthey, Barnett, Howie, and Kavanagh, 2003).

Maternal depression and anxiety are rarely reported in Bangladesh, and is not commonly considered to be an indicator of women’s health in this geographic region. Depression is not screened or diagnosed in primary care settings in the country, and those afflicted seek care at the medical college hospital and specialized private clinics only when the illness is severe.

1.3 RISK FACTORS FOR PERINATAL DEPRESSIVE AND ANXIETY SYMPTOMS

1.3.1 Theories

Three theories of why perinatal depression occurs are discussed in this thesis: One emphasizes the stress that arises from the demands of the pregnancy and childbirth; another emphasizes the mother’s cognitive-behavioral coping mechanisms; and a third emphasizes the role of fluctuating hormones, thyroid function, and neurotransmitters triggered by pregnancy and childbirth.

Theories of stress and coping

The stress and coping theories postulate that depression in general, and in the antepartum period, arises as a result of an imbalance between perceived demands
(infantile, social, physical, or marital) and perceived resources, both personal (from an appraisal of stressors and coping strategies) and social (based on situational characteristics and social support) (Lazarus and Folkman, 1984). Maternal cognitive style, including beliefs about one’s own competence as a parent and/or appraisal of existing stressors, has been posited as a mediating factor on the effects of stress on postpartum adjustment (Cutrona and Troutman, 1986).

**Cognitive-behavioral theories**
Cognitive and behavioral theories of depression consider dysfunctional thoughts and behavior to be the risk factors that precipitate, exacerbate, and maintain depression. Beck (1967) proposed that consistently negative expectations about one’s self, the world and the future lead to feelings of depression. In a related theory, Abramson, Seligman, and Teasdale (1978) described persons with depressive attributional styles as reacting to negative external events with a belief that these events will always continue to happen. These individuals are therefore more likely to become depressed when faced with life events that are perceived as uncontrollable.

**Biological theories**
The biological theories postulate that perinatal depressive disorders originate in the profound hormonal and biochemical changes that occur in a woman’s body during pregnancy and the postpartum period (Nott, Franklin, Armitage, and Gelder, 1976). One biological theory argues that significant hormonal changes in estrogen, progesterone, cortisol or prolactin, triggered by parturition, may be responsible for dysphoric mood in the perinatal period (Glover, 1992). A second biological model posits a link between disorders of the thyroid gland and thyroid antibody status and the onset of postpartum depression (Harris, 1996). A third biological explanation for perinatal depression suggests that it, like other forms of mood disorder, is due to disturbances in neurotransmitters such as noradrenalin (Taylor, Dore, and Glover, 1996).

### 1.3.2 Theoretical framework
The most common viewpoint among researchers is that the psychosocial and biological factors must coexist to produce depression (Harris, 1996). Hence the theoretical framework of the thesis is based on the above three theories as described below.

**Biopsychosocial model of postpartum depression**
Milgrom, Martin, and Negri (1999) proposed the use of George Engel’s (1980) biopsychosocial model of postpartum depression. It presupposes using the link between psychological, social, and biological theories as described above to search for the risk factors of postpartum depression. Research literature and clinical experience has led to the development of a biopsychosocial model of postpartum depression as shown in Figure 1. The model can be used both for research and clinical practice (Milgrom et al., 1999).
Figure 1. The biopsychosocial model of postpartum depression (Milgrom et al., 1999)
On the left of the model are vulnerability factors reflecting that some women are more susceptible to developing postpartum depression than others (Figure 1). These factors include both those present from an early age, such as personality traits, and others that have come into play, such as psychiatric disorders and negative life events. In addition, women and their significant others (partner, relatives, friends, etc.) may react to the postpartum depression in ways that exacerbate and maintain the disorder. David and Holden (1970) found that maternal hostility toward family and negative child rearing attitudes during pregnancy were associated with anxiety and depression at eight months postpartum. Anxiety and depression in pregnancy and postpartum may be accentuated when skill levels become open to scrutiny by professionals, family, and friends (O’Hara, 1986). A possible mechanism may be that women who lack skills in eliciting positive reinforcement from others, including their infants, through poor social skills become susceptible to develop depression (Milgrom et al., 1999). In addition, infant temperament is postulated to have both a direct effect on the level of postpartum depression as well as influencing parenting self-efficacy (Cutrona and Troutman, 1986).

Sociocultural factors impact postpartum depression via the pathways of precipitating and exacerbating factors. The lack of support provided to some mothers in high-income countries, for example, leaves no protective buffer against the stress occurring in association with a birth (Eberhard-Gran, Garthus-Niegel, Garthus-Niegel, and Eskild, 2010). Guilt, self-esteem, and feeling of inadequacy arise in response to postpartum depression when cultural myths falsely imply that the motherhood experience should be exclusively positive (Milgrom et al., 1999). O’Hara (1994) pointed out that features may vary according to cultures between the countries, or within a country. In some societies, particularly in Asia, the Middle East, and Africa, tradition dictates that many family members, primarily women, provide support before, during, and after childbirth, and that this support may help protect women from the crippling symptoms of depression (Halbreich and Karkun, 2006). In Muslim cultures, family connotes a center of honor, loyalty, and reputation, and a large extended family is greatly appreciated. Women are traditionally subordinate to male relatives; however they receive recognition, honor, and substantial social support during a 40-day social-support period after childbirth (Klainin and Arthur, 2009; Eberhard-Gran et al., 2010).

1.3.3 Risk factors

Risk factors for antepartum depressive and anxiety symptoms

Studies in high-income countries suggest a link between disadvantaged socioeconomic background, domestic violence, and antepartum depressive and anxiety symptoms (ADS and AAS, respectively) (Field et al., 2004, Bennett et al., 2004). A few studies on ADS, and even less on AAS, have been conducted in low-income countries that demonstrate inconsistent result. The predictors of antepartum depression and anxiety in Pakistan were husband’s unemployment, low household wealth, 10 or more years of formal education, unwanted pregnancy, and partner violence (Karmaliani et al., 2009). In a study in Nigeria, socioeconomic and obstetric factors were not found to be
associated with ADS and AAS (Esimai, Fatoye, Quiah, Vidal, and Momoh, 2008). Age at current pregnancy and at first delivery, obstetric complications, having no friends in the community, living in a crowded household, low occupational status, and history of previous psychiatric disorder were found to be associated with antepartum common mental disorders in Brazil (Faisal-Cury, Menezes, Araya, and Zugaib, 2009).

**Risk factors for postpartum depressive symptoms**

A meta-analysis of 84 studies by Beck (2001) identified nine significant risk factors of postpartum depressive symptoms (PDS), six with moderate effect sizes and three with small effect sizes. The moderate effect sizes included factors such as antepartum depression, low self-esteem, poor marital relationship, history of previous depression, infant’s difficult temperament, and maternity blues. The small effect-size factors encompassed low socioeconomic status, being a single parent, and having an unplanned or unwanted pregnancy. The strongest etiological association was found with the level of support, particularly from the spouse and the mother (O’Hara and Swain, 1996). In low-income countries, poverty does feature more strongly, as do specific aspects of support that are culturally related. Antepartum depression, unwanted pregnancy, poverty, and son preference are the identified associated factors for PDS in Asian cultures (Klainin and Arthur, 2009). Low income, son preference, difficult relationship with mother-in-law and parents, adverse life event during pregnancy, and lack of physical help were found to be risk factors in India (Chandran, Tharyan, Muliyil, and Abraham, 2002). The other associated factors for perinatal depression in low-income countries (India, Pakistan, Zimbabwe, and rural South Africa) are reported to be girl child, low level of education, being a housewife, domestic violence, and perinatal death (Kermode et al., 2007; Patel et al., 2003; Rahman et al., 2003).

### 1.4 CONSEQUENCES OF PERINATAL DEPRESSIVE AND ANXIETY SYMPTOMS

Evidence, mostly from high-income countries suggests that maternal depression has long-term effects on women, their infants, and family relationships as described below.

#### 1.4.1 The women: Persistent depression

Maternal depression usually resolves spontaneously after a couple of months, but, if untreated, it may persist in up to 25%–30% of those cases that are affected one year after delivery (Brockington, 1996). A 12-month follow-up longitudinal study have shown that postnatally depressed mothers continued to rate themselves as being more tense and anxious, more depressed and dejected, more angry and hostile, more fatigued, more confused and bewildered, and less vigorous and active than the non-depressed mothers till 12 months postpartum (Milgrom and McCloud, 1996). Rahman and Creed (2007) have reported that 56% of women affected by depression in the third trimester of pregnancy are persistently depressed one year after giving birth. There is also a 30%–50% risk of relapse in future pregnancies (Cooper and Murray, 1995).
1.4.2 Mother-infant relationship

A mother’s emotional communicative skills are very important during the first postpartum period to regulate the infant’s states of arousal and emotion, and ineffective regulation may disrupt the infant’s engagement with the environment (Tronick and Reck, 2009). Depressed mothers tend to be more social withdrawn, have less interest and energy, and be more intrusive than non-depressed mothers (Stein, Lehtonen, Harvey, Nicol-Harper, and Craske, 2009). Withdrawn mothers are more disengaged and unresponsive and do little to support their children’s activities. Intrusive mothers engage in rough handling, speak angrily, poke at the children, and actively interfere with their activities (Tronick and Weinberg, 1997, Canadian Pediatric Society, 2004). The relational behavior of depressed mothers in high-income countries has been characterized by low sensitivity, restricted range of affective expressions, and inconsistent support for the infant’s growing social engagement (Feldman et al., 2009). Stein et al. (2009) proposed that mothers’ recurrent negative thinking, namely preoccupation, is a key mechanism in the transmission of psychiatric disturbance. Preoccupation interferes with specific aspects of mental functioning, especially attention and responsiveness to the environment. This impairs the mother’s parenting capacity and adversely affects mother-child interaction. Tronick and Reck (2009) argued that maternal depression distorts the emotional communication between mothers and infants that generates mismatching of emotions (the infant expressing a positive affect and the mother expressing a negative affect) and intentions (the infant intending to look away toward an object and the mother soliciting the infant to look at her). Mismatches generate negative affect and mood in the infant, whereas reparation to a matching state is associated with positive affect, leading to a sense of mastery and control over the world. The interactive mismatches are not repaired in the case of maternal depression, and consequently the infant has repeated negative experiences that can lead to the accumulation of negative affect and to the development of depression and a negative affective state of mood (Tronick and Reck, 2009).

In turn, children of depressed mothers become disengaged, unresponsive, less active, less attentive, less positive, and less vocal, and they protest more often than the children of non-depressed mothers (Edhborg, Nasreen and Kabir, 2011; Tomlinson, Cooper, Stein, Swartz, and Molteno, 2006; Canadian Pediatric Society, 2004). Murray (1992) reported that the disrupted behavior of depressed mother-child interactions at two months postpartum, when the child momentarily arrests his or her active engagement and avoids contact, as a key mechanism in later adverse cognitive development.

1.4.3 The infant: Birth, growth, and development

Table 2 summarizes the consequences of maternal perinatal depressive symptoms on birth outcome, and cognitive and behavioral development of children.

Consequences on birth outcome

Conceptual models linking exposure to antepartum psychological stress have hypothesized on its possible direct and indirect effects on LBW. There is some evidence supporting the direct effects of the psychoneuroendocrine process on poor
neonatal outcome, especially birth weight (Oberlander, Warburton, Misri, Aghajanian, and Hertzman, 2006; Field et al., 2004). Impaired mental health has also been associated with unhealthy maternal antenatal behavior including reduced attendance to antenatal care, increased substance use, and lower weight gain in pregnancy (Patel, Kirkwood, Pednekar, Weiss, and Maybe, 2006; Dayan et al., 2002), which in turn has led to an increased likelihood of LBW (Bonari et al., 2004). Despite these vulnerabilities, the evidence linking maternal depressive and anxiety symptoms with infant LBW is conflicting. Studies from India (Patel et al., 2006), Pakistan (Rahman, Bunn, Lovel, and Creed, 2007), and Brazil (Ferri et al., 2007) found an association between antepartum mental disorders and LBW. On the contrary, studies from the United States (Suri et al., 2007), Sweden (Andersson, Sundström-Poromaa, Wulff, Åström, and Bixo, 2004), China (Chung, Lau, Yip, Chiu, and Lee, 2001), and Ethiopia (Hanlon et al., 2009) have shown no significant associations. However, in high-income countries, positive associations have been reported in studies of disadvantaged populations (Diego et al., 2009) where socioeconomic status acted as an effect modifier.

**Consequences on the child’s cognitive and socio-emotional development**

Despite inconsistencies, it is likely that the early experience of a mother’s PDS may be of importance for the child’s cognitive development. Hay et al. (2001) has proposed that insensitive and incontingent responses resulting from maternal depressive symptoms act as meditational cognitive factors that prevent children from learning how to regulate their own attention and emotions, with deleterious effects on cognitive as well as social development. Murray, Cooper, Wilson, and Romaniuk (2003) draw attention to the fact that depressed mothers show a reduced level of imitation of the child’s expressions during interaction that could theoretically negatively affect the child’s ability to make distinctions between self and others.

In a review and critical analysis of literature, Grace, Evindar and Stewart (2003) showed a significant association between postpartum depression in the first year and cognitive deficit (Table 2). A follow-up study reported that eleven-year-old children whose mothers had been depressed at three months postpartum had significantly lower IQ scores, intentional problems, and difficulties in mathematical reasoning and were more likely than other children to have special educational needs. The effects of maternal depression coincide with infant gender; in other words, boys were more severely affected than girls (Hay et al., 2001). No effect of postpartum depression was found on the child’s cognitive development at 20 months, 4 years and 8 months, and 6 years and 3 months (Kurstjen and Wolke, 2001).

Studying the impact of postnatal depression on socio-emotional development, Murray (1992) found that mothers who had been depressed reported more behavioral disturbance in their children at 18 months postpartum (mostly sleeping, eating, and separation problems); also, a higher level of disturbance was observed at age five (Murray et al., 1999). Both postpartum and later depressions in mothers have been reported to be associated with hyperactivity and distractibility in their children,
particularly in boys (Grace et al., 2003). Halligan, Herbert, Goodyer, and Murray (2004) reported that maternal postnatal depression was associated with higher, more variable morning cortisol in their offspring when they become adolescents, a pattern previously found to predict major depression. Maternal PDS have also been found to be associated with depressive and anxiety disorders in adolescent offspring (Halligan, Murray, Martin, and Cooper, 2007).

Table 2. Consequences of maternal depression on child’s cognitive and behavioral development

<table>
<thead>
<tr>
<th>Stage</th>
<th>Cognitive</th>
<th>Behavioral</th>
<th>Academic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prenatal</td>
<td>Inadequate prenatal care, poor nutrition, higher preterm birth, and low birth weight</td>
<td>Passivity, withdrawal, self-regulatory behavior, and dysregulated attention and arousal</td>
<td>Lower cognitive performance</td>
</tr>
<tr>
<td>Infant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Behavioral</td>
<td>Cognitive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Passive noncompliance, less mature expression of autonomy, internalizing and externalizing problems, and lower interaction</td>
<td>Less creative play and lower cognitive performance</td>
</tr>
<tr>
<td>Toddler</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Behavioral</td>
<td>Cognitive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Impaired adaptive functioning, internalizing and externalizing problems, depressive and anxiety disorders</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School age</td>
<td></td>
<td>Behavioral</td>
<td>Academic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Impaired adaptive functioning, internalizing and externalizing problems, depressive and anxiety disorders</td>
<td>Attention deficit/hyperactivity disorder and lower IQ scores</td>
</tr>
<tr>
<td>Adolescent</td>
<td></td>
<td>Behavioral</td>
<td>Academic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Affective disorders (depression), anxiety disorders, phobias, panic disorders, substance abuse and alcohol dependence</td>
<td>Attention deficit/hyperactivity disorder and learning disorders</td>
</tr>
</tbody>
</table>

Source: Canadian Pediatric Society, 2004

Consequences on the child’s growth and physical development

Perinatal depressive symptoms may also impact negatively on children’s physical development (Murray and Cooper, 1997). It was predicted that perinatal depression would impact severely on infant growth in environments that were hostile to successful child rearing (in terms of economic resources, hygiene, and health-care availability), as there would be less of a safety net for the infants of depressed and struggling mothers (Rahman, Harrington, and Bunn, 2002). This is confirmed by studies from the US, Sweden and the UK that showed no association between maternal depression, and infant underweight (Drewett, Blair, Emmett, and Emond, 2004). In high-income countries, associations between perinatal mental disorder and poorer growth and development have been reported in studies of disadvantaged populations, where socioeconomic status acts as an effect modifier (Stewart, 2007). A number of studies in some South Asian countries, such as India (Patel et al., 2003) and Pakistan (Rahman, Iqbal, Bunn, Lovel, and Hurrington, 2004), and in Brazil (Surkan et al., 2008) and
Nigeria (Adewuya, Ola, Aloba, Mapayi, and Okeniyi, 2008), demonstrate that postpartum depression negatively impacts the physical development of the infant. Baker-Henningham, Powell, Walker, and Grantham-McGregor (2005) found maternal depression associated with poorer motor development, especially of boys, in the West Indies and Jamaica.

**Consequences of maternal anxiety on the child**

Though research on the consequences of maternal anxiety symptoms on the child has not received much attention, Gласheen, Richardson, and Fabio (2010) reported that it has similar effects on children’s emotional, behavioral and physical development as does maternal depression. There is emerging evidence of the potential negative impact of anxiety antepartum and postpartum, such as diminished feelings of efficiency in the parenting role, decreased maternal sensitivity and responsibility toward the infant (Britton, 2005), disrupted mother-child bonding and attachment (Gласheen et al., 2010), behavioral problems toward children up to 8–9 years, and increased risk of hyperactivity among preschool children in high-income countries (Luoma et al., 2001; O’Connor, Heron, Beveridge, and Glover, 2002). A systematic review of 18 studies showed that infants exposed to postpartum maternal anxiety had poorer personal-social-psychological development (Gласheen et al., 2010). Similar evidence is lacking in low-income countries.

**1.4.4 The marital relationship and the partner**

Postnatally depressed mothers consistently rate their relationship with their partners as poor on a number of dimensions, including consensus, satisfaction and support (Goodman, 2004; Klainin and Arthur, 2009). In many cases it appears that PDS exacerbates problems that existed before the pregnancy, since a poor marital relationship has been described as a risk factor for PDS (Milgrom et al., 1999). In one study, Zelkowitz and Milet (1996) reported that the spouses of women with postpartum psychiatric disorders had greater marital dissatisfaction and more change in household routines, recreation, and intimacy with partners than that of women not affected by psychiatric disorders. In a later study, Zelkowitz and Milet (2001) found that 60% of partners of the women with PDS had had a psychiatric diagnosis two months postpartum. Moreover, the spouses of depressed women reported more life stress, felt more restricted in parenthood and experienced more difficulties in their marital relationships over a 12-month period after childbirth (Milgrom & McCloud, 1996; Areias, Kumar, Barros, and Figueiredo, 1996).

**1.5 SETTING THE CONTEXT: BANGLADESH**

Born in 1971 after the liberation war, the People’s Republic of Bangladesh is a sovereign state located in South Asia. It is bordered by India on all sides except for a small border with Myanmar to the far southeast and by the Bay of Bengal to the south. Bangladesh is a deltaic land and covered with a network of rivers and canals forming a maze of interconnecting channels. This is a tropical country with a hot and rainy summer and a dry winter. The humidity varies from 73% to 86%, the highest in the monsoon and the lowest in the winter.
1.5.1 Population and demography
With a land mass of 147,570 square kilometers and a population of 143.91 million in 2007 [Bangladesh Bureau of Statistics (BBS), 2009], Bangladesh is the eighth most populous (980 persons/sq. km in 2008) countries in the world [Government of Bangladesh (GoB), 2010]. Three quarters of the population live in rural areas and one quarter in urban areas. The average household size is 4.72. The male:female ratio is 105:100. Adult (15+ years) literacy rate is 59% with a net school enrollment rate of 81% (for both boys and girls). The life expectancy at birth is 67 years (66 years for males and 68 years for female). The majority (89%) of the people are Muslim, followed by Hindu (10%), Buddhist (0.57%), Christian (0.27%), and Sikh (0.17%) (GoB, 2010).

1.5.2 Governance
Bangladesh is a unitary state governed by a parliamentary democracy. For the smooth running of government programs, the country is divided into seven administrative divisions (GoB, 2010). The divisions are subdivided into 64 districts, each further subdivided into sub-districts. The area within each sub-district, except for those in metropolitan areas, is divided into several unions, with each union consisting of multiple villages (GoB, 2010). An average village contains 1,300 to 1,400 people, an average union about 15 villages and a population of about 20,000, and an average sub-district has 8 to 10 unions with about 200,000 people. Dhaka is the capital and largest city of Bangladesh (GoB, 2010).

1.5.3 Economy
Bangladesh has an agrarian economy, although the share of agriculture to gross domestic product has decreased over the last few years. The population growth rate is 1.4% per annum and it ranks 129 in 169 countries in the United Nations Development Program (UNDP) Human Development Index (HDI) with an estimated per capita GDP of USD 621 (UNDP, 2010; BBS, 2009). According to the UNDP (2010), 83% of the population lives on less than USD 2 a day, and 25% on less than USD 1 a day. Through continuous effort by the government and the nongovernmental sectors, the incidence of poverty (below the upper poverty line) has declined from an estimated 58% of the population in 1983–84 to 40% in 2005 and 31.5% in 2010 (BBS, 2011).

1.5.4 Gender relations and the status of women
Despite some improvement in ranking in the HDI, the status of women still remains low in Bangladesh. The UNDP gender inequality index ranks Bangladesh very low, at 116 out of 169 countries (UNDP, 2010). This implies inequalities in income and education between men and women. Women experience greater deprivation and vulnerability than men do in their subordinate position and low status in a society with a patriarchal value system. Women are largely involved in the informal sector and subsistence activities. Violence against women in the form of rape, assault, trafficking and acid throwing is prevalent [United Nations Populations Fund (UNFPA), 2003]. Gender-based violence in the country aggravates the built-in gender discrimination. Several measures have been adopted to safeguard women’s legal rights, for instance,
special initiatives, such as stipend for girls, free schooling for girls, and food for education. Despite these provisions, loopholes in the existing laws and a lack of proper implementation are some of the impediments encountered. Women’s participation at the policy-making level and in politics is still very low. Despite the head of the ruling and opposition parties being women, in general, few women hold high positions in the government and the private sector. Bangladesh has a gender strategy, based on the National Policy and Action Plan on Women, coordinated by the Ministry of Women and Children’s Affairs [Asian Development Bank (ADB), 2001]. However, women in Bangladesh have to continue to fight for basic rights and status in terms of political participation, education, health care, labor force participation, mobility, food security, freedom from violence, and the recognition of and respect for their sexuality.

1.5.5 Health status and inequity
Despite modestly declining poverty and inadequate health services, Bangladesh has achieved substantial gains in the field of health in the last few decades since the nation’s independence in the 1970s (Mahmud, 2004), as evidenced in mortality and fertility declines in this low income country compared to other South Asian countries. Table 3 shows the selected health and demographic indicators in a historical perspective.

Table 3. Selected health and demographic indicators over time in Bangladesh

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude birth rate (per 1000 population)</td>
<td>47.0</td>
<td>33.0</td>
<td>20.5</td>
</tr>
<tr>
<td>Crude death rate (per 1000 population)</td>
<td>17.0</td>
<td>11.4</td>
<td>6.0</td>
</tr>
<tr>
<td>Population growth rate (%)</td>
<td>2.7</td>
<td>2.1</td>
<td>1.4</td>
</tr>
<tr>
<td>Life expectancy at birth (in years)</td>
<td>45.0</td>
<td>56.1</td>
<td>66.8</td>
</tr>
<tr>
<td>Total fertility rate (per women)</td>
<td>-</td>
<td>5.1</td>
<td>2.7**</td>
</tr>
<tr>
<td>Contraceptive prevalence rate (any modern methods)</td>
<td>-</td>
<td>23.2</td>
<td>47.5**</td>
</tr>
<tr>
<td>Complete vaccination coverage (%)</td>
<td>-</td>
<td>75.0</td>
<td>81.9</td>
</tr>
<tr>
<td>Maternal mortality ratio (per 1000 live births)</td>
<td>30.0</td>
<td>6.0</td>
<td>1.9†</td>
</tr>
<tr>
<td>Infant mortality rate (per 1000 live births)</td>
<td>150.0</td>
<td>94.0</td>
<td>52.0**</td>
</tr>
<tr>
<td>Under-5 mortality rate (per 1000 live births)</td>
<td>-</td>
<td>146.0</td>
<td>53.8</td>
</tr>
</tbody>
</table>

Source: BBS 2009; GoB (Health Bulletin) 2010; **Bangladesh Demographic and Health Survey (BDHS), 2009; †Maternal mortality survey 2010.

Although there has been considerable improvement in the health indicators, more than 60% of the population has very little access to basic healthcare [Ministry of Health and Family Welfare (MOHFW), 2003]. The number of qualified physicians and nurses in Bangladesh is quite low compared to other low-income countries (Cockcroft, Milne, and Anderson, 2004). Table 4 gives figures for Bangladesh.

Bangladesh has a highly stratified society characterized by substantial socioeconomic differentials in health-care access and utilization (Cockcroft et al., 2004), and health benefits gained from public and private health expenditures, all disfavoring the poor.
Table 4. Health service provision in Bangladesh

<table>
<thead>
<tr>
<th>Service Provided</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of doctors under health services (June 2010)</td>
<td>12,359</td>
</tr>
<tr>
<td>No. of registered nurses (March 2010)</td>
<td>25,018</td>
</tr>
<tr>
<td>No. of nurses in public sector (June 2010)</td>
<td>14,338</td>
</tr>
<tr>
<td>No. of registered midwives (March 2010)</td>
<td>23,472</td>
</tr>
<tr>
<td>No. of trained skilled birth attendants (June 2010)</td>
<td>5,179</td>
</tr>
<tr>
<td>No. of mental hospitals</td>
<td>1 (500 beds)</td>
</tr>
</tbody>
</table>

Source: GoB, 2010

Hence, the poor fare worse than better-off people almost everywhere and with respect to nearly every health indicator. Gwatkin et al. (2007) has reported a wide rich-poor gap in all health indicators as well as in health-care utilization in the country. This demands the restructuring and reorientation of the present health system to be sensitive and responsive to the needs and priorities of the poor and other disadvantaged groups in Bangladesh.

1.5.6 Millennium development goals: The Bangladesh situation

Over the last three decades, Bangladesh has undergone remarkable improvements in social indicators (life expectancy at birth 56 year in 1989–1990 to 67 years in 2008–2009) (GoB, 2010) and graduated to the ‘medium human development’ group of countries (UNDP, 2004). The value of HDI for Bangladesh increased at an average rate of 8.8% per annum during the 1990s, the fastest growing HDI in South Asia (Bangladesh Human Development Report, 2000). Bangladesh has made successful progress achieving millennium development goals (MDG) 4 and 5 on child and mother survival, respectively (GoB, 2010). The mortality of under-5 children has come down to 65 per 1000 live births in 2007 from 146 in 1990 (baseline year of MDG) indicating an average rate of reduction of 6.5% between 2000 and 2008 and 4.9% between 1990 and 2000 (BDHS, 2009; GoB and UNDP, 2008). This reduction is slightly over the final target to achieve a mortality rate of 48 by 2015 (GoB and UNDP, 2008). High immunization coverage (82%) is one of the factors responsible for the improvement in the reduction of child mortality in the country (BDHS, 2009). However, concerning child mortality, there are some lagging districts that need special attention to reach the target uniformly by 2015. Progress in neonatal mortality remains slow and neonatal mortality accounts for 41% of deaths in children younger than 5 years. Maternal mortality declined from 322 in 2001 to 184 in 2010, a 40% decline in nine years. To achieve this success, the Government of Bangladesh took combated action by ensuring 50% skilled attendance at birth in recent decades (Bangladesh Maternal Mortality Survey, 2011).

1.5.7 Health-care delivery system

Like most traditional societies, the simultaneous existence of different systems of medicine, or medical pluralism, is a fact of life in Bangladesh (Ahmed, 1993). Indeed, a wide range of therapeutic choices from self-care to traditional to modern medicine is
available. The public sector is largely used for inpatient and preventive care, while the private sector is used for outpatient curative care (World Bank, 2003). Because of the absence of any prepayment or risk-pooling mechanism, expenditure on health is mainly met by an out-of-pocket payment from the household.

The health-service delivery system in the public sector is divided into primary, secondary, and tertiary levels. At the primary level, the Upazila Health Complex is staffed by eight to ten medical doctors and supporting staff, and the Upazila Health and Family Welfare Centre by a medical assistant (with a 3-year training in therapeutics) and a midwife (with an 18-month training on delivery and maternal and child health). There is a network of community health workers (CHWs) at the community level that provides services to the community people at the doorstep (GoB, 2010). Among the CHWs there are three male health workers in each union who are supposed to make home visits every two months for preventive health-care services, and three family welfare assistants (females) who supply condoms, oral pills, and injectables during home visits. There are 89 maternal and child-welfare centers that provide emergency obstetric, antenatal, delivery, postnatal, and clinical contraception care, one for every one to two million people. Research shows that there is a 40% rate of absenteeism, particularly among medical doctors, and that about 26% of positions are vacant at the primary care level (Choudhury and Hammer, 2003). These centers also lack appropriate diagnostic facilities and medicines, causing a gradual decline in the use of government health services from 17% in 2000 to 13% in 2003 (Cockcroft et al., 2004).

Above the sub-district level, district hospitals and medical colleges (serving groups of districts) provide services at the secondary and national tertiary levels. There is a high level of unmet need among visitors to primary health care facilities (Mercer et al., 2005). A typical phenomenon is the imbalance of service utilization at public health facilities: There is low utilization of most facilities at the primary level (upazila and below) and overutilization at the secondary and tertiary levels in the district and teaching hospitals (Mahmud, 2004). Because of the unavailability and inaccessibility of public sector services at the community level, 60% of the people seek services from unqualified nonformal practitioners, such as village doctors, drug sellers, and traditional and faith healers in rural Bangladesh (Cockcroft et al., 2004).

1.5.8 Mental health in the health system
Bangladesh’s mental health policy, strategy and plan was approved in 2006 as a part of a policy, strategy, and action plan for the surveillance and prevention of noncommunicable disease (WHO, 2007). This policy lacks a strategy to screen pregnant and postpartum women for mental illnesses. According to the National Mental Health Survey during 2003–2005, 16% of the adult population in the country suffered from mental disorders. People in Bangladesh do not consider mental disorder as a disease like other diseases, and people with mental health disorders do not go to hospitals because of social stigma and unawareness. A small proportion of patients report to government facilities and receive some psychotropic medicines (WHO, 2007).
The amount of money spent on mental-health services in 2005 was less than 0.5% of health-care expenditure by the government, of which 67% was devoted to mental hospitals. There is one 500-bed mental hospital and 31 community-based psychiatric inpatient units, or a total of 0.58 beds per 100,000 people in the country (WHO, 2007). In 2006, there were 0.073 psychiatrists per 100,000 people, 0.196 nurses, 0.007 psychologists, 0.002 social workers, and 0.002 occupational therapists (WHO, 2007). According to the report, only 10 non-government (development) organizations (NGOs) are involved in individual assistance activities for individuals with mental health problems. There is no specific mental health authority, nor are there legislative and financial provisions to protect and provide support for mental health service users with respect to employment and the protection of rights in the country.

1.5.9 Maternal depression in Bangladesh

The rate of depression among women in rural Bangladesh is 14.6% (Asghar, Hussain, Alit, Khan, and Magnusson, 2007). Two studies in a rural sub-district in the southwest part of Bangladesh have reported the prevalence of antepartum depression to be 33% (Gausia, Fisher, Ali, and Oosthuizen, 2009a), of postpartum depression to be 22%, and the incidence of postpartum depression at 3 months to be 9.8% (Gausia, Fisher, Ali, and Oosthuizen, 2009b). These studies identified partner violence, unsupportive husband and/or mother-in-law and son preference as predictors of ADS (Gausia et al., 2009a). A history of past mental illness, depression in current pregnancy, perinatal death, and a poor relationship with the mother-in-law were predictors of PDS (Gausia et al., 2009b). Another study reported that depressive symptoms were related to poverty and to social and environmental conditions, such as low education, and that there was synergy between maternal depressive symptoms and maternal perception of infants as being irritable (Black et al., 2007). Only one study has shown a relationship between maternal postpartum depressive symptoms and infant stunting (Black, Baqui, Zaman, El Arifeen, and Black, 2009).
1.6 RATIONALE AND OBJECTIVES

1.6.1 Rationale
Bangladesh is committed to achieving MDGs 4 (reduction of child mortality) and 5 (improvement of maternal health) by 2015. Mental health is relevant to the achievement of these MDGs and for promoting gender equality and empowering women, reducing child mortality, and improving maternal health. However, scarce evidence exists to inform the policy about the prevalence, incidence, and risk factors of perinatal depressive symptoms and its association with infant growth. Evidence linking maternal depressive/anxiety symptoms with infant low birth weight, and poor development is still lacking in Bangladesh, due to an absence of research. This thesis aims to fill some of these gaps in knowledge. The results of the studies in this thesis can assist policy makers in considering perinatal depression as an indicator of women’s health status in a national health policy and making an appropriate strategy for the early detection and management of depressive and anxiety symptoms during pregnancy and postpartum through the deployment of community health workers across Bangladesh.

1.6.2 Objectives

General
To explore the prevalence and risk factors of depressive and anxiety symptoms surrounding childbirth and its impact on birth outcomes and infant physical development at 2–3 months and 6–8 months postpartum in rural Bangladesh.

Specific
1. To examine and identify the prevalence of potential contributors to antepartum anxiety and depressive symptoms (AAS and ADS) among women in a rural area of Bangladesh (Study I).
2. To examine the association between depressive and anxiety symptoms during the third trimester of pregnancy and low birth weight (LBW) babies at term among rural women in Bangladesh (Study II).
3. To investigate the incidence of postpartum depressive symptoms (PDS) at 2–3 months and 6–8 months postpartum and its risk factors in rural Bangladesh (Study III).
4. To examine the association of maternal perinatal depressive symptoms with infant growth and motor development up to 6–8 months of age in rural Bangladesh (Study IV).
2 METHODS AND MATERIALS

2.1 STUDY SETTING
The study was carried out in rural areas of two sub-districts of the Mymensingh district (120 km north of the capital city of Dhaka) of Bangladesh (Figure 2). This district is typical of deltaic Bangladesh and is a predominantly agricultural community characterized by heterogeneity in terms of ethnicity, culture, and language. Approximately 40% of the population lives below the poverty line (caloric intake less than 2122 kilo calorie per capita per day) (BBS, 2009). The majority of women are involved in household work and child care. BRAC (formerly the Bangladesh Rural Advancement Committee), an NGO, provides a variety of services in the area for the social and economic development of communities. BRAC’s development intervention targets the poorest of poor people with special emphasis on improving the health and socioeconomic condition of women and children through group formation in village organizations, skill development training, provision of nonformal education, and collateral free loans for income-generating activities.

![Map of Bangladesh showing the study sites](image.png)

Figure 2 Map of Bangladesh showing the study sites

The BRAC health program provides education in preventive health and nutrition as well as promotion of safe water and sanitation, immunization, family planning, pregnancy and reproductive health care, and basic curative services. The community health volunteers of BRAC, who were selected from members of village organizations...
and received training on preventive health care, deliver these services by regular household visits. Moreover, they identify pregnancies during the first trimester, estimate gestational age (based on the last menstrual period reported by the women), confirm pregnancies at 4–5 months, and register them.

2.2 STUDY DESIGN

This thesis is based on four studies originating from a community based, prospective cohort study of women during late pregnancy and 2–3 and 6–8 months postpartum, using quantitative methods. The pregnant women were selected at their third trimester of pregnancy (7 months onward of gestational week) from the pregnancy register of BRAC at the community setting when the baseline data was collected (I). The women and their infants were followed up during birth (II), 2–3 months postpartum and 6–8 months postpartum (III, IV). In the first study (I), cross-sectional baseline data was used to assess the prevalence and associated factors of depressive and anxiety symptoms during pregnancy. Studies II (involving the effect of antepartum depressive and anxiety symptoms on birth outcome), III (involving incidence and risk factors of postpartum depressive symptoms) and IV (involving impact of perinatal depressive symptoms on infant growth and development) used longitudinal data from the last trimester of pregnancy to 6–8 months postpartum. The summary facts of the different studies are shown in Table 5.

2.3 SAMPLE

2.3.1 Selection of study site

Mymensingh district has a population of 4,114,730 with 12 sub-districts, 141 unions and 2160 villages. Stratified random sampling method was followed to select two sub-districts and 10 unions (five unions per sub-district) and 154 villages (approximately 15 villages per union). Finally, respondents in their third trimester of pregnancy were selected from the BRAC pregnancy registers of the selected villages at the sub-district level.

2.3.2 Sample size

The pregnancy registration maintained by the BRAC health program provided the sampling frame for this study. The gestational age recorded in the register was verified by the interviewers during data collection. As there was no prevalence on depression available for Bangladeshi population when the study was initiated, the prevalence from South Asia was chosen as a reasonable estimate of expected prevalence. Considering the prevalence of maternal depression at 20% in India (Patel et al., 2003) and Pakistan (Rahman et al., 2004), a significance level of 5%, a power of 80%, 100 women was required in order to detect differences with an effect size of 40% between women with and without depressive symptom during the perinatal period. Hence a sample of 600 women in their third trimester of pregnancy was required in the study. Taking into account a non-response, or drop-out rate of 20%, the total sample size was 720. With an average village population of 1250 in Bangladesh, delivery rate of 3%, 37 women were
expected to give birth in each village per year. Hence 154 villages were needed to obtain the required sample size of 720 pregnant women for the study.

The mandatory requirements for participation were residence in the area and being at third trimester of pregnancy; in other words, the length of pregnancy was 7 months and onward.

Amongst 720 pregnant women, 60 (8.3%) were lost to follow-up over the period due to outmigration (11), intrauterine death (1), multiple birth (3), maternal death (2), stillbirth (25), neonatal death (6), and infant death (11) (Figure 3). Hence the sample size for different studies were different, such as 720 pregnant women during baseline in study I, 583 women and infants at birth in study II (excluded further 85 prematurely delivered infants), 588 women during 2–3 and 6–8 months postpartum in study III (excluded 132 women who had depressive symptoms during pregnancy), and 652 women and infants at 6–8 months postpartum in study IV due to flagging out further 8 cases from WHO Anthro (2005b) because of extreme value. Women lost to follow-up, were similar in the background characteristics of the participating women.

Figure 3. Loss to follow-up at different phases of the study
2.4 DATA COLLECTION

Data collection was performed during July 2008 - August 2009 through structured interviews by ten trained female interviewers at the respondents’ homes. The interviewers were sociologists or anthropologists that had received two weeks training on the questionnaire and data collection procedure, which consisted of lectures and role play to facilitate interview skills. Subsequently the questionnaires were pretested in a rural district (Gazipur) outside Dhaka. The questionnaire was revised based upon feedback received in the field test. The interviewers did not have any formal linkage with BRAC health services. They resided in the local area for a period of one year and built a sympathetic and trustworthy relationship with the community. The complete questionnaire was composed in English and translated into Bangla, and then the interviews were carried out, in Bangla.

The enumerators were divided into two groups for the two sub-districts with five members in each group, one was selected as a team leader. Each interviewer completed three questionnaires per day. To ensure the quality of data collection, a three-layered monitoring system was developed. The first layer was composed of team leaders who monitored the activities of their respective teams each evening. Their work was cross-checked, controlled and monitored by two field supervisors weekly. Lastly, the principal researcher (Hashima-E-Nasreen) based at the BRAC head office monitored field activities through field visits at regular intervals.

2.4.1 Stages of data collection

Data was collected at four stages as shown in figure 4.

Baseline data

Baseline data was collected during late pregnancy on demographic (age), socioeconomic (education, occupation, sex of household head, husband’s literacy, land owned by the household, NGO membership, selling of manual labor, access to safe water, type of latrine in the household, and per capita daily household expenditure on food), maternal anthropometric (height, weight and mid-upper arm circumference [MUAC]), reproductive health (history of dead child, planned index pregnancy, antenatal consultation [ANC]), social support network (family and social support, perceived relationship with husband and mother-in-law), intimate partner violence, and depressive and anxiety symptoms.

Child birth

At birth, data was collected on a broad array of obstetric outcomes, such as length of pregnancy, mode and place of delivery, sex of the newborn, complications during labor, live or still birth, and birth weight, height, and head circumference of the newborn.
Figure 4. Schematic diagram over data collection

For home delivery, data were collected in the homes of the women upon their recovery from labor. The time periods varied between 2 to 48 hours following delivery. In hospital delivery cases, birth data were taken from the hospital records.

**First follow-up at 2 – 3 months postpartum**
At 2-3 months postpartum, the mothers were assessed for depressive and anxiety symptoms. Information on previous depressive symptoms was also collected. The infant weight and height were measured as infant growth indicators and the mothers were asked about the information about breastfeeding, infant’s illnesses and mother’s bonding with infant.

**Second follow-up at 6–8 months postpartum**
At 6–8 months postpartum, maternal depressive and anxiety symptoms, and infant’s weight and height were assessed. Mothers are asked about the infant’s breastfeeding, supplementary feeding, illnesses, temperament and motor development.

### 2.5 ASSESSMENT OF BACKGROUND PREDICTORS
The summary of the four studies in terms of design, variables and analyses are shown in Table 5. Analysis such as Cronbach’s alpha that used to see the internal reliabilities of different measurement scales are specified in the table.
<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>Independent variables</th>
<th>Dependent variables</th>
<th>Statistical analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Cross-sectional</td>
<td>Age, SES, obstetric history, family support, partner violence</td>
<td>Antepartum depressive (ADS) &amp; anxiety symptoms (AAS)</td>
<td>Independent t-test, $X^2$, unadjusted and multiple logistic, and multiple linear regression</td>
</tr>
<tr>
<td>II</td>
<td>Prospective cohort</td>
<td>Age, SES, maternal nutrition, support during pregnancy, partner violence, ADS, AAS</td>
<td>Low birth weight</td>
<td>Independent t-test, $X^2$, unadjusted and multiple logistic regression</td>
</tr>
<tr>
<td>III</td>
<td>Prospective cohort</td>
<td>Age, household SES, maternal malnutrition, number of children, family/social support partner violence, AAS, previous depression, child sex, infant illness, breastfeeding, maternal bonding with infant</td>
<td>Depressive symptoms at 2–3 &amp; 6–8 months postpartum</td>
<td>Incidence proportion, unadjusted and multiple Cox regression</td>
</tr>
<tr>
<td>IV</td>
<td>Prospective cohort</td>
<td>Age, SES of household, ante- &amp; post- partum depressive symptoms, women’s &amp; child’s anthropometrics, support and social network, mother’s bonding with infant, infant’s temperament, illness, breastfeeding</td>
<td>Infants weight-for-age, height-for-age, motor development</td>
<td>Independent t-test, $X^2$, multiple linear regression</td>
</tr>
</tbody>
</table>

### 2.5.1 Demographic and socioeconomic variables

The age of each woman was calculated in years (I, II, III, and IV).

Socioeconomic status (SES) was indicated by the parental literacy (ability to read and write) and education (years of completed schooling), and economic status of the household (I, II, III, IV). Three measures were used to assess household economy: the woman’s involvement in income-earning activities, the amount of land owned by the household and per capita daily household expenditure on food in study I. Study II only used the latter two indicators to define the household economy. Poor household economic status was assessed if the household owned <50 decimals of land or if the per capita daily household expenditure on food was less than the median in Bangladeshi taka of BDT 31.25 (USD 0.45).

Study III and IV defined SES status by the women’s education (completed years of schooling), occupation as homemakers versus employed, and socioeconomic status of the household. SES of the household was measured by an index computed through principal component analysis using data on sex of household head, husband’s literacy, land owned by the household, NGO membership, selling manual labor, access to safe
water, type of latrine in the household, and per capita daily household expenditure on food. Based on the index, the household was ranked 1-3, 1 indicating low and 3 high SES of household. In study III, SES index was categorized as poor (rank 1) and non-poor (rank 2 and 3).

2.5.2 Women’s anthropometric measures
Anthropometric indicators of the pregnant women at baseline included mean weight (kg), mean height (m), mean maternal body mass index (BMI) [weight (kg)/height x height (m)²] and mean mid-upper arm circumference (MUAC) (cm). However, since BMI was measured during pregnancy, it is assumed to be over reported. Hence, MUAC was considered as a proxy indicator of nutritional status of women as it is independent of gestation and height (II, IV).

2.5.3 Obstetric and reproductive variables
Obstetric and reproductive indicators encompassed the number of live and dead children, planned current pregnancy (yes vs. no), antenatal consultation by health personnel (yes vs. no), parity (primi vs. multi), number of children (>4 children vs. ≤4 children) and planned current pregnancy (yes vs. no) (I, II, III, IV).

2.5.4 Social and family support
Family support was indicated by practical support from family members during pregnancy and women’s perception of relationship with the husband and mother-in-law. Practical support included any kind of domestic help in household chores, such as cooking, washing, cleaning, or child rearing (yes vs. no) (I). Social support was measured by family structure, such as living in a nuclear family or extended family, and practical and psychological support (from family members, friends, or health professionals) (yes vs. no) (II). Study III encompassed both family and social support, where family support was indicated by the women’s perception of the relationships with husband and mother-in-law (good vs. poor), and social support by practical support from family members/relatives, support from health professionals, and having trusting relationship with close friends (yes vs. no).

2.5.5 Partner violence
Partner violence was indicated by physical violence ever, forced sex ever, and partner violence during the indexed pregnancy. Physical violence ever included being slapped, shoved, punched, kicked or dragged on the ground by the partner (Garcia-Moreno, Jansen, Ellsberg, Heise, and Watts, 2006). Physical violence was scored 0–4 based upon number of violent acts faced. For the purpose of the analysis physical violence was categorized as no act of violence (score 0) and acts of violence (score 1–4); violence during pregnancy as yes vs. no (I, II, III). Forced sex was considered if the women reported that they had been forced by their husbands into sexual intercourse (yes vs. no) (I).
In addition, study III included women’s autonomy measured by women’s independence to make decisions in family matters, going to market and visiting parental home (yes vs. no).

### 2.5.6 Previous depressive symptoms
Women were asked about their previous experiences of depressive symptoms in terms of their feelings of similar problems as we asked in the EPDS earlier, and the variable was dichotomized as yes vs. no (I, III).

### 2.6 ASSESSMENT OF MATERNAL DEPRESSIVE AND ANXIETY SYMPTOMS
Research in this area requires tools for measuring maternal depressive and anxiety disorders. Reliable diagnoses of depression and anxiety disorders can be made using a standardized clinical interview and comparing the symptoms by DSM-IV criterion or ICD 10. Screening tools can be used, to measure depressive symptoms either by self-reports or in interviews. Although not diagnostic, these can be used as proxy measures of depressive disorder after validation against interviews by psychiatrists (Cox, Holden, and Sagovsky, 1987).

#### 2.6.1 Antepartum and postpartum depressive symptoms
This thesis used the Edinburgh Postnatal Depression Scale (EPDS) to measure ADS and PDS. EPDS is a 10-item self-report scale, specifically designed to screen for postnatal depression in community samples (Cox et al., 1987). Each item is scored on a 4-point scale (0 to 3), and the total score ranged from 0 to 30. The scale rates the intensity of depressive symptoms present within the last seven days. Five of the items are concerned with dysphoric mood itself, two with anxiety, and one each with guilt, suicidal ideas and ‘not coping’. EPDS is widely used in the world and it has been validated in a number of South-Asian countries including India and Bangladesh (Patel et al., 2002; Gausia, Fisher, Algin, and Oosthuiuzen, 2007).

EPDS cannot confirm a diagnosis of depressive disorder. However, using >12 as a cutoff, Cox et al. (1987) showed a sensitivity of 86%, a specificity of 78%, and positive predictive value of 73% for major depressive disorders at postpartum. Another validation of EPDS in a large community sample, using the same cutoff, showed a sensitivity of 68%, specificity of 96% and a positive predictive value of 67% for both major and minor depressive disorder (Murray and Carothers, 1990). As it is important in some clinical and research settings to find all persons affected by major depressions, a cutoff level of ten (≥10) was proposed to reduce detection failure (Cox et al., 1987). When selecting this threshold, the sensitivity for the detection of major depression increased to almost 100% with a specificity of 82% (Harris, Huckle, Thomas, John, and Fung, 1989). In Bangladesh, a validation study by Gausia et al. (2007) showed a sensitivity of 89%, specificity of 87%, positive predictive value of 40% and negative predictive value of 99% using 10 as the cutoff score.
EPDS has also been validated for use during pregnancy. Using a cutoff of >12, the sensitivity for major depression was 100%, specificity 87% and positive predictive value 33%. One-fourth of the false positive had a minor depression. For major depression, the cutoff>14 was optimal as the sensitivity was 100%, false positive rate 4% and positive predictive value 60% (Murray and Cox, 1990).

In addition to the clinical applications for which it was designed, EPDS has much potential as a research tool (Green and Murray, 1994). Validation of EPDS in non-postpartum women showed similar validity as for postpartum women at the cutoff >12 (Cox, Chapman, Murray, and Jones, 1996).

The cutoff score suggested by Gausia (2007) was used to categorize depressed (score ≥10) and non-depressed (score <10) states both in ante- and postpartum period in this study. The scale demonstrates good reliability in the present study with a Cronbach’s alpha of 0.87 for assessment of ADS and 0.70 and 0.75 for depressive symptoms at 2–3 months and 6–8 months postpartum, respectively.

2.6.2 Antepartum anxiety symptoms
General anxiety was assessed using the trait-anxiety scale of the State-Trait Anxiety Inventory (STAI), which has been validated against the pregnancy-related anxiety questionnaire and is often used to assess anxiety in pregnancy (Huizink, Mulder, Medina, Visser, and Buitelaar, 2004; Spielberger, 1983). STAI-trait consists of 20 items scoring from 1 to 4. The scale assesses anxiety levels in general, such as feelings of pleasure, nervousness, restlessness, satisfaction, or happiness. STAI-trait is a reliable and valid measure that can be used in both clinical and general populations (Spielberger, 1983). A cutoff score of 45/46 was used to categorize anxious (score ≥45) or not-anxious (score <45) states (Austin et al., 2007). Translation and back translation of the items on the scale was done by two bilingual social science researchers. Qualitative in-depth interviews with rural pregnant women outside the study area on the items of STAI helped to identify appropriate terminology in Bangla. STAI demonstrated good internal consistency in the present study with a Cronbach’s alpha of 0.82 for the antenatal assessment. Stability test was performed by Spilt-Half test (equivalent to test and re-test) which showed Spearman-Brown Coefficient is 0.809 and Guttman Split-half co-efficient 0.808. Dimensionality of the scale is good as indicated in the factor analysis through KMO and Bartlett’s test, 0.878 p<0.001. The correlations of all items value >0.5.

2.7 ASSESSMENT OF INFANT CHARACTERISTICS

2.7.1 Birth weight
Infant birth weight was measured to the nearest 0.1 kilogram within 48 hours of birth by trained interviewers using a portable digital Salter bathroom scale (Japan) in case of home delivery. The mother was requested to hold the baby while being weighed, and the baby’s weight was calculated by subtracting the mother’s weight from the sum
weight of mother and baby. The standard cutoff for LBW 2500 grams or less was used (Valero de Berbabé et al., 2004) (II, IV).

2.7.2 Infant's anthropometrics and nutritional status
Infant’s length and weight were measured at 2–3 months and 6–8 months. Infants were weighed to the nearest 0.1 kilogram using the same procedure as used in birth weight. Length was measured by a measuring tape to the nearest 0.1 centimeter. The measurements were compared with the growth standards of the World Health Organization (WHO) using WHO Anthro 2005b. Three anthropometric indices were used: weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ) expressed in terms of z-scores to categorize stunting (HAZ < −2), underweight (WAZ < −2), and wasting (WHZ < −2) (IV).

2.7.3 Mother’s bonding with infant
The mother’s bonding with the infant at 2–3 months postpartum was assessed by three sub-scales of the Postpartum Bonding Questionnaire (PBQ) (Brockington et al., 2001): impaired bonding (12 items), rejection and anger toward the infant (7 items), and anxiety about care (4 items). The sub-scales were scored 0–5, and a high score indicated more bonding problems (III, IV). The Cronbach’s alpha on the three sub-scales ranged from 0.51–0.65. The scale has previously been used in Bangladesh (Edhborg et al., 2011).

2.7.4 Infant temperament
Infant characteristics questionnaire (ICQ) (Bates, Freeland, and Lounshury, 1979), previously used in Bangladesh (Black et al., 2007), assessed mothers’ perceptions of the infants’ temperament. The ICQ comprised four sub-scales, including fussy and difficult (9 items), unadaptable (5 items), unpredictable (6 items), and dull (4 items), rated 1–7, and a higher score indicating more difficult infant temperament (III, IV). The Cronbach’s alpha was between 0.45 and 0.79 on the four sub-scales.

2.7.5 Infant’s motor development
Motor development (IV) was assessed by the infant reaching special milestones (Yaqoob, Femgren, Jalil, Nazir, and Karlberg, 1993). As the motor development assessment was done at 6–8 months, only 9 of the 12 milestones were used (holding head, lifting head, picking up cubes, transferring objects, sitting with support, hand-and-knee crawling, sitting without support, pulling self to stand, standing with assistance). The performance of each milestone was evaluated by the following coding possibilities: inability – the infant tried but failed; refusal – the infant was calm and alert, but refused to cooperate; ability – the infant performed the task; mother’s reporting of infant’s ability to perform the task; and, unable to test – the infant’s emotional state interfered with the testing. For the analyses, each milestone was coded as 1 = ability (the infant could perform or the mother said he/she could) and inability = 0 (the infant failed, refused, or was unable to perform the test). Finally, a scale was composed ranging from 0 to 9 to assess the infant’s ability to perform the designated motor activities at 6–8 months.
The other characteristics of the infant considered in the study were sex (boy=0, girl=1), breastfeeding practices, infant’s illnesses in general, and history of diarrhea or acute respiratory infection (yes versus no) (III, IV).

2.8 ANALYSIS
Descriptive analyses were performed for the background characteristics of respondents (I, II, IV), prevalence of ADS and AAS (I), and incidence of PDS (III). Independent t-tests and bi-variate analyses ($X^2$ test and Fisher’s exact two-sided p test) were conducted to characterize the group level differences in depressed and anxious state (I, II, III). Chi-square statistics and univariate logistic regression, or Cox regression were performed for each indicator of independent variables in all studies (Table 6). All factors with p<0.05 were included in the multiple linear regression Enter model (I, IV), logistic regression Enter model (I, II), and Cox regression Backward model (III) for controlling the simultaneous confounding effects of possible risk and protective factors to find the study specific determinants of the associations. We reported odds ratios (OR) or hazard ratios (HR) at a 95% confidence level to indicate the likelihood of reporting depressive and anxiety symptoms (I, III), and to indicate the association between depressive and anxiety symptoms with infant’s LBW (II), HAZ (<-2SD) and WAZ (<-2SD) (IV). We used the Enter method in a multiple logistic regression model to determine the associated factors of ADS and a multiple linear regression model for AAS. As EPDS was used with a definitive cutoff to indicate women with or without depressive symptoms, we used it as a dichotomized outcome variable in the multiple logistic and Cox regression model, and the independent variables were dichotomous or categorical (I, II, III). STAI-trait did not have any definitive cutoff and was used as a continuous scale in the multiple linear regression model in study I. Height-for-age and weight-for-age was also used as continuous scale in study IV. Any violation of assumption was observed by examining the interaction between explanatory variables and outliers in all models, and diagnostic tests in the linear regression model.

2.9 ADDITIONAL INFORMATION THROUGH QUALITATIVE DATA
A qualitative exploration was carried out with thirty women (15 depressed and 15 non-depressed) who were randomly selected from the 720 pregnant women screened by the Edinburgh Postnatal Depression Scale (EPDS) for depression status. Semi-structured interviews were conducted to understand women’s perception of depression and anxiety, problems faced during these conditions, reasons behind them, its impact on activities and health, coping mechanisms and support needed from the community. Interviews and notes were taken simultaneously by an anthropologist and a social scientist. Two researchers read the qualitative interviews independently. The contents were coded, categorized and some themes emerged from the women’s perceptions of depression encompassing sadness, anxiety (“mental strain”) and negative thinking and lack of concentration due to financial strain, lack of understanding by husband, violence, and lack of practical support. These data were not used in this thesis, but facilitated understanding the quantitative data, particularly for the depressive and anxiety symptoms at the community settings.
2.10 ETHICAL CONSIDERATIONS
The study was approved by the Bangladesh Medical Research Council [BMRC/Eth.C/2008/402] in Bangladesh and the Regional Ethical Board at the Karolinska Institutet, Sweden [2008/919-31].

Detailed information about the study was provided verbally to the participants in presence of a witness. The interviews were conducted after obtaining verbal informed consent as many of the respondents were illiterate. To ensure that the individual was fully informed, we informed about the nature, duration, purpose and methods involved in the research. We only interviewed those individuals who had given their voluntary/autonomous consents to participate.

The respondents’ identities were kept confidential. They were assured that identifying information would not be made available to anyone who is not directly involved in the study. Obviously, the anonymity standard is a stronger guarantee of privacy, but sometimes it was difficult to follow as we collected information from the same participants at different points in time. We followed strictly the principle of confidentiality, which essentially means that the individuals were identified by code numbers and all data were used solely for research purpose.

Taking into account participants’ right to service, if a woman scored more than 16 on the EPDS during the study, we referred her to the psychiatric department of a nearby hospital. Mothers with low birth weight babies, and underweight/stunting infants were advised to take services from the nearest maternal, neonatal and child health unit of both government and non-government organizations.
3 RESULTS

3.1 SAMPLE PROFILES

The sample profiles of the participating women in the four studies are shown in Table 6 and 8. Although the sample sizes differed in the studies, the baseline characteristics in terms of all background indicators remained similar in all studies (I, II, III, and IV).

3.1.1 Socioeconomic and anthropometric profile

The baseline sample included 720 women in the third trimester of pregnancy with a mean age of 25 years. Almost 60% of the study sample was literate. The average level of schooling was 3.7 years. More than 90% of the women were homemakers (Table 6). Approximately 30% of the women were involved in income-earning activities, such as weaving, handicraft, or poultry rearing (data not shown).

<table>
<thead>
<tr>
<th>Baseline characteristics</th>
<th>Study I N = 720</th>
<th>Study II N = 583</th>
<th>Study III N = 588</th>
<th>Study IV N = 652</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socioeconomic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age (±SD)</td>
<td>24.6 (±6.2)</td>
<td>24.6 (±6.6)</td>
<td>24.1 (±5.9)</td>
<td>24.2 (±6.7)</td>
</tr>
<tr>
<td>Years of schooling (±SD)</td>
<td>3.7 (±3.5)</td>
<td>3.7 (±3.5)</td>
<td>3.9 (±3.5)</td>
<td>3.7 (±3.3)</td>
</tr>
<tr>
<td>Primary occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homemakers (%)</td>
<td>94.0</td>
<td>94.5</td>
<td>94.6</td>
<td>94.3</td>
</tr>
<tr>
<td>Land owned by the households (&lt;50 decimal) (%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Median per capita daily household expenditure on food (BDT)</td>
<td>31.25</td>
<td>31.25</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SES Index of household (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>-</td>
<td>-</td>
<td>31.7</td>
<td>32.8</td>
</tr>
<tr>
<td>Middle</td>
<td>-</td>
<td>-</td>
<td>32.5</td>
<td>32.5</td>
</tr>
<tr>
<td>High</td>
<td>-</td>
<td>-</td>
<td>35.9</td>
<td>34.7</td>
</tr>
<tr>
<td>Social/family support (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living in joint family</td>
<td>81.1</td>
<td>83.0</td>
<td>-</td>
<td>81.1</td>
</tr>
<tr>
<td>Poor relationship with husband</td>
<td>23.9</td>
<td>-</td>
<td>19.6</td>
<td>23.8</td>
</tr>
<tr>
<td>Poor relationship with mother-in-law</td>
<td>48.1</td>
<td>-</td>
<td>47.6</td>
<td>47.3</td>
</tr>
<tr>
<td>Received emotional support</td>
<td>95.7</td>
<td>96.3</td>
<td>-</td>
<td>95.9</td>
</tr>
<tr>
<td>Received practical support from family</td>
<td>80.7</td>
<td>82.8</td>
<td>-</td>
<td>80.7</td>
</tr>
<tr>
<td>Received support from a health provider</td>
<td>-</td>
<td>-</td>
<td>45.1</td>
<td>-</td>
</tr>
<tr>
<td>Trust and share feeling with close friends</td>
<td>-</td>
<td>-</td>
<td>49.8</td>
<td></td>
</tr>
<tr>
<td>Partner violence (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever experienced physical violence</td>
<td>70.0</td>
<td>67.5</td>
<td>67.5</td>
<td>69.8</td>
</tr>
<tr>
<td>Experience violence during pregnancy</td>
<td>18.1</td>
<td>15.5</td>
<td>15.5</td>
<td>17.9</td>
</tr>
</tbody>
</table>
Almost 60% of the respondents owned less than 50 decimals of land (100 decimals = 1 acre), indicating poor economic status in terms of ownership of land. The median daily per capita household expenditure on food was BDT 31.25 (USD 0.45) signifying that half of the household were poor. Approximately 97% of the women were Muslim (data not shown). One-third of the sample belonged to the household of low SES (Table 6). The mean weight of participating women is approximately 48 kilogram and the mean BMI 21 (Table 7).

3.1.2 Family/social support and intimate partner violence

Seven in ten participants reported being the victim of at least one single act of physical intimate partner violence, one third of multiple acts, and eight in ten experienced being forced into having sex with their spouse. Eighteen percent reported physical violence during the current pregnancy. Despite the high prevalence of reported intimate partner violence, only one-fifth to one-quarter rated their relationship with their husband as bad. Half of the women reported that they had a bad relationship with their mother-in-law. However, almost eighty percent of the participants stated that they had experienced practical support during the current pregnancy from family members. The source of the support in most cases was the husband or the mother-in-law.

Table 7. Physical, biological and mental health profile of the participating women

<table>
<thead>
<tr>
<th>Baseline characteristics</th>
<th>Study I N = 720</th>
<th>Study II N = 583</th>
<th>Study III N = 588</th>
<th>Study IV N = 652</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Anthropometric</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight ± SD kg</td>
<td>-</td>
<td>47.9 (±6.9)</td>
<td>-</td>
<td>48.1 (±6.9)</td>
</tr>
<tr>
<td>MUAC ± SD cm</td>
<td>23.3 (±2.3)</td>
<td>23.4 (±2.3)</td>
<td>23.4 (±2.3)</td>
<td></td>
</tr>
<tr>
<td>BMI ± SD</td>
<td>21.3 (±2.6)</td>
<td>21.4 (±2.7)</td>
<td>21.3 (±2.6)</td>
<td></td>
</tr>
<tr>
<td><strong>Reproductive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primipara (%)</td>
<td>27.8</td>
<td>29.8</td>
<td>29.8</td>
<td>-</td>
</tr>
<tr>
<td>Mean number of children ±SD</td>
<td>1.9 (±1.9)</td>
<td>1.8 (±1.8)</td>
<td>1.8 (±1.8)</td>
<td>-</td>
</tr>
<tr>
<td>Planned index pregnancy (%)</td>
<td>51.1</td>
<td>-</td>
<td>53.9</td>
<td></td>
</tr>
<tr>
<td><strong>Mental health</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPDS mean score (antepartum)</td>
<td>-</td>
<td>6.3 (±3.8)</td>
<td>-</td>
<td>6.3 (±3.7)</td>
</tr>
<tr>
<td>STAI mean score (antepartum)</td>
<td>-</td>
<td>41.0 (±7.1)</td>
<td>39.7 (±6.2)</td>
<td>-</td>
</tr>
<tr>
<td>Previous depressive symptoms (%)</td>
<td>11.9¹</td>
<td>-</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td><strong>Obstetric (index pregnancy)</strong></td>
<td>-</td>
<td>89.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Home delivery (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrumental delivery (%)</td>
<td></td>
<td>6.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean gestational age at week (±SD)</td>
<td>40.0 (±1.3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mother-infant bonding at 2–3 months postpartum, mean±SD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impaired bonding</td>
<td>-</td>
<td>6.7 (±3.9)</td>
<td>6.7 (±3.8)</td>
<td></td>
</tr>
<tr>
<td>Rejection and anger</td>
<td>-</td>
<td>4.4 (±3.4)</td>
<td>4.5 (±3.3)</td>
<td></td>
</tr>
<tr>
<td>Anxious about infant care</td>
<td>-</td>
<td>3.0 (±2.1)</td>
<td>3.0 (±2.1)</td>
<td></td>
</tr>
</tbody>
</table>

¹N=671, because was collected during 2–3 months postpartum when 49 women were lost to follow-up
Forty-five percent of the women had received support, such as antenatal consultation (ANC) and related support to their health problems, from community health workers during the indexed pregnancy (Table 6).

### 3.1.3 Reproductive history

Almost one-third of respondents were primiparas. The mean number of children was around 2. Half of the indexed pregnancies were planned (Table 7). Twenty-three percent of the mothers had experienced the death of 1–3 children including miscarriage and stillbirth. Forty-four percent of women received at least one ANC from a health care provider during the antenatal period (data not shown).

### 3.1.4 Obstetric profile of the indexed pregnancy

Eighty-nine percent of the deliveries took place at home by traditional birth attendants at the gestation age of 40 weeks. Amongst the deliveries that occurred at hospital, approximately 6% was done by cesarean section (Table 7). No significant differences were noted with respect to complicated labor and instrumental delivery between depressed and non-depressed, anxious and non-anxious women (data not shown).

### 3.1.5 Mental state

The mean score of depressive symptoms and anxiety symptoms during the last trimester of pregnancy was found to be similar in studies II, III & IV (Table 7). The mean scores in all items of EPDS were found to be significantly higher among depressed women compared to the non-depressed (data not shown). Approximately one in ten women reported a previous history of depressive symptoms (Table 7).

When respondents were assessed on the EPDS scale during pregnancy, the highest mean score was found on the item ‘things have been getting on top of you’ followed by ‘look forward with enjoyment to things’, ‘blamed yourself unnecessarily when things went wrong’, and ‘felt sad or miserable’ and so on. The depressed women scored highest on the item ‘felt sad or miserable’ and then ‘things have been getting on top of you’. Approximately 4% women reported on the thought of harming herself, amongst two depressed women thought about this quite often (data not shown).

### 3.1.6 Maternal bonding with infants

Mothers’ bonding with infants at 2–3 months postpartum showed the consistent state of impaired bonding, rejection and anger, and anxious about care in studies III and IV (Table 7). Similarly, impaired mother-infant bonding was found mainly among women with PDS (III) (data not shown).
3.2 PROFILE OF THE PARTICIPATING INFANTS

The profile of the participating infants is given in Table 8. Irrespective of depression and anxiety state, 19% (n = 108) of the mothers had delivered low birth weight (LBW) babies at term, 14% (n=95) premature babies, and 4% (n=25) stillbirths.

Table 8. Profile of the participating infants

<table>
<thead>
<tr>
<th>Infant’s anthropometrics at birth [M (SD)]</th>
<th>Study II N=583</th>
<th>Study III N=548</th>
<th>Study IV N = 652</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>2.9 (0.4)</td>
<td>2.9 (0.4)</td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>45.9 (3.2)</td>
<td>45.9 (3.3)</td>
<td></td>
</tr>
<tr>
<td>Head circumference (cm)</td>
<td>34.0 (1.5)</td>
<td>34.0 (1.7)</td>
<td></td>
</tr>
<tr>
<td>Prematurity (&lt;37 weeks) (%)</td>
<td>-</td>
<td>13.0</td>
<td></td>
</tr>
<tr>
<td>Low birth weight (≤2.5 kg) (%)</td>
<td>18.5</td>
<td>17.6</td>
<td>19.6</td>
</tr>
<tr>
<td>Sex of the infant (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girl</td>
<td>48.4</td>
<td>48.6</td>
<td>50.7</td>
</tr>
<tr>
<td>Boy</td>
<td>51.6</td>
<td>51.4</td>
<td>49.3</td>
</tr>
<tr>
<td>Exclusive breastfeeding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Until age 2–3 months (%)</td>
<td>-</td>
<td>42.6</td>
<td>-</td>
</tr>
<tr>
<td>Until age 6–8 months (%)</td>
<td>-</td>
<td>-</td>
<td>40.0</td>
</tr>
<tr>
<td>Mother’s perception of infant’s temperament at 6–8 months [Mean (SD)]</td>
<td>-</td>
<td>-</td>
<td>29.6 (8.4)</td>
</tr>
<tr>
<td>Fussy/difficult</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadaptable</td>
<td></td>
<td></td>
<td>16.8 (6.0)</td>
</tr>
<tr>
<td>Unpredictable</td>
<td></td>
<td></td>
<td>17.0 (4.6)</td>
</tr>
<tr>
<td>Dull</td>
<td></td>
<td></td>
<td>9.8 (3.7)</td>
</tr>
<tr>
<td>Infant’s illness (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>88.3</td>
<td>98.3</td>
<td></td>
</tr>
<tr>
<td>Acute respiratory infection</td>
<td>8.8</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>Diarrhea</td>
<td>4.4</td>
<td>9.4</td>
<td></td>
</tr>
</tbody>
</table>

The rate of LBW was higher among depressed and anxious women. No significant differences were noted between depressed and non-depressed women, and anxious and non-anxious women, in terms of the average birth weight of infants and gestational age at delivery. Head circumference of the newborns was found to be significantly lower among the depressed and anxious women compared to their counterparts (data not shown).

Boys and girls were equally represented in the sample. Four in 10 women exclusively breastfed their babies till 6–8 months. Approximately nine in 10 infants had suffered from general illnesses at age 2–3 months and nearly all of them at age 6–8 months. Higher proportion of children suffered from diarrhea at 6–8 months when the complementary feeding was initiated (5.3 months ±1.0).

The mean score (±SD) of weight-for-age (WAZ) was −1.16±1.15 and −1.36±1.01 at 2–3 and 6–8 months, respectively and height-for-age (HAZ) −2.37±1.63 and −2.64±1.28. At 2–3 months, 23.3% of the infants were underweight (WAZ < −2), 58.4% stunted (HAZ < −2), and 5.2% wasted (HWZ < −2). At 6–8 months, 24.2% were underweight, 70.7% stunted, and 2.6% wasted. Due to the small numbers, wasting was excluded.
from further analysis. In the milestone scale, infants scored 7.2 ± 1.5 (mean ± SD) at 6–8 months (data not shown).

### 3.3 OCCURRENCE AND ASSOCIATION OF PERINATAL DEPRESSIVE AND ANXIETY SYMPTOMS

#### 3.3.1 Prevalence of perinatal depressive and anxiety symptoms

Of the 720 participants assessed at the third trimester of pregnancy, 132 had EPDS scores ≥10, indicating an ADS point prevalence of 18% (CI\textsubscript{95%} 15.9–20.7), with a mean score 12.3 (SD 2.8) (I). Results revealed that the point prevalence of depressive symptoms went down to 14% (CI\textsubscript{95%} 11.5–16.7) after delivery at 2–3 months, mean score 12.0 (SD 2.0) and increased to 32% (CI\textsubscript{95%} 28.2–35.3), mean score 11.7 (SD 1.7) at 6–8 months postpartum (Figure 5) (III).

Similarly, the point prevalence of AAS (STAI Trait ≥45) was 29.4% (CI\textsubscript{95%} 26.1–32.7), mean score 49.6 (SD 4.6) during the pregnancy (I). High co-morbidity was found between depressive and anxiety symptoms during pregnancy. Amongst 132 women with depressive symptoms during pregnancy, 86 (65.2%) had both ADS and AAS (data not shown).

#### 3.3.2 Incidence of postpartum depressive symptoms

A total of 139 participants developed depressive symptoms (scored ≥10 on EPDS) from the third trimester of pregnancy to 6–8 months postpartum. Thus the overall rate of new episodes of depressive symptoms during the period (mean 40.3±3.1 weeks) was 23.6% (CI\textsubscript{95%} 20.2–27.0) (data not shown).

![Figure 5. Prevalence and incidence proportion of depressive symptoms during the last trimester of pregnancy to 2–3 months postpartum and 2–3 to 6–8 months postpartum](image-url)
The incidence proportion of PDS in the first 2–3 months postpartum was 8% (CI\textsubscript{95%} 5.8–10.2), and from 2–3 to 6–8 months postpartum 18% (CI\textsubscript{95%} 15.0–21.8) (Figure 5) (III).

### 3.3.3 Associated factors of antepartum depressive and anxiety symptoms

A number of independent factors potentially associated with ADS and AAS were examined. These were organized into factors defined as socioeconomic, family support, intimate partner violence, obstetric, and previous history of depressive symptoms (Figure 6 and Table 9) (I).

After adjusting the multivariate logistic regression model, ADS was significantly associated with six factors (Figure 6). These were older maternal age (≥35 years) (OR = 3.00; CI\textsubscript{95%} = 1.12–8.01), literacy (OR = 0.59; CI\textsubscript{95%} = 0.37–0.95), poor relationship with husband (OR = 2.23; CI\textsubscript{95%} = 1.37–3.62), forced sex ever (OR = 1.95; CI\textsubscript{95%} = 1.01–3.75), physical violence (OR = 1.69; CI\textsubscript{95%} = 1.02–2.80), and previous history of depressive symptoms (OR = 4.62; CI\textsubscript{95%} = 2.72–7.85). It is noted that considering <20 years as a reference category, women of 20–34 years (OR = 1.48; CI\textsubscript{95%} = 0.71–3.06) was not found to be at risk of developing ADS in the adjusted model.

![Figure 6. Associated factors of antepartum depressive symptoms (ADS) among women in a rural area of Bangladesh using multiple logistic regression model](image)

Figures without \(p\) value are not significant
Using the Wald estimates, a previous history of depressive symptoms showed the strongest association with ADS, followed by poor relationship with husband, older maternal age, literacy, physical violence, and forced sex. No significant interaction between the explanatory variables was found (data not shown). The models indicated almost the same log-likelihood ratio (-540.23) after excluding outliers (-538.98). A Hosmer-Lemeshow test (p = 0.794) indicated that the model fit the data well (I).

Table 9. Linear regression models examining associated factors of general anxiety symptoms (AAS) among rural Bangladeshi women during third trimester of pregnancy (N = 720)

<table>
<thead>
<tr>
<th>Associated factors</th>
<th>B</th>
<th>Std. error</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socioeconomic indicators</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age*</td>
<td>-0.035</td>
<td>0.051</td>
<td>0.499</td>
</tr>
<tr>
<td>Literacy (yes = 1, no = 0)</td>
<td>-2.079</td>
<td>0.543</td>
<td>0.000</td>
</tr>
<tr>
<td>Involved in income-earning activity (yes = 1, no = 0)</td>
<td>0.332</td>
<td>0.543</td>
<td>0.534</td>
</tr>
<tr>
<td>Per capita daily household expenditure on food*</td>
<td>-0.077</td>
<td>0.019</td>
<td>0.000</td>
</tr>
<tr>
<td>Family support</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship with husband (poor = 1, good = 0)</td>
<td>2.344</td>
<td>0.632</td>
<td>0.000</td>
</tr>
<tr>
<td>Practical support during pregnancy (yes = 1, no = 0)</td>
<td>-1.447</td>
<td>0.626</td>
<td>0.021</td>
</tr>
<tr>
<td>Intimate partner violence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever experienced physical violence *</td>
<td>0.521</td>
<td>0.202</td>
<td>0.010</td>
</tr>
<tr>
<td>Ever experienced forced sex (yes = 1, no = 0)</td>
<td>0.769</td>
<td>0.582</td>
<td>0.187</td>
</tr>
<tr>
<td>Experienced violence during pregnancy (yes = 1, no = 0)</td>
<td>1.612</td>
<td>0.714</td>
<td>0.024</td>
</tr>
<tr>
<td>Obstetric indicator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parity (primipara = 1, multipara = 0)</td>
<td>-0.378</td>
<td>0.699</td>
<td>0.589</td>
</tr>
<tr>
<td>History of child death (yes = 1, no = 0)</td>
<td>0.639</td>
<td>0.619</td>
<td>0.302</td>
</tr>
<tr>
<td>Current pregnancy planned (yes = 1, no = 0)</td>
<td>-0.753</td>
<td>0.518</td>
<td>0.146</td>
</tr>
<tr>
<td>Poor household economy X poor relationship with husband</td>
<td>0.083</td>
<td>0.018</td>
<td>0.000</td>
</tr>
<tr>
<td>Total $R^2$</td>
<td>$R^2 = 0.19$</td>
<td>$R^2$(adjusted) = 0.18</td>
<td></td>
</tr>
</tbody>
</table>

*Continuous scale

The adjusted linear regression model for anxiety showed similar results (Table 9). The model shows that general anxiety (STAI-trait) was inversely associated with literacy, per capita daily household expenditure on food, and practical support during pregnancy; it was directly associated with poor relationship with husband, physical violence ever, and violence during pregnancy. The interaction between poor household economy and poor relationship with husband was significant. All the considered associated factors explained 19% of the variance. No violation of assumption was observed (I).
3.3.4 Risk factors of postpartum depressive symptoms

The univariate Cox regression analyses identified no/little education (0 to ≤5 years of schooling), poor socioeconomic status, maternal malnutrition (MUAC <22 cm), having four or more children, experience of physical partner violence ever or during pregnancy, anxiety symptoms during pregnancy, previous depressive symptoms and impaired mother-infant bonding as possible risk factors of PDS at 6–8 months postpartum. The probable protective factors of PDS were to trust and share feelings with close friend and support received from health-care providers. No significant difference was evident between women with and without depressive symptoms on other potential risk factors (data not shown).

However, multiple Cox regression (Backward) analyses (Figure 7) showed that, after simultaneous adjustment for these possible predictors, poor socioeconomic status, experience of physical partner violence during pregnancy, anxiety symptoms during pregnancy, and previous depressive symptoms were identified as risk factors of PDS at 6–8 months postpartum. No significant interaction between the variables was found (III).

![Figure 7. Risk factors of postpartum depressive symptoms (PDS) (during third trimester of pregnancy to 6–8 months postpartum) selected by stepwise Cox regression amongst women in rural Bangladesh](image)

3.4 CONSEQUENCES ON INFANT HEALTH

This study revealed the consequences of ADS and AAS on infant’s birth weight as well as the consequences of perinatal depressive symptoms on infant’s growth and motor development.
3.4.1 Consequences of antepartum depressive and anxiety symptoms on birth outcome

Univariate OR showed a significant association between LBW and antepartum depressive symptoms, antepartum anxiety symptoms, poor household economic status, and maternal malnutrition, and a significant negative association with maternal antepartum consultation, psychological support during pregnancy, and living in a joint family (data not shown).

Multiple logistic regression analyses (Figures 8 and 9) showed that, after simultaneous adjustment for the associated factors, mothers with symptoms of depression (OR = 2.24; CI$_{95\%}$ = 1.37–3.68) and anxiety (OR = 2.08; CI$_{95\%}$ = 1.32–3.29) were twice more likely to give birth to LBW babies than mothers who did not report these symptoms. Other associated factors of higher likelihood of LBW babies were poor economic status of household and maternal malnutrition. Those reporting to psychological support during pregnancy and living in a joint family (anxiety only) were less likely to have babies with LBW.

![Figure 8. Association of depressive symptoms during pregnancy with LBW using multiple logistic regression model](image)

A Wald estimate indicates that depressive and anxiety symptoms contributed most to LBW, followed by maternal malnutrition, emotional support during pregnancy, and poor household economic status. No significant interaction between explanatory variables was found. The models indicated almost the same Log likelihood ratio (–520.56 for depression Model and –516.60 for the anxiety Model) after excluding the outliers (Cook’s distance >0.049). A Hosmer-Lemeshow test indicated that Models (p = 0.809 and p = 0.106 for depression and anxiety, respectively) fit the data well (II).
3.4.2 Consequences of perinatal depressive symptoms on infant growth

Infants of women with a high EPDS score during pregnancy and 2–3 months postpartum were found to be stunted at 2–3 months and 6–8 months, but not underweight. The repeated analysis-of-variance measures of maternal depressive symptoms at 2–3 months postpartum showed that infant growth was affected more at age 6–8 months (WAZ: F = 11.145, \( p = 0.001 \), HAZ: F = 4.135, \( p = 0.042 \)) (data not shown) (IV).

In the adjusted model, maternal perinatal depressive symptoms were associated with infant growth at age 6–8 months after controlling for all possible predictors (Table 10). Maternal depressive symptoms at 2–3 months postpartum was associated with infant underweight (lower WAZ_{6-8m}) at age 6–8 months (model I), and maternal antepartum depressive symptoms with infant stunting (lower HAZ_{6-8m}) at 6–8 months (model II) (Table 10). No significant association was found between maternal postpartum depressive symptoms at 2–3 months and infant stunting at 6–8 months (Model II). Poor SES of the household, boy child, infant’s lower weight at age 2–3 months, and mother’s perception of infant’s temperament as unadaptable were significantly associated with infant underweight (lower WAZ_{6-8m}) at age 6–8 months. Similarly, lower maternal height, infant’s lower birth height, boy child, infant’s lower height and weight at age 2–3 months, infant’s illness at 6–8 months, and maternal perceptions of the infant’s temperament as fussy/difficult and unpredictable were associated with infant’s stunting (lower HAZ_{6-8m}) at 6–8 months. All the considered associated factors explained 34% of the variance in the case of infant’s underweight and 24% in the case of stunting (IV).
Table 10. Association of maternal ante- and postpartum depressive symptoms at 2–3 and 6–8 months with infant’s weight-for-age and height-for-age at 6–8 months (N = 652).

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Model I Weight-for-age&lt;sub&gt;6–8 months&lt;/sub&gt;</th>
<th>B</th>
<th>Std. error</th>
<th>Model II Height-for-age&lt;sub&gt;6–8 months&lt;/sub&gt;</th>
<th>B</th>
<th>Std. error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household SES (high=0, middle=1, low=2)</td>
<td></td>
<td>-0.148*</td>
<td>0.063</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Maternal height (cm)</td>
<td></td>
<td>—</td>
<td>—</td>
<td>0.026***</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>Infant height at birth (cm)</td>
<td></td>
<td>—</td>
<td>—</td>
<td>0.070***</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td>Infant’s sex (boy = 0, girl = 1)</td>
<td></td>
<td>0.495***</td>
<td>0.104</td>
<td>0.681***</td>
<td>0.091</td>
<td></td>
</tr>
<tr>
<td>Infant’s height (cm) at 2–3 months</td>
<td></td>
<td>—</td>
<td>0.033*</td>
<td>—</td>
<td>0.016</td>
<td></td>
</tr>
<tr>
<td>Infant’s weight (kg) at 2–3 months</td>
<td></td>
<td>0.720***</td>
<td>0.072</td>
<td>0.383***</td>
<td>0.067</td>
<td></td>
</tr>
<tr>
<td>Infant’s illness, 6–8 mos. (no = 0, yes = 1)</td>
<td></td>
<td>—</td>
<td>—</td>
<td>-1.270**</td>
<td>0.381</td>
<td></td>
</tr>
<tr>
<td>Infant’s temperament, unadaptable</td>
<td></td>
<td>-0.019*</td>
<td>0.008</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Infant’s temperament, fussy/difficult</td>
<td></td>
<td>—</td>
<td>-0.016*</td>
<td>0.006</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infant’s temperament, unpredictable</td>
<td></td>
<td>—</td>
<td>-0.023*</td>
<td>0.012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s EPDS score during pregnancy</td>
<td></td>
<td>—</td>
<td>-0.256*</td>
<td>0.123</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother’s EPDS score at 2–3 months postpartum</td>
<td></td>
<td>-0.383*</td>
<td>0.171</td>
<td>-0.263</td>
<td>0.140</td>
<td></td>
</tr>
</tbody>
</table>

R<sup>2</sup> = 0.34                           R<sup>2</sup> = 0.24

*p<0.05; **p<0.01; ***p<0.001

3.4.3 Consequences of perinatal depressive symptoms on infant motor development

A high maternal EPDS score postpartum, but not during pregnancy, was found to be associated with poorer motor development of the infant at age 6–8 months. In a multivariate linear regression analysis, maternal depressive symptoms at 2–3 months postpartum predicted impaired infant motor development at 6–8 months (Table 11).
Maternal age, mother’s MUAC, infant’s WAZ at 6–8 months, and maternal anxiety about infant care were directly associated with infant’s motor development. Infant’s birth weight, infant suffering from acute respiratory infection, impaired mother-infant bonding, and mother’s perception of infant’s temperament as fussy/difficult and unadaptable were inversely associated with infant’s motor development. The model explained 29% of the variance (Table 11) (IV).

Table 11. Association of maternal postpartum depressive symptoms at 2–3 months with infant’s motor development at age 6–8 months (N = 652)

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Milestone scale</th>
<th>B</th>
<th>Std Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age (years)</td>
<td></td>
<td>0.054**</td>
<td>0.017</td>
</tr>
<tr>
<td>Mother’s MUAC (cm)</td>
<td></td>
<td>0.078</td>
<td>0.046</td>
</tr>
<tr>
<td>Infant’s height at birth (cm)</td>
<td></td>
<td>–0.077*</td>
<td>0.033</td>
</tr>
<tr>
<td>Infant’s HAZ at 6–8 months</td>
<td></td>
<td>0.154</td>
<td>0.090</td>
</tr>
<tr>
<td>Infant’s WAZ at 6–8 months</td>
<td></td>
<td>0.320**</td>
<td>0.110</td>
</tr>
<tr>
<td>Infant suffering from acute respiratory infection at 2–3 months (no = 0, yes= 1)</td>
<td></td>
<td>–0.737*</td>
<td>0.319</td>
</tr>
<tr>
<td>Maternal impaired bonding with infant at 2–3 months</td>
<td></td>
<td>–0.109**</td>
<td>0.034</td>
</tr>
<tr>
<td>Maternal anxiety about child care</td>
<td></td>
<td>0.122*</td>
<td>0.059</td>
</tr>
<tr>
<td>Infant’s temperament, fussy/difficult</td>
<td></td>
<td>–0.062***</td>
<td>0.016</td>
</tr>
<tr>
<td>Infant’s temperament, unadaptable</td>
<td></td>
<td>–0.054**</td>
<td>0.020</td>
</tr>
<tr>
<td>Mother’s EPDS at 2–3 months</td>
<td></td>
<td>–0.739*</td>
<td>0.359</td>
</tr>
<tr>
<td>Total R²</td>
<td></td>
<td>R² = 29%</td>
<td>R² (adjusted) = 26%</td>
</tr>
</tbody>
</table>

*p<0.05; **p<0.01; ***p<0.001
4 DISCUSSION

This community based cohort study showed that perinatal depressive and anxiety symptoms were prevalent in a rural area of Bangladesh, and women with depressive and anxiety symptoms exhibited an increased likelihood of giving birth to low birth weight (LBW) babies and infants with poor growth and motor development. This implies that cumulative pathways of accumulated stressors in the life of a woman might lead to depressive symptoms during pregnancy and postpartum, LBW in her newborn, and infants are likely to continue the cycle by being stunted and underweight at age 6–8 months.

4.1 MAGNITUDE OF PERINATAL DEPRESSIVE AND ANXIETY SYMPTOMS IN RURAL BANGLADESH (I & III)

The prevalence of ADS (18%) and AAS (29%) in the present study indicate the magnitude of the problem in a rural area of Bangladesh and are in agreement with previous reports from both high-income countries, ADS 12% (Bennett et al., 2004), AAS 24% (Yonker et al., 2001) and low-income countries, [20% in Pakistan (both ADS and AAS) (Karmaliani et al., 2009)], and 10%–20% in Brazil (Lovisi, López, Coutinho, and Patel, 2005; Freitas and Bogeta, 2002). A previous study in Bangladesh reported a higher prevalence of ADS, 33%, which may be due to recruitment of women at a later stage of pregnancy, in this case 34–35 weeks, compared to the current study (Gausia et al., 2009a).

In this cohort of pregnant women, 8% developed depressive symptoms in the first 2–3 months postpartum and 18% during 2–3 to 6–8 months. Our findings were in accordance with 9.8% and 11% during the first 1.5–3 months postpartum which is reported in Bangladesh and India, respectively (Chandran et al., 2002; Gausia et al., 2009b). However, Patel et al. (2006) reported a 12-month incidence of either depressive or anxiety disorder of 1.8%. However, comparison of study results of both prevalence and incidence is complicated due to the use of different screening/diagnostic tools, different cutoff points to determine postpartum depression, varying time points in pregnancy and postpartum when the symptoms are assessed, and cross-cultural variables (Halbreich and Karkun, 2006; Klainin and Arthur, 2009). This study assessed symptoms of depression, rather than clinical depression, but comparing with the prevalence of depression (15%) among general women in Bangladesh (Asghar et al., 2007), the prevalence of ADS in this study indicates that pregnancy is a risk factor for the onset of depression.

The prevalence of depressive symptoms of 18% in the last trimester of pregnancy, dropped to 14% at 2–3 months postpartum, and nearly doubled (32%) at 6–8 months postpartum, indicating greater onset after 2–3 month postpartum. This finding differs with the results from a systematic review of prevalence and incidence of perinatal depression from high-income countries, where an upward trend in incidence was
observed in the first 3 months postpartum (Gavin et al., 2005). Halbreich and Karkun (2006), Eberhard-Gran et al. (2010) and Fisher, Cabral de Mello, Izutsu, and Tran (2011) argued that perinatal mental health problems were not observed in traditional cultures, including low-income settings, because women were given structured postpartum care, which included a status of honor, relief from normal household tasks, and a 40-day of mandated rest, which are protective. Our result partly confirms this. The low incidence of PDS at 2–3 months, compared to the incidence at 6–8 months, can be explained as being a result of this protective period, since cultures in Bangladesh dictate similar traditional rituals and supportive mechanism until 40 days after delivery. The woman and baby are not generally left alone during this period; are commonly accompanied by the woman’s mother, mother-in-law or female relatives; and household work is done by others. However, the high incidence after 2–3 months postpartum is noteworthy. One explanation may be that the postpartum period after the mandated period of rest and support is vulnerable in relation to child-care related stress, illnesses and worries regarding socioeconomic conditions and gender related disadvantages.

4.2 UNDERLYING RISK FACTORS OF PERINATAL DEPRESSIVE AND ANXIETY SYMPTOMS (I & III)

The biopsychosocial model forecasts a number of socio-cultural, vulnerability, precipitating and aggravating factors for predicting perinatal depressive symptoms (Figure 1). Among these, factors such as literacy, family support, intimate partner violence, anxiety symptoms during pregnancy, and previous depressive symptoms were found to be important predictors in this thesis (Figure 10).

4.2.1 Socioeconomic status

The biopsychosocial model of PDS denotes that socioeconomic factors contribute to the psychosocial context of depressive symptoms through moderating the stress events. Poor household economic status/low socioeconomic status (SES) has emerged as one of the most significant determinants of AAS, and PDS in this study, but not for ADS. The direct association between poverty and depression is well documented in high-income countries (Mezey, Bacchus, Bewley, and White, 2005), and evidence on this association from low-income countries is growing (Patel et al., 2002). The relationship between poverty (indicated by low level of education, minimum wage, low household income, and husband’s unemployment) and mental disorder have been elucidated in a recent review of studies from six low- (Pakistan, Indonesia, Chile, Lesotho, Zimbabwe) and middle-income country (Brazil) (Patel and Kleinman, 2003). Findings from this study suggest that the association between poverty and common mental disorders is a universal one, occurring in all societies irrespective of their levels of development. Bangladesh is a socially disadvantaged country where 40% of the population lives below poverty line (BBS, 2009). Hence, the low SES can posit a woman to be at increased risk of depressive symptoms during 6–8 months postpartum when facing troubles related to increased number of children, infant’s increased demand of food, clothes and education, care for infant’s illnesses and other stressful life events.
Poor education is a consistent vulnerability factor for maternal mental disorder (Patel and Kleinman, 2003). The positive effect of literacy was pronounced in our study on the outcomes of both ADS and AAS and is consistent with the findings from Brazil, Chile, Indonesia, and Pakistan (Patel and Kleinman, 2003). Social consequences of poor education are obvious: lack of education represents a diminished opportunity for persons to access resources to improve their situation (Hussain, Creed, Tomenson, 2000). Francis, Weiss, Senf, Heist, and Hargraves (2007) and Weiss, Francis, Senf, Heist, and Hargraves (2006) explain that literacy gives individuals a sense of improved self-esteem or self-efficacy, enhances their feelings of self-worth, diminishes feelings of shame, and in turn, reduces depressive and anxiety symptoms.

4.2.2 Gender-based violence, marital relations, and culture

Gender-based violence has been described as the single most important predictor of depression (Heise, Pitanguy, and Germain, 1994; Patel et al., 2002; Bacchus, Mezey, and Bewley, 2004; Ludermir, Lewis, Valongueiro, Barreto de Araújo, and Araya, 2010) and anxiety (Karmaliani et al., 2009) in women. This evidence is well documented in high-income countries (Mezey et al., 2005; Bacchus et al., 2004) and is growing in low-income countries (Karmaliani et al., 2009; Gausia et al., 2009a&b; Lovisi et al., 2005). Violence during pregnancy results in adverse consequences for fetal and maternal survival. Bacchus et al. (2004) identified pregnancy as a ‘high-risk’ period for abuse which may be initiated or accelerated during pregnancy. This thesis identifies intimate partner violence, particularly physical violence, as contributing to ADS and AAS, and violence during pregnancy as contributing to AAS and PDS. Although seven in ten women reported being abused by their husbands, the physical partner violence ever does not contribute in developing PDS in this study. Astbury (2001) explained that in a patriarchal society like Bangladesh (where men control the family, wealth and divorce restriction for women), the rural women do not necessarily recognize certain acts (such as a slap or shove) as violence and that such violent behavior is considered to be the husband’s prerogative. The majority of Bangladeshi men feel that a wife is accountable to her husband for her behavior and that violence is an acceptable form of corrective punishment (UNFPA, 2003). A WHO multi-country study indicated that 50%–90% of the women accepted violence by their husbands under certain circumstances as normal, such circumstances being if a woman goes out without informing her husband, neglects their children, argues with him, refuses to have sex with him, or burns the food (Garcia-Moreno et al., 2006).

Although a high rate of violence is reported in this study [34% reported being abused physically by multiple (three or four) acts and 80% sexually (forced into having sex) by their husbands], only a quarter of the women reported poor relationships with their husband in general. Consistent with other research (Clavarino et al., 2011; Beach and O’Leary, 1993), this study showed that poor marital relationship is an important vulnerability factor that has a significant impact on reporting both ADS and AAS. An even more pronounced effect was observed in the case of AAS, when poor partner relationship interacted with poor household economy.
4.2.3 Social support

Women with low social support lack effective psychosocial resources including social stability and social participation, and therefore receive insufficient emotional and practical support from partner, family members and friends (Elsenbruch et al., 2007). The biopsychosocial model identifies ‘lack of social support’ as a stress moderating variable for the onset of depressive symptoms. During pregnancy, a time of significant life change requiring major psychological adjustment, the perception and expectation of insufficient support clearly have a detrimental effect on maternal health (Horowitz and Goodman, 2004). This study identified practical support from the mother-in-law and husband as protective against anxiety and depressive symptoms among pregnant women. This reflect the observations of other researchers that family/social support during pregnancy plays a significant role in predicting women’s emotional status in the antepartum period (Logsdon, Birkimer, Simpson, and Looney, 2005; Elsenbruch et al., 2007). Support from family members may be of special significance in the context of traditional South Asian societies. In these societies, the newlywed couple usually becomes part of the husband’s extended family, including his parents and siblings. Rarely do couples set up homes of their own. In such cases, the newlywed woman’s mother-in-law is the matriarch who holds effective power and control over household matters. Under her guidance and supervision, the daughter-in-law is expected to carry out all instructions and household chores (Aziz, 1994). In this context, receiving support from the mother-in-law is a sign of approval and a source of confidence and, hence, protective against antenatal depressive and anxiety symptoms. Hence social
support is a protective and strong health promotive factor against depressive symptoms in all societies.

4.2.4 Psychological factors
The transition of risk from anxiety antenatally to depression postnatally has been noted elsewhere in the literature (Moss, Skouteris, Wertheim, Paxton, and Milgrom, 2009; Austin, 2003; Heron et al., 2004), a pattern demonstrated in our study as well. While many perinatal interventions have focused on the treatment or prevention of depression, almost none have addressed perinatal anxiety (Austin, 2003). Our result also revealed another notable finding, namely, that anxiety in pregnancy predicted an increased likelihood of postpartum depression, after controlling for the stability of depression at the antepartum period. This may be a particularly important finding for understanding the nature of maternal mood and the effect on the developing child. Researchers may have overemphasized the role of perinatal depression on child development and underestimated the effect of perinatal anxiety. Thus anxiety should be a focus of increased attention in future research because it forecasts subsequent illness and development on the fetus (O’Connor et al., 2002).

In accordance with previous research (Gausia et al., 2009 a&b; Dennis et al., 2009; Beck, 2001; Lee, Yip, Chiu, Leung, and Chung, 2001), our study has shown that a previous history of depression is a strong vulnerability factor for ante- and post-partum depressive symptoms. According to the ‘stress and coping’ theory, previous history of depression makes the women vulnerable for developing depressive symptoms in later life (Cutrona and Troutman, 1986). However, a major limitation of the study is that the previous depressive symptoms were not screened, instead we only asked whether the women faced the symptoms listed in EPDS ever before.

4.3 CONSEQUENCES ON INFANT HEALTH (II & IV)
The early child period is considered to be the most important developmental phase throughout the lifecourse (Irwin, Johnson, Henderson, Dahinten, and Hertzman, 2007). Experience of healthy early childhood starting from mother’s womb strongly influences infant’s well-being, stunting, underweight, obesity, mental health, heart disease, diabetes and competency in literacy through the life course. A broad array of experiences matter, particularly infant’s connection with mother and other family members and the quality of time and care provided. This thesis explored the impact of maternal depressive and anxiety symptoms during pregnancy and postpartum on infant birth weight and growth in a socially disadvantaged sample from a rural district of Bangladesh.

4.3.1 Consequences of antepartum depressive and anxiety symptoms on birth weight (II)
The high prevalence of LBW (24%–36%) in Bangladesh (Khatun and Rahman, 2008; Hosain, Chatterjee, Begum, and Saha, 2006; Ahmed and Das, 1992) is one of the main causes of infant morbidity and mortality, and many studies have shown maternal nutrition to be an important predictor of LBW in low-income countries (Valero de
Barnebé et al., 2004; Bhutta et al., 2004; Sachar, Soni, Grewal, and Sofat, 1994). This thesis reveals that women with depressive and anxiety symptoms in the third trimester of pregnancy exhibit an increased likelihood of giving birth to LBW infants (Figure 10). This association was independent of the effects of conventional risk factors of LBW, such as poverty, maternal nutritional status, and support during pregnancy. This is consistent with previous research from other South Asian countries like Pakistan and India, documenting that woman who exhibit elevated depressive symptoms during pregnancy are at increased risk of delivering LBW infants (Rahman et al., 2007; Patel and Prince, 2006). Results from high-income countries have found a similar association, but only in socially deprived group (Diego et al., 2009; Hoffman and Hatch, 2000). Negative association between ADS and LBW is also reported from sub-Saharan Africa (Hanlon et al., 2009) where the prevalence of LBW is as high as in the South Asian region. In conditions of extreme poverty, the association may also be absent. In an area affected by severe food insecurity, any measurable impact of maternal depression may be shadowed by the impact of lack of food. It may be due to the fact of etiological heterogeneity across these settings because of the different cultures, health-care systems, and maternal and child health profiles.

In South Asian countries, including Bangladesh, women are exposed to various socioeconomic, social, and family life stressors, which contribute significantly to maternal depressive and anxiety symptoms (Gausia et al., 2009a; Karmaliani et al., 2009). Fetal exposure to these hostile environments in mother’s utero may lead to intrauterine growth retardation and in turn to premature delivery and LBW (Darnton-Hill, Nishida, and James, 2004). The antenatal association may be mediated through the deleterious effect of mental disorder upon maternal physical health, self-care and health seeking behavior during pregnancy (Stewart, 2007). It has also been suggested that maternal stress and/or depression leads to disturbance of hypothalamic-pituitary-adrenal axis, thus exerting a direct physiological effect upon the intrauterine environment (Field et al., 2006) through suppressing maternal cortisol levels, thereby restoring fetal automatic nervous system activities, reducing vascular constriction, and potentiating the uterine artery blood flow that carries oxygen and nutrients to the fetus (Diego et al., 2006).

4.3.2 Consequences of perinatal depressive symptoms on infant growth and development (IV)

The studies in this thesis revealed that depressive symptoms postpartum had adverse effects on infant underweight, and depressive symptoms antepartum on stunting at age 6–8 months, even after controlling for conventional risk factors, such as maternal and infant anthropometrics, and socioeconomic status. Also maternal depressive symptoms at 2–3 months were associated with infant’s impaired motor development at 6–8 months after controlling for stunting, underweight, and infant illnesses particularly acute respiratory infection (IV). These findings are consistent with other South Asian studies (Patel et al., 2003; Rahman et al., 2004; Black et al., 2009). This thesis demonstrates three ways by which maternal perinatal depressive symptoms may be associated with impaired infant growth and motor development in rural Bangladesh.
1) **Maternal depressive symptoms as risk factors for impaired infant growth and motor development**

Maternal depressive symptoms exert negative effect on infant growth and physical development through different pathways as described below and shown in figure 10.

**Through negative birth outcome**

Maternal antepartum depressive symptoms exert negative impact on the infant’s growth from mother’s womb through premature delivery (Patel et al., 2002) or low birth weight infant (Rahman et al., 2007) that are considered as well established antecedents for infant’s underweight and stunting (Rahman et al., 2004; Surkan et al., 2008; Kulkina, Ramakrishnan, Stein, Barnhart, and Martorell, 2006). In Bangladesh, growth faltering, or stunting and underweight, begins early in life (Saha et al., 2008). The earlier study showed that women with depressive symptoms were the most impoverished and more likely to deliver low birth-weight infants. Thus, infants may be particularly vulnerable to maternal depressive symptoms early in life, when their dependency and nutritional needs are high.

**Interference with mother-child interaction**

An alternate route by which maternal depressive symptoms may affect infant growth and development is through its effect on mother-child interaction (Stewart, 2007). Our earlier study indicated that mothers with depressive symptoms showed lower emotional bonding to their infants 2–3 months postpartum compared to non-depressed mothers (Edhborg et al., 2011). Depressed mothers may be less emotionally sensitive, and attuned, which in turn leads to apathy and withdrawal among infants (Murray and Cooper, 1997). This dysfunctional mother-child interaction has previously been shown to be associated with infant under-nutrition (Gardner, Grantham-McGregor, Himes, and Chang, 1999).

**Through mothers’ perception of infant temperament**

Consistent with another study in Bangladesh (Baker-Henningham, Hamadani, Huda, and Grantham-McGregor, 2009), this study showed that the mother’s perception of her infant’s temperament was associated with underweight, stunting, and motor development at 6–8 months. If a mother perceived her infant as unadaptable, the infant was more likely to be underweight, and, if infants were perceived as fussy and unpredictable, they were more likely to be stunted. In rural Bangladesh, mothers’ actions are often guided by perceptions of their children’s behavior, rather than by mothers’ actual skills of child rearing, such as sensitive responsiveness and stimulation (Moore, Akhter, and Aboud, 2006). In addition, mothers of fussy and difficult infants are more likely to be depressed (Murray, Stanley, Hooper, King, and Fiori-Cowley, 1996), which may have severe implications on the infant’s nutrition and thus, infant temperament can act as a moderator between maternal depression and poor infant growth (Wachs, 2008). The study also found impaired bonding, and fussy and unadaptable infant temperament to be risk factors in the infant’s impaired motor development. Explanations might be that the mother’s delayed bonding could result in
low attention, interest, and sensitivity toward the infants’ cues. This is particularly so if
the mother perceived her infant as temperamentally difficult, resulting in an
unsatisfactory early mother-infant relationship. According to attachment theories,
problems in the early relationship can result in the infant not being able to use the
mother as a “secure base” and thus is hindered in exploring the environment (Bowlby,
1969), which might result in delayed motor development (Black et al., 2007).

**Infant illnesses**
The other possible mechanism by which maternal depressive symptoms affect infant
growth include interference with consistent and responsive physical and emotional
care-giving, feeding, and reduced care seeking for infant illness (Rahman et al., 2004;
Black et al., 2007). Our result showed that infants of depressed mothers were more
likely to suffer from general illnesses or ARI that in turn, has an effect on infant’s
stunting and impaired motor development at 6–8 months.

2) **Confounding factors/effect modifiers may have an effect on infant’s growth
and development**

**Socioeconomic status**
In this study, SES appeared to affect only underweight, not stunting and motor
development. The relation between maternal depressive symptoms and poor infant’s
growth and development is often exacerbated by low SES, but not always (Hadley,
Tegegn, Tessema, Asefa, and Galena, 2008). The lack of direct association between
measures of SES and child development, even in low-income countries, may be that the
mother as a potential primary caregiver absorbs the negative ecological impacts that are
facing children (Hadley et al., 2008). However, evidence from South Asian countries,
where poverty and poor sanitation are common, suggests that suboptimal maternal care,
resulting from maternal depressive symptoms, can cause greater risk for infant growth
and development (Patel et al., 2003; Rahman et al., 2004). As rural societies in
Bangladesh experience economic pressures, family structures often change, leading to
limited family support, and potentially giving rise to symptoms of maternal depression.
Thus infants of mothers with depressive symptoms in Bangladesh are exposed to
adverse economic and social conditions that may trigger delayed infant growth.

**Premature delivery**
Although the literature shows that premature birth contributed toward impaired child
growth (Shonkoff & Philips, 2002), this thesis found no contribution in the effect
modification on the association. Given the situation in the community setting, it is hard
to conclude as the gestation age is based on health worker’s report, not on any
diagnostic method. Similar to earlier research (Kuklina et al., 2006), results of this
study showed a positive effect of child’s size and growth, and maternal height on
infant’s motor development.
Infants’ sex
Infant’s sex also contributed with child growth and this is well supported by the literature, boys are more likely to be underweight than girl (Baker-Henningham et al., 2005). Although the evidence is mixed, stunting and underweight is more prevalent among boys than girls in India, China and Ethiopia (Medhin et al., 2010; Svedberg, 2007). However, Avan, Richter, Ramchandani, Norris, and Stein (2010) found no contribution of gender on the association between maternal depression and child growth in South Africa, which could be partially explained by cultural variation in child rearing norms and parental expectations.

3) The role of contextual factors
The research currently published indicates that there is an impact of maternal depression on infant growth in Asia, but not Africa or South America. In UK, a high-income country, the evidence is equivocal, with clear support only for a transient impact among the most socioeconomically deprived. The difference between UK and Asia supports the hypothesis that it is in a more ‘hostile environment’ (in terms of poverty and health care availability, etc.) that the functional impairment secondary to maternal depression impacts on infant nutrition (Stewart, 2007). In conditions of extreme poverty, such as in sub-Saharan Africa, the association may be absent due to homogeneity of extreme poverty that flooded the association between maternal depression and infant’s under-nutrition. It may not be just the economic conditions that differentiate the Asian context from other low-income countries, but also socio-cultural factors. Harpham, Huttly, De Silva, and Abramsky (2005) speculate that the role of women in Asia may be pressured, and motherhood particularly disempowering, in a manner that is not the case elsewhere. In this environment, depressed mothers find it difficult to function efficiently. The impact of maternal mental health may be one factor explaining the so-called ‘Asian Paradox’ referred by Stewart (2007) whereby rate of malnutrition is higher in the South Asian region than would be expected given food availability.

4.4 METHODOLOGICAL CONSIDERATIONS

Design
This is a community-based cohort study, given the study population was selected from a defined geographical rural area in Bangladesh with minimal loss to follow-up (8.3%). Repeated measures were collected from the same individual at multiple times to assess the individual change over time. This repeated measures helped to keep the validity of the results high (Jones and Kenward, 2003). This design is well suited for this study population as they are stationary indicated by the low migration rate (1.5%). However, the disadvantage of this repeated measures design is that it might not be possible for each participant to participate in the measurements at different times due to various reasons, hence threatening the internal validity of the results (Jones and Kenward, 2003). The strength of this study is the low attrition. An additional limitation of the study is that it was conducted in two sub-districts of rural Bangladesh and does not represent the urban scenario. Although the findings cannot be generalized even for
other rural areas of the country, the community-based sample is likely to be indicative of the situation among rural women in Bangladesh.

Data collection
Structured face-to-face interviews with pre-tested questionnaires were used to elicit information from the respondents. Several biases are common in this kind of interview survey. Recall bias may arise in many cases especially when the reports were retrospective, such as previous depressive symptoms. There is possibility of state bias as the dysphoric persons show greater sub threshold priming of depression describing words than the non-dysphoric subjects, and depression has a negative effect on memory overall (Kuyken and Dalgleish, 1995). The Hawthorne effect (Last, 1983) may arise due to the subject knowing that they are being followed-up. Interviewer bias may occur when certain characteristics such as experience and knowledge base of the interviewers, and quality of the interviewer-respondent interaction influence the responses. There may also be information bias due to respondent answering in a certain way to please the interviewer (Hardon et al., 2001). In case of reporting physical violence, women may not have reported the actual scenario due to its sensitive nature.

To reduce these biases, several strategies were adopted. These include, recruitment of experienced interviewers, standardized training on questionnaire contents, interview algorithm, probing techniques, and strategies to establish rapport and neutrality essential to complete and accurate data collection, and avoidance of inter-observer variation and interviewer bias. We also used early deployment of interviewers in the field to allow time for rapport building activities and desensitization for Hawthorne effect and assuring the respondents of confidentiality of data for information bias. Finally, intensive supervision, on-the-spot checking for inconsistencies, and a random post-enumeration survey of 5% of the households surveyed in the past 72 hours on the selected variables was carried out by the quality control team. They gave corrective feedback to the interviewers in case of inconsistencies to ensure reliability of the data.

Tools
Often primary health care workers fail to identify depressed women in the puerperium (Cox, Connor, and Kendell, 1982). There are several limitations in the existing screening instruments for depression in childbearing women (Cox, 1983; Harris et al., 1989), for instance, Beck Depression Inventory lack specificity (O’Hara, 1994; Harris et al., 1989). EPDS developed by Cox et al. (1987) has overcome these deficiencies. Its main feature is the exclusion of items that might reflect physical discomfort that can confuse depression with the somatic effects of childbirth.

The thesis has utilized a widely used and locally validated EPDS, known as EPDS-B to measure PDS (Gausia et al., 2007) that is also routinely used in the antepartum period and in clinical and community settings (Murray and Cox, 1990). This local validation was performed using the structured clinical interviews for DSM-IV diagnosis of depression. The internal consistency of the items observed in the EPDS-B scale is consistent with that from the original validation study in Scotland, other high-
income countries as well as Asian countries (Cox et al., 1987; Mahmud, Awang, and Mohamed, 2003). The optimum threshold score of EPDS-B was 10. This score yielded a sensitivity of 89%, specificity of 87%, positive predictive value of 40% and negative predictive value of 99% (Gausia et al., 2007). However, the anxiety scale used in the study is not validated for low-income countries such as Bangladesh. Internal reliability was tested by Cronbach’s alpha. Given the transitory nature of anxiety state, measures on internal consistency such as alpha coefficient provide a more meaningful index of the reliability of the anxiety scale than test-retest correlation (Spielberger, 1983). Nevertheless, translation and back translation was done on this instrument by two bilingual social science researchers. They sat together several times in order to minimize the error and inconsistencies. The initial qualitative exploration helped to identify the culturally and locally appropriate terminology. The cutoff at a ≥45 percentile in the study to report prevalence is similar to that used in high-income countries (Austin et al., 2007). It is very difficult to set a cutoff for any psychological state because of its subjective nature which may over- or under-report the prevalence ofADS and AAS.

**Data analysis**

As study I was cross-sectional in nature, issues related to causality cannot be addressed. In study II, analysis was restricted to babies born at term to distinguish the risk factors of intrauterine growth restriction from those of preterm births. This restriction of the final sample to full-term deliveries may have resulted in the lack of difference in gestational age between depressed/anxious women and non-depressed/non-anxious women.

Additionally several important variables were not controlled for in study I [physical illness, gynecological morbidities, previous infertility, complications during pregnancy (hypertension, preeclampsia, bleeding), and smoking], study II [anemia, weight gain during pregnancy, physical ill-health (diabetes/hypertension), and smoking], and study III [chronic physical illness, gynecological morbidities, complications during pregnancy (hypertension, preeclampsia, bleeding), and smoking].

4.5 **CONCLUSION AND POLICY IMPLICATIONS**

This population-based study in rural Bangladesh confirms that in Bangladesh, depression and anxiety are common during pregnancy, and postpartum, and that they affect infant’s birth weight, and infant growth and motor development at 6–8 months, consequently extending the burden of disease to the next generation. This study also identified a number of risk factors of perinatal depressive and anxiety symptoms encompassing poor SES, illiteracy, intimate partner violence, bad relationships with husbands, lack of practical support, previous depressive symptoms, and anxiety symptoms during pregnancy (only for postpartum depressive symptoms). These findings have a number of policy implications as follows:
4.5.1 Screening and management of perinatal depressive and anxiety symptoms

The reduction of LBW at term, and infant’s stunting and underweight are important indicators of the internationally agreed Millennium Development Goals (MDG) for reducing child mortality. As this research and others have noted (Patel et al., 2003; Stewart, 2007; Austin, 2003; Heron et al., 2004), it may be just as important to focus on the detection and management of antepartum and postpartum depressive and anxiety symptoms given its significant association with subsequent infant growth and development. Keeping in mind that the MDGs are to be met by 2015, it is crucial to integrate mental health with existing maternal and child health care in Bangladesh both at policy and practice level. All those concerned with antenatal and postnatal care at least up to 6–8 months postpartum need to pay attention and screen for depressive and anxiety symptoms as well as relevant risk factors. Health care professionals, including community health workers, can enquire about the relevant risk factors as part of their overall assessment. In order to execute this, the government may use its own infrastructure including the community health workers as frontline workers and work with NGOs to use their community health workers. In addition, using various avenues to raise community awareness and enhance mother’s knowledge on the association between maternal depression and infant’s impaired development is important.

4.5.2 Couple-focused intervention

Given the partner violence and relationship with husband as one of the most important predictor of both ADS and PDS in this thesis, interventions aiming at reducing depressive and anxiety symptoms during pregnancy and postpartum at the community level should be couple-focused. Intervention should also target those women who are poor, had anxiety symptoms during pregnancy, and had previous history of depressive symptoms. This can include counseling for mothers at risk in order to reduce perinatal depressive and anxiety symptoms through reduction in intimate partner violence, and to facilitate mother-infant bonding and, enhance maternal sensitivity and care giving to prevent poor growth and development of infants. Policies aimed at referring women with depressive symptoms to the nearest medical college hospital where psychological treatment is freely provided may help mothers in receiving appropriate support.

Public health programmers on child development in low income countries have started to focus on interventions that promote maternal mental health and appropriate parenting as a means to improve child outcome (Cooper et al., 2002; Lanata, 2001; Elliott et al., 2000). The process and effectiveness of scaling up mental health interventions has not been adequately assessed. Such research is needed to inform the continuing process of service reform and innovation. However, policymakers should act on the available evidence to introduce effective interventions for maternal mental health at the community level.
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6 REFERENCES


