EFFECTS OF NATURAL DISASTERS ON WOMEN'S REPRODUCTIVE
PROCESSES USING BANGLADESH DEMOGRAPHIC AND HEALTH SURVEYS

by

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ABSTRACT

EFFECTS OF NATURAL DISASTERS ON WOMEN'S REPRODUCTIVE PROCESSES
USING BANGLADESH DEMOGRAPHIC AND HEALTH SURVEYS

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Bangladesh is widely recognized as one of the most disaster-prone countries in the world. It is predicted that disaster-related losses in Bangladesh will be higher by 2025 compared with all other countries (Smith, 2012). All individuals or communities are not vulnerable to natural disasters equally. Women in Bangladesh are disproportionately more vulnerable to natural hazard due to social norms, entrenched gender inequality, and reproductive responsibilities (Ahmad, 2012, Rezwana, 2018; Tanny, Rahman, & Ali, 2017). The immediate effects of natural disasters are found in marital disruptions, unplanned pregnancy, lack of access to contraception and contraceptive use, abortion, lack of antenatal perinatal care, poor birth outcomes and infant health, vulnerable psychosocial health, and high fetal and infant mortality (Currie & Rossin-Slater, 2013; Brock et al., 2015; Djafri, Chongsuvivatwong, & Geater 2015; Grabich et al., 2016; Harville et al., 2015; Sugawara et al., 2016; Torche & Kleinhaus, 2011).

A natural disaster, cyclone Sidr, hit Bangladesh on November 15, 2007, and affected a total of l 8.9 million people (UNICEF, 2007). The current study aims to understand: (a) the effects of cyclone Sidr on women's reproductive processes and (b) the effects of well-known reproductive health determinants on the three phases of reproduction in a disaster prone country, Bangladesh. The current study examines the effects of cyclone Sidr on women's intercourse, conception, and gestation phases using a conceptual framework along with a difference-in-

differences approach. It also examines the effects of education, wealth, and place of residence on women's intercourse, conception, and gestation phases net of the effect of Sidr. The Bangladesh Demographic Health Surveys (BDHS) is analyzed in the study using logistic regression. It is found that women's gestation phase was disrupted by cyclone Sidr in Bangladesh and education level, wealth status, and place of residence are important reproductive health determinants in women's reproduction net of the effect of Sidr. This study attempted to address women's reproductive health issues in the context of disaster. Implications for social work theory, research, practice, and policy are discussed in the study. The conceptual framework proposed in the study can be utilized in understanding the effects of natural disasters in developing countries on women's reproductive processes. The study provides generalizable findings and suggests gender focused disaster management and policies.

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CHAPTER 1: INTRODUCTION TO THE STUDY

Introduction

Disaster is defined as a serious disruption that causes widespread human, material, economic, or environmental losses that are unmanageable for the affected society without receiving an extraordinary response from the national or international community (World Health Organization [WHO], 2017). The combination of hazards, vulnerability, and inability to reduce the potential negative consequences of risk results in a disaster (International Federation of Red Cross and Red Crescent Societies [IFRC], 2018). Damages are widespread and far beyond the public's ability to recover (Neuberg, Pawłosek, Lopuszański, & Neuberg, 1998; Quarantelli, 1985, 1998). A disaster associated with a hazard is a natural disaster. "A natural disaster is an act of nature of such magnitude as to create a catastrophic situation in which day-to-day patterns of life are suddenly disrupted and people are plunged into helplessness and suffering, and, as a result, need food, clothing, shelter, medical and nursing care, and other necessities of life" (WHO, 2018, para 1). Natural hazards include earthquakes, hurricane, volcanic activity, landslides, tsunamis, tropical cyclones and other severe storms, tornadoes and high winds, river and coastal floods, wildfires and associated haze, drought, sand or dust storm, and infestations.

The number of disasters reported each year has been steadily increasing in recent decades, from 78 in 1970 to 348 in 2004 (Than, 2005). Weather related disasters between 1995 and 2015 have been caused by recorded floods, storms, heatwaves, and droughts (Wahlstrom & Guha-Sapir, 2015). Floods accounted for 47% of all weather-related disasters from 1995-2015, affecting 2.3 billion people and killing 157,000 (Wahlstrom & Guha-Sapir, 2015). Storms accounted for the deadliest type of weather-related disaster, resulting in 242,000 deaths, or 40% of the global weather-related deaths. There have been three major natural disasters since 2000 -

the Asia tsunami in 2004, the Myanmar cyclone in 2008, and the Haiti earthquake in 2010 - causing more than 100,000 deaths (WHO, 2016). Out of the 1.4 million disaster-related deaths during the period of 2000-2015, 58% occurred in Asia (United Nations Office for Disaster Risk Reduction [UNISDR], 2015). In 2017, although 335 natural disasters affected over 95.6 million people globally, the bulk of the affected 58% of the total deaths and 70% of the affected population were in Asia (Centre for Research on the Epidemiology of Disasters [CRED], 2017).

The vast majority of these deaths (89%) occurred from strong storms in lower-income countries, even though they experienced just 26% of all storms (UNISDR, 2015). The frequency and severity of natural disasters in developing countries have increased dramatically (Thomas & Lopez, 2015). Fatalities from natural disasters are nearly 20% higher in low- and middle- income countries today than previously (Stromberg, 2007). Over 60,000 deaths occur from disasters every year in developing countries (WHO, 2017).

Bangladesh, a developing country, is widely recognized as one of the most disaster-prone countries in the world (Khan, 2018). In the 2015 Climate Change Vulnerability Index, 32 countries were identified as being exposed to extreme risk (Figure 1.1) from climate change, with Bangladesh ranking first among them (Verisk Maplecroft, 2015). It is predicted that disaster-related losses in Bangladesh will be higher by 2025 from climate change and natural disasters compared with all other countries (Smith, 2012).
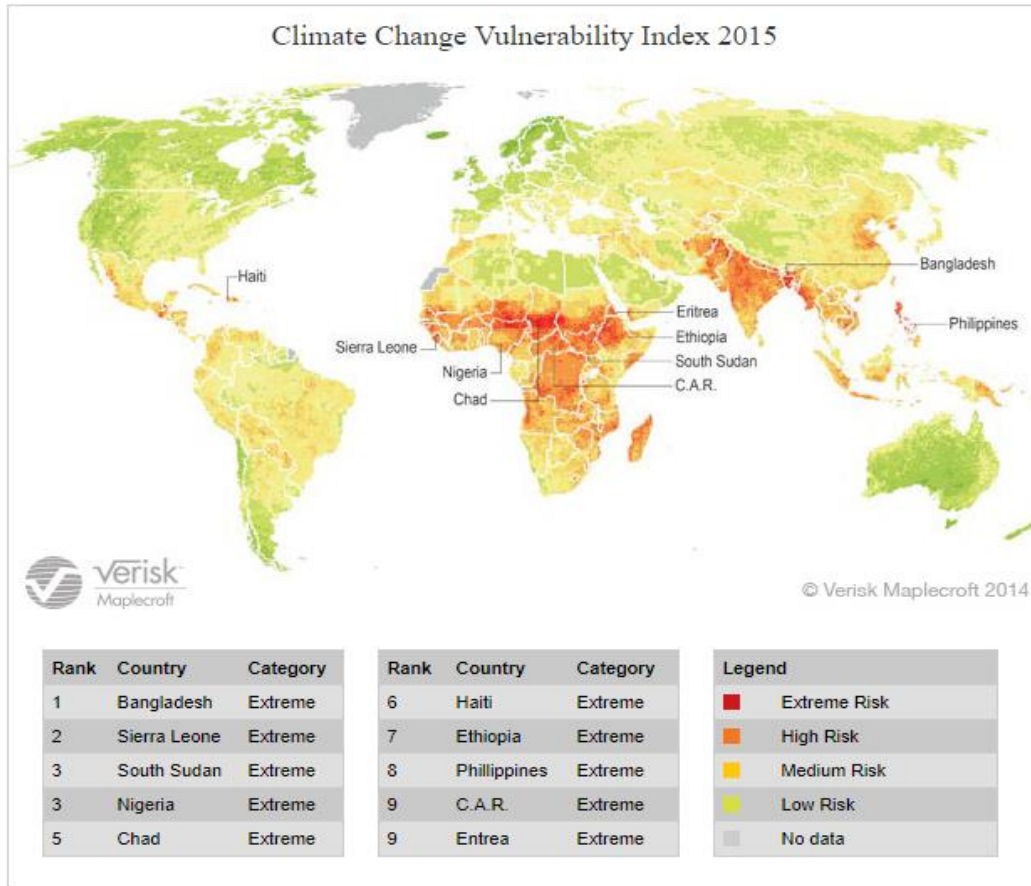
Figure 1.1. Verisk Maplecroft Climate Change Vulnerability Index 2015

Bangladesh experienced nearly 200 climate-related disasters between 1980 and 2013,

which killed thousands of people, destroyed homes and livelihoods, and cost the nation around

$16 billion in damage and economic losses (Give2Asia, 2018). According to the World Bank,

more than 80% of the Bangladeshi population is potentially exposed to either floods,

earthquakes, or droughts and nearly 70% of the population experiences tropical cyclones (2018).

Climate change, sea level rise, population density, and lower socioeconomic environment make

Bangladesh highly susceptible to different hazards including floods, water-logging, cyclones,

storm surge, river or coastal erosion, landslides, earthquake, drought, salinity intrusion, fire, and

tsunami (Asian Disaster Reduction Center [ADRC], 2008). The people in the coastal areas of

Bangladesh are more vulnerable to natural disasters (Balachandran, 2017). Almost one fourth of

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the total population of the country lives in the coastal areas of Bangladesh and they are vulnerable to mostly cyclones (Denissen, 2012). The most deadly among the Bangladesh cyclones were the 1970 Bhola cyclone, the 1991 cyclone, and the 2007 Sidr (ADRC, 2008). The 1970 Bhola cyclone caused 500,000 deaths, the 1991 cyclone caused 140,000 deaths, and 2007 Sidr caused 3,363 deaths in Bangladesh.

Background of the Study

Bangladesh is located at the tail end of the fragile delta formed by the Ganges, the Brahmaputra, and the Meghna Rivers with a highly dense population, low resources, and a lack of coastal protection systems (Rashid, 2016). Bangladesh is one of the world's countries most vulnerable to global warming and sea level rise (United States Agency for International Development [USAID], 2018). Current prediction of mortality from disasters indicates that 50 million Bangladeshi people will be displaced by 2100 due to a 5 to 6 foot rise in sea level (Glennon, 2017). About 40% of the total global storm surges are recorded in Bangladesh (Haque et al., 2012). Deadly cyclones and storms surge often threaten Bangladeshi coastal communities with the most recent being cyclone Sidr in 2007.

Cyclone Sidr hit the southwestern coast of Bangladesh on the night of November 15, 2007, and spread through the heart of the country from the southwest to the northeast. Sidr was a category 4 storm with winds up to 240 km per hour, tidal waves up to 5 meters high, and surges up to 6 meters in some areas (GoB, 2008). It was a cause of 3,363 deaths with 55,282 injured people; 1.5 million damaged or destroyed homes; 1.87 million livestock and poultry destroyed; and 2.5 million acres of cropland damaged (UNICEF, 2007) affecting a total of l 8.9 million people (UNICEF, 2007). Bangladesh is the eighth most densely populated country in the world with a fertility rate of 2.14 and a population density of 13,310 people per square mile, and 43%

of its populations subsist on less than US$1.25 per day (El-Saharty, Ohno, Sarker, Secci, & Alam, 2014; Worldometers, 2018).

Women's reproductive health is a relatively new area of a health intervention in Bangladesh. Married adolescents are identified as the most vulnerable population with respect to reproductive health problems (Rahman, 2013). Traditionally, marriage remains the only avenue to exposure to sexual intercourse in Bangladesh. The country has a long history of child marriage and early motherhood although women's legal minimum age of first marriage is 18. 71% of rural girls and 54% of urban girls in Bangladesh are married before the age of 18 as a result of deeply embedded cultural and religious beliefs, poverty, an insecure societal environment for girls, and a high prevalence of sexual harassment (UNICEF Bangladesh, 2018).

Disasters add an additional element of hardship to the daily reality of many Bangladeshi families, especially for those who live in the most marginal and disaster-affected regions of the country. Women are more vulnerable to the hazards of environmental degradation and disasters than men (Enarson, 2000; Fothergill, 1996). The female death ratio (1:5) was far higher than men's during Sidr (Ahmad, 2012). Women are socioeconomically vulnerable and less prepared to meet the immediate costs of recovery from the effects of disasters (Morrow & Phillips, 1999). Bangladeshi women suffer from social vulnerability owing to their low status in society and are more likely to be neglected and discriminated against in terms of disaster assistance and aid throughout the recovery phases (Alam & Rahman, 2014; Chowdhury, Bhuyia, Choudhury, & Sen, 1993; Swatzyna & Pillai, 2013). One consequence of the high levels of vulnerability among women is that when natural disasters occur, women are far more exposed to microphysical health dangers than men (Enarson & Morrow, 1998). In disaster periods, Bangladeshi women are more

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vulnerable to reproductive and sexual health problem because they are poor to begin with (Rahman et al., 2013).

Natural disasters play a passive role for child marriage in Bangladesh as their family become incapable to provide food, shelter, education, and safety after being affected by disaster. Many parents who can neither feed nor educate nor protect their daughter during or after the disaster consider child marriage as their best option to safeguard her future (Human Rights Watch, 2015). Researchers of a Human Rights Watch carried out a study (2015) in Bangladesh among women who had married before the age of 18 to understand how girls become brides before the legal age of marriage. In their study, one participant described how she was married at her age of 14 in this statement - "whatever land my father had and the house he had gone under the water in the river erosion and that is why my parents decided to get me married." Alston, Whittenbury, Haynes, & Godden (2014) also examined the relationship between natural disaster and child marriage in Bangladesh. They found that socio-economic crises created by the natural disasters leaded to an increase in child and forced marriages in Bangladesh. In addition, studies found that maternal death and child death rates in Bangladesh remain significantly high owing to child marriage and early motherhood (Alam, 2000; Bates, Maselko, & Schuler, 2007; Kamal, 2012; Khan, Jahan, & Begum, 1986). Annually 171, 000 infants die from infection, birth asphyxia, and low-birth weight in Bangladesh (UNICEF Bangladesh, 2018). According to UNFPA (2018), every year 5,200 mothers die in Bangladesh from pregnancy-related causes of postpartum haemorrhage (31%), eclampsia or preeclampsia (20%), delayed and obstructed labor (7%), abortion (1%), other direct causes (5%), and indirect causes (35%). Maternal malnutrition, infections, anaemia, and repeated pregnancies, along with high domestic workloads, less access

to antenatal and postnatal care and obstetric care are commonly observed risks for maternal death in Bangladesh (UNICEF Bangladesh, 2016).

The key factors affecting maternal deaths are knowledge, attitude, child marriage, and practice of family planning and safe motherhood care as well as accessibility to and availability of health services. Availability of and accessibility to health services are disrupted by the effects of disasters. In addition, there is a lack of disaster management program that can ensure availability of health services and women's access to those services during and after disasters to reduce the negative health outcome. In Bangladesh, the practice of family planning is low; only 54% of married women practice family planning (UNFPA, 2018). Although Bangladesh is unique among developing countries in registering significant declines in maternal and child mortality in recent times, the decline is not uniform across the country. In Bangladesh, the estimated maternal death range is from 158 to 782 maternal deaths per 100,000 live births (Ahmeda & Hillb, 2011).

The United Nations recently launched Sustainable Development Goal (SDG 2030) agenda to lift millions of people out of poverty and hunger, increase gender equality, improve health and wellbeing, and ensure environmental and social justice. The third goal of SDG 2030 is ensuring good health and well-being for all people around the world. The targets of the SDG are, by 2030, to reduce the global maternal mortality ratio to less than 70 per 100,000 live births; end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births; ensure universal access to sexual and reproductive health-care services including for family planning, information and education; and the integration of reproductive health into national strategies and programs (UN, 2018). Since

Bangladesh is a signatory to the SDG 2030 agenda, Bangladesh needs to make active plans to meet these targets. Otherwise, sustainable development will remain in jeopardy.

Statement of the Problem

Not all individuals or communities are affected by natural disasters equally. The human impact of natural disaster depends on individuals' economic, cultural, and social status. Natural disasters progress through four phases: (a) the interim or mitigation phase, where no specific disaster is imminent; (b) the immediate pre-disaster preparation phase when an identified disaster is anticipated; (c) the immediate post-disaster rescue and relief phase; and (d) the prolonged recovery and rebuilding phase (American Red Cross, 1993). In the different phases of disaster prevention, mitigation, preparation, and aftermath, entrenched social patterns of discrimination remain intact, making certain groups more vulnerable than others (Singh & Subramaniam, 2009). Inequalities in access to resources, capabilities, and opportunities systematically create disadvantages for certain groups of people (Neumayer & Plumper, 2007). Women, in general, tend to have less access to assets, such as physical, financial, human, social, and natural capital - land, credit, decision-making bodies, agricultural inputs, technology, extension, and training services. They often have more limited capacity to manage the short- and long-term risks of disaster (Aguilar, 2009; Sapir, 1993).

Men and women are affected differently by natural disasters (Aguilar, 2009). A study of 141 countries over the period 1981-2002 found that natural disasters and their subsequent impact on average kill more women than men (Neumayer & Plümper, 2007). According to Oxfam (2007), in the 1991 floods in Bangladesh, five times as many women perished as men; the 2005 South Asian tsunami killed four times as many women as men; even in the developed nation of

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Japan, women died at a rate 1.5 times the rate of men in the 1995 earthquake. Women are more vulnerable than men to death, injury, and physical and psychosocial health as well as disaster-related economic effects and medical disruptions (Carballo, Hernandez, Schneider, & Welle, 2005; Gasseer, Dresden, Keeney, & Warren, 2004; Gibbons & Garfield, 1999; Harville, Xiong, & Buekens, 2010).

Ahmad (2012) found that women in Bangladesh are disproportionately more vulnerable to natural hazard due to social norms, entrenched gender inequality, and reproductive responsibilities. Women's reproductive health is at increased risk both during and after natural disasters because of the wide range of damage to healthcare facilities, lack of health services, and women's poor control over capital and decision making (Ahmad, 2012; Engstrom, 2014; Harville et al., 2010; Nour 2011; Saulnier & Brolin 2015; Swatzyna & Pillai, 2013).

Women's reproductive health is an important aspect of women's wellbeing. Reproductive health is defined as a state of complete physical, mental, and social well-being (WHO, 2017). It is considered a pivotal part of human development and general health. Reproductive health addresses the reproductive processes, functions, and system at all stages of life (WHO, 2017). Satisfying and safe sex life is implied under reproductive health with a focus on "the capacity to reproduce and freedom to decide, if, when, and how often to do so" (WHO, 2017, par. 1). Reproductive health affects the health of future generations. Mother's health and nutrition status and her level of access to health care affect her infant's health (United Nations Population Fund [UNFPA] 2017), and women's health is the key to survival and health for her children (Izadkhah, Jahangiri, & Sadighi, 2014). Consequently, women's reproductive process is a crucial part not only of the status of the mother's physical and mental health but also of the infant's health and

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well-being. Although to live a healthy life, reproductive health is very important part in women's life, women's reproductive health is ignored during natural disasters in Bangladesh.

Purpose of the Study

The purpose of the study is to explore the effects of a natural disaster on women's reproductive processes and the effects of well-known reproductive health determinants on women's three phases of reproduction in a disaster prone area. The study has two research questions: (a) are women's three reproductive phases affected by a disaster? and (b) what are the effects of well-known health determinants on women's intercourse, conception, and gestation phases in a disaster prone country, Bangladesh? The study examines the effects of cyclone Sidr on women's three reproductive phases - intercourse, conception, and gestation - in Bangladesh. It also examines the effects of education, wealth, and place of residence on women's intercourse, conception, and gestation phases net of the effect of Sidr. This study controls for influential factors and compares the effects of Sidr across time and regions. To examine the influences of Sidr on women's three reproductive processes by comparing the disaster-affected and disaster-unaffected areas and also pre- and post-disaster periods, the study uses a difference-in-differences approach. In addition, the current study also proposes a conceptual framework based on the vulnerability perspective and fertility theory to examine whether women's three phases of reproduction were interrupted by the cyclone Sidr in Bangladesh. Secondary data, the Bangladesh Demographic Health Surveys (BDHS), is analyzed in the study. Although BDHS is a large and nationally representative sample, it has not yet been exploited to examine the effects of disasters in reproductive health research.

Significance of the Study

Studies find that women's reproductive health is adversely affected by natural disasters (Ahmad, 2012; Engstrom, 2014; Nour 2011; Swatzyna & Pillai, 2013). The immediate effects of natural disasters are found in marital disruptions, unplanned pregnancy, lack of access to contraception and contraceptive use, abortion, lack of antenatal perinatal care, poor birth outcomes and infant health, vulnerable psychosocial health, and high fetal and infant mortality (Callaghan et al., 2007; Currie & Rossin-Slater, 2013; Brock et al., 2015; Djafri, Chongsuvivatwong, & Geater 2015; Grabich et al., 2016; Harville et al., 2015; Sugawara et al., 2016; Torche & Kleinhaus, 2011). However, significant gaps exist in our knowledge both at the theoretical and methodological levels. At the methodological level, most of the empirical studies have focused only on women who were exposed to the harmful effects of natural disasters. Those studies focused only on women who had disaster experience while they did not examine the health outcome of women who were not exposed to disasters. One of the major methodological shortcomings is that it is not known whether the health risks equally prevail among women who are exposed to disasters and women who are not exposed to disasters in the same time period. The literature on disasters and women's reproductive health lacks a time framework for comparing the health consequences in pre- and post-disaster periods. In particular, studies have not compared the effect of disasters on women's health across time and regions.

In addition to these methodological issues, there are theoretical shortcomings as well. There is a scarcity of theoretical frameworks needed to investigate the reproductive health vulnerability of disaster-affected women. Most of the studies have not presented a theoretical explanation to understand the effects of natural disasters on women's reproductive health. The

current study addresses some of these methodological and theoretical gaps with respect to the relationship between natural disasters and women's reproductive processes.

Women's reproductive health is vulnerable during or after disasters because of a lack of access to health care, medications, and public and health care institutions (Ahmad, 2012; United Nations [UN], 2017). The United Nations International Conference on Population and Development [ICPD], 1994) has advocated for a number of reproductive rights for all women across the world including the right to access high-quality reproductive healthcare; the right to education and access in order to make free and informed reproductive choices; the right to birth control; the right to legal and safe abortion; the right of access to appropriate health-care services that will enable women to go safely through pregnancy and childbirth and provide couples with the best chance of having a healthy infant; and the right to have access to safe, effective, affordable, and acceptable methods of family planning of their choice for regulation of fertility (Pillai & Wang, 1999; Wang, 2016).

The results of the current study can have implications to use gender based disaster management in disaster preparation and mitigation phases. It can also contribute to an awareness of social justice and reproductive rights of vulnerable disaster-affected women. Social justice is a social work imperative. Consequently, the findings of this study can increase the attention of social work researchers and practitioners and health-related policy makers to address reproductive health vulnerability that results from disasters.

CHAPTER 2: LITERATURE REVIEW

This chapter presents a review of the literature concerning the effects of natural disasters on women's reproductive health. Because there is a scarcity of literature focusing squarely on Bangladesh and the consequences, therefore I expanded my inquiry to explore the literature on the effects of natural disasters on women's reproductive health globally. I conducted a systematic literature review to explore the effects of different natural disasters on women's reproductive health around the world. The aim of this literature review is to assess the universal impacts of natural disasters on women's reproductive health from empirical disaster research at a global level. This literature review follows the PRISMA protocols (Figure 2.1) for conducting a systematic literature review.
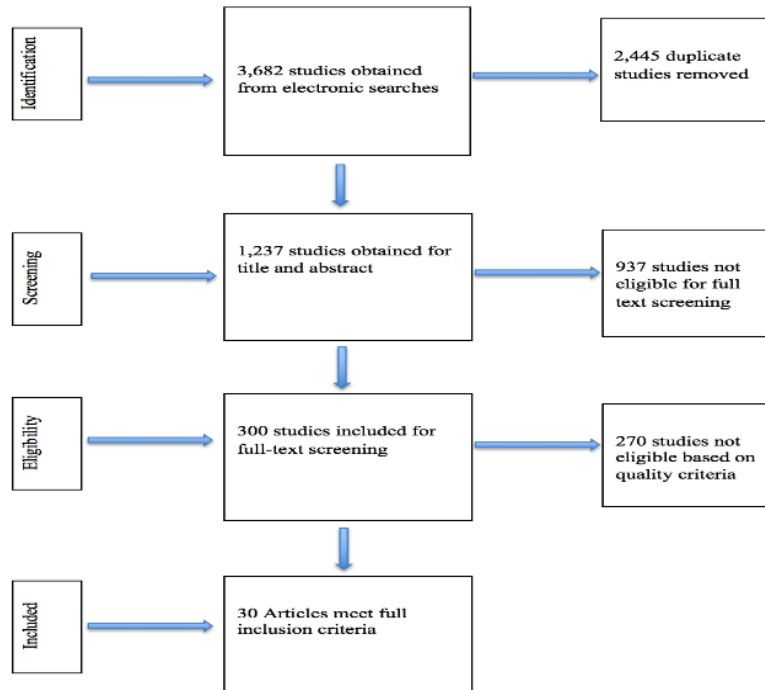
Figure 2.1. Flow Diagram of Studies Selected for Systematic Review of Natural Disasters and Women's Reproductive Health

Review Methods and Search Criteria

Studies on natural disasters and women's reproductive health were identified using a set of keywords for two main themes: (a) different natural disasters - AB (natural disaster* OR disaster* OR earthquake* OR flood* OR tsunami* OR hurricane* OR cyclone) and (b) reproductive health - AB (Reproductive health* OR sexual health* OR pregnancy* OR maternal health* OR maternal mortality* OR women's health* OR birth outcomes* OR contraceptive* OR antenatal care* OR fetal mortality* OR abortion* OR gestation* OR unplanned pregnancy). Moreover, reference lists and related items used in published articles identified additional studies for review. Several electronic databases including Academic search complete; alt healthWatch; MEDLINE; CINAHL Complete; Psychology and behavioral sciences collection; PsycINFO; PUBMED, Social Services Abstracts; ProQuest Dissertations and Theses Database; and Social Work Abstracts were included for a full review of peer-reviewed articles.

Inclusion Criteria

After filtering 3,682 studies, a total of 300 studies were included for full text screening, and eventually, 30 empirical studies were selected for assessing the findings of the study due to their relevance to the subject area and comparative fit with the purpose of this study (Figure 2.1). This review included studies pertaining to any natural disasters and their effects on getting married/divorced, unplanned pregnancy, pregnancy interval, access to contraception and contraceptive use, abortion, gestation age at birth, birth outcomes, antenatal care, perinatal outcome, fetal mortality, maternal mental health, infant health, and infant mortality. This study included reproductive health-related studies only women aged from 15 to 49. It focused only on studies that were related to natural disasters worldwide published between the years 1986 and 2017 and were studied based on empirical evidence.

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Results

Thirty empirical studies from the United States, Haiti, Taiwan, Indonesia, Japan, Canada, China, and Thailand were assessed here based on the type of natural disasters and their effects on reproductive health. For example, the effects of the hurricane on reproductive health; effects of the earthquake on reproductive health; effects of the flood on reproductive health; and effects of storms on reproductive health.

Effects of Hurricanes on Women's Reproductive Health

Thirteen empirical studies were identified in which the consequences of six hurricanes have been studied: Katrina, Ike, Andrew, Hugo, Charley, and Jeanne. Effects of Hurricane Katrina on family development, sexual behavior, contraceptive use, pregnancy, maternal prenatal care, birth outcomes, and mental health were examined by six articles (Table 2.1). Hurricane Katrina hit the Gulf Coast of the United States in August 2005 and has been considered one of the worst catastrophes in the country. It was a category 3 hurricane, killed 2,000 people and cost more than 1,800 lives across Louisiana, Mississippi, Florida, Georgia, and Alabama (CNN, 2017; Kent, 2005). The devestation was most concentrated in New Orleans. Hurricane Katrina directly affected approximately 56, 000 pregnant women and displaced at least 10,000 (Buekens, Xiong, & Harville, 2006; Harville, Xiong, & Buekens, 2009). Two empirical articles were found regarding Hurricane Hugo and one on Hurricane Ike, Andrew, Charley, and Jeanne. Hurricane Hugo a category 4, formed over the eastern Atlantic and hit Florida, South Carolina, North Carolina, and Georgia on September 9, 1989 (National Weather Service, 2015). It was ranked fourth in natural disaster relief costs by the Federal Emergency Management Agency. Hurricane Andrew was category 5 and one of the most destructive hurricanes, struck on August 24, 1992, to Bahamas and Florida and knocked out power to 1.3 million households (Herald, 2015). On

August 13, 2004, Hurricane Charley made landfall on the southwest coast of Florida as a category 4 storm and caused 10 direct fatalities and an estimated $14 billion in economic losses (U.S. Department of Commerce, 2004). Hurricane Jeanne was the sixth major hurricane of 2004 and ended up the deadliest with over 3,000 deaths in Haiti, the Dominican Republic, Puerto Rico, and Florida (National Weather Service, 2004). Hurricane Ike made landfall on September 13, 2008, in Texas and produced a destructive and deadly storm surge across upper Texas and southwest Louisiana coasts (National Weather Service, 2008).

Empirical studies regarding hurricanes were explored in three major areas of reproductive health: change in family development, sexual behavior, and access to reproductive care; pregnancy and birth outcomes; and maternal stress and infant health.

Change in Family Development, Sexual Behavior, and Access to Reproductive Care

Hurricanes bring change in family development by affecting the main life course transitions. Cohan and Cole (2002) stated that in the year following Hurricane Hugo, marriage and divorce rates increased in the 24 disaster declared counties of South Carolina. It indicates that a life-threatening event motivates people to take significant action in their close relationships that affect individuals, families, and the entire community. Attachment theory was applied in this study, which suggested that marriages and births would increase and divorce would decline after the hurricane. In this study, time-series and vital statistics were used for marriages, births, and divorces records of 46 counties of South Carolina that were obtained from the annual South Carolina Statistical Abstract.

Hurricanes also cause rapid displacement of people and disruption in health care access. Contraception and reproductive health care are hard to find in the aftermath of a disaster. Kissinger, Schmidt, Sanders, and Liddon (2007) conducted an empirical study to explore the

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changes in sexual behavior and access to reproductive care due to hurricane Katrina among a cohort of young women receiving family planning services before displacement. They have collected data from August 1, 2004, through August 25, 2005, applying follow-up surveys to 164 women (mostly Black) 16 to 24 years old were attending a public family planning clinic in New Orleans. They found that after Hurricane Katrina women were less likely to have attended family planning services, to have used birth control, to have a sex partner, and to have a vaginal odor or discharge. In their study, 17% women needed health care but could not access it, 40% had not used birth control, and 4% experienced an unintended pregnancy as a result of lack of access to care.

Another study also found that 13% of women reported difficulties accessing contraception after Hurricane Ike when Black women had more difficulty than their White ($p <$ 0.001) and Hispanic ($p = 0.019$) counterparts and a lack of access to birth control was related to having a higher frequency of unprotected sex for women of all races ($p = 0.001$, Leyser-Whalen, Rahman, & Berenson, 2011). This study also found that a lack of access to birth control was related to having a higher frequency of unprotected sex for women of all races ($p = 0.001$). This study conducted a cross-sectional survey on health behaviors among women 16–24 years old between August 2008 and July 2010 attending one of five publicly funded reproductive health clinics. Multivariable logistic regression was used to identify the correlation of an inability to access contraceptives.

Pregnancy and Birth Outcomes

Hurricanes have short-and long-term effects on pregnancy and birth outcomes. Hurricane exposures increase extremely preterm delivery, low fetal growth, and low birth weight. Applying the Cox regression model on 342,942 singleton births data, a study found that Hurricane Charley

was associated with a 9% to 21% increase in the hazard of extremely preterm delivery in Florida (Grabich et al., 2016). Extremely preterm delivery was considered as <32 gestational weeks.

Harville et al. (2015) found the relationship between experiencing damage during Katrina and birth weight (median birth weight was 3250 g) and between injury and gestational age (median gestational age was 39.2 weeks). In this study, the incidence of low birth weight was 39%, preterm birth was 39%, and both low birth weight and preterm birth was 23%. In this study, 308 pregnant women of New Orleans were interviewed after Hurricane Katrina about their exposure to the disaster (danger, damage, and injury); current disruption; and perceptions of recovery. Birth weight, gestational age, birth length, and head circumference were examined in linear models, and low birthweight (<2500 g) and preterm birth (<37 weeks) in logistic models, with adjustment for confounders.

Another study also found that fetal distress risk in the Hurricane Andrew exposure period is statistically significant ($t = -3.903$, $p \leq 0.001$ (Zahran, Snodgrass, Peek, & Weiler, 2010). The risk of fetal distress was higher during the hurricane exposure period in Florida ($\mu = 0.019$, CI 95% = 0.026 to 0,032) as compared to non-exposure periods ($\mu = 0.024$, CI 95% = 0.023 to 0.025). Hurricanes during pregnancy have significant effects on abnormal conditions of the newborn and on complications of labor and delivery. In this study, logistic regression and spatial analytic techniques are used to model fetal distress risk as a function of maternal exposure to Hurricane Andrew.

Currie and Rossin-Slater (2013) found that exposure to a hurricane during increased the probability of abnormal conditions of the newborn such as being on a ventilator more than 30 minutes and meconium aspiration syndrome (MAS). This study used Ordinary Least Squares (OLS) method on the birth records information from the Texas Department of State Health

Services data from 1996 to 2008. Birth records include information about the mother's demographic (age, race, education, marital status), the child sex and birth order, method of delivery, complications of labor and delivery, risk factors of the pregnancy, and maternal behaviors such as prenatal care and smoking.

However, two studies found no association between a hurricane and live birth rate (Christopher, 2017; Grabich, 2015). Applying individual-level analysis, Grabich found evidence of an association between hurricane exposure and increased hazard of extremely preterm delivery (<32 weeks gestation), but no association with overall preterm delivery (<37 weeks gestation). Suggested associations appeared driven by White Hispanic and Black Hispanic subgroups, although he found limited evidence of statistical interaction. Another study also did not find evidence of increasing hazards of preterm delivery with exposure to multiple hurricanes (Christopher, 2017).

Maternal Stress and Infant Health

Studies found that psychosocial and physiological stressors during pregnancy are associated with changes in behavioral, cognitive, and physiologic infant outcomes (DiPietro, Ghera, Costigan, & Hawkins, 2004; O'Connor, Heron, Glover, & Alspac Study Team, 2002; Sjöström, Valentin, Thelin, & Maršál, 2002). In a study of hurricane experience, mental health, and infant temperament, large associations between maternal stress due to Hurricane Katrina and infant temperament were not seen, but maternal mental health was associated with reporting difficult temperament (Tees et al., 2010). In this study, women were more likely to report having a difficult infant temperament at 1 year if they had screened positive for PTSD. Data were collected using questionnaires and interviews from a cohort of 288 mothers who gave birth in New Orleans. Questionnaires and interviews assessed the mother's experiences during the

hurricane, living conditions, and psychological symptoms. Infant temperament characteristics were reported by the mother using the activity, adaptability, approach, intensity, and mood scales of the Early Infant and Toddler Temperament Questionnaires. Logistic regression was used to examine the association between hurricane experience, mental health, and infant temperament.

Kinney, Miller, Crowley, Huang, and Gerber (2008) investigated whether autism is associated with exposure to stressful events during sensitive periods of gestation experienced during the course of Hurricane Katrina. They found that Autistic Disorder prevalence in Louisiana children increased significantly with the severity of prenatal storm exposure. This study analyzed Louisiana's Department of Health and Hospitals (DHH) data and the National Center for Health Statistics (NCHS) data, applying z-test, Chi-square tests, and multiple logistic regression.

Another study found that after the Hurricane Katrina mental illness symptoms were very common (30.7% had likely depression, 17.4% had anxiety, and 9.0% had posttraumatic stress) among pregnant women of New Orleans (Barcelona de Mendoza, Harville, Savage, & Giarratano, 2016). In this study, 402 pregnant women were interviewed between 2010 and 2012 as part of a larger cross-sectional study on hurricane recovery and models of prenatal care. Also, symptoms of depression (Edinburgh Postnatal Depression Screen), prenatal anxiety (Revised Prenatal Distress Questionnaire), post-traumatic stress (PCL-S), and perceived stress (PSS) were examined. Logistic regression was used to adjust for income, race, education, parity, and age.

However, another study found that although disaster causes distress, many disaster victims do not develop long-term psychopathology (Harville, Xiong, Buekens, Pridjian, & Elkind-Hirsch, 2010). This study found that 35% of pregnant and 34% of the postpartum women were resilient to depression, whereas 56% and 49% were resilient to posttraumatic stress

disorder. Resilience was most likely among White women, older women, and women who had a

partner. A greater experience of the storm, particularly injury, illness, or danger, was associated

with lower resilience. In this study, 222 pregnant southern Louisiana women and 292 postpartum

women were interviewed and resilience was measured using the Edinburgh Depression Scale and

the Post-Traumatic Stress Checklist. Posttraumatic growth was measured by questions about the

perceived benefits of the storm. Women were asked about their experience of the hurricane,

addressing the danger, illness or injury, and damage. Chi-square tests and log-Poisson models

were used to calculate associations and relative risks for demographics, hurricane experience,

and mental health resilience and perceived benefit.

Effects of Earthquake on Reproductive Health

Ten empirical studies were identified in which consequences of different earthquakes,

such as the 1999 Taiwan Earthquake, the 2005 Tarapaca earthquake in Chile, the 2006

Yogyakarta earthquake in Indonesia, the 2007 Peninsula earthquake in Japan, the 2008 Sichuan

earthquake in China, the 2009 Sumatra earthquake in Indonesia, the 2010 Haiti earthquake, and

the 2011 Great East Japan earthquake have been studied (Table 2.2). Three major factors have

been identified to determine these earthquakes' effects on women's reproductive health:

availability and accessibility of reproductive health services and pregnancy outcomes; maternal

mental health; and birth outcomes.

Availability of Reproductive Health Services and Pregnancy Outcomes

Earthquakes can damage the infrastructure of health care institutions, which can result in

disruption to the availability and accessibility of health care services. One study found that in the

acute phase of the Great East Japan Earthquake and tsunami, maternity institutions were forced

to stop medical services due to severe damage and perinatal transport came to a standstill

(Sugawara et al., 2016). As a result, pregnant women inevitably gave birth in unplanned institutions, and the number of pre-hospital births increased extremely. This study examined the Great East Japan Earthquake and tsunami damages to 50 maternity institutions, evacuation status and transport of pregnant women, and pre-hospital child-births by applying a survey method.

In addition, Djafri et al. (2015) examined the effect of the 2009 Sumatra earthquake on availability and accessibility of reproductive health services by interviewing 667 clients of 26 health facilities in Padang City of Sumatra. Although they found that antenatal and emergency obstetric care was minimally disrupted, the previous rate of improvement in maternal and child mortality was slowed down with an increasing rate of stillbirths after the earthquake. In this study, the percentage of public facilities' damage was described graphically. From the client interview, individual perception and practice before and after the earthquake were compared and shown as frequency of changes. Also, odds ratios (ORs) with 95% confidence intervals (CI) were computed.

Two studies were identified that examined access to contraception and change in contraceptive methods before and after the earthquakes (Behrman & Weitzman, 2016; Hapsari, Nisman, Lusmilasari, Siswishanto, & Matsuo, 2009). Although these studies examined the two different earthquakes – the 2006 Yogyakarta earthquake and the 2010 Haiti Earthquake - both studies found that the percentage of participants who used injections and implants tended to decrease and the prevalence of unplanned pregnancy was significantly higher in a group of participants who had difficulty accessing contraceptive methods and family planning services compared with a group that did not. In the 2006 Yogyakarta study, 450 married women participated who were recruited through the cooperation of cadres (Hapsari et al., 2009). Information of participants' background, contraceptive methods, difficulties in accessing

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contraceptive methods, and unplanned pregnancy were included in the study questionnaires. The study results were displayed as frequencies, percentages, means, and standard deviations. Analysis of the difference between two proportions was used for comparison between groups. On the other hand, 2005 and 2012 Demographic and Health Survey (DHS) were used in the 2010 Haiti Earthquake study, which included information about fertility history, fertility preferences, contraceptive use, contraceptive access, prenatal care, displacement, destruction, mortality, and morbidity (Behrman & Weitzman, 2016). This study applied department-level variation in the destruction of the earthquake to assess the effects of the earthquake on reproductive health outcomes using a difference-in-difference (DID) analysis.

One study examined the relationship between exposure to the 2010 Haiti earthquake and pregnancy wantedness, interpregnancy interval, and birth weight (Harville & Do, 2016). This study found that post-earthquake births were less likely to be wanted and more likely to be born after a short interpregnancy interval. Earthquake exposure was associated with increased likelihood of a child being born too small. Mean birth weight was 150 to 300g lower in those exposed to the earthquake. This study used data from the Haiti 2012 Demographic and Health Survey (DHS), which included information before and after the earthquake on size of child at birth (too small or not), birth weight, pregnancy wantedness, short (<1 year) interpregnancy interval. Multivariate logistic regressions were implemented to assess the influence of household and regional experience with the earthquake on the reproductive and birth outcomes. Contrary, the study of Torche and Kleinhaus (2011) examined the sex-specific effect of stress on the duration of pregnancy and the observed sex ratio among pregnant women exposed to a major earthquake in Chile.

Maternal Mental Health

Three empirical studies were identified that examined the effects of an earthquake on maternal mental health (Dong et al., 2013; Xu, Herrman, Bentley, Tsutsumi, & Fisher, 2014). Xu et al. (2014) found that women who have lost an only child in a natural disaster are especially vulnerable to long-term psychological problems, especially if they have reached an age when conception is difficult. In their study, the prevalence of psychological symptoms was higher in mothers who did not have a child after losing the first one. In an adjusted model, symptoms of anxiety (odds ratio, OR: 3.37; 95% confidence interval, CI: 1.51–7.50), depression (OR: 9.47; 95% CI: 2.58–34.80), PTSD (OR: 5.11; 95% CI: 2.31–11.34) and CG (OR: 10.73; 95% CI: 1.88–61.39) were significantly higher among the 116 women without a subsequent child than among the 110 mothers who had another child after bereavement. More than two thirds of mothers with new infants had clinically important psychological symptoms. In the study, a cross-sectional survey of bereaved mothers was conducted 30 to 34 months after the 2008 Sichuan earthquake using individual structured interviews to assess sociodemographic characteristics, post-disaster experiences, and mental health. The interviews incorporated standardized psychometric measures of anxiety, depression, post-traumatic stress disorder (PTSD), and complicated grief (CG). Social support was also assessed. An adjusted model taking potential confounders into account was used in this study to explore any association between psychological symptoms and the birth of a subsequent child.

A study by Hibino et al. (2009) assessed the health impact of stress on 99 women who were pregnant during or immediately after the 2007 Peninsula earthquake and were living in the disaster area. In this study, the psychological impact was assessed on the Edinburgh Postnatal Depression Scale (EPDS) and stress resistance was assessed on the Sense of Coherence Scale

(SOC). This study found that the SOC during pregnancy significantly moderated between "existing anxiety about an earthquake" and "EPDS" (b = -0.21, P = 0.02). Although the SOC during pregnancy did not moderate between a physical abnormality and earthquake-related stress, the EDPS was a significant predictor of a physical abnormality during pregnancy or childbirth (odds ratio, 1.21; 95% confidence interval: 1.04 - 1.41).

However, Dong et al. 2013 found that the 2008 Sichuan earthquake did not necessarily have a long-lasting effect on pregnant women who were victims of the disaster. It was found that pregnant women who experience high levels of pressures from the pregnancy and receive medium support from husbands are more susceptible to experience antenatal depression than pregnant women who perceive higher levels of support from their husbands. In this study, the prevalence rate of depression among pregnant women in the earthquake area was 34.5% (95% CI, 28.9–40.6), while the rate in the non-earthquake area was 39.6% (95% CI, 33.9–45.5). The perceived stresses associated with pregnancy and social support from husbands are significantly correlated with antenatal depression. In this study, 520 pregnant women were interviewed from June 2012 to October 2012 of whom 253 were from an earthquake-struck area and 267 were from a non-earthquake struck area. Symptoms of antenatal depression were measured using the Edinburgh Postnatal Depression Scale (EPDS) with a cutoff of ≥10. Chi-square tests and bivariate correlate analysis were performed so as to examine the correlation between the outcome variable and independent variables and sociodemographic factors. Multivariate logistic regression was employed to identify predictors of antenatal depression.

Birth Outcomes

Two empirical studies were identified in which maternal mental health was associated with a wide range of adverse birth outcomes (Chang, Chang, Lin, & Kuo, 2002; Torche &

Kleinhaus, 2011). The study of Chang et al. (2002) investigated the prevalence of minor psychiatric morbidity in a group of women who were pregnant during or immediately after the 1999 Taiwan earthquake and prognostic factors that may have influenced the perinatal outcome of the pregnancy. The study was initiated 6 months after the earthquake and enrolled 171 women in a town near the epicenter. A Post-Earthquake Questionnaire, Chinese Health Questionnaire (CHQ-12), and posttraumatic stress disorder (PTSD) symptoms checklist were completed before delivery whereas the perinatal data were retrieved from hospital obstetrical records. Pearson's chi-square test and logistic regression were applied. The study found that the prevalence of minor psychiatric morbidity (MPM) was 29.2%. Women with starvation experience, higher negative attitude scores about the influence of earthquake on pregnancy and more casualties among relatives were significantly correlated with high CHQ. A significant positive correlation between the MPM and PTSD scores was noted. Among the 115 pregnancies with the known perinatal outcome, there were nine (7.8%) low-birth weight neonates, defined as birth weight $\leq$ 2500g. Maternal history of an abdominal injury, spouse casualty, and instability in living condition were significantly correlated with low birth weight. Spouse casualty was the only significant factor that predicted neonatal low birth weight.

A study of Torche and Kleinhaus (2011) examined the sex-specific effect of stress on the duration of pregnancy and observed sex ratio among pregnant women exposed to the 2005 Tarapaca earthquake in Chile. In this study, regression models were used to measure the impact of earthquake exposure on gestational age and preterm birth by sex across the month of gestation, and a counterfactual simulation was implemented to assess the effect of the earthquake on the secondary sex ratio, accounting for the differential impact of stress on gestational age by sex. By applying the quasi experimental design, this study found that the 2005 Tarapaca

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earthquake exposure in Months 2 and 3 of gestation resulted in a significant decline in gestational age and an increase in preterm delivery. The effects of Tarapaca earthquake varied by sex, and were much larger for female births than male. Among females, the probability of preterm birth increased by 0.038 [95% confidence interval (CI): 0.005, 0.072] in Month 2 and by 0.039 (95% CI: 0.002, 0.075) in Month 3.

Effects of Flood on Reproductive Health

Five empirical studies were identified that examined the effects of different floods such as the 2011 Network Queensland flood (Simcock et al., 2017), the 2011 Thailand flood (Sanguanklin et al., 2014), the 2009 North Dakota Red River flood (Hilmert, Kvasnicka-Gates, Teoh, Bresin, & Fiebiger, 2016), the 2008 Iowa flood (Brock et al., 2015), and the 1997 North Dakota Red River flood (Tong, Zotti, & Hsia, 2011) on adverse pregnancy and birth outcomes and prenatal maternal stress (Table 2.3).

Pregnancy and Birth Outcomes

The study of the 2011 Thailand flood examined the effect of displacement on infant birth weight and gestational age at birth and also examined the moderating effect of perceived social support on the relationship between displacement and birth outcomes (Sanguanklin et al., 2014). This longitudinal study was conducted with 175 women who were at least 18 years old, employed full time, pregnancies were between 26 and 38 weeks of gestation, had uncomplicated pregnancies, had no history of mental illness based on a chart review, and had a singleton intrauterine pregnancy. This study found that 70% ($n = 123$) of the participants experienced displacement during the flood, and they had a mean infant birth weight of 175 grams less than that of the non-displaced women, $t(173) = -2.38$, $p = .02$, whereas infant gestational age was not different. Furthermore, the interaction term between displacement and perceived social support

was statistically significant and additionally explained the variance in infant birth weight, F (6, 168) =3.24, p = .005.

A study of the 1997 North Dakota Red River flood using county-level birth data pre-disaster (1994–1996) and post-disaster (1997–2000) examined the associations between the disaster and low birth weight (<2,500g) and preterm birth (<37 weeks, Tong et al., 2011). This study found that there was an increase in medical risks, low birth weight, and preterm delivery among women giving birth in North Dakota following the flood. Also, the study of the 2009 North Dakota Red River flood found that pregnant women (N = 169) in the first trimester who experience a major flood near their homes were at risk of having lower birth weight neonates due to a reduction in fetal growth (Hilmert et al., 2016).

Perinatal Maternal Stress

Prevalence rates of maternal depression during pregnancy and the months following childbirth (i.e., perinatal maternal stress), ranging from 7% to 19%, is of considerable mental health concern (Gavin et al., 2005; O'Hara & McCabe, 2013). A study examined the impact of the 2008 Iowa floods on perinatal maternal depression and well-being on 171 perinatal women (Brock et al., 2015). Using regression analysis, this study found that prenatal flood exposure was associated with greater depression (r = .15) and general well-being (r = .18) and that flood-related peritraumatic distress was uniquely associated with greater depression (r = .23).

Because prenatal maternal stress (PNMS) negatively affects a range of infant outcomes, a study of the 2011 Network Queensland flood examined the effects of flood-related stress in pregnancy on 6 month olds' neurodevelopment and examined the moderating effects of timing of the stressor in gestation and infant sex on these outcomes, using hierarchical regression analyses (Simcock et al., 2017). Although infants' communication skills had not been affected by PNMS

in this study, gender had significant dissimilar effects in male and female infants, where high levels of stress were found among female infants who had significantly lower problem-solving scores than male infants. It indicates that differential aspects of maternal flood-related stress in pregnancy influenced the neurodevelopment of infants.

Effects of Storm on Women's Reproductive Health

Two empirical studies were identified in which one study examined the effects of the 1998 Canadian ice storms on birth outcomes, including gestational age at birth, birth weight, head circumference, birth length, and head circumference to birth length ratio (Dancause et al., 2011); contrarily, another study focused on the factors that were associated with having an emergency plan among postpartum women in Arkansas during 2009 (Zilversmit, Sappenfield, Zotti, & McGehee, 2014, Table 2.4). Using hierarchical linear regression analyses ($N = 172$ women), Dancause et al. (2011) found that exposure to 1998 Canadian ice storms during pregnancy influenced birth outcomes. They found that gestation lengths, predicted birth weights, and birth lengths were shorter among participants exposed to the ice storm during early to mid-pregnancy compared with third trimester and pre-pregnancy exposure, and high objective PNMS levels predicted smaller head circumferences in early pregnancy.

In the study of Zilversmit et al. (2014), multivariable logistic regression ($N = 1, 173$) was conducted to examine associations between maternal race/ethnicity, sociodemographic characteristics, a region of residence, disaster experience, and having a disaster plan. They found that 40% of women reported having an emergency plan; Hispanic women were less likely to report having a plan than non-Hispanic White women; and families with five or more members were more likely to have a plan compared with smaller families. It indicates that although

emergency planning is an important factor in public health emergency preparedness (Nelson, Lurie, Wasserman, & Zakowski, 2007), it varies based on race and family size.

These empirical studies explored mainly the effects of natural disasters on family development, sexual behavior, access to reproductive cares, contraceptive use, pregnancy and pregnancy outcomes, maternal mental health, prenatal maternal stress, and birth outcomes. Most of the studies indicate that natural disasters have a negative impact on pregnant women and their children. However, none of the studies have focused on all three phases of reproduction: intercourse, conception, and gestation. Though all of the studies focused on women's disaster experience on reproductive health, none of the studies examined whether the health risks equally prevail among women who are exposed to disasters and women who are not exposed to disasters in the same time period. Studies have not compared the reproductive health risk between women in a disaster-affected area and women in a disaster-unaffected area. In addition, most of these studies applied regression analysis design for estimating the relationships among variables. All of the studies used cross-sectional data. Longitudinal studies are needed to understand the pre- and post-disaster effects and also long- and short-term effects of disasters on health. Only one theory focused study was identified. It used stress theory to examine whether an environmental stressor is related to reproductive health services (Cohan, & Cole, 2002). More theory focused studies are needed to understand the effects of natural disasters on the processes of women's reproduction.

Moreover, there is a lack of social work perspective and theoretical modeling to understand this severe social problem. Most of the studies were conducted by researchers from Public Health, Geography, and Sociology disciplines. More studies are needed to bridge the social work knowledge gap in the context of natural disasters and health equity.

Specially, although, Bangladesh is one of the most disaster-prone countries with low resources, there is little literature to understand the effects of natural disasters on women's reproductive health there. More studies on this area in Bangladesh will help the government and disaster mitigation policy makers to effectively address the short- and long-term goals to decrease the consequences of natural disasters on public health.

CHAPTER 3: THEORETICAL PERSPECTIVES

Modeling Sidr's Effects on Women's Reproductive Health

In this chapter, a conceptual model and hypotheses of the study are presented to

understand the consequences of Sidr on women's reproductive health in Bangladesh drawing

from both streams of literature on natural disasters and women's reproductive health. The

conceptual model of this study is drawn substantially from two theoretical perspectives:

vulnerability perspective and fertility theory.

Vulnerability Perspective

The word "vulnerable" is derived from the Latin root vulnus (wound) and vulnerable

populations are those who are susceptible to damage or injury (Aday, 1993, 2001; Wisner,

Blaikie, Cannon, & Davis, 2004). Vulnerability means the characteristics of a person or group

and their situation that influence their capacity to anticipate, cope with, resist, and recover from

the impact of a natural hazard (Wisner et al., 2004). There is likely to be considerable variation

in vulnerability across individuals and groups. Negative or stressful life events put people more

at risk for poor physical, psychological, or social health than others (Aday, 2001, p.4). For

disaster victims, the experience of surviving itself is considered a stressful life event, making

them vulnerable to these negative effects (Cohan & Cole, 2002; Zakour & Gillespie, 2013). Risk

is defined as attributes or exposures that lead to an increased probability of health-related

outcomes (Aday, 1993, 1994, 2001). Low socioeconomic status and lack of environmental

resources are the fundamental cause of being vulnerable which ultimately increases morbidity,

premature mortality, and diminished quality of life (Aday, 1993; Flaskeraud & Winslow, 1998;

Centers for Disease Control [CDC], 2018). Health is defined as "a state of complete physical,

mental, and social well-being" (WHO, 2018). Women and children are identified as a vulnerable

group based on their increased risk for poor physical, psychological, or social health outcomes and inadequate health care (Aday, 1993, 2001; Flaskeraud & Winslow, 1998). Specially, mothers in disadvantaged socioeconomic positions exposed to environmental risk are identified as the most vulnerable populations (Aday, 2001). It suggests that disaster victims who are women, living in a lower socioeconomic environment with lower education, and have less access to healthcare resources are the most vulnerable populations. According to vulnerability perspective, high rates of teenage pregnancies, failing to receive adequate health care, low birth weight, high maternal mortality and infants' mortality are the common factors that are related to vulnerable mothers and infants (Aday, 2001). Empirical studies on the impact of disasters on women's reproductive health find that disasters have negative effects on family development, sexual behavior, contraceptive use, pregnancy, maternal prenatal care, birth outcomes, mental health, and maternal and child mortality (Currie & Rossin-Slater, 2013; Djafri et al., 2015; Grabich et al., 2016; Hapsari et al., 2009; Harville et al., 2015; Kissinger et al., King et al., 2012; Kinney et al., 2008; Zahran et al., 2010).

Resource availability, relative risk, and health status are significant components of the vulnerability perspective (Aday, 1993, 1994, 2001; Flaskeraud & Winslow, 1998). Resource availability is seen as having access to socioeconomic and environmental resources. Social status (prestige and power), social capital (social support), and human capital (productive potential) are the key factors that shape differential socioeconomic, environmental, and behavioral exposures to health risks among different groups. Social status is associated with the positions that individuals hold in a particular society as a function of age, sex, race, or religious belief. Social capital is defined as the quantity and quality of interpersonal relationships among people and communities. Human capital refers to investments in individuals' skills and capabilities, such as

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education, that empower them to act in a new way or increase their capacity to contribute in

development. Relative risk is defined as the ratio of the risk of poor health among groups who

lack access to resources and are also exposed to risk factors compared with those groups who

have access to resources and are not exposed to the risk factors. Risk factors increase the chance

of occurrence of health-related outcomes. According to the vulnerability perspective, some

groups can be more at risk of poor physical, psychological, and social health than others at any

given time due to the prevalence of risk factors. The risk is greater for those who have least

social status, social capital, and human capital to either prevent or ameliorate the origins of the

consequences of poor physical, psychological, and social health. Disease prevalence, morbidity,

and mortality rates are indicators of the health status of vulnerable groups. Figure 3.1 shows the

linkage among resource availability, relative risk, and health status. It shows that risk factors

increase when social and environmental resources decrease. Consequently, health status is

directly affected by risk factors which are determined by social and environmental resources.
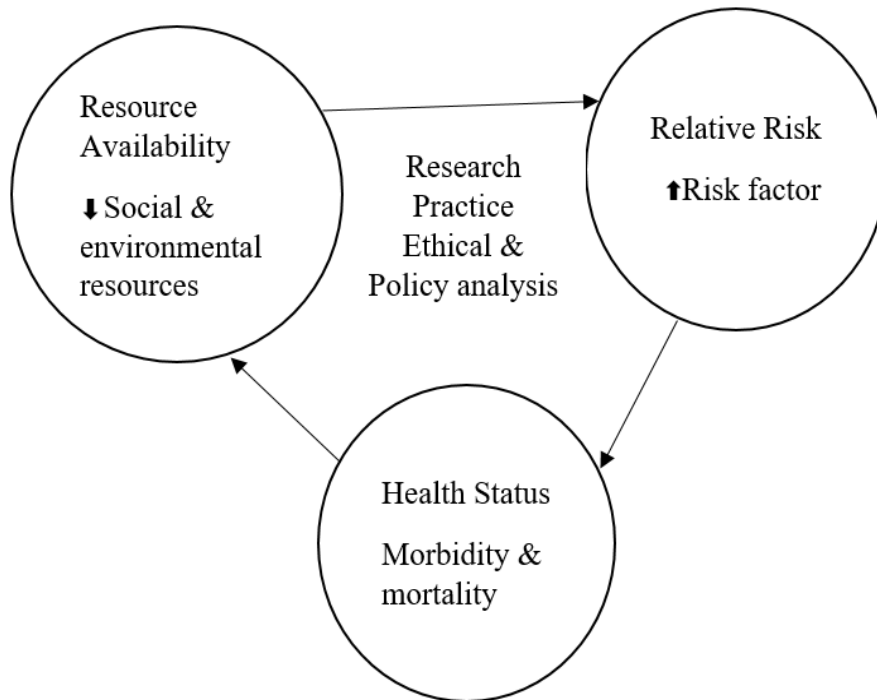
Figure 3.1. Vulnerability Conceptual Framework (Flaskeraud & Winslow, 1998, p. 2)

Fertility Theory

Fertility theory proposes two types of determinants in reproduction process: indirect determinants and direct or intermediate determinants (Bongaarts, 1978; Davis, 1963; Davis, & Blake, 1956). Socioeconomic, cultural, and environmental factors are considered to be the indirect determinants on the process of reproduction. For example, level of education, wealth, and living place are considered related to the outcome of fertility or women's reproduction. On the other hand, biological and behavioral factors are considered the direct or intermediate determinants affected by the socioeconomic, cultural, and environmental variables. Fertility theory also proposes three necessary phases in the process of reproduction: intercourse, conception, and gestation (Figure 3.2). Davis and Blake (1956) describe 11 biological and behavioral factors that play significant roles in these three phases of human reproduction. Under the intercourse phase, they include six factors that govern the formation and dissolution of unions in the reproductive period and exposure to intercourse within unions. The six intercourse factors are age of entry into sexual union; proportion of women never entering sexual unions; amount of reproductive period spent after or between unions; voluntary abstinence; involuntary abstinence; and coital frequency. Under the conception phase, they include three factors: fecundity or infecundity as affected by involuntary causes; use or non-use of contraception; and fecundity or infecundity as affected by voluntary causes. Lastly, under gestation phase, they include two factors: foetal mortality from involuntary causes and foetal mortality from voluntary causes.
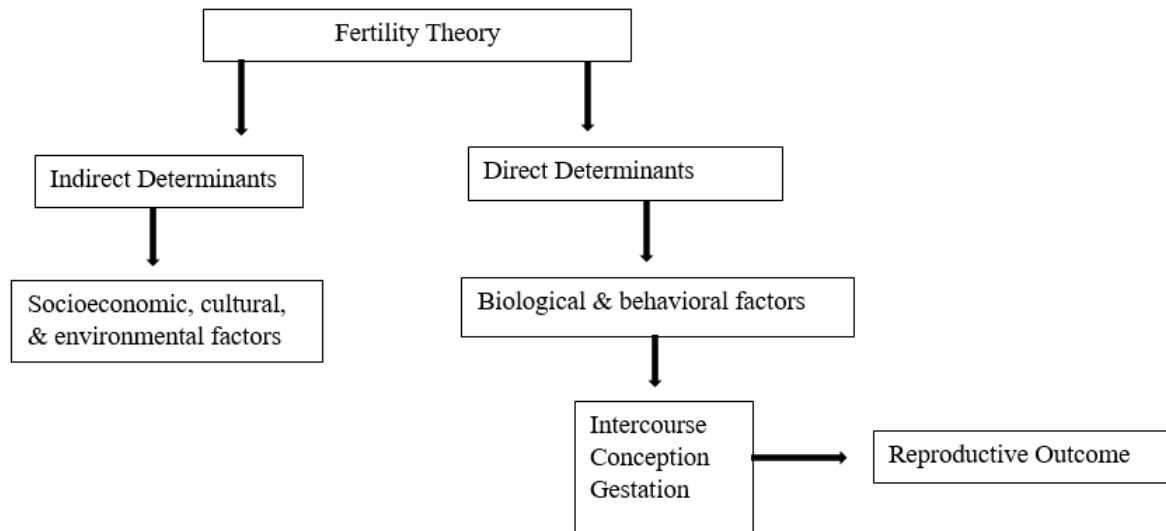
Figure 3.2. Determinants of Reproductive Health

Conceptual Model of the Current Study

The vulnerability perspective suggests that women as disaster victims are the most vulnerable population due to their increased risk for poor physical, psychological, or social health outcomes and inadequate health care (Aday, 1993, 2001; Flaskeraud & Winslow, 1998). According to fertility theory (Bongaarts, 1978; Davis, 1963; Davis, & Blake, 1956), indirect determinants - socioeconomic, cultural, and environmental variables - and direct determinants - biological and behavioral variables - have great influence on the reproduction processes of human culture. Vulnerability perspective and fertility theory both focus on socioeconomic factors to determine the health vulnerability of the individual. Moreover, the literature supports that women can be vulnerable across the three phases of reproductive processes of intercourse, conception, and gestation because of sudden disruption and lack of resources during or after disasters. When disasters happen, women's reproductive process can be affected by the dramatic changes in socioeconomic, cultural, and environmental resources. The following conceptual model (Figure: 3.3) is proposed based on the vulnerability perspective and fertility theory to

address the purpose of the current study to examine the well-known reproductive health determinants and the effects of disasters on women's reproductive health. In the conceptual model of the current study, socioeconomic status is an essential factor that significantly links the woman's reproductive process. The socioeconomic factor is coined from both the vulnerable perspective and fertility theory. Both vulnerable perspective and fertility theory theorized individual's wealth, education, and living place are important factors to understand their socioeconomic status and access to resources (Aday, 1993; Bongaarts, 1978; Davis, & Blake, 1956; Flaskeraud & Winslow, 1998). On the other hand, three phases of the reproductive process and factors under each phases are coined from direct determinants of reproductive health (Davis & Blake, 1956).
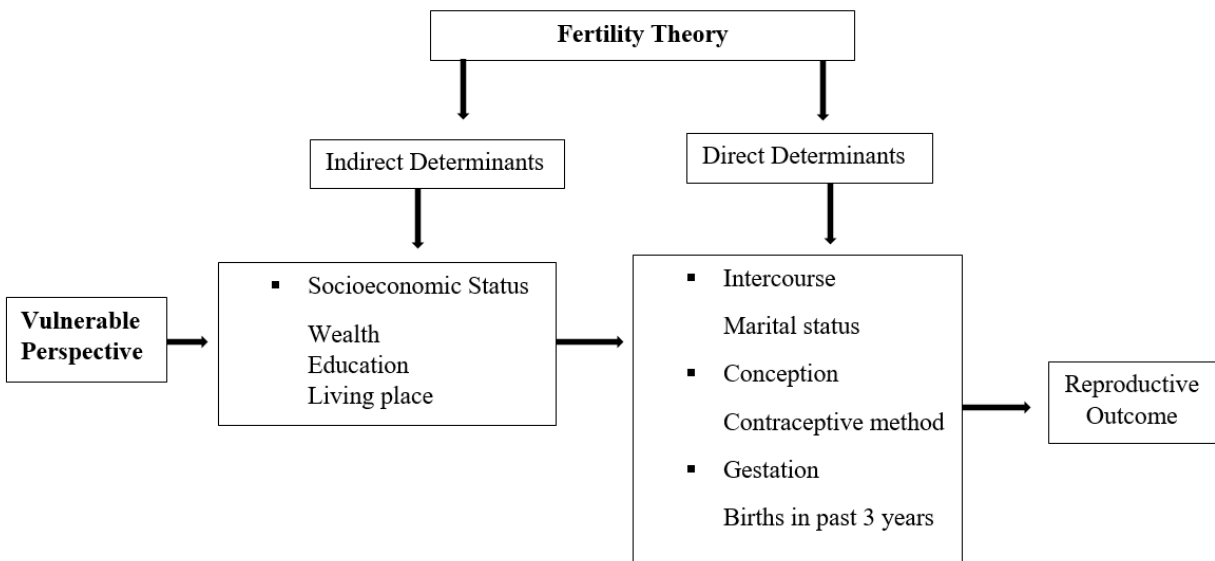
Figure 3.3. Conceptual Model of the Study

Study Hypotheses

Studies explored that well-known health determinants: level of education, wealth, and place of residence have influences on women's reproductive health in disaster-unaffected areas. (Afifi, 2009; Al Riyami, Afifi, & Mabry, 2004; Delvaux, & Nöstlinger, 2007; Elfstrom, & Stephenson, 2012; Martin, 1995; Shapiro, 2012; Skirbekk, V., & Samir, 2012; Vespa, & Painter, 2011). However, it is yet unexplored that whether these determinants still have similar influences on women's three reproduction phases in a disaster prone area like Bangladesh. One of the research questions of the current study investigates this issue. Another research question examines whether women's intercourse, conception, and gestation phases are affected by cyclone Sidr in Bangladesh. Based on the research questions of the study, following hypotheses are proposed for each phase of women's reproduction.

Intercourse Phase

Hypothesis 1

Odds of being married among women in the educated group would be lower than the odds of being married among women in the non-educated group.

Hypothesis 2

Odds of being married among women in the rich group would be lower than the odds of being married among women in the poor group.

Hypothesis 3

Odds of being married among women in the urban group would be lower than the odds of being married among women in the rural group.

Hypothesis 4

Odds of being married in the Sidr affected areas during post-Sidr would be higher

than the odds of being married in rest of the areas (pre-Sidr-affected area; pre-Sidr-
unaffected area, and post-Sidr-unaffected area)

Conception Phase

Hypothesis 5

Odds of modern contraceptive use among women in the educated group would be higher than the
odds of modern contraceptive use among women in the non-educated group.

Hypothesis 6

Odds of modern contraceptive use among women in the rich group would be higher than the
odds of modern contraceptive use among women in the poor group.

Hypothesis 7

Odds of modern contraceptive use among women in the urban group would be higher than the
odds of modern contraceptive use among women in the rural group.

Hypothesis 8

Odds of modern contraceptive use in the Sidr affected areas during post-Sidr would be
lower than the odds of modern contraceptive use in rest of the areas (pre-
Sidr affected area; pre-Sidr unaffected area, and post-Sidr unaffected area).

Gestation Phase

Hypothesis 9

Odds of child birth among women in the educated group would be lower than the odds of child
birth among women in the non-educated group.

Hypothesis 10

Odds of child birth among women in the rich group would be lower than the odds of child birth
among women in the poor group.

Hypothesis 11

Odds of child birth among women in the urban group would be lower than the odds of child birth among women in the poor group.

Hypothesis 12

Odds of having a child in the past 3 years in the Sidr affected areas during post-Sidr would be higher than the odds of having a child in the past 3 years in rest of the areas (pre-Sidr affected area; pre-Sidr unaffected area, and post-Sidr unaffected area).

CHAPTER 4: METHOD

As discussed in previous chapters, the objective of this study is to advance a conceptual and methodological model to examine the well-known reproductive health determinants and the influence of a disaster on women's reproductive process. This study investigates the changes brought by cyclone Sidr on three phases of women's reproduction in Bangladesh. Guided by the proposed conceptual model, this chapter provides detailed information on the empirical methodology: (a) protection of human subjects; (b) data source and sampling design; (c) operationalization of variables and measures; and (d) data analysis process.

Building on the theoretical and methodological gaps in the natural disasters and reproductive health literature, this study uses data from the Bangladesh Demographic and Health Surveys (BDHS). BDHS is part of the worldwide Demographic and Health Surveys (DHS) program, which is designed to collect data on fertility, family planning, and maternal and child health. The DHS program surveys collect socioeconomic, demographic, and health data for a sample of the countries that participate in the DHS program. By using a qualitative approach to examine the social and cultural contexts of daily life, the DHS Program works to increase the validity and reliability of its surveys. Many steps are followed to ensure that the data properly reflect the situations they intend to describe and that the data are comparable across countries. The program developed and followed standard procedure, and methodologies that guided the Bangladesh survey undertaken in 1993.

Protection of Human Subjects

Procedures and questionnaires for standard BDHS surveys were reviewed and approved by Informed Consent Forms (ICF) Institutional Review Board (IRB) in Bangladesh. The ICF IRB ensured that the survey complied with the laws and norms of Bangladesh. Participation in

the survey was voluntary and the respondents could refuse to answer any question, decline any biomarker test, or terminate participation at any time. The respondents' identity and information were kept strictly confidential. Interviews and biomarker testing were performed as privately as possible. Within each household, an eligible respondent was not interviewed in the presence of another eligible respondent. Each respondent's interview and biomarker data files were identified by a series of numbers, including enumeration area (EA) number, household number, and individual number. Confidentiality was a major concern in BDHS. The BDHS surveys were anonymous and did not allow any potential identification of any single household or individual in the data file. Confidentiality was also a key factor that affected the response rate to sensitive questions regarding sexual activity and partners. Soon after data processing, the questionnaire cover sheets containing identifier numbers were destroyed, and new EA and household numbers were randomly reassigned. Although BDHS is a public data set, an application was submitted to the Office of Research of the University of Texas at Arlington (UTA) for approval of the proposed research activities based on the UTA IRB protocol. The application was successfully approved by the UTA IRB.

<div align="center">

Data Source and Sampling Design

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The study setting of the current study is Bangladesh. This study presents an analysis of data from the BDHS, a population-based national survey, of 2007 and 2011. These two surveys were conducted under the authority of the National Institute for Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare and implemented by Mitra and Associates of Dhaka. The BDHS of 2007 was collected from March to August of 2007. A total of 10,996 ever-married women ages from 15 to 49 were interviewed in this survey. Cyclone Sidr hit on November 15, 2007. Since the BDHS of 2007 was collected immediately before the

Sidr occurred, it represents pre-Sidr data in this study. The BDHS of 2011 was collected from July to December of 2011 and thus presents post-Sidr data. A total of 17,842 ever-married women ages from 12 to 49 were interviewed in this survey.

In the BDHS of 2007, the country was divided into six divisions: Khulna, Barisal, Chittagong, Rajshahi, Dhaka, and Sylhet. Among them, two divisions, Khulna and Barisal, were Sidr-affected regions and the other four were Sidr-unaffected regions (Table 4.1). In the BDHS of 2011, the country was divided into seven divisions: Khulna, Barisal, Chittagong, Rajshahi, Dhaka, Sylhet, and Rangpur. Among them, two divisions, Khulna and Barisal, were Sidr-affected regions and the other five were Sidr-unaffected regions (Table 4.1). In both datasets, Khulna and Barisal divisions were Sidr-affected regions.

Data sets	Sidr-affected Regions (Treatment group-influenced sample)	Sidr-unaffected Regions (Control Group-uninfluenced sample)
2007 (Pre-disaster) N = 10,996	Khulna and Barisal	Chittagong, Rajshahi, Dhaka, and Sylhet.
2011 (Post-disaster) N = 17,842	Khulna and Barisal	Chittagong, Rajshahi, Dhaka, Sylhet, and Rangpur.

Table 4.1. *Sidr-affected and Sidr-unaffected Year and Regions*

Methodology, sampling procedure, the sample size, sample allocation, survey domains, and stratification are explained in the BDHS documents of sample design. To achieve comparability and consistency, sampling activities were guided by a number of key principles, such as full coverage of the target population; probability sampling; obtaining a suitable sample size; maintaining the confidentiality of individual's information, and implementing the sample

survey exactly as designed. A scientific probability sampling methodology is used in BDHS surveys. In BDHS, a probability sample is defined as one in which the units are selected randomly. To facilitate the accurate implementation of the survey, the sampling design for BDHS was as simple and straightforward as possible. The BDHS standard procedure recommended that households be pre-selected in the central office prior to the start of fieldwork and the interviewers were required to interview only the pre-selected households. In order to prevent bias, no changes or replacements were allowed in the field.

Operationalization of Variables and Measures

The current study has a total of eleven variables based on the research hypotheses (Table 4.2). All of the variables are coded dichotomously in the study.

Independent Variables	Dependent Variables	Control variables
▪ Place of residence ▪ Education ▪ Wealth	Intercourse ▪ marital status	Media Exposure ▪ Heard FP on radio, TV, or newspaper
	Conception ▪ contraceptive method	Family planning ▪ Husband's desire for children
	Gestation ▪ Births in the past 3 years	Age ▪ Current age

Table 4.2. *Variables of the Study*

Independent Variables

The study has three independent variables: place of residence, education, and wealth. All of the independent variables present the participant's socioeconomic status which is an indirect determinant of reproductive health, as proposed in the conceptual model. "Place of residence" (V102) is the type of place, urban or rural in which the respondent was interviewed. Urban areas are classified into large cities (capital cities and cities with over 1 million population), small cities (population over 50,000), and towns (other urban areas). All rural areas are assumed to be countryside. In the study, place of residence is coded 1 if the participant resides in an urban area.

The second independent variable, "education" (V106), is measured by highest education level attended. This is an ordinal variable with four levels of education: no education, primary, secondary, and higher. In the survey, higher scores indicated a higher level of education. In the study, "education" is coded 1 if the participant attended secondary or higher (labeled educated) and rest are coded 0.

The third independent variable is "wealth" (V190). Information on the wealth index is based on data collected in the Household Questionnaire. This questionnaire includes questions concerning the household's ownership of a number of consumer items such as car; dwelling characteristics such as flooring material; types of drinking water source; toilet facilities; and other characteristics that are related to wealth status. Each household asset for which information is collected is assigned a weight or factor score generated through principal components analysis. The resulting asset scores are standardized in relation to a standard normal distribution with a mean of zero and a standard deviation of one. These standardized scores are then used to create the break points that define wealth quintiles as: lowest, second, middle, fourth, and highest. Each

household is assigned a standardized score for each asset, where the score differs depending on whether the household owned that asset. These scores are summed by household, and individuals are ranked according to the total score of the household in which they reside. The sample is then divided into five population quintiles: poorest, poorer, middle, richer, and richest with the same number of individuals in each quintile. In the study, "wealth" is coded 1 if the participant's wealth index was in middle, richer, or richest quintile (labeled rich) and rest are coded 0.

Variable ID	Description	Measures	Recoded measures
V102	Place of residence	1 = Urban 2 = Rural	1→ 1 2 → 0
V106	Highest education level	0 = None 1 = Primary 2 = Secondary 3 = Higher	0 & 1 → 0 2 & 3 → 1
V190	Wealth	1 = Poorest 2 = Poorer 3 = Middle 4 = Richer 5 = Richest	1 & 2 → 0 3, 4, & 5 → 1

Table 4.3. *Measures of Independent Variables*

Dependent Variables

The study has three dependent variables: marital status, contraceptive method, and births in the past 3 years. The first variable, "marital status" (V501), is measured by whether the respondent is currently, formerly, or never married. Currently married includes currently living with a partner, and formerly married includes widowed, divorced, and currently not living with a partner. In the study, "marital status" is coded 1 if the participant is currently living with a partner and rest are coded 0. The second variable, "contraceptive method" (V313), indicated whether the participant used no method, folkloric method, traditional method, or modern method

during the data collection. In the study, "contraception method" is coded 1 if the participant used

modern method and it is coded 0 if the participant used other method/s. The third variable,

"births in the past 3 years" (V238), indicated how many childbirths: no child birth, one birth, two

births, or three births a participant had in past 3 years prior to the survey. "Births in the past 3

years" is coded 1 if the participant had one or more child births in the past 3 years and it is coded

0 if the participant had no child birth in the past 3 years.

Variable ID	Description	Measures	Recoded Measures
V501	Current marital status	0 = Never in union 1 = Married 2 = Living with partner 3 = Widowed 4 = Divorced 5 = No longer living together/separated	0, 2, 3, 4, & 5 →0 1→1
V313	Current contraceptive method	0 = No method 1 = Folkloric method 2 = Traditional method 3 = Modern method	0, 1, & 2 →0 3 → 1
V238	Births in the past 3 years	0, 1, 2, & 3	0 → 0 1, 2, & 3 → 1

Table 4.4. *Measures of Dependent Variables*

Control Variables

The study has five control variables: media exposure, husband desire for children, age,

region, and year. The first control variable "media exposure" is recoded whether the participant

heard family planning on radio, TV, or newspaper during the months before the survey. In the

original datasets, three separate questions (V384A, V384B, and V384C) were asked to measure

the participant's media exposure on family planning. This new variable "media exposure" is

coded 1 if the participant heard family planning on either radio, TV, or in the newspaper. The

second control variable "husband desire for children" is measured by whether the participant's

and her husband both had a similar desire for children or only husband had a desire for more or

fewer children. "Husband's desire for children" is coded 1 if the desire for children is influenced

by both husband and wife. The third variable, "age" indicated the participant's age during the

survey. "Age" is coded 1 if the participant is 35 years old or under 35. The fourth variable,

"region," is coded 1 if the participant is from either of the two Sidr-affected divisions, Barisal

and Khulna. The "year" variable was created and added to the datasets. In the combined datasets

of 2007 and 2011, this "year" variable is assigned a value of 1 if the participant belongs to the

2011 survey.

Variable ID	Description	Measures	Recoded Measures
V384A	Heard FP on Radio last months	0 = No 1 = Yes	0 → 0 1 → 1
V384B	Heard FP on TV last months	0 = No 1 = Yes	0 → 0 1 → 1
V384A, V384B, and V384C	Heard FP on Newspaper last months	0 = No 1 = Yes	0 → 0 1 → 1
V621	Husband's desire for children	1 = Both want same 2 = Husband wants more 3 = Husband wants fewer	2 & 3 → 0 1 → 1
V012	Current age	13 – 49 years old	Under 35 years → 1 Above 35 years → 0
V024	Region	1 = Barisal 2 = Chittagong 3 = Dhaka 4 = Khulna	2, 3, 5, 6, & 7 → 0 1 & 4 → 1

		5 = Rajshahi 6 = Rangpur 7 = Sylhet	
Yea	Year of the survey		$2007 \rightarrow 0$ $2001 \rightarrow 1$

Table 4.5. *Measures for Control Variables*

Data Analysis Process

The initial stage of data analysis involved data screening and data cleaning. Since two BDHS (2007 and 2011) are used in this study, maintaining homogeneity between datasets was essential. During data screening and cleaning, consistency among variables of two datasets was ensured. The extent of missing data was assessed prior to moving forward to the next steps in data evaluation. After careful screening of both datasets, three datasets were created separately for intercourse, conception, and gestation phases for each year 2007 and 2011. Separate datasets were created for the three phases because not all of the participants in the intercourse phase were eligible to be included in conception or gestation phases. All participants were included in the intercourse phase (currently married and not currently married) but not in the conception or the gestation phase. "Husband desire for children" is a variable in the conception phase. Participants who are not currently married are excluded from both conception and gestation phases.

Thus the study has first created six datasets for all phases of reproductive process: 2007 intercourse ($N = 10,996$); 2011 intercourse ($N = 17,842$); 2007 conception ($N = 10,146$); 2011 conception ($N = 16,704$); 2007 gestation ($N = 10,146$); and 2011 gestation ($N = 16,704$). For each phase, an additional dataset was created that combined 2007 and 2011. Therefore, there are three more datasets - combined intercourse ($N = 28,838$); combined conception ($N = 26,850$); and combined gestation ($N = 26,850$) to test all of the hypotheses of the study.

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The study uses the difference-in-differences approach to assess the effects of the cyclone Sidr on women's reproductive processes. The difference-in-differences approach is particularly suitable for assessing the effects of events such as disaster on selected outcomes (Kim, & Marcouiller, 2015; Rodriguez-Oreggia, De La Fuente, De La Torre & Moreno, 2013; Wooldridge, 2015). The well-known difference-in-differences approach is an econometric technique (Card, Katz, & Krueger, 1994) that attempts to implement an experimental research design in natural settings in order to assess the differential effect of a treatment on an outcome in a treatment group compared with a control group.

Difference-in-differences attempts to mimic experimental research design using observational data by estimating the effect of exposure (treatment) on an outcome as the difference in the average change over time in the exposed group and the unexposed group. The exposed group must have an exposure status that changes across the two time points, while the referent group remains unexposed in both time periods. Cross section estimate of the difference between treatment and a control group in terms of an outcome is compared with changes in the outcome variable over time. It is thus essentially a design suitable for comparing the significant differences in the outcome variable as a result of treatment against differences in the outcome variable over time in the control group. Difference-in-differences can be applied in individual or aggregate analysis. In the current study, the Sidr-unaffected regions were set as the control group and Sidr-affected regions as the treatment group. Two crucial variables involved in the use of this method are region denoted by the places affected and unaffected by the event, cyclone Sidr, and the time of occurrence, before and after the occurrence of Sidr.

The study uses three analytical strategies: (a) univariate analysis; (b) bivariate analysis; and (c) multivariate analysis to test the proposed hypotheses.

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Univariate Analysis

In the univariate analysis, frequency distribution and measures of dispersion are observed and addressed to assess the distributional properties of the variables. The findings of univariate analysis provide the background information of all the variables used in the model.

Bivariate Analysis

Bivariate analysis is used to test the relationship between variables and also to examine the assumptions for an advanced and multivariate test. In this stage, multicollinearity is evaluated by using the Phi coefficient. The Phi coefficient is a measure of the degree of association between two dichotomous variables.

Multivariate Analysis

The selected variables in the study, all dependent and control variables, are binary. A multivariate method for the analysis of categorical data is logistic regression. As a multivariate analysis, logistic regression requires assumptions to be met, mainly related to sample representativeness; level of measurement; multicollinearity; and sample size (Abu-Bader, 2010). As a first step in conducting a logistic regression analysis, all the underlying assumption are examined. Logistic regression analysis uses several statistics to evaluate the accuracy of the regression and to estimate the probability of occurrence of a specific event. These statistics include the omnibus tests of model coefficients, likelihood-ratio test (*-2LL*); Cox and Snell *R* square; Nagelkerke *R* square, Hosmer and Lemeshow test; and Wald test. The omnibus test of the model coefficient is a test of the overall regression model. It uses the chi-square test to examine the level of significance for each logistic regression model. The likelihood-ratio test (*-2LL*) is a statistical technique that examines the goodness-of-fit between the observed and predicted models. It examines how well the data fit the population. The Cox and Snell *R* square

estimates the proportion of variance in the outcome variable accounted for by the factors entered in the logistic regression analysis. The Hosmer and Lemeshow test is the chi-square goodness-of-fit test. It examines the overall goodness-of-fit of the predicted model. The Wald test examines the level of significance for each regression coefficient (*b*) in a regression model.

To test the research hypotheses, this study analyzed the data using the IBM SPSS statistics, version 25.

CHAPTER 5: RESULTS

This chapter presents empirical data analysis results. It is divided into three sections based on the three phases of women's reproduction. The first section outlines the results of the intercourse phase; the second section outlines the results of the conception phase; and the third section outlines the gestation phase. These three sections provide the results from descriptive, bivariate, and multivariate analyses. The study sample is representative of women ages from 12 to 49 in Bangladesh.

Intercourse Phase

No missing value is reported in the intercourse phase. Table 5.1 presents the descriptive statistics of intercourse phase. It presents the descriptive analysis of combined 2007 and 2011 data ($N = 28,838$). In the intercourse phase, 27.3% of the participants were Sidr-affected residents and 72.7% were Sidr-unaffected residents. More than half of the participants lived in rural areas (64.1%). Approximately 35% of the participants were poor and 41.9% were educated. Percentages of currently married women were 93.1. Only 31.8% of the women have heard about family planning on radio, television, or in the newspaper.

Variables			% (*N*) Combined 2007 & 2011
Region		Sidr-affected residence	27.3 (7,871)
		Sidr-unaffected residence	72.7 (20,967)
Independent Variables	Place of residence	Urban	35.9 (10,347)
		Rural	64.1 (18,491)
	Wealth	Rich	64.6 (18,27)
		Poor	35.4 (10,211)
	Education	Educated	41.9 (12,071)
		Not educated	58.1 (16,764)
		Currently married	93.1 (26,850)

Dependent Variable	Marital status	Not currently married	6.9 (1,988)
Control Variable	Media exposure	Heard FP on radio/TV/newspaper	31.8 (9,161)
		Haven't Heard FP on radio/TV/newspaper	68,2 (19,677)

Table 5.1. *Descriptive Statistics of the Participants of the Intercourse Phase*

Due to the nature of the outcome variable as a dichotomous variable many of the required assumptions for regression analysis are not required for logistic regression (Abu-Bader, 2010). Although testing the normality of distribution is not required for logistic regression, the current study examined the skewness and kurtosis to understand the distributional properties. Skewness measures the degree of normal distribution around the mean and kurtosis measures the degree of peakness (Mertler & Vannatta, 2002). In the case of a normal distribution the value of skewness and kurtosis is zero (Mertler & Vannatta, 2002; Morgan et al., 2004).

Table 5.2 presents the measure of the degree of association or correlation coefficient between variables. A correlation coefficient that is greater than .80 ($r > .80$) indicates a multicollinearity problem (Abu-Bader, 2010). According to Yule (1912), phi value 0.70 or higher indicates a very strong association between variables; from .40 to .69 indicates a strong association; from .30 to .39 indicates a moderate association; from .20 to .29 indicates a weak association, and from .00 to .19 indicates no association. Phi coefficients among variables of the intercourse phase remain below .80, suggesting that multicollinearity is not a significant threat. In the intercourse phase, the multicollinearity test indicates that there is a moderate positive association between education and wealth ($r = .331, p < .10$); no association between education and place of residence ($r = 0.155, p < .10$); a weak positive association between education and

media exposure ($r = .258$, $p < .10$); a moderate positive association between wealth and place of residence ($r = .329$, $p < .10$); a weak positive association between wealth and media exposure ($r = .299$, $p < .10$); and no association between place of residence and media exposure ($r = .180$, $p < .10$).

Independent Variables	Phi Coefficient (combined 2007 & 2011)
Education & Wealth	0.331**
Education & Place of residence	0.155**
Education & Media exposure	0.258**
Wealth & Place of residence	0.329**
Wealth & Media exposure	0.299**
Place of residence & Media exposure	0.180**

** indicates significance level of 0.01

Table 5.2. *Phi Coefficient Value between Variables of the Intercourse Phase*

Table 5.3 presents the odds ratio of selected variables in the intercourse phase. The results of the likelihood ratio logistic regression of intercourse phase reveal that among three independent factors education ($Wald_{(df = 1)} = 269.360$, $p < .01$), wealth ($Wald_{(df = 1)} = .020$, $p > .01$), and place of residence ($Wald_{(df = 1)} = 40.920$, $p < .01$), education and place of residence emerge as significant predictors of being in the currently married women's group.

Although the Wald test shows that education is a significant predictor, it does not correctly predict the probability of classifying a married woman in the educated group. It indicates that odds of being married among women in the educated group are higher than the odds of being married among women in the non-educated group, which is not expected by the research hypothesis; *Exp(B)* = 2.623. However, place of residence emerges as significant in the Wald test and it correctly predicts the probability of classifying a married woman in the urban group. It indicates that odds of being married among women in the urban group are lower than the odds of being married among women in the rural group; *Exp(B)* = .719.

Results of the likelihood ratio logistic regression of intercourse phase also show that "interaction of region and year" ($Wald_{(df = 1)}$ = .024, p >.01), is not a significant predictor in the model. It indicates that odds of being married in the Sidr affected areas during post-Sidr is not significantly different than the odds of being married in rest of the areas (pre-Sidr-affected area; pre-Sidr-unaffected area, and post-Sidr-unaffected area).

Variables	*Exp(B)* (combined 2007 & 2011)
Education	2.623**
Wealth	0.992
Place of residence	0.719**
Media exposure	1.375**
Region	1.062
Year	1.199**
Interaction of region and year	0.983
Constant	9.138**

Table 5.3. *Exp(B) of Selected Variables in the Intercourse Phase*

Although the results of the omnibus tests of model coefficients indicate that the overall intercourse phase model is significant (chi square = 449.686, *Sig.* = .000), the results of the Hosmer and Lemeshow chi-square test (chi square = 16.440, *Sig.* = .036, which is less than .05) indicate that the intercourse phase model is not adequately specified. According to Abu-Bader (2010), a non-significant *p* value (*p* > .05) of the Hosmer and Lemeshow chi-square test indicates the model has a good fit.

Conception Phase

In the conception phase, only 3.9% of cases missed the value under the variable "husband's desire for children," which has no influence on the study results. According to Abu-Bader (2010), if the number of cases with missing value is smaller than 5%, excluding those cases from the analysis could not affect the study results and its conclusion. Table 5.5 presents the descriptive statistics of the conception phase. It presents the descriptive analysis of combined 2007 and 2011 data (*N* = 26,850). In the conception phase, 27.4% of the participants were Sidr-affected residents and 72.6% were Sidr-unaffected residents. More than half of the participants lived in rural areas (64.4%). Approximately 35% of the participants were poor and 43.3% were educated. Half of the participants used modern contraceptive method. Percentages of both husband and wife's decision making on desired children were nearly 75.7.

Variables			% (*N*) Combined 2007 & 2011
Region		Sidr-affected residence	27.4 (7362)
		Sidr-unaffected residence	72.6 (19,488)
	Place of residence	Urban	35.6 (9,571)
		Rural	64.4 (17,279)

Independent Variables	Wealth	Rich	65.0 (17,447)
		Poor	35.0 (9,403)
	Education	Educated	43.3 (11,633)
		Not educated	56.7 (15,214)
Dependent Variable	Current contraceptive method	Modern method	50.0 (13,427)
		Not modern method	50.0 (13,423)
Control Variable	Husband desire for children	Both want same	75.7 (20,330)
		Both do not want same	20.4 (5,474)

Table 5.4. *Descriptive Statistics of the Participants of the Conception Phase*

Table 5.5 presents the measure of the degree of association or correlation coefficient between variables. We already know that a correlation coefficient that is greater than .80 ($r >$ .80) indicates a multicollinearity problem (Abu-Bader, 2010). A phi value 0.70 or higher indicates a very strong association between variables; from .40 to .69 indicates strong association; from .30 to .39 indicates moderate association; from .20 to .29 indicates a weak association, and from .00 to .19 indicates no association (Yule, 1912). Phi coefficients among variables of the conception phase also remain below .80, suggesting that multicollinearity is not a significant threat. In the conception phase, the multicollinearity test indicates that there is a moderate positive association between education and wealth ($r = .336$, $p < .10$); no association between education and place of residence ($r = .162$, $p < .10$); no association between education and husband desire for children ($r = .056$, $p < .10$); a moderate positive association between wealth and place of residence ($r = .326$, $p < .10$); no association between wealth and husband desire for children ($r = .032$, $p < .10$); and no association between place of residence and husband desire for children ($r = .019$, $p < .10$).

Independent Variables	Phi Coefficient (combined 2007 & 2011)
Education & Wealth	0.336**
Education & Place of residence	0.162**
Education & Husband desire for children	0.056**
Wealth & Place of residence	0.326**
Wealth & Husband desire for children	0.032**
Place of residence & Husband desire for children	0.019*

** indicates significance level of 0.01 and * indicates significance level of 0.05

Table 5.5. *Phi Coefficient Value between Variables in the Conception Phase*

Table 5.6 presents the odds ratio of selected variables in the conception phase. The results of the likelihood ratio logistic regression of conception phase reveal that three independent factors education ($Wald_{(df=1)} = 30.121, p < .01$), wealth ($Wald_{(df=1)} = .13.992, p < .01$), and place of residence ($Wald_{(df=1)} = 79.755, p < .01$) emerge as significant predictors of currently modern contraceptive using women.

Education emerges as a significant predictor by the Wald test. It also correctly predicts the probability of classifying a modern contraceptive using a woman in the educated group. It indicates that odds of modern contraceptive use among women in the educated group are higher than the odds of modern contraceptive use among women in the non-educated group; $Exp(B) = 1.159$. Although the Wald test shows that wealth is a significant predictor, it does not correctly

predict the probability of classifying a modern contraceptive-using woman in the rich group. It indicates that odds of modern contraceptive use among women in the rich group are lower than the odds of modern contraceptive use among women in the poor group; *Exp(B)* = .896. Finally, type of place of residence emerges as a significant predictor and also correctly predicts the probability of classifying a modern contraceptive-using woman in the urban group. It indicates that odds of modern contraceptive use among women in the urban group are higher than the odds of modern contraceptive use among women in the rural group; *Exp(B)* = 1.280.

Results of the likelihood ratio logistic regression of conception phase shows that "interaction of region and year" (*Wald*$_{(df=1)}$ = .439, $p > .01$), is not a significant predictor in the model. It indicates that odds of modern contraceptive use in the Sidr affected areas during post-Sidr is not significantly different than the odds of modern contraceptive use in rest of the areas (pre-Sidr affected area; pre-Sidr unaffected area, and post-Sidr unaffected area).

Variables	*Exp(B)* (combined 2007 & 2011)
Education	1.159**
Wealth	0.896**
Place of residence	1.280**
Husband desire for children	1.239**
Region	1.256**
Year	1.116**
Interaction of region and year	0.963
Constant	0.636**

** indicates significance level of 0.01

Table 5.6. *Exp(B) of Selected Variables in the Conception Phase*

Although the results of the omnibus tests of model coefficients indicates that the overall conception phase model is significant (chi square = 244.073, *Sig.* = .000), the results of the Hosmer and Lemeshow chi-square test (chi square = 25.254, *Sig.* = .001, which is less than .05) indicate that the conception phase model is not adequately specified. A non-significant *p* value (*p* > .05) of the Hosmer and Lemeshow chi-square test indicates the model has a good fit (Abu-Bader, 2010).

Gestation Phase

No missing value is reported in the gestation phase. Table 5.9 presents the descriptive statistics of the gestation phase. It presents the descriptive analysis of combined 2007 and 2011 data (*N* = 26,850). In the gestation phase, 27.4% of participants were Sidr-affected residents and 72.6% participants were Sidr-unaffected residents. Among them, more than half of the participants lived in rural areas (64.4%). Approximately 35% of the participants were poor and 43.3% were educated. 29.8% of the participants had birth in the past 3 years and approximately 70% were 35 or under 35 year old women.

Variables			% (*N*) Combined 2007 & 2011
Region		Sidr-affected residence	27.4 (7362)
		Sidr-unaffected residence	72.6 (19,488)
Independent Variables	Place of residence	Urban	35.6 (9,571)
		Rural	64.4 (17,279)
	Wealth	Rich	65.0 (17,447)
		Poor	35.0(9,403)
	Education	Educated	43.3 (11,633)
		Not educated	56.7 (15,214)
Dependent Variable	Birth in last 3 years	Has birth in past 3 years	29.6 (7,947)
		No birth in past 3 years	70.4 (18903)
Control Variable	Age	13-35	69.9 (18,768)
		36-49	30.1 (8,082)

Table 5.7. *Descriptive Statistics of the Participants of the Gestation Phase*

Table 5.8 presents the measure of degree of association or correlation coefficient between variables in the gestation phase. We already know that a correlation coefficient that is greater than .80 ($r > .80$) indicates a multicollinearity problem (Abu-Bader, 2010). A phi value 0.70 or higher indicates a very strong association between variables; from .40 to .69 indicates a strong association; from .30 to .39 indicates a moderate association; from .20 to .29 indicates a weak association, and from .00 to .19 indicates no association (Yule, 1912). Phi coefficients among gestation phase variables remained below .80, suggesting that multicollinearity is not a significant threat. Between education and wealth variables, a moderate positive association is found in all data analyses - combined 2007 and 2011 data ($r = .336$, $p < .10$); 2007 data ($r = .327$, $p < .10$); and 2011 data ($r = .343$, $p < .10$). Between education and place of residence, no

association is found combined 2007 and 2011 data ($r = .162$, $p < .10$); 2007 data ($r = .162$, $p < .10$); and 2011 data ($r = .162$, $p < .10$). Between education and age, a weak positive association is observed - combined 2007 and 2011 data ($r = .244$, $p < .10$); 2007 data ($r = .223$, $p < .10$); and 2011 data ($r = 0.257$, $p < .10$). Between wealth and place of residence, a moderate positive association is found - combined 2007 and 2011 data ($r = .326$, $p < .10$); 2007 data ($r = .328$, $p < .10$); and 2011 data ($r = .324$, $p < .10$). Between wealth and age, no association is observed - combined 2007 and 2011 data ($r = -.040$, $p < .10$); 2007 data ($r = -.050$, $p < .10$); and 2011 data ($r = -.034$, $p < .10$). Also, between place of residence and age, no association is found - combined 2007 and 2011 data ($r = -.021$, $p < .10$); 2011 data ($r = -.022$, $p < .10$); and 2007 data ($r = -.020$, $p < .10$).

Independent Variables	Phi coefficient (combined 2007 & 2011)	Phi coefficient (2007)	Phi coefficient (2011)
Education & Wealth	0.336**	0.327**	0.343**
Education & Place of residence	0.162**	0.165**	0.162**
Education & Age	0.244**	0.223**	0.257**
Wealth & Place of residence	0.326**	0.328	0.324**
Wealth & Age	- 0.040	-0.050**	-0.034**
Place of residence & Age	- 0.021	-0.022	-0.020**

** indicates significance level of 0.01

Table 5.8. *Phi Coefficient Value between Variables in Gestation Phase*

Table 5.9 presents the odds ratio of selected variables in the gestation phase. In the combined 2007 and 2011 data analysis, the results of the likelihood ratio logistic regression of gestation phase reveal that all three independent factors education ($Wald_{(df=1)} = 57.617$, $p < .01$), wealth ($Wald_{(df=1)} = 100.744$, $p < .01$), and place of residence ($Wald_{(df=1)} = 4.796$, $p < .05$), emerge as significant predictors of women who have a child birth in past 3 years.

Although the Wald test shows that education is a significant predictor, it does not correctly predict the probability of classifying a child birth in the past 3 years in the educated women's group. It indicates that odds of child birth among women in the educated group are higher than the odds of child birth among women in the non-educated group, which is not expected by the research hypothesis; *Exp(B)* = 1.271. Wealth emerges as significant in the Wald test, and it correctly predicts the probability of classifying a child birth in the past 3 years in the rich women's group. It indicates that odds of child birth among women in the rich group are lower than the odds of child birth among women in the poor group; *Exp(B)* = .713. Finally, the place of residence also correctly predicts the probability of classifying a child birth in the past 3 years in the urban women's group. It indicates that odds of child birth among women in the urban group are lower than the odds of child birth among women in the rural group; *Exp(B)* = .029.

Also, results of the likelihood ratio logistic regression of gestation phase show that "interaction of region and year" ($Wald_{(df=1)} = 5.050$, $p < .05$), is a significant predictor in the model. It indicates that odds of having a child in past 3 years in the Sidr-affected areas during post-Sidr are significantly higher than the odds of having a child in past 3 years in rest of the

areas (pre-Sidr affected area; pre-Sidr unaffected area, and post-Sidr unaffected area); *Exp(B)* = 1.163.

Variables	*Exp(B)* (combined 2007 & 2011)	*Exp(B)* (2007)	*Exp(B)* (2011)
Education	1.271**	1.221**	1.302**
Wealth	0.713**	0.677**	0.737**
Place of residence	0.932*	0.981	0.901*
Age	11.427**	10.247**	12.512**
Region	0.660**	0.663**	0.766**
Year	0.706**		
Interaction of region and year	1.163*		
Constant	0.089**	0.101**	0.056**

** indicates significance level of 0.01 and * indicates significance level of 0.05

Table 5.9. *Exp(B) of Selected Variables in Gestation Phase*

Although in the combined 2007 and 2011 data, the results of the omnibus tests of model coefficients indicates that the overall gestation phase model is significant (chi square = 4200.693, *Sig.* = .000), the results of the Hosmer and Lemeshow chi-square test (chi square = 26.564, *Sig.* = .001 which is less than .05) indicate that the gestation phase model is not adequately specified. However, a non-significant *p* value (*p* > .05) of the Hosmer and Lemeshow chi-square test indicates the model has a good fit (Abu-Bader, 2010).

Since interaction between time and region of gestation phase was significant, this study further explored how the effects of education, wealth, and place of residence were on child birth in past 3 years in pre-Sidr and post-Sidr period. This study found that education is a significant

predictor in the gestation phase model of the both pre-Sidr and post-Sidr data analyses - 2007 data ($Wald_{(df = 1)} = 15.929$, $p < .01$) and 2011 data ($Wald_{(df = 1)} = 42.052$, $p < .01$). However, both pre-Sidr [$Exp(B) = 1.221$, 2007 data] and post-Sidr [$Exp(B) = 1.302$, 2011 data] results show that odds of child birth among women in the educated group are higher than the odds of child birth among women in the non-educated group. Also, results show that in the education variable, the odds ratio of post-Sidr ($Exp(B) = 1.302$) is higher than the odds ratio of pre-Sidr ($Exp(B) =$ 1.221); [$Exp(B) = 1.221$, 2007 data $< Exp(B) = 1.302$, 2011 data]. It indicates that the odds of child birth/s among post-Sidr women in the educated group compared with the non-educated group are lower than the odds of child birth/s among pre-Sidr women in the educated group compared with the non-educated group.

Results also indicate that wealth is a significant predictor in the model of the both data analyses - 2007 data ($Wald_{(df = 1)} = 52.641$, $p < .01$) and 2011 data ($Wald_{(df = 1)} = 49.793$, $p < .01$). Results of also indicate that the $Exp(B)$ value of wealth variable in the post-Sidr period is higher than the pre-Sidr period; [$Exp(B) = .677$, 2007 data] $< [Exp(B) = .737$, 2011 data].

Finally, although the Wald test of 2011 data analysis ($Wald_{(df = 1)} = 6.289$, $p < .05$) shows that place of residence is a significant predictor in the gestation phase model, it is not a significant predictor in the Wald test of 2007 data analysis ($Wald_{(df = 1)} = .142$, $p > .01$). It indicates that odds of child birth/s among post-Sidr women in the urban group compared with the rural group are not significantly different than the odds of child birth/s among pre-Sidr women in the urban group compared with the rural group.

CHAPTER 6: DISCUSSION, IMPLICATIONS, AND CONCLUSION

This chapter includes four major sections. The first section presents a discussion on the overall summary of the study findings. The second section describes the limitations of the current study. The third section discusses the implications of the current study for Social Work and policy. Finally, the study conclusion is presented in the last section.

Summary of the Study Findings

Summary of the study findings highlights two major things: (a) what are the significant health determinants of women's three phases of reproductive process net of the effect of Sidr and (b) whether women's reproductive processes: intercourse, conception, and gestation were interrupted by the effects of Sidr.

First, the study hypothesized that socioeconomic determinants of health may likely influence women's intercourse, conception, and gestation phases net of the effect of Sidr in Bangladesh. In the study, it was assumed that women's education level, wealth status, and place of residence could be influential predictors of being married, using a modern contraceptive, and having children in the past 3 years. These factors are included in this as indirect determinants of fertility theory and based on the presence of extensive literature that considered these determinants are important in women's reproductive process. Although most of the studies have focused on the influence of education level, wealth status, and place of residence on women's reproductive health, this study examined whether these factors have similar effects on women's reproductive health in a disaster prone area. The current study found that education and place of residence are significant determinants of intercourse, conception, and gestation phases in Bangladesh, where wealth is a significant predictor for conception and gestation phases.

Scholars found that education has strong effects on being married, family size preference, contraceptive use, and fertility around the world (Bongaarts, 2003, 2010; Caldwell, 1980; Jejeebhoy, 1995; Martin, 1995; Shapiro, 2012; Skirbekk, V., & Samir, 2012). However, there is a lack of literature which examined the influence of education in all phases of women's reproduction in disaster prone areas. The current study examined whether education is a significant factor in women's three phases of reproduction net of the effect of Sidr. This study found that education is a significant determinant of women's intercourse, conception, and gestation phases in a disaster prone area.

Moreover, the current study finds that education has a positive influence on women's modern contraceptive use in Bangladesh, which is also supported by other studies worldwide (Al Riyami, Afifi, & Mabry, 2004; Lopez, Grey, Hiller, & Chen, 2015; Shapiro, & Tambashe, 1994). The study results on conception phase suggest that the odds of modern contraceptive use among women in the educated group are higher than the odds of modern contraceptive use among women in the non-educated group; *Exp(B)* = 1.159. In addition, the literature suggests that around the world education is negatively associated with marriage and fertility (Lopez, Grey, Hiller, & Chen, 2015; Shapiro, & Tambashe, 1994). But, in the study, results of the intercourse and the gestation phases consecutively suggest a positive relationship between education and marriage and between education and fertility net of the effect of Sidr, which is contrary to the expectation of the study. Results of the conception phase indicate that the odds of being married among women in the educated group are higher than the odds of being married among women in the non-educated group in Bangladesh, *Exp(B)* = 2.623. Results of the gestation phase also indicate that the odds of child birth among women in the educated group are higher than the odds of child birth among women in the non-educated group in Bangladesh, *Exp(B)* = 1.271.

One of the aims of the study was to test the influence of the education on women's reproductive process in disaster prone areas. Results of the study indicate that the influence of education on women from disaster prone and non-disaster prone areas is not similar. Positive relationship between education and marital status could be due to a selection effect. In Bangladesh lower educated women might be disproportionately involved in public work and may experience loss or separation from a partner. Burden of dowry could be higher in post-disaster and it can prevent lower educated women from getting married. These disadvantages may likely increase the likelihood of being not married. In Bangladesh, post-disaster recovery processes may force women to get involved with more work-load for managing enough food and safe shelter for the family members. Consequently, stress of work load can decrease their physical ability or desire for having more children. Stress can also increase abortion rate or fetal deaths among lower educated women in post-disaster.

Scholars also found that wealth has a strong influence on reproductive health worldwide (Adebowale, Adedini, Ibisomi, & Palamuleni, 2014; Afifi, 2009; Creanga, Gillespie, Karklins, & Tsui, 2011; Rahman, Haque, Mostofa, Tarivonda, & Shuaib, 2011; Vespa, & Painter, 2011). This study examined whether wealth is a strong predictor in women's three phases of reproduction in Bangladesh. The study results suggest that wealth is a significant predictor in conception and gestation phase, but not in the intercourse phase. Although in the conception phase it was expected that the odds of modern contraceptive use among women in the rich group would be higher than the odds of modern contraceptive use among women in the poor group in Bangladesh, the study results did not suggest that. One reason could be improved availability and access to free contraception in post-disaster period among poor women. In the disaster mitigation phase, both Non-Governmental Organizations (NGO) and government focus on free accessibility

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to health services for poor victims. Consequently, it may increase the use of modern contraceptive among poor women. However, according to literature, wealth is negatively associated with fertility across the globe. The study results of gestation phase are also supported by other studies. It indicates that the odds of child birth among women in the rich group are lower than the odds of child birth among women in the poor group; *Exp(B)* = .713.

Similarly, literature also suggests that place of residence is one of the strong predictors of women's reproductive processes, especially in developing countries (Delvaux, & Nöstlinger, 2007; Elfstrom, & Stephenson, 2012; Lou, Wang, Tu, & Gao, 2008; Mahmood, & Ringheim, 1996; Tuladhar, 1985). The study examined whether the living place is an influential predictor in women's intercourse, conception, and gestation phases net of the effect of Sidr in Bangladesh. Results of all phases support that the place of residence is a significant predictor for being married, using modern contraception, and having child birth in a disaster prone country, Bangladesh. Results on intercourse phase suggest that in Bangladesh the odds of being married among women in the urban group are lower than the odds of being married among women in the rural group; *Exp(B)* = .719. Results on conception phase also found that in Bangladesh odds of modern contraceptive use among women in the urban group are higher than the odds of modern contraceptive use among women in the rural group; *Exp(B)* = 1.280. Finally, results on gestation phase also correctly predicted that the odds of child birth among women in the urban group are lower than the odds of child birth among women in the rural group; *Exp(B)* = .029. Here, results of all phases are supported by the literature. Place of residence has influence on all three phases of women's reproduction in a disaster prone area.

Second, we found that few studies empirically tested the effects of natural disasters in different countries on family development, sexual behavior, access to reproductive services, and

birth outcomes (Currie & Rossin-Slater, 2013; Djafri et al., 2015; Grabich et al., 2016; Hapsari et al., 2009; Zahran et al., 2010). But, there is scarce literature on examining the effects of natural disasters on women's reproductive processes in Bangladesh even though Bangladesh is one of the most disaster prone countries. This is a pioneering study that examines whether women's reproductive processes were affected by a natural disaster in Bangladesh after controlling the influential factors.

The study examined the effects of cyclone Sidr on all phases of women's reproduction - intercourse, conception, and gestation by comparing the effects of Sidr across time and regions. To examine the effects of Sidr on women's reproductive processes, this study used difference-in-differences approach that is an addition to the natural disasters and reproductive health research. Findings of the current study partially supported the proposed effects of cyclone Sidr on women's reproductive processes in Bangladesh. Findings of the study suggest that among women's three phases of reproduction, gestation phase was interrupted by Sidr in Bangladesh. Although the study expected Sidr effects on women's intercourse and conception phases, the results did not suggest that. Gestation phase included whether participants had childbirth in the past 3 years. The study assumed that because of the effects of Sidr, child marriage (Alston et al., 2014; Human Rights Watch carried out a study, 2014) and lack of contraception access (Behrman & Weitzman, 2016) could rise among Sidr-affected women, consequently, that may lead them to have more children. The results of the gestation phase indicate that childbirth status of Sidr-affected women is higher than the Sidr-unaffected women.

This study addresses an exceedingly important aspect of life in an era of globalization. Because of globalization and unbridled consumption, the volume of environmental refugees and disaster victims all over the world has increased considerably and has precipitated huge public

outcries and antagonism against them. One consequence of this is immediately felt in the

declining mental and physical health status of vulnerable populations, such as women and

children. While research on women's health has focused on identifying cultural determinants of

health, in the context of the structural effects of disasters on women's health remains

inadequately investigated. This study focuses on the independent effects of several social

characteristics on women's reproductive health impacted by disasters.

Limitations of the Study

Limitations of the current study broadly fall into two groups. Some limitations are mainly

methodological and other limitations are oriented to the conceptual framework.

First one relates to the sampling of 2011 BDHS that is not designed exclusively for

disaster victims. In the study, although participants from Sidr-affected areas were considered as

disaster victims, all participants from the Sidr-affected areas might not be disaster victims. By

2011, some disaster victims could have migrated to Sidr-unaffected areas for a better

opportunity. This study did not select the disaster victims purposively. It is unlikely that the

proposed sample of the current study would be representative of all Sidr-affected women of

Bangladesh.

The other limitation of the current study design relates to the survey instrument used in

the BDHS. The questionnaire used for BDHS was designed for general population of

Bangladesh. The current study used data on Sidr-affected population using BDHS instrument

that might have excluded vital information with respect to their reproductive health. Disaster

related questions were not asked in the BDHS. Because of uniqueness in lifestyle after affected

by Sidr, it is crucial to obtain information on Sidr-affected women through a sensitive

instrument. Hence, information collected on Sidr-affected women through the 2011 BDHS may lack comprehensiveness because of this shortcoming.

In addition, the selection of variables was biased because of the unavailability of variables on datasets. The study was unable to use a few important variables because of unavailability of values for a specific variable in both datasets; 2007 and 2011. For example, child birth weight is an important variable, but it was not used in the study due to this problem. The results of the study might be different if it was possible to include more variables in the study.

With reference to conceptual limitation, it should be noted that the conceptual framework of the current study has not been developed on the basis of a particular theory, rather, it is a synthesis of vulnerability perspective and fertility theory. Use of multiple perspectives compromises the parsimony offered by a single conceptual framework. Even though vulnerability perspective provides a holistic integrated perspective, because of its lack of focus on reproductive health determinants, it was difficult to be tested empirically. Similarly, fertility theory also has limitation to provide a holistic integration on women's reproduction and to be tested empirically.

Another major limitation to the conceptual framework of the study is that the study did not test a dynamic model of women's reproductive processes. The study treated three phases of the reproductive process as independently. But the intercourse, conception, and gestation phases are interrelated. One phase is the consequence of other phases. It the study could use a dynamic model, it would be possible to identify what are the effects of one phase to others.

Social Work Implications

Effects of natural disasters on women's reproductive health is a new discourse in social work field although social work is a transdisciplinary profession and promotes equity and social justice. Given the ambiguity surrounding theory and methodologies for studying the effects of disasters on women's health, this study applied an innovative methodology for collecting and analyzing data on disaster victims. The study addresses the lacuna in knowledge by advancing a conceptual and methodological model of reproductive health. Consistent with the current shift toward framing health issues around equity concerns, the current study may contribute to social work's conceptualization of reproductive health among women who are disaster victims by creating a fertile field of inquiry for social work theory, research, and practice and also policy implications.

Social Work Theorizing

Social work as a profession is continuously urged to enter new arenas to respond to clients' everyday demands. In response to the different contextual needs, social workers are induced to use eclectic theories and multiplicity of methodologies. A comprehensive social work paradigm is essential in social work that necessitates ideological and empirical analyses. To meet the burgeoning human needs, social workers need to focus on interdisciplinary work. The use of a vulnerability perspective and fertility theory could widen viable opportunities for social workers to engage in theorizing. These two perspectives are not conceptualized well to test empirically. Social work can take the lead to enhance the theoretical grounding inherent in the interaction between vulnerability and reproductive health both in the micro and macro areas of social work. Social work can contribute towards building a theoretical framework to empirically test the effects of disasters on reproductive health.

Social Work Research

Although social workers are historically involved in disaster relief work (Webster, 1995; Yanay, & Benjamin, 2005), there is scarce of literature in social work on disasters and women's health (Dodds & Nuehring, 1997; Zakour 2007; Zakour, & Gillespie, 2013)). The effects of natural disasters are increasing around the world. The issue of environmental sustainability and its impact on vulnerable groups is of increasing importance, and the current study agenda is timely and innovative. Disaster Natural disasters are a perennially prevalent problem, and a major risk factor affecting many marginalized poor communities. Examining the health outcomes that can lead to prevention and early intervention is an important social work research and practice goal. Further, the study of disaster management also necessitates a strong focus on interdisciplinary research given the breadth of associated risk factors. Disaster and women's health related study is mostly conducted by public health researchers. As many researchers have noted, the subject of how human beings create, interact, and cope with natural disasters and associated risks and vulnerabilities, is too complicated and requires the input of more than one discipline. Social work research can explore further how disaster management programs can more effectively address the short and long term reproductive health consequences of disasters. Natural disasters set in motion prolonged and multiphasic crisis. Disaster victims experience violence and loss of life, property, and health. Although all victims experience more or less stressful and traumatic recoveries, pathways to recover vary significantly. Future research can also explore the disaster coping experience of victims and expressions of distress and coping patterns among different socio-economic groups of victims of recent hurricanes Harvey, Irma, and Florence in the USA. Future research can focus on external and internal factors that either

prevent or hasten recovery among different groups of victims. This study opens new directions

for further research to advance and strengthen social work research methodologies, such as

designing a survey exclusively for disaster victims. The current study used quantitative method;

but the use of qualitative and mixed methods could enhance the findings of this research area.

There is a lack of empirical studies using qualitative or mixed methods to explore the effects of

disasters on women's reproductive processes. Qualitative and mixed methods will provide depth

and detailed information which was not addressed in this study. Results of the current study

indicate that intercourse and conception phases of women's reproduction are not interrupted by

cyclone Sidr in Bangladesh. Future studies may focus on the findings from the current study to

examine more on the significant effects of a natural disaster on intercourse and conception

phases.

Social Work Practice

Implications for social work practice spur around social work practice with disaster

victims and their health equity and well-being. This study contributes addressing the needs of

intervention in the social and physical environments of individuals and groups, which is also a

social work value to prevent serious long-term social and health problems. This study provide an

evidence to design a comprehensive health program for disaster victims. Disaster management

programs supervised by a Social Worker can more effectively reduce the short and long term

reproductive health consequences of disasters. Social Work should be considered as a profession

in Bangladesh. A gender sensitive approach toward meeting women's reproductive health needs

during and after disasters have not yet become the basis for long term disaster management

programs in developing countries like Bangladesh. Governmental and non-governmental disaster

management organizations in Bangladesh need to design gender focused interventions for

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reducing the effects of disasters on women's reproductive processes. Women Social Workers are required in Bangladesh to assess and address the needs of women in pre and post-disaster periods. Social Workers can help the victims by involving them with different services, for example shelter, free food, and health services. Social Workers can also provide emotional support, counseling, and hope to manage the disaster related problem.

Policy Implications

Results of the study suggest that women's gestation phase has interrupted by cyclone Sidr in Bangladesh. Sidr influences to increase child birth rates in Sidr-affected regions. Although Bangladesh is one of the densely populated countries, the country does not have a policy which could address the fertility control issue based on the effects of natural disasters. Reproductive health policy should consider incorporating the strategies to control fertility after natural disasters. Results also indicate that education, wealth, and place of residence are important determinants of women's reproductive health in disaster prone areas. Policy makers should pay more attention to these health determinants during and after natural disasters.

In Bangladesh, gender disparities in different social, economic and political institutions make women vulnerable to natural disasters (Rezwana, 2018). Women have less control over required health and wealth resources, disaster risk reduction planning, and capacity building programs to mitigate the risks involved with natural disasters. Although the effects of disasters could be life-long on women's health and other aspects, there was no gender based disaster management policies in Bangladesh till 2011. For the first time in 2011 the Ministry of Women and Children Affairs of Bangladesh Government included a section on "Pre-disaster, During Disaster and Post-disaster Protection of Women and Children" under the *Women Advancement*

Policy. This policy included ten agenda in the women and children in disaster section. Among them, only one agenda touches the women's reproductive health rights.

The women's reproductive health related agenda in the policy is "to make special arrangement for the expectant mothers, postnatal woman and the new born like maintaining a breast feeding corner" (Gob, 2011). However, this policy does not address the needs of health facilities and services for women of all reproductive age in the disaster prevention, preparation, and mitigation phases. Adolescent girls, single women, female-headed households, and women with disabilities are in need of greater attention during and after disasters. This policy only focuses on few issues of pregnant women. In addition, poor, illiterate, and/or rural women's accessibility to health services are limited and due to disaster their accessibility to resources become more restricted. This policy does not provide detailed information on how healthcare services such as mobile clinic, free contraceptive and sanitary pads, and sexual and reproductive health related education and training will be ensured for these women.

Moreover, although this policy addresses necessities of the gender focused disaster risk management, it does not explain how disaster prevention, preparation, and mitigation programs will be female friendly. Bangladesh is a patriarchy society and women's voice are ignored from home to parliament. Sexual and gender-based violence is high in Bangladesh, especially during disasters women become victims of physical, mental, and emotional violence (Jahid, 2017; Islam 2011; Rezwana, 2018). During disasters women face sexual and gender-based violence in shelters and disaster relief related service receiving processes. There is a lack of women's involvement in the disaster policy making, disaster program design, and disaster service providing processes. Gender based disaster management programs should ensure women's

involvement in prevention, preparation, and mitigation phases to reduce vulnerabilities for women and make them more resilient.

There is a lack of public policy evaluation in Bangladesh. Research institutions should be funded to explore the impact of public policies on women's health especially in disaster affected areas. The government should create or change policies based on empirical research toward decreasing effects of disasters on women's health.

Conclusion

In the study, I have attempted to develop a conceptual framework to examine empirically the effects of a natural disaster on women's three reproductive processes and the effects of well-known heath determinants on women's reproductive processes. This study adds a noble contribution in theoretical frame work and methodology. One of the main contributions of this study is examining the effects of a natural disaster on all phases of women's reproduction that was not examined before using a conceptual framework. This study attempted to address the women's reproductive health issues in disaster prevention, preparation, and mitigation phases. Bangladesh is one of the most disaster prone lands with limited resources (Mallick et al., 2005). Even when Bangladesh government and Non-Government Organizations (NGOs) attempt to take necessary steps to reduce the damages from disasters, due to lack of gender focused disaster management, women stay outcasted in the development process although they are the most affected group. Male centered disaster management should be replaced by gender focused management to achieve a sustainable disaster recovery. Gender focused disaster management is also required to increase women's sustainable inclusion in the development processes and help women to enjoy their reproductive rights.

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Table 2.1. *Description of Hurricane and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results	Theory
Cohan & Cole, (2002)	Hurricane Hugo, South Carolina, USA, 1989	Examined whether an environmental stressor is related to family development, namely the transition to marriage, childbirth, and divorce	Secondary; longitudinal; from 1975 to 1997 all 46 counties; 24 disaster counties; 24 disaster countries (1,900,000 citizens) and 22 non-disaster counties (1,6000,000) in South Carolina; Survey	The time-series analyses used to assume a stable background trend (relatively constant incidence, or a steady increase, or decline in outcome incidence). Autoregressive integrated moving average (ARIMA) models explicitly analyzed the relationship among subsequent observations in a time series to eliminate the correlations among residuals.	Time-series analysis indicated that the year following the hurricane, marriage, birth, and divorce rates increased in the 24 counties declared disaster areas compared with the 22 other counties in the state. The results suggested that a life threatening event motivated people to take significant action in their close relationships that altered their life course.	Stress theory
Kissinger, et al., (2007)	Hurricane Katrina, New Orleans, Louisiana, USA, 2005	Described changes in sexual behavior and access to reproductive care pre and post rapid displacement among a cohort of young women	Primary; cross sectional; 164 women 16 to 24 years old women who were attending 2 public family planning clinics and enrolled in a vaginal douching prevention study, were located 5 to 6 months after Katrina; interviewed by telephone to elicit information about sexual	Percentage and Fisher's exact test	17% needed health care but could not access it, 40% had not used birth control, and 4% experienced an unintended pregnancy as a result of lack of access to care. When compared with baseline, after the hurricane, women were less likely to have attended family planning	

Table 2.1. *Description of Hurricane and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results	Theory
		receiving family planning services before displacement	behavior and access to reproductive care		services, to have used birth control, to have >1 sex partner, to have a vaginal odor or discharge.	
Kinney, et al., (2008)	Hurricane Hugo, Louisiana, USA, 1980 - 1995	Prenatal Exposure to Hurricane	Secondary; longitudinal; 55,566 women; Survey; Louisiana's Department of Health and Hospitals (DHH), National Center for Health Statistics (NCHS) Maryland, and National Weather Service on all hurricanes, tropical storms, or floods that struck Louisiana from 1980 to 1995	Chi square test, Fisher's exact test, multiple logistic regression	Autistic Disorder prevalence in Louisiana children increased significantly with the severity of prenatal storm exposure.	Stress theory
Harville, et al., (2010)	Hurricane Katrina, Louisiana, USA, 2005	Examined demographic and hurricane related predictors of resilience and posttraumatic	Primary; cross sectional; interviewed 222 pregnant women and 292 postpartum women	Chi-square tests and log-Poisson models were used to calculate associations and relative risks for demographics, hurricane	35% of pregnant and 34% of the postpartum women were resilient from depression, whereas 56% and 49% were resilient from posttraumatic stress disorder. Resilience was most likely among White women, older women, and	

Table 2.1. *Description of Hurricane and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results	Theory
		growth	behavior and access to reproductive care	hurricane experience, and mental health resilience and perceived benefit	women who had a partner. A greater experience of the storm, particularly injury/illness or danger, was associated with lower resilience. Experiencing damage because of the storm was associated with increased report of some perceived benefits.	
Tees, et al., (2010)	Hurricane Katrina, New orleans & Baton Rouge, Louisiana, USA, 2005	Investigated temperament in infants whose mothers were exposed to Hurricame Katrina and its aftermath, and determined if high hurricane exposure is associated with difficult infant temperament.	Primary; 288 women; cohort study who giving birth in New Orleans and Baton Rouge between 2006 -2007; Questionnaires and interviews assessed the mother's experiences during the hurricane, living conditions, and psychological symptoms, 2 months and 12 months postpartum.	Logistic regression was used to examine the association between hurricane experience, mental health, and infant temperament.	Maternal mental health was associated with report of difficult infant temperament, with women more likely to report having a difficult infant temperament at 1year if they had screened positive for PTSD at 2 months. Large associations between maternal stress due to a natural disaster and infant temperament were not seen, but maternal mental health was associated with reporting difficult temperament.	

Table 2.1. *Description of Hurricane and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results	Theory
Zahran, et al., (2010)	Hurricane Andrew, Florida, 1992	Investigated the statistical relationship between maternal exposure to Hurricane Andrew and fetal distress risk.	Secondary; 1,097,409 observed births in Florida from 1991 to 199; Survey; National Center for Health Statistics (NCHS) Vital Statistics Natality Birth Data, 1991–1997	Logistic regression and spatial analytic techniques were used to model fetal distress risk as a function of maternal exposure to Hurricane Andrew	Fetal distress risk increased significantly with maternal exposure to Hurricane Andrew in second and third trimesters, adjusting for known risk factors. Distress risk also correlates with the destructive path of Hurricane Andrew, with higher incidences of fetal distress found in areas of highest exposure intensity. Hurricane exposed African-American mothers were more likely to birth distressed infants.	
Leyser-Whalen, et al., (2011)	Hurricane Ike, Upper Texas Gulf Coast, 2008	Examined whether Hurricane Ike created an environment that restricted access to birth control as self-reported by non-Hispanic white, non-Hispanic black, and Hispanic women who	Primary; Cross-sectional; 975 white, black, and Hispanic women; 16–24 years of age between August 2008 and July 2010 attending one of five publicly funded	Bivariate comparisons were performed using a chi-square test or Fisher's exact test as appropriate. Multivariable logistic regression was used to identify correlates of an inability to access contraceptives.	13% of women reported difficulties accessing contraception. Black women had more difficulty than their white and Hispanic counterparts. Lack of access to birth control was related to having a higher frequency of unprotected sex for women of all races.	

Table 2.1. *Description of Hurricane and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results	Theory
		received reproductive care at public clinics	reproductive health clinics; Surver	hurricane experience, and mental health resilience and perceived benefit	women who had a partner. A greater experience of the storm, particularly injury/illness or danger, was associated with lower resilience. Experiencing damage because of the storm was associated with increased report of some perceived benefits.	
Currie, & Rossin-Slater. (2013)	Hurricane in Texas, USA, from 1996 to 2008	Examined the effects of exposure to hurricanes during pregnancy	Secondary, Longitudinal; 4,237,494 single births; Texas birth records over 1996–2008, Texas Department of State Health Services; Survey	Frequency; Ordinary least squares (OLS).	Exposure to a hurricane during pregnancy increases the probability of abnormal conditions of the newborn such as being on a ventilator more than 30 min and meconium aspiration syndrome (MAS).	
Giarratano, et al., (2015)	Hurricane Katrina, New Orleans, Louisiana, USA, 2005	Examined the health of prenatal women who accessed the New Orleans Healthy Start	Primary; cross sectional; 402 women from prenatal clinics, Healthy Start, and hospital based	Frequency, Chi square test, and t tests were applied to examine	Women accessing Healthy Start were more socially "at risk"(younger, lower income, not living with a partner,	

Table 2.1. *Description of Hurricane and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results	Theory
		program to those women used traditional prenatal care (PNC) during long term recovery from the Hurricane Katrina disaster	prenatal classes in the greater New Orleans area (282 used only traditional PNC and 120 used nontraditional PNC); survey	differences between the subjects in the Healthy Start and traditional prenatal care models. Linear and logistic models were used to examine relationships with adjustment.	African American), lived through more hurricane trauma, and had a higher incidence of depression and post-traumatic stress disorder (PTSD) than women in traditional PNC. Women using Healthy Start reported more mental health counseling and prenatal education than did women in only traditional PNC.	
Harville, et al., (2015)	Hurricane Katrina, New Orleans, Louisiana, USA, 2005	Examined how the recovery following Hurricane Katrina affected pregnancy outcomes.	Primary; cross sectional; 308 pregnant women from 7 clinics; interview	Factor analysis and regression	Associations were found between experiencing damage during Katrina and birthweight and between injury and gestational age. Of the indicators of recovery experience, most consistently associated with worsened birth outcomes was worry that another hurricane would hit the region.	

Table 2.1. *Description of Hurricane and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results	Theory
Barcelona de Mendoza, et al., (2016)	Hurricane Katrina, New Orleans, Louisiana, USA, 2005	Determined if complementary and alternative medicine therapies are associated with mental health in post-disaster environments.	Primary; cross sectional; 402 pregnant women; interview	Logistic regression was used to adjust for income, race, education, parity, and age.	Mental illness symptoms were common - 30.7% had likely depression, 17.4% had anxiety, and 9.0% had posttraumatic stress). Massage was protective for depression, while use of aromatherapy and keeping a journal were associated with increased odds of depression. Aromatherapy was associated with symptoms of pregnancy-related anxiety.	
Grabich, et al., (2016)	Hurricane Charley, Florida, USA, 2004	Examined associations between maternal hurricane exposure and hazard of preterm delivery	Secondary; cross sectional; 342,942 singleton births; Florida Vital Statistics Records 2004–2005; Survey	Frequency; percentage; Wald heterogeneity test; confidence interval (95%)	Associations appeared greater for Hispanic mothers compared to non-Hispanic white mothers. Hurricane exposure did not appear to be associated with hazard of overall preterm delivery. Exposure to multiple hurricanes did not appear more harmful than exposure to a single hurricane.	

Table 2.1. *Description of Hurricane and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results	Theory
Grabich, (2015)	Hurricane Jeanne , Florida, USA, 2004	Examined the effects of hurricane Jeanne to pregnancy outcomes (live birth and fetal death)	Secondary; longitudinal; pregnant women; Vital Statistics Records of Florida between 2003 to 2005	A difference-in-differences model was used to assess the county-level association between hurricane exposure and birth rates. An individual-level analysis using time-to-event modeling was used to investigate hazard rates of single and multiple hurricane exposures on preterm delivery stratified by race/ethnicity.	In individual-level analysis, the study found evidence of association between hurricane exposure and increased hazard of extremely preterm delivery (<32 weeks gestation) but no association with overall preterm delivery (<37 weeks gestation).	

Table 2.2. *Description of Earthquake and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results
Chang et al., (2002)	Taiwan Earthquake, 1999	Psychiatric morbidity and perinatal outcome of the pregnancy in a disaster area of Taiwan	Primary; cross sectional; enrolled 171 women in a town near the epicenter; survey method; A Post-Earthquake Questionnaire, Chinese Health Questionnaire (CHQ-12) and post-traumatic stress disorder (PTSD) symptoms checklist were completed before delivery while the perinatal data were retrieved from hospital obstetrical records	t-test was used to assess the association between CHQ scores and variables including psychosocial factors, PTSD subscales, life events during the earth-quake, living condition, and subjective feeling toward influence of earthquake if appropriate. Variables found to be significant were put into a logistic regression model to disclose any independent prognostic factor of delivering a low birth weight neonate after adjusting maternal age, parity, and socioeconomic status.	Women with starvation experience, higher negative attitude scores about the influence of earthquake on pregnancy and more casualties among relatives were significantly correlated with high CHQ. Maternal history of abdominal injury, spouse casualty, and instability in living condition were significantly correlated with low birth weight.
Hibino, et al., (2009)	Peninsula earthquake, Japan, 2007	Health impact of stress on pregnant women living in an area affected by a major earthquake	Primary; panel study consisted of 99 women who provided responses before and after delivery; Pregnant women who received routine prenatal care at four hospitals	Pearson's correlation coefficient (r) was calculated to explore the relationship between dependent and independent variables. Multiple linear regression analysis was conducted against postnatal depression (EPDS) and stepwise multiple logistic regression was conducted against physical abnormality during pregnancy or childbirth.	The Sense of Coherence Scale (SOC) during pregnancy significantly moderated between 'existing anxiety about an earthquake' and 'EPDS' (b=-0.21, P=0.02). During pregnancy the EDPS was a significant predictor of a physical abnormality during pregnancy or child birth (odds ratio, 1.21; 95% confidence interval:1.04–1.41)

Table 2.2. *Description of Earthquake and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results
Hapsari, et al., (2009)	Yogyakarta earthquake, Indonesia	Examined access to contraception and change in contraceptive methods before and after the disaster and evaluated the prevalence of unplanned pregnancy.	Primary; 450 married women; Questionnaires, which included participants' background, contraceptive methods, difficulties in accessing contraceptive method, and unplanned pregnancy	Frequencies, percentages, means and standard deviations. Analysis of the difference between two proportions was used for comparison between groups. Confidence intervals (95%) were calculated.	Within 1 year of the disaster, the percentage of participants who used injections and implants tended to decrease, while the percentage of participants who used pills tended to increase. Use of coitus interrupt us significantly increased after the disaster. The prevalence of unplanned pregnancy was significantly higher in a group of participants who had difficulty accessing contraceptive methods compared to a group that did not.
Torche, & Kleinhaus, (2011)	Tarapaca earthquake, North Chile, 2005	Observed sex specific effect of stress on the duration of pregnancy and sex ratio among pregnant women exposed to a major earthquake in Chile	Secondary; longitudinal; Chilean birth certificates of 2004 to 2006 produced by the Chilean Ministry of health; over 200,000 births a year; survey	Regression models were used to measure the impact of earthquake exposure on gestational age and preterm birth by sex across month of gestation.	Earthquake exposure in Months 2 and 3 of gestation resulted in a significant decline in gestational age and increase in preterm delivery. Effects varied by sex, and were much larger for female than male pregnancies. Maternal exposure to an exogenous stressor early but not late in the pregnancy affects gestational age and the probability of preterm birth.

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Table 2.2. *Description of Earthquake and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results
Dong, et al., (2013)	Sichuan earthquake, China, 2008	Depression and its risk factors among pregnant women who disaster victims	Primary; cross sectional; 520 pregnant women (253 women from earthquake area and 267 from non-earthquake area); interviewed; Symptoms of antenatal depression were measured using the Edinburgh Postnatal Depression Scale (EPDS)	Chi-square tests and bivariate correlate analysis were performed so as to examine the correlation between outcome variable and independent variables and socio-demographic factors. Multivariate logistic regression was employed to identify predictors of and antenatal depression..	The prevalence rate of depression among pregnant women in the earthquake area was 34.5%, while the rate in the non-earthquake area was 39.6%. The perceived stresses associated with pregnancy and social support from husbands are significantly correlated with antenatal depression.
Xu, et al., (2014)	Sichuan earthquake, China, 2008	Assessed whether having a subsequent child had an effect on the mental health of Chinese mothers who lost a child during an earthquake	Primary; cross sectional; 397 women; structured interviews to assess sociodemographic characteristics, post-disaster experiences, and mental health. The interviews incorporated standardized psychometric measures of anxiety, depression, post-traumatic stress disorder (PTSD) and complicated grief (CG).	Groups with and without a subsequent child were calculated and statistically significant differences between the two groups were estimated by using the χ2 test. Logistic regression was used to investigate the association between the presence or absence of a subsequent child (with the presence of a subsequent child as the reference category) and mental health.	The prevalence of psychological symptoms was higher in mothers who did not have a child after losing the first one. Symptoms of anxiety and CG were significantly higher among the 116 women without a subsequent child than among the 110 mothers who had another child after bereavement. More than two thirds of the mothers with new infants had clinically important psychological symptoms.

Table 2.2. *Description of Earthquake and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results
Djafri, et al., (2015)	Sumatra earthquake, Indonesia, 2009	Examined the effect of the Sumatra earthquake on availability and accessibility of Reproductive Health services and its possible impact on local Millennium Development Goals (MDGs)	Primary; cross sectional; 667 women were interviewed from 26 health facilities	Frequencies, percentages, and confidence intervals (95%)	Antenatal and emergency obstetric care was minimally disrupted, and family planning practice of the study couples was not changed by the earthquake. The previous rate of improvement in maternal and child mortality was slowed down, whereas still births increased after the earthquake.
Harville & Do, (2016)	Haiti earthquake, Haiti, 2010	Examined the relationship between exposure to the 2010 Haiti earthquake and pregnancy wantedness, interpregnancy interval, and birth weight	Secondary; cross sectional; 7280 singleton births; Haiti 2012 Demographic and Health Survey,	F-tests were used to examine the statistical significance level of the variations in binary outcomes; t-tests were used to examine differences in the continuous outcome (birth weight). Multivariate logistic regressions were implemented to assess the influence of household and regional experience with the earthquake on the reproductive and birth outcomes	Earthquake exposure was associated with increased likelihood of a child being born too small: timing of birth, region, and house damage. Experience with the earthquake was associated with worse reproductive and birth outcomes.

Table 2.2. *Description of Earthquake and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results
Behrman & Weitzman, (2016)	Haiti earthquake, Haiti, 2010	Explored the effects of the 2010 Haiti earthquake on women's reproductive health	Secondary; longitudinal; women aged 15–49; 2005 and 2012 Haiti Demographic and Health Survey (DHS) in Haiti; included information about fertility history, fertility preferences, contraceptive use, contraceptive access, prenatal care, and child mortality.	A difference-in-difference (DID) analysis was used to assess the effects of the earthquake on reproductive health outcomes. Estimated the DID by running an OLS regression of reproductive health outcomes on a time period indicator.	Heightened earthquake intensity reduced use of injectable - the most widely used modern contraceptive method in Haiti and increased current pregnancy and current unwanted pregnancy. Severe earthquake intensity significantly increased women's unmet need for family planning and reduced their access to condoms.
Sugawara, et al., (2016)	East Japan Earthquake, Japan, 2011	Examined the damages to maternity institutions, evacuation status, and transport of pregnant women, and prehospital child births due to earthquake	Secondary; longitudinal; Survey on Disaster Damages of Maternity Institutions; Surveys on Evacuation Status of Pregnant Women; Surveys on Prehospital Childbirths; 50 maternity institutions and 12 fire departments in Miyagi; interviewed to know about pregnant women status	Frequencies and percentages	In the acute phase of the tsunami disaster, maternity institutions were damaged severely and perinatal transport was not possible; as a result, pregnant women inevitably gave birth in unplanned institutions, and the number of prehospital births was increased extremely.

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Table 2.3. *Description of Flood and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results
Tong, et al., (2011)	Red River flood, North Dakota, USA, 1997	Documented changes in birth rates, birth outcomes, and pregnancy risk factors among North Dakota women who gave birth before and after the Red River disaster	Secondary; 57,007 birth files of North Dakota from 1994 to 2000 (pre-disaster 1994–1996 and post-disaster 1997–2000); survey	Logistic regression was conducted to examine associations between the disaster and low birth weight and preterm birth	The crude birth rate and direct adjusted fertility rate decreased significantly after the disaster. Following the flood, there was an increase in medical risks, low birth weight, and preterm delivery among women giving birth in North Dakota. Further research that examines birth outcomes of women following a catastrophic disaster is warranted.
Sanguanklin, et al., (2014)	Thailand flood, Thailand, 2011	Determined the effects of displacement due to flooding during pregnancy on birth outcomes (infant birth weight and gestational age) and the moderating effect of	Primary; longitudinal; 175 pregnant women; university affiliated hospital; questionnaire	Chi-squared tests and multiple linear regression analyses were performed to determine the effect of displacement on infant birth weight and gestational age. Hierarchical multiple linear regression analyses were performed to determine the moderating effect of perceived social support on the relationship between	Seventy percent of the participants experienced displacement during the flood. The displaced women had a mean infant birth weight of 175 grams less than that of the non-displaced women. Displacement and other variables explained

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Table 2.3. *Description of Flood and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results
		perceived social support on the relationship between displacement and birth outcomes		displacement and infant birth weight.	approximately 8% of the variance in infant birth weight. The interaction term between displacement and perceived social support was statistically significant.
Brock, et al., (2015)	Iowa flood, USA, 2008	Examined the impact of floods on perinatal maternal depression and well-being.	Primary; cross sectional; 269 women; survey; completed measures of depressive symptoms and general well-being at 5 time points from pregnancy to 30 months postpartum.	Regression analysis was applied to estimate the univariate association between the predictor (IF100) and the mediator (PDI). Next examined the simultaneous effects of the predictor and mediator on each outcome.	Flood related peritraumatic distress was uniquely associated with greater depression and was a key mechanism through which flood exposure led to depression. Prenatal flood exposure was also associated with general well-being; however, a mechanism other than peritraumatic distress appears to have been responsible for the effect of flood exposure on well-being.

Table 2.3. *Description of Flood and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results
Hilmert, et al., (2016)	Red River flood, North Dakota, USA, 2009	Examined the impact of experiencing a major flood during pregnancy on fetal growth and length of gestation	Primary; cross sectional; 169 intrauterine pregnant women (at least 18 years old); study carried out for 3 months immediately after the historic 2009 crest of the Red River in Fargo, North Dakota; Survey	Frequency; percentage; mean; standard deviation; regression	For pregnancies earlier in gestation during the crest birth weight decreased as distance from flooding decreased. For pregnancies later in gestation at crest, distance was not associated with birth weight. Length of gestation was not associated with distance from or the timing of the flood. Pregnant women in the first trimester who experience a major flood near their homes are at risk of having lower birth weight neonates due to a reduction in fetal growth.
Simcock, et al., (2017)	Queensland Flood, Australia, 2011	Examined the effects of flood related stress in pregnancy on 6 month olds' neurodevelopment and the moderating effects of timing of the stressor in gestation and infant sex on these outcomes.	Primary; cross sectional; 115 women exposed to the 2011 Queensland floods in pregnancy; survey	Frequencies; mean, standard deviation; regression	Subjective flood stress in pregnancy had significantly different effects in boys and girls, and that at high levels of stress girls had significantly lower problem solving scores than boys. Timing of the flood later in pregnancy predicted lower personal social scores in the sample, and there was a trend (p < .10) for greater objective flood exposure to predict lower scores. prenatal maternal stress (PNMS) had no effect on infants' communication skills.

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Table 2.4. *Description of Storm and Women's Reproductive Health Studies*

Author	Disaster Name, Place, & Year	Study Area	Data Collection Method & Source	Statistical Analysis	Results
Dancause, et al., (2011)	Ice Storm; St. Lawrence River Velley, Canada, 1998	Disaster related prenatal maternal stress influences birth outcomes	Primary; cross sectional; 172 mothers of singleton newborns; mailed from the doctor's office; questionnaire	Z test; Regression	Gestation lengths and predicted birth weights were shorter among participants exposed to the ice storm during early to mid-pregnancy. Birth lengths were shorter in the sample compared to population references, and predicted values were shorter among participants with a "discrepancy" between their objective and subjective prenatal maternal stress (PNMS) levels.
Zilversmit, et al., (2014)	Arkansas Storm, USA, 2009	Examined associations between sociodemographic characteristics and disaster experience and the presence of an emergency plan.	Primary; cross sectional;1,173 women; survey	Multivariable logistic regression was conducted to examine associations between maternal race/ethnicity, sociodemographic characteristics, region of residence, disaster experience, and having a disaster plan.	48% of women reported having an emergency plan. Hispanic women were less likely to report having a plan compared with non-Hispanic White women. Families with five or more members were more likely to have a plan compared with smaller families.

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BIOGRAPHICAL INFORMATION

Shamsun Nahar completed her Ph.D. in Social Work in 2019 and received her Master of Social Work (MSW) in 2014 from the University of Texas at Arlington (UTA). She received her Master of Social Science (MSS) and Bachelor of Social Science (BSS) in Sociology from the University of Dhaka, Bangladesh. Her research lies at the intersection of health equity among women and disaster social work. Her research focuses on promoting women's health rights and gender equality among critically disadvantaged and underrepresented women, such as disaster affected women, homeless women, and gender discriminated women. Over the course of her Ph.D. career, Shamsun has gained qualitative and quantitative research skills through her work as principal investigator, co-investigator, and graduate research assistant. As an Adjunct Professor at UTA, she has taught a variety of courses both online and face-to-face including Introduction to Social Work, Social Work Research Method, Social Work Policy, Diverse Populations, Foundation Field Practice, and Applied Social Work Practice. Her devotion to social work derives from her work experience with diversified populations. Her professional background encompasses work experiences in the areas of sexual and reproductive health, community development, and intimate partner violence in national and international settings. Her career goal is to promote social, economic, and environmental justice; improve the quality and effectiveness of social programs and services; and infuse a multicultural perspective as a dedicated teacher, a productive researcher, and an engaged social worker in the community.